1862

Natural History of the Echinoderm Zoophytes: A Translation of *Histoire Naturelle de Zoophytes Échinodermes*

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HISTOIRE NATURELLE

DES

ZOOPHYTES

ÉCHINODERMES

COMPRENANT

LA DESCRIPTION DES CRINOÏDES, DES OPHIURIDES, DES ASTÉRIDES, DES ÉCHINIDES ET DES HOLOTHURIDES;

PAR

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PROFESSEUR DE ZOOLOGIE, DOYEN DE LA FACULTÉ DES SCIENCES DE RENNES,

ET PAR

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OUVRAGE ACCOMPAGNÉ DE PLANCHES.

PARIS

A LA LIBRAIRIE ENCYCLOPÉDIQUE DE RORET,

RUE HAUTEFEUILLE, 12.

1862.

NATURAL HISTORY

OF THE

ECHINODERM
ZOOPHYTES

CONTAINING

THE DESCRIPTION OF THE CRINOIDS, OPHIUROIDS, ASTEROIDS,

ECHINOIDS AND HOLOTHUROIDS.

BY

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AND BY

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WORK ACCOMPANIED BY PLATES.

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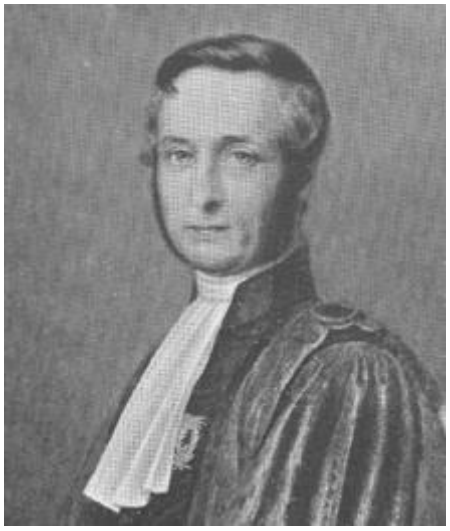

Felix Dujardin, 1847

Félix Dujardin (5 April 1801 – 8 April 1860) was born in Tours. Dujardin was appointed to the chair of geology and mineralogy on the faculty of sciences at the University of Toulouse (1839) and professor of botany and zoology and dean of the faculty of sciences at the University of Rennes (1840). Dujardin was largely self-taught, the son of a watchmaker. He was an accomplished microscopist and in 1834 proposed a new group of one-celled organisms he called Rhizopoda.

Louis Hippolyte Hupé (14 March 1819 — 22 February1867 was born and died in Paris). He was an assistant naturalist at the National Museum of Natural History. He wrote the malacological part of Francis de Castelnau's journey.

Translator's Notes.

"M. Michelin a établi ce genre avec le *Spatangus atropos* auct.," "Auct." is the abbreviation of the Latin word "auctor" that means "author". (Michelin established this genus with the *Spatangus atropos* of authors.) Authors meaning individuals who had referred to *S. atropos*.)

"La méthode" is frequently used. E. g., "La position de ce genre dans la méthode a varié à plusieurs reprises." (The position of this genus in the method has varied several times.). "La méthode" refers to the systematic classification used in the 19th century.

In citations, "apud" is frequently used. Apud" is a Latin word used in citations indicating the material can be found in the works of the author listed after "apud." E.g., "Leske apud Klein." I have translated this as "Leske in Klein."

Sometimes there are gaps in numbering in the lists of genera and species. Misnumbering?

Plates
Plate I is not in focus.
Plates III, IV, VIII are missing.

"Vacuoles" is used as a synonym of "lunules". E.g., "Lunules ou vacuoles au nombre de six." (There were six lunules or vacuoles.)

Echinoid spines:
"Tous ces tubercules sont destinés à servir de support à des organes auxquels on a donné les noms d'*épines*, de *baguettes*, *piquants* ou *radioles*." (All these tubercles support organs to which we have given the names spines, sticks, spines or spines.) Radioles is often used as the category. "Grande espèce à radioles en forme de piquants allongés," ("Large species with elongated spines."). "Les radioles, en forme de baguettes, …" (Spines in the form of sticks…) "Radioles formés de gros batons". (Spines formed of large rods.)

The word "échinulés" means "spiny". This makes some sentences awkward. E.g., "chaque plaque latérale porte sept piquants échinulés." (Each lateral plate has seven spiny spines.). I have translated "piquants échinulés" as "bristly spines".

"Tribulo" is used. "*Cidaris tribuloides*". Tribulo is a Latin word meaning caltrop, a type of spiked object placed on the ground as a defensive weapon or obstacle.

"Verrues" is used. Regarding *Cidaris drogiaca*. "Aires ambulacraires étroites, portant seulement deux rangées de granules avec quelques très-petites verrues au milieu." (Ambulacral areas narrow with only two rows of granules with some very small warts in the middle.) "Verrues" are a type of protrusion that appear as warts.

“Angle rentrant interbrachial” (interbrachial re-entrant angle) is used. E.g. Regarding *Astropecten hystrix.* “Les deux plaques de l'angle rentrant interbrachial …” (The two plates of the interbrachial re-entrant angle…) A re-entrant angle is an interior angle of a polygon that is greater than 180 degrees. It is an angle with its point turning back into the figure rather than out from it In French, “angle” means either “angle” in a mathematical sense or “corner” in a physical sense. Here, “angle” is the appropriate translation.

“Pièces porales” is used with blastoids. These are the ambulacral side plates. E.g. for *Pentatremitioidea paillettti*, “lls sont composés de grandes pièces porales, au nombre de dix environ dans chaque rangée, et de pièces porales supplémentaires qui se détachent facilement.” (They are composed of large ambulacral side plates, approximately ten in each row, and outer side plates that detach easily.)

”Ergot” is an obsolete word. It is used here for the cirri of comatulids. E. g., “15 à 20 cirrhes dorsaux de 15 à 25 articles, dont les 15 à 17 derniers portent un crochet pointu en forme d’ergot.” (15 to 20 dorsal cirri of 15 to 25 articles, of which the last 15 to 17 have a pointed hook in the form of a spur.) The word "ergot" does not mean "spur" in modern English. It refers to a parasitic fungus (*Claviceps purpurea*) that infects cereal grains like rye and has the shape of a spur. It has its roots in a word that refers to a spur. Ergot comes from the earlier French word "argot," which means "spur on a rooster".

“Musée de Paris” is used 15 times, “Muséum d'histoire naturelle de Paris”, 7 times, and “Muséum d'histoire naturelle”, 1 time. All refer to the Muséum national d'histoire naturelle.

“Id.” is used is in lists of citations. "Id." stands for "Ibidem," which is Latin for "the same place" or "the same work." It is used in academic citations to indicate that the next item refers to the immediately preceding entry. E. g. “C. Paultrei, (Sp.) Cotteau. Du Néocomien de St.-Sauveur. — C. Robinaldinus, (Sp.) Cotteau. Id., id.” "Id." means that the geological formation (e.g., "Du Néocomien de St.-Sauveur") is the same as the previous one. "Id., id." means that both the geological formation and the location (e.g., "St.-Sauveur") are the same as the previous one.

“(Sp.)” is often used after a species’ or genus’ name. This may indicate the species or genus was moved from the original species or genus to another species or genus. E. g., p. 272:

“14^{e} Genre. Ophiacanthe. OPHIACANTHA. — Müller et Troschel.
Asterias (sp.), RETZIUS. - *Ophiura* (sp.), GRUBE. — MÜLLER ET TROSCHEL, Syst. der Aster., p. 106.”

I translated the common name epithet. It does not always correspond to the species’ name epithet and may be obsolete..

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CLASS

OF

ECHINODERMS.

FIRST BOOK.

GENERALITIES

DEFINITION.

Marine animals, free-living or fixed by an articulated stalk or completely sessile. — radiate, i.e., have a more or less regular arrangement of all their parts, following the rays (ordinarily five in number) of a circle or of a star. But having at the same time a tendency for bilateral symmetry. — Of globular form, or oval, or cylindrical, or discoidal, or in a pentagonal plate, or in a star with more or less elongated branches and simple or ramified or pinnate. — producing, either in all their tissues or only in the integument, of symmetrical calcareous pieces, ordinarily very numerous, that sometimes form an internal skeleton or a regular test, and that have the same internal structure: a reticulated structure crossed in every direction by a mail or irregular lacunae, rounded, very small, whose intervals are formed of rhomboidal carbonated chalk, having everywhere its crystallization axis is perpendicular to the surface of the body. As a result, by fossilization, all the lacunae are filled by the same substance that transforms them into a continuous mass of *calcareous spar* with the same axis of crystallization without the exterior form being changed. — Having an integument more or less consistent, often covered with cilia, often also pierced with holes with retractile tubes (feet or gills, or tentacles, and that can have in addition appendage of several kinds (articulated spines, scales, tentacles or pedicellariae). — Always having internal or external respiratory organs, and a rudimentary nervous system. — Ordinarily having the ability to regenerate their mutilated parts. — Having distinct sexes, ordinarily separate and reproducing by eggs whose embryo undergoes metamorphosis such that sometimes the Echinoderm appears to be simply a fruiting organ detached from a certain living part, as some medusae are the fruiting organ of a hydroid polyp. (Likewise, some fossil types appear to be multiplied by gemmation.)

Review

Echinoderms, very common on all the shores of the Mediterranean, and of which several (Urchins, Holothurians) serve a food for man, have at all times attracted the attention of fishermen. Aristotle among the Greeks, like Pliny after him, tells us about urchins or hedgehogs of the sea (εχινοζ, *echinus*), Sea Stars and Holothurians, although under the latter name they also contain marine animals that are not echinoderms. In the latter half of the sixteenth century and in the seventeenth, Rondelet (1554), Gesner (1569), Aldrovande (1599–1640) and Fabius Columna (1626) spoke of these animals and described some. The latter of these authors, in particular, after the language of the fishermen, described, under the name of *pudendum regale*, one of the Holothurians of the Mediterranean. Collections and museums had begun to form, and during the first half of the eighteenth century appeared successively the publications of Lhwyd or Luidius (1699), Petiver (1702), Rumph (1705), Breyn (1732), Linck (1734), Klein (1734), Seba (1734–1765), Plancus or Bianchi (1739–1743), Bourguet (1742), Gualtieri (1742), Scilla, Dargenville (1742), etc., and described, either in particular or among other shells or marine productions, a large number of urchin and Sea Stars of the coasts of Europe and especially inter-tropical regions. At the same time also, several of these authors, struck by the resemblance of some petrifications with living urchins, had also begun to describe fossil species.

Until then, although the name *Echinodermata* was already found in Klein, who had even tried to make a classification of (*Naturalis dispositio*) of these animals, although this author as well as Breyn, Linck, Seba and Gualtieri had designated the various forms of Urchins by names that have been adopted (recently as generic names. Until then, we say, there did not exist a methodical classification for Echinoderms in general. The Holothurians and Crinoids were scarcely known. Urchins were placed among the multivalve shells.

Linné, the great legislator of natural history, then in the twelve successive editions of his *Systema naturæ* (1735–1766), inscribed our animals in his sixth class, that of Vers, placing the Urchins, *Echinus*, and the Sea Stars, *Asterias*, among the Vers testacés, with the Molluscs with shells, and the Holothurians among the Vers mollusques. Under the influence or inspiration of this great naturalist, works multiplied and Bohadsh (1761), Gunner (1767), Pallas (1767–1780), Guettard (1767–1783), Van Phelsum (1774), Forskal (1775–1776), Pennant (1776–1777), O.-F. Müller (1776–1789), Leske, a follower of Klein (1778), Diquemare (1778), O. Fabricius (1780), etc., published numerous descriptions that permitted Gmelin to inscribe in the 13° edition of the *Systema naturæ* of Linné (1788), more than one hundred species still distributed in the three genera of *Echinus, Asterias* and *Holothuria* of the Class of Vers. It was only in 1789 that Bruguières, in the *Encyclopédie méthodique*, where he had reproduced all the figures given by the preceding authors, established the class of Echinoderms. (εχινοζ, δερμα skin) for the two genera Urchin (*Echinus*) and Asteroid (*Asterias*) in leaving the Holothurians among the Vers Mollusca. Finally, Lamarck, in his *Système des Animaux sans vertébres* (1801), and more completely in his *Histoire des Animaux sans vertébres* (1815–1816), established the order of *Radiaires échinodermes*, that made part of his class of *Radiaires*, the third of his classification that began with the Infusoiria and the Polyps. The remainder of the class of Radiaires, under

the name of Radiaires mollasses, contains the Medusas and the other Acalephes, and his order of Radiaires échinodermes itself is divided into three families or sections: 1° *Stellérides* (Comatule, Euryale, Ophiure, Astérie), 2° *Echinoids*, 3° *Fistulides*, among which it incorrectly contains Actinies, which are Polypes or Anthozoaires, and Siponcles, which are Vers of the order Géphyriens. Also at the same time, Lamarck, fooled by their general aspect, had left Pentacrinids among the Polyps. These three families, for Lamarck, contained 19 genera, of which 16 were true Echinoderms.

Cuvier, the following year, published his *Régne animal*, in which he places the Echinoderms, as a distinct class, at the head of his fourth branch, that of Zoophytes or Animaux rayonnés. He then divides them into two orders, *Pédicellés* and *Echinodermes sans pieds*, the latter containing Siponcles as the single genus *Molpadie* that can be left with the Echinoderms. In his first order, Cuvier accepted as sub-genera the two Linnéen genera, Astérie and Oursin (*Echinus*), all genera of Lamarck. He has for the third genus *Holothuries*, which he does not distinguish Fistulaires of Lamarck. He correctly makes a fourth principal genus between the Asteroids and Oursins, Encrinids (Crinoids) that he compared to Euryalids, and later (1830) to Comatulids supported on a stalk.

At the same time or even a little earlier, Tiedemann, for his response to the to the prize program proposed by the Académie des Sciences de Paris, had published (1816) his beautiful work on the anatomy of the three principal types (Asteroid, Oursin and Holothurian) of Echinoderms. But Cuvier himself, in his lessons on comparative anatomy (1802–1805), had already treated in part these same questions. Konrad and Meckel (1814), each on his own, had also studied the structure of Asteroids. In the time after 1789, several descriptive works had been published, notably by Montague (1803) on the species living on the coasts of England, Parkinson (1804-1811, *Organic remains*) on fossils, Abildgaard (1806), to continue *Zoologia Danica* of O. F. Müller, and Leach (1817, *Zoological miscellany*). The study of fossils, which had already produced so much was continued by Schlotheim (1820–1822), and Defrance (1815–1830), in the *Dictionnaire des sciences naturelles*, which were enriched at the same time by articles by de Blainville that would later form the basis of the treatise on Actinologie (1834) by this author. Say (1820), in America, published fossil Echinoderms (*Pentremites*). Chamisso and Eysenhardt in Germany, as well as Otto (1821), also published new descriptions and, and Miller in England (1821) gave the first classification of fossil Crinoids already containing 9 genera and 24 species. Cuvier and Brongniart, in the geological description of the environs of Paris (1822), Mantell (1822–1827), Phillips (1829), Desmoulins (1831), Münster and especially Goldfuss (1825–1832), and several other scholarly authors, increased considerably the number of fossil species and, on the other hand, Delle Chiaje (1823–1825), in his great work on the animals without vertebrae of the Two Sicilies, made a remarkable contribution to the knowledge of the structure of Echinoderms, while new living species were described by Quoy and Gaimard (1824), Risso (1826), Lesson (1828–1832), Fleming (1828), Ed. Gray (1828), Jaeger (1833).

In 1834, in his *Manuel d'Actinologie*, Blainville summarized all that had been done before him and all that his own investigations had taught him about Echinoderms, which were then classified more methodically. He made three orders like his predecessors, but he divided each of the orders into families and more numerous genera. Thus, the order STELLÉRIDES formed for him three families corresponding to the Astéries (*Astérides*), the Ophiures (*Astérophides*) and the Crinoids (*Astérencriniens*). The order of ECHINOIDS forms

three families sub-divided into 17 genera. The order of HOLOTHUROIDS, without Siponcles that Blainville classes among the Vers, contains only a single family divided into five genera.

The following year (1835), Brandt published a work on classification and description that we shall return to when we consider Holothurians, as well as the works of Nardo (1834) on the subject of Asteroids and the works of Ch. Desmoulins (1835–37), Ed. Gray (1835), and Gratteloup (1836) on the subject of Echinoids. But a more important work, because of its consequences, was that of Agassiz (Prodrome d'une classification des Echinodermes, Mém. Soc. sc. nat. de Neufchâtel, 1836). These are still the same three orders divided, the first into three families, *Astéries, Ophiures* and *Crinoids*, the second also into three families: *Spatangues, Clypéastres* and *Cidarites*. The third contains only the family of Holothurians divided into 11 genera, which are those of Jaeger. The family of Astéries contains 9 genera; that of Ophiures, 7; that of Crinoides, 5, in addition to the fossils previously established; finally, the three families of Echinoids containing 29 in all.

The same author also published, after 1838, other works on the Echinoderms and began the publication of his monographs. We have also from Johnston (1838), Phillips, Murchison, Munster, Roemer, Bronn, Zenker, d'Eichwald, etc. (1839–40), new descriptions of fossil genera and new species. Sharpey gave (In *The Cyclopædia of anat. and physiol*. 1839), a very remarkable article on the anatomy of these animals.

We ourselves, in 1840, in the annotations of the 3rd volume of the 2nd edition of the animals without vertebrae of Lamarck, tried to present a summary of what had been done until then. We increased the number of described species in this work from 214 to 263, without counting the fixed Crinoids that are described in the 2nd volume.

In 1841, de Quatrefages published his beautiful Monographie de la Synapte. Ed. Forbes, in his History of British Asteroids, divided the 55 species of Echinoderms that he had observed, 1° into *Pinnigrades* (Crinoids), *Comatula rosea*; 2° *Spinigrades*, Ophiures, 12 in number, and *Astrophyton* or *Euryale*; 3° *Cirrigrades* or Astérides, containing 8 genera and 14 species; 4° *Cirrhispinigrades* or Echinoids, containing 7 genera and 12 species; 5° *Cirrhivermigrades* or Holoothuroids, containing 6 genera and 15 species. A sixth division, Vermigrades, contained the Siponcles and Echiures, which today we regard as Vers.

J. Müller, who, later, was to bring great light to the history of development of Echinoderms, had begun in 1840 his publications, first in common with Troschel on the Asteroids and Ophiroids, then alone on *Pentacrinus*, Comatulids (1841) and on Crinoids in general.

On the other hand, Sars, who after 1825, published very curious observations on Zoophytes or radials from the coasts of Norway, had published in 1837 important facts on the development of *Asterias sanguinolenta* (*Echinaster*). He treats the same subject again in a more interesting way in 1844. It was in the following year (1845) that the celebrated geologist Léopold de Buch published his work on the *Cystidés*, intended to shed new light on the Crinoids, whose species and genera were multiplying in a surprising way by the works of Bronn, Goldfuss (1838), Hisinger, Meyer (1837), Zenker (1839), D'Orbigny, who published in 1839 a very nice Monograph, Eichwald (1840), Austin (1842–1843), Volborth (1842–1846), of Mac Coy (1844), Roemer (1844–1851), Hagenow (1846), and many other authors that we shall have the reason to cite later, and especially Ed. Forbes, who published in 1848 a valuable Monograph of British Cystidés in the memoirs of the

Geolog. Survey, that he had previously enriched with no less valuable works on the other fossil Echinoderms.

Returning to general classification, we have to mention again Agassiz, who published in the *Comptes Rendus de l'Académie des sciences* in 1846, a summary of the work on the classification of Echinoderms and who, after this same summary was published in the *Annales des Sciences naturelles* (1846–1847), published with Desor a Catalogue raisonné des *Echinoids*, divided into four families and 93 genera, and containing the listing of 323 living species and a larger number of fossils. These numbers have further increased for the Echinoids as for the other orders, either in the *Prodrome* (1850) and the *Cours élémentaire de Paléontologie* (1852) of D'Orbigny, or in the *Traité &e Paléontologie* of Pictet (1857), or in the last edition of *Lethaea geognostica* of Bronn and Roemer, or in many other publications. We can even estimate the number of already known living species as 700 and the number of fossil species as 700 or 800. We cannot leave this subject without considering the *Zoologie médicale* of Gervais and Van Beneden (1859), who consider the Echinoderms no longer as a class, but as a group of a higher order, susceptible of dividing itself into three classes: 1° *Echinoids*, containing four families; 2° *Stellérides*, forming two orders, Astéries and Encrines, subdivided into families (Astéridés, Euryalidés, Ophiuridés, Comatulidés, Eucrinidés, Cystocrinidés); 3° *Holothuries*, containing only two families of Holothuridés and Synaptidés.

A no less important question, that of embryology and metamorphosis, has specially made immense progress for 14 or 15 years, thanks to the zealous perseverance of the famous and regretted J. Müller (1846–1852). Even before, as we said above, Sars (1835-1844) had made on Asteroids, curious observations that were confirmed by Koren and Danielsen in 1847. The same year, Dufossé and Derbès each made on the development of Urchins, some observations similar to those that, the preceding year, Baer had published at Saint Petersburg, and to those that J. Müller, also in 1846, had published at Berlin to continue them and ultimately complete them. Krohn, who had already in 1841 corrected our knowledge on the nervous system of Echinoderms, also worked with success on their embryogenesis and, after his nice memoir on the development of the larva of urchins (1849), has continued to collect new facts on their development in other orders.

The similarity of the composition of the various types of Echinoderms, or the unity of type, has also occupied several eminent naturalists and, in addition, of ideas suggested by Blainville in 1822 and by Agassiz in the work we cited above (1846). It is necessary to report first a good memoir by Duvernoy (1848) in the *Mémoires de l'Académie des sciences*, t. XX. Then we shall report also the work of Gaudry, on the skeleton of Echinoderms in the Annales des Sciences naturelles, 1851, and finally, the great work of J. Müller, *Ueber die Bau der Echinodermen*, in the *Mémoires de l'Académie de Berl*in (1854) for the year 1853.

To end this review, it is necessary to say also that the 2nd edition of the *Anatomie* of Cuvier had been brought up to date and that the *Manuel d''Anatomie comparée* of Siebold and Stannius was, at the time of its publication, the most complete summary on the same subject[1].

[1] Available from the Librairie Encyclopédique of Roret.

THE FORM OF ECHINODERMS.

Seeing the very varied forms of Echinoderms, we can ask if they really can be referred to a single type and what is this type? The question, very simple if it concerns only the variations observed in particular in each of the four principal orders of living Echinoderms (Ophiuroids, Asteroids, Holothuroids), still does appear insoluble if one only has to compare these four orders together. Perhaps even, from one to the other, we can refer to this common type Comatulids and those of fossil and living Crinoids that are closest to it. But if the other Crinoids, those of the most ancient fossiliferous terrains, should also be referred to this common type, then the difficulty becomes extreme.

This ideal type, in fact, will lose successively all its attributes and it will become completely elusive unless we start from this principle, that the Echinoderms, and particularly those of the most ancient layers of the globe have preserved the remains, may not be complete animals, but a part of an animal, an organ of reproduction, susceptible to respire, to live by itself for some time, without a digestive system, and consequently without mouth and without anus. These are, in this regard, comparable to some Medusae (Rhizostomes) that are produced by a hydroid polyp like other Medusae provided with a digestive system (Aurélies, Océanies, etc.), and that are no less reproductive or oviparous bud of a polyp. This character of an oviferous bud and with digestive organs is observed moreover also in Urchins and Asteroids that are produced from a larva much larger than the definitive embryo and is largely abandoned by this embryo when it acquires a determined form and its own organs. Some, moreover, of the Echinoderms (Crinoids) supposed to be without a mouth, must have been produced manifestly in the state of a pedicellate bud, from a radiating stub spread out on the rocks of the bottom of the sea, like the stub of large fucus (*Laminaria*) and although it can be accepted, like these fucus, that they are first nourished only by absorption, we shall see later that Urchins and Asteroids, independently of their digestive system, are provided externally with multiple special organs of nutrition, the pedicellaria. We can thus accept that these similar organs are distributed on the surface of ancient Echinoderms, there especially where this surface is covered with granules similar to those that support the pedicellaria of Echinoids.

If one accepts this similarity of Medusae produced by a polyp like reproductive buds, and Echinoderms with a calcareous or rather calciferous test, it will not be more difficult to conceive the parallelism between these two kinds of animal organisms as the parallelism between ordinary algae and calciferous algae (Corallines, Millepores). In one case as in the other, it is the same tissue of the living organism that separates or secretes the carbonate of chalk brought by the ambient liquid in the state of sulfate or chloride. Here, the carbonate of chalk is not molded in a special organ but deposed with its permanent crystalline structure in the mail or lacunae of the living tissue. It necessarily results for all calcareous parts of Echinoderms (except the teeth of Urchins and the hooks of Synaptids) a uniform lacunar or reticulated structure, and when these parts undergo the effect of fossilization, it also results that all the lacunae are formed of limestone, the crystalline form, already easy to see by the polarization in the reticulated tissue of the living animal, continues the same in all the mass that has become homogenous. From this comes the spathic break, so regular and so special that makes recognizable until now the smallest fragments of fossil Echinoderms, as the reticulated or lacunar structure of the solid pieces, lamellae or spines

of a living Echinoderm makes them equally recognizable. There is thus a general character, and it is even one of those that is never missing. Not even in Synaptids, that support their hooks with lacunar plates in their integument, not even in larvae and embryos that show, from the first days, in the interior, very thin calcareous stalks with lateral branches that are the beginning of a calcareous network. Another, no less general character, is the presence of cilia either on all the surface or on some external or internal organs, or in the interior of these organs. This character, that is in common with Molluscs, Acalephs, anthozoan Polyps and some orders of Vers, separates them, on the contrary, from Articulates.

A much more striking character, although less general is the radiate disposition of the parts of the body and he organs or appendages around an axis and most ordinarily quinary (the number 5). But on one hand, even where this radiate disposition is most regular, as in the Asteroids and the Urchins, we find an indication of a bilaterally symmetrical arrangement. This latter mode of arrangement of parts tends to predominate in the Holothurians and Spatangoids, for example, to the point of nearly completely hiding the radiate disposition. On the other hand, the number five that, at first glance, seems to distinguish Echinoderms from Medusae, in which the number four and its multiples dominate, this number five, we say, does not have an absolute value. Except for deviations or anomalies that some Asteroids show us having four or six arms instead of five. There are Asteroids, like *Solaster, Echinites* and some *Asteracanthion*, that normally have 15, 20 and up to 36 rays. Among the Crinoids, some groups always have a ternary disposition or following multiples of three (*Caryocrinus, Hemicosmites*); and some Cystidids, on the contrary, appear subjected to a form of division by two or four. Finally, among the Holothurians, those, like Synapatids, that have only the radiate disposition often have twelve tentacles.

This more or less regular arrangement of the parts of the body is shown exteriorly by the arrangement of the contiguous or fused pieces that form the test of Echinoids, Crinoids, and *Goniodiscus* among the Asteroids, although the test is covered in life by a soft integument in the thickness of which it is produced. It also has a ciliated epithelium. However, these calcareous pieces, instead of being contiguous near the surface, are disseminated in the thickness of the integument, as in most Asteroids. There are sometimes thin lamellae, pierced with holes in the integument of Holothuroids. These pieces, located deeper, make a kind of interior skeleton in Ophiuroids, Asteroids and in the arms of some Crinoids.

AMBULACRA AND FEET OF ECHINODERMS AND TENTACLES.

Some rows or multiple series of solid pieces thus regularly disposed in the rays of a circle or a star, are pierced by holes from which leave feet that are tubular, retractile, ordinarily ended by a sucker. These are rows called *ambulacra*, after some resemblance to walkway of a garden or avenue (*ambulacrum*). These ambulacra, that do not exist in some Crinoids and Holothuroids, can be more or less wide, and their ambulacral areas or segments can form a very narrow band between the interambulacral areas that separate them, or sometimes widened to the point of exceeding the width of the interambulacral areas, or even making them disappear entirely, in which case the Echinoderm is everywhere provided with pores for the exit of feet, as in some Holothuroids. The ambulacra can moreover, without changing character, extend from on pole to the other in spheroidal

Urchins, and from one end to the other in cylindrical or fusiform Holothuroids, or even extend only to the end of the ray on the ventral surface of Asteroids.

In spheroidal Urchins, Asteroids and on the ventral surface of some Holothuroids, all the ambulacral holes have ambulatory tube feet with terminal suckers. The ambulacra of depressed Urchins, in which a bilaterally symmetrical arrangement predominates, are dissimilar, either between themselves or in the various parts of their length. They have ventrally ambulatory feet and, on the contrary, in the upper or dorsal region, feet although leaving the ambulacra in the same way are exclusively for respiration. Similar respiratory ambulacra can be found in some Crinoids and Ophiuroids. There are, moreover, also feet converted into respiratory organs that we see leave the holes of dorsal ambulacra of some Holothuroids. And Asteroids, in general, have similar respiratory organs leaving holes scattered on the dorsal surface always lacking ambulacra.

Other respiratory organs can also be seen on the exterior. These are ramose cutaneous gills, located at a certain distance around the mouth of Urchins and the tentacles that are hollow, branched or pinnate tentacles that immediately surround the mouth of Holothuroids and that can be completely retracted into the buccal cavity.

EXTERNAL APPENDAGES OF ECHINODERMS, SPINES AND PEDICELLARIAE.

The surface of Echinoderms has, moreover, also several kinds of articulated appendages, or partly embedded in the integument, secreted and covered by the same living tissue as the pieces of the test, having the same reticulated or lacunar structure and also covered by a ciliated epithelium either completely or in part, or at a certain time only. These appendages contribute, with the portion of the surface that is covered with a ciliated epithelium, to general nutrition and respiration in particular. These are the *spines* that we also call rods, radioles and that take the most varied forms. There are also scales that we can equate to very short and flattened spines. There are finally pedicellariae, singular sessile organs or pedicels and formed of two or three microscopic jaws that come together like the jaws of pincers. Animal or vegetal bodies, worms, microscopic bodies that come in contact with the pedicellariae are seized and compressed by them so that their juices come in contact with the living substance that absorb them and serve directly as nutrition. These pedicellariae thus are not, as is sometimes said, simple organs of prehension that transport from place to place to the mouth, prey that it has captured because intermediaries would often be lacking for this transport that has never been seen and the captured prey, on the contrary, always remains between the jaws of the pincer, would be by its extremely smallness completely out of proportion with the mouth of an Urchin or Asteroid. We also cite, as a dependency of superficial pieces, the madrepore plate. We shall speak of it later in regard to the stone canal that leaves this plate to open into the circulatory vessel of the water system. We cite it here only as a vestige or rudiment of the very important stalk in fixed Crinoids. This stalk, formed of articulated pieces, often has very numerous accessory rays. It sometimes leaves from a common base widely spread out on the rocks. Finally, it can grow by itself and has everywhere, both in the living and fossil states the same structure as the test of Echinoderms.

GROWTH OF ECHINODERMS.

Growth of Echinoderms is made in two ways, either by the centrifugal development of each piece that, consequently, can result in growth stripes and of tubercles, or of more and more numerous appendages. We conceive that if the pieces of the test are contiguous, they should, in joining edge to edge, take and preserve, in growing all around, a polygonal form, most often hexagonal. The other mode of growth has instead the production of new pieces between the old ones, on all the surface in some Crinoids, or at determined points, as at the end of the arms in Asteroids, and at the two ends of the ambulacral and interambulacral areas of Urchins.

TYPE OF ECHINODERMS.

Now, if we investigate what could be the general form that would be the common type of Echinoderms, We see that, for most, their form could be described as a spherical body divided into ten segments by meridians going from one pole to the other, five segments being the ambulacral areas pierced by holes for the feet or for the external or internal respiratory organs, the five other segments being the interambulacrals. One of the poles is occupied by the mouth, when it exists, would especially be the point of departure and of divergence of the rays. This would be the *radial* pole. The opposite pole, where the rays should converge, at least virtually, would be the *apical* pole.

For Urchins strictly speaking and the Cidarids in general, the sphere becomes a flattened spheroid, keeping its vertical axis with the radial pole, and consequently the mouth, below. The anus is very near the apical pole around which approach, without joining, the ambulacra and the intermediary segments.

In other Echinoids (Clypeastroids), the axis still being vertical and the mouth below, the body would become much more depressed, and the anus would be separated from the apical pole to become sometime infra-marginal. The ambulacra then would have a varied form and attributes at various points along their length, becoming exclusively respiratory in the dorsal region. In Spatangoids, finally, the axis would become oblique, and the mouth still directed to the ground, with the pole radial or basal, it would have been carried toward the anterior end while the apical pole and anus, and all the dorsal or upper region, would have kept nearly the same characters as in the Clypeasteroids. We note, however, the dissimilarity, often very pronounced, of the anterior or unpaired ambulacrum that contributes thus to give to the whole of the body a bilateral symmetry still more pronounced than in the preceding.

In all the Echinoids, the madrepore plate is very near the apical pole.

The Holothuroids, except for the lack of a crust or consolidation of their integument, contains only thin calcareous lamellae pierced by holes. The Holothuroids, we say, can be considered as being derived from the common spherical type, which would be elongated into a cylinder or fusiform with the axis horizontal, the mouth forward at the radial or basal pole and the anus posteriorly at the apical pole. But the ambulacra that, in these animals, extends ordinarily from one pole to the other, can be completely missing exteriorly in Synaptids, or even be widened on the contrary to make the interambulacrals disappear (*Sporadipus*). Or, finally, have different attributes, becoming locomotory on the ventral surface and respiratory on the dorsal surface. In them, the madrepore plate, although not

visible exteriorly, should be represented by the dependencies of the stone canal near the radial pole.

All the Asteroids, in their so varied forms, could still be derived from the common spherical type, in accepting the space circumscribed by the end of the ambulacra around the apical pole of Urchins is dilated in a way to push laterally the end of these ambulacra to the edge of a body that has become discoidal (*Culcita*), or to the end of the corners of the pentagonal body of *Goniodiscus* and *Asteriscus,* or up to the end of the arms of all the others. The axis here is always vertical, with the radial pole and the mouth and the ambulacra below. The ambulacra are entirely locomotory, but, on the dorsal surface that corresponds to the circumpolar space of Urchins are scattered holes that are respiratory appendages. The anus, when it exists, is near the center of the dorsal surface that corresponds to the apical pole. It is likewise on the dorsal surface that the madrepore plate is found, but farther from the center, and, remarkably, this plate is repeated several times in Asteroids that have more than five arms as if there were here a group of several individuals.

The *Ophiuroids* would be derived, like the Asteroids, from the common type, with this difference that the arms, much longer, serve only as locomotory organs, and that from this, the ambulacra in part covered by scales on the ventral surface, are used only for respiration by means of the fleshy tentacles that emerge laterally. At the same time, the calcareous pieces, supporting the ambulacra of the Asteroids, fuse in each arm and become a single internal series of ossicles comparable to vertebrae. The madreoric plate, or what is taken for it, is found very near the mouth. Moreover, there is never an anus as in some Asteroids and the dorsal surface lacks holes and respiratory organs.

If we pass now to the study of Crinoids, the difficulties will be more difficult to relate to a common type, whether we consider the globulose forms of *Cystidids*, in appearance similar to Urchins but without ambulacra, or at least without ambulatory feet, or the *Blastoids* with their five exclusively respiratory ambulacra, or even the Crinoids with five ramified or pinnate arms that give them with the Ophiuroids and Euryalids in particular a resemblance that for a long time they were united in the same family. Many of these latter Crinoids, in fact (Actinocrinians), also manifestly lack a digestive system like the Cystidids and Blastoids, and we can find neither a basal that would be determined by the location of the mouth nor an apical pore, if they would be the point of encounter or convergence of the ambulacra. They poles would thus be the two ends of the axis from the center of the base and around which the arms are symmetrically arranged, or the ambulacra, or the rows of plates composing the test. The lower pole, center of radiation of the plates and the arms, would be attached to other bodies (*Agelacrinus, Cyathidium*), or fixed, to openings of the digestive system when it exists. The other pole, truly apical, would be near the anus (Comatula, Pentacrinus), as in the Urchins, but it corresponds at the same time to the mouth, to which would go to the ambulacra, or ciliated and tentacular groove of the arms. All the digestive system with its two openings, thus turned above, toward the apical pole and not below, toward the basal or radial radial pole as in the Clypeastroids. The arms, which have their gutter below or toward the basal or radial pole in the Asteroids and which have lateral respiratory organs in the Ophiuroids, have them here above or toward the apical pole. It is necessary to note, moreover, that if some Crinoids have the respiratory surface of their arms directed above or toward the apical pole, other, like *Eucalyptocrinus* or *Hypanthocrinus*, have them attached to their sides and fusiform so we cannot say which of

the two ends of the arms, equally narrowed, should be taken as its base, and consequently, if the respiratory surface is above instead of below. As for considering the attached arms of Cystidids, Polycrinids and even those of Cyathocrinids, as having to serve both digestive and genital functions like those of Comatula and not simply for respiration, we shall see later the reasons to reject this opinion. But the very fact of Comatula and Pentacrinids that have their reproductive organs located on the upper surface of the base of the pinnules of the arms, while these organs occupy the spheroidal cavity of most other Echinoderms, this fact shows us that it is still necessary to eliminate from the notion of the general type of these animals, the arrangement of their reproductive organs.

There remains thus to positively express this type: 1º that the spheroidal form, more or less depressed in the direction of the axis, or, on the contrary, elongated and cylindrical or fusiform; — 2° on one hand, a general and absolute tendency to secrete in the tissue of the organs, lamellae or reticulated calcareous pieces susceptible to transformation by fossilization without losing their exterior form into homogeneous masses of spathic limestone; — 3° on the other hand, a general tendency for radiate arrangement of all organs, arms, ambulacra, plates, etc., except of the poles; — 4° We must finally add also to the notion of type, the ability of all these animals to carry out by all their surface, the functions of nutrition (respiration and absorption), either by means of cilia or by means of pedicellariae and other similar appendages.

Instead of considering at the same time the whole class of Echinoderms, let us consider these animals in the successive order of forms and the modifications they have during the various geological periods of the crust of the globe. We can, then, starting with the preceding results, get a precise idea of the transformation of the type, starting with *Sphaeronites* and other Cystids of the Silurian terrain. If we then pass by the Pentremites and Melonites of the latter Paleozoic terrain, and by the Crinoids of the first secondary terrains, we shall reach present forms that have scarcely varied except by generic or even specific characters after the last secondary terrains.

The Spheronites of the Lower Silurian, whose respiratory pores are scattered over all the surface and whose rudimentary arms are variable in number (2, 3 or 4), would be *Caryocystites* of their plates were wider and *Hemicosmites* if the number of plates were limited. The *Caryocrinus* of the Upper Silurian differs essentially from the latter only by the development of their arms whose number increases with age up to twelve and that are produced successively by budding. *Actinocrinus* of the Carboniferous period still lack digestive organs like the preceding, but they are distinguished by their arms, five in number, sometimes sub-divided, and have at their base openings by which the current of the dorsal gutter or ambulacra can enter into the interior of the body. These crinoids, moreover, have an opening in the form of a proboscis for the release of water and internal products of reproduction.

From the latter, the passage is easy to follow to Pentacrinus of secondary terrains that have a digestive system, and whose eggs develop at the base of the pinnules. Comatulids of the present period, finally, have nearly the same animal form, with a stalk only at a young age and become free later.

Melonites of the Carboniferous terrain, if they are not the oldest manifestation of the Echinoid form, are at least those nearest the form of Spheronites. These, with more uniform plates and pores regularly arranged into five ambulacral areas, would resemble exteriorly Melonites, from which the transition is easy to other Echinoids and step by step to

Spatangoids that in turn show externally an incontestable similarity with Holothuroids. We can even report the similarity of the form of *Eloeacrinus* with that of Urchins, but especially we can also pass from the form of Eucalyptocrines or Hypanthocrines of the Silurian and Devonian terrains to that of Urchins, in considering on one hand that their ten laterally attached arms are equal in number to demi-ambulacra and that the sunken and hollow base of *Eucalyptocrinus rosaceus* of the Devoian period of the Rhine gives a true idea of a transformation of the basal pole into a mouth of the Urchin, while the pieces of the vertex recall the circumpolar plates of the Urchin.

These same *Eucalyptocrinus*, and especially *E. decorus* of the Upper Silurian of England, can give us an idea of a transformation in one of the Asteroids (*Lepidaster*), the oldest of the geological series. The mouth was also produced at the basal pole, and the vertex widened more and more to make the ambulacra horizontal, it would become the dorsal surface of the Asteroid.

Blastoids or Pentremites of Devonian and Carboniferous terrains, if one accepts the possibility of the formation of a mouth at the basal pole, would become theoretically Asteroids by spreading out and the folding down to the basal plane their five arms with the ambulacra that are close only at the apical pole where they leave a space between them that we do not see in *Elaecrinus* of the same family.

Finally, in accepting the production of a mouth at the basal pole, *Agelacrinus* would become Ophiuroids after the elongation of the arms or ambulacra.

For all these progressive developments of the type of Echinoderms, we must accept the appearance at some time of a digestive system that is essentially lacking in primitive forms.

NUTRITION IN ECHINODERMS.

Nutrition by means of gaseous elements dissolved in water (*respiration*) is done by internal organs, or externally, either by means of the cilia of which we have already spoken or by the fleshy tentacles that we see leave the two sides of the arms in Ophiuroids or in the ambulacral groove of the arms of Crinoids, or by means of the branchial feet that leave by holes of some region of the ambulacra in several Echinoids and Holothuroids, and that probably, were also found during life in some fossil Crinoids. Similar organs leave by holes on the dorsal surface of Asteroids. These various organs all have the same structure. They are hollow, tubular, covered with cilia inside. It is across their wall that the liquid that circulates in the interior exchanges its excess carbonic acid for dissolved oxygen in the ambient liquid.

Internal respiration occurs, in general, also by means of cilia that cover the interior of the inter-visceral cavities, where the water penetrates by means of special openings, such as the holes of the test of some Crinoids or the slits of the ventral surface of Ophiuroids. The internal respiratory surfaces, moreover, can be considerably increased by means of a system of parallel lamellae in Cystidids and a special cavity, in the form of a very complex branched tree in some Holothuroids.

Circulation, always in close relation with respiration, is of two kinds in Echinoderms, and takes place in two orders of perfectly distinct vessels. These are the blood vessels and the water vessels. The latter are particularly in relation with the membranous ampullae

located on the interior that by their contraction causes the liquid content of the contractile feet to go outside and to enlarge again when the feet are contracted. However, this movement of liquid circulating in the water vessels must also contribute to respiration. It is with this order of vessel that the stone canal, consequently the madreporite appears to be more specially in relation, without our being able to describe their functions. We have already said above that we can consider the stalk of Crinoids as a vestige.

Circulation, always in close relation with respiration, is of two kinds in Echinoderms and in fact in two distinct kinds of vessels. These are the blood vessels and the water *vessels*. The latter are particularly in relation with membranous ampoules located in the interior that contract to move the liquid it contains into the contract feet to make them go outside and enlarge again when the feet are retracted. However, this movement of circulating water in the water vessels much be associated with respiration. It is with this kind of vessel that the stone canal, and consequently the madreporite appear to be especially related without understanding their functions. We have already said previously that we can consider them a vestige of the stalk of Crinoids.

Absorption of water can also occur by the ciliated epithelium as in most embryos, and by the external respiratory organs (tentacles). We have, moreover, previously indicated the function of *pedicellariae* that seize and compress small, organized bodies to absorb their nutritive juices. We see pedicellariae today only in Asteroids and Urchins, but it is probable that similar organs must have existed in some Crinoids during the life of these animals.

A *digestive system*, with one or two openings, is seen today in all living echinoderms, but it is only developed at a certain time and underwent singular transformations during the life of larvae of these animals. It is missing in most fossil Crinoids. The digestive system has two openings, mouth and anus, in all Echinoids, Holothuroids, Comatulids and living Pentacrinus. In most Asteroids, this latter opening is nearly rudimentary so that the presence of an anus scarcely changes the characters and internal disposition of the organs of these animals that, alone, are distinguished from other Echinoderms by the extension of the stomach, in the form of ramified caeca into the arms. There are some Asteroids that lack an anus and all Ophiuroids are in the same case. In the latter animals, the digestive cavity is like a rounded or spheroidal sac. It is nearly the same in Asteroids that have in addition, as we just said, ramified caeca in the arms. Comatulids also have the digestive cavity in the form of a sac with the two openings directed upwards and a tubular anus. The intestine of Echinoids and Holothuroids is a tube one or two times longer than the body and coils and folds in the interior. That of Synaptas is extended from one end to the other of the body.

The mouth of Comatulids and Holothuroids completely lack teeth. Those of Spatangoids, have the form of lips and are covered with small calcareous plates, those of Ophiuroids and Asteroids are strongly armed with plates and the skeletal pieces that surround it and by spines, scales or calcareous papillae these pieces bear, which, coming together, have the effect of powerful jaws. But the Echinoids and Clypeasteroids have a true masticatory system in the form of 25 to 30 distinct pieces, sometimes fused, of the same structure as the rest of the test and having five teeth of a special structure and much harder that serve to gnaw on fucus, while Asteroids and Opiuroids eat living molluscs while Spatangoids and Holothuroids feed exclusively on organic particles scattered in the sand

with which they fill the intestine. Comatulids, on the contrary, feed on floating microscopic algae and organic bodies the cilia in the ambulacral grooves take to the mouth.

LOCOMOTION, MOTILITY.

All Echinoderms have muscles with smooth fibers, either to connect and move pieces of the skeleton that are not fused or to move articulated spines of Echinoids, Asteroids and Ophiuroids, as well as their jaws and the arms of Crinoids. There are very powerful longitudinal muscles that cause the contractions of Holothuroids with such force that all the viscera are sometimes ejected outside. Other muscles in these animals move their buccal ring and their cloaca, and make up the major part of the fleshy body wall.

The feet with suckers of Echinoids, Asteroids and Holothuroids have circular and longitudinal fibers that give them the means for active locomotion of these animals, even on the vertical wall of a glass container where they attached by their terminal sucker, then elongate considerably, then shorten and act like a mooring line.

The spines of Urchin function like so many stilts for another means of locomotion much less regular for no other goal but a change of direction. Ophiuroids move only on the ground by contractions of their arms in one direction and in another like the tail of a serpent and consequently without direction. It is the same for Comatulids that ordinarily attach to marine plants by the dorsal cirri and change places very slowly. They can move rather quickly in water by alternate movement of their arms. As for Crinoids attached by a stalk. They can only have movements from flexions of the stalk and the arms and, also like Comatulids, contractions of the buccal and anal openings.

The movement of cilia that we just reported as functioning in various ways for nutrition, are used exclusively for locomotion of embryos and larvae of Echinoderms not fixed by a stalk.

NERVOUS SYSTEM OF ECHINODERMS. — SENSES.

The nervous system was known in Echinoderms only after the work of Krohn in 1841. What we had taken for it were ligaments or portions of fibrous tissue. The usual color of nerves of these animals, their location in the integument and the ambulacral skeleton in Asteroids had prevented for a long time recognizing them. The nerve trunks of the ambulacra had, moreover, this unexpected particularity that they are flattened, wider in the middle than at the ends and especially two times thicker than the cord that surrounds the mouth and that comes from the junction of the two branches in which these trunks are divided. We thus can consider each of them as a nerve center (brain) special for each ambulacrum, especially as an arm detached from the body of an Asteroid keeps it vitality for a long time.

The nervous system of Echinoderms is thus composed, in general, of nerve trunks in each ambulacrum and their lateral branches, and the ring or pentagon surrounding the mouth, formed by the union of each of the halves, in which each trunk is divided at its base, with half of the nerve trunk of the adjacent ambulacrum.

We can perhaps, also, strictly speaking, consider each nerve trunk as formed of two parallel trunks coming from the buccal ring, especially as we see on their surface a longitudinal groove.

The sense of *touch* is necessarily distributed in Echinoderms on all their exterior parts covered with a sarcodic or ciliated epithelium. It is nearly the only sense that can be seen in these animals. However, we generally attribute eyes to them, taking for them a red point located at the end of each ambulacrum of Asteroids, although these organs are located below and not above the nerve trunk that must furnish an optic nerve. By analogy, we give the same name to the organ that occupies the last unpaired plate of each ambulacrum of Urchins and that can at least receive a nerve thread from the cord extended on the internal surface of the ambulacrum. Consequently, we give the name of ocular plates to those terminal plates of the ambulacrum although nothing proves they really contain the eyes. However, we have noted that some Asteroids raise, in walking, the end of the arm where the eye is found to perceive light at least, which, in rest, is directed toward the ground.

REPRODUCTION IN ECHINODERMS.

Under this title, we must first speak of the function of regeneration, or the reproduction of parts detached from the body. This ability is especially very pronounced in Asteroids, Ophiuroids and Crinoids, of which one or several arms detached spontaneously or accidentally, is regenerated by a kind of *gemmation*. The arm, in the vicinity of the fracture, as first a fleshy bud covered with cilia, in which we distinguish no trace of segmentation, then the bud elongates and has, with smaller dimensions, a form completely similar to the part that must be replaced. Sone calcareous secretion having continued, segmentation of this part also becomes completely similar, so well that count the same number of pieces as in the other arms and these pieces have only to grow individually until the new arm becomes equal to the old arms. It is only then that if it must undergo later development, it will grow like the others by the production of new articles or new pieces at the end of the arms, immediately before the unpaired terminal piece.

For the Echinoids, a rupture of the test can without doubt be repaired, as seen in deformed specimens that we sometimes find, but an entire ambulacrum cannot be removed, even in part, as in Asteroids, without the interior cavity being exposed to all the destructive influences. Spines, on the contrary, are often replaced, either entirely, which is very common, or in part, when they have been broken but have kept their vitality as we see in *Acrocladia* (*A. trigonaria*), whose spines sometimes end in a narrower and shorter part.

As for Holothuroids, we know well that Synaptids that break easily, can continue to live and that they very probably repair the lost part. But we must, until now, reject with doubt the assertion of some naturalists who give to Holothuroids the ability to regenerate the interior of their muscular and fleshy wall the entire mass of viscera that they have expelled in abruptly contracting with force.

Reproduction of Echinoderms by propagation or propagation strictly speaking has been studied with admirable success for thirty or forty years. Sars was the first, as we have said previously, to observe a larva of Asteroid that he first described (1835) as a distinct animal under the name of *Bipinnaria asterigera*, but later (1844) he regarded as a developing Asteroid. This opinion was confirmed in 1847 by Koren and Danielsen. Sars had also observed directly the development of another species of Asteroid (*Echinaster*

sanguinolentus), that takes place on another plan that of *Solaster furcifer* coming from the Bipinnaria. In 1845 or 1846. Baër, also the first, having practice artificial fertilization of Urchins, observed the development of the egg of these animals and saw it cover itself with cilia and move in the water.

These observations were repeated following the same procedure and confirmed in 1847 by Dufossé and by Derbès at Marseille. The latter went even further because he saw the larva with its very strange hollow pyramidal form with cilia at the edge, or like the easel of a painter as J. Müller said. But it was J. Müller himself who, from 1846 to 1852, followed with more zeal the study of the development of various orders of Echinoderms, and who believed that all the very remarkable metamorphosis to the same type: giving them all for a starting point after the first changes of the ciliated embryo, a flesh lamella that was fleshy, elliptical, swollen, curved at one of its end the form of a cap, edged by a ciliated cord and containing it is longitudinal axis a digestive system with two openings , of which the anus corresponded to the base of the cap. After successive development, the ciliated edge elongated and folded variously and became either sinuous or lobed or prolonged both in front and back as on the sides, into long points supported by thin calcareous stalks, ramified or reticulated, according to the particular and bizarre forms that gave these larvae the name of *Pluteus*, and the names of *Bipinnaria, Auricularia, Tornaria, Brachiolaria*, according to the time where they would show a small bud, the body of the Echinoderm and notably the Asteroid that should derive from this larva, or which the larva would later be abandoned as superfluous by the new animal. In addition to these two openings of the digestive system, we see on the dorsal surface a third that will be the point of departure of the water system, and also, according to Müller, and of the stone canal. Consequently, this would also be the point of production of the bud of the definitive animal, that contains the stomach, or the central and posterior part of the digestive system, but neither the mouth nor the esophagus that would be replaced later by a new mouth located opposite the first.

This variation of the digestive system supports the ideas that we have expressed above on the complete absence of this system in Crinoids (Cystids) from the first geological periods.

The theoretical ideas of J. Müller cannot agree on all points with the observations of other naturalists, notably Krohn, who published in 1849 excellent observations on the larvae of Urchins and who has continued the same investigations on other orders of Echinoderms. We ourselves will report later the worm-like larvae hatched in large numbers in a vessel containing for a long time small Ophiuroids and that we can relate only to this species of animal. We have thus for free Echinoderms, metamorphoses that we can liken to a point to alternating generations, especially if we want to equate Bipinnaria, Brachiolaria, Pluteus in general producing the definitive form as a bud, to the mycelium producing the mushroom, to the hydroid polyp producing the Medusa. According to this even, we understand the stem or root of some Crinoids as being able to produce buds that later would contain only respiratory and reproductive organs without digestive organs.

Returning to the general history of procreation in Echinoderms, we must say that we have long believed them hermaphroditic. The contrary opinion is very recent.

Only in 1840, Peters showed that Urchins have separate sexes and Rathke made the same observation in Asteroids. The organs of both sexes are so similar, moreover, that we can distinguish them only at the time of spawning. In the edible Urchin, for example, the testes like the ovaries are five pyramidal bodies attached to the internal wall of the cavity

and orange in color. But at the time of fertilization, the testes become paler, releasing by the openings of the circumpolar plates a whitish liquid, and the ovaries release by corresponding openings that are a little larger in this case, reddish eggs. It is these eggs that can be artificially fertilized by contact with the liquid of the male when we want to observe their development. We then see, as in other animals, the yolk divides more and more and is transformed into a cylindrical embryo covered with cilia by means of which it moves, then takes little by little the form of Pluteus that we have indicated above.

Moreover, the genital organs of Urchins are, in both sexes, formed of very numerous tubes or caeca making a compact mass that leads to the excretory duct that opens by the genital pores. Those of Asteroids that are bunches of more or less numerous tubes, fixed in the intervisceral cavity between the arms on each side of the interradial wall and sometimes forming two prolonged series on the dorsal surface of the cavity of the arms. These organs, in Ophiuroids are complex utricles, pedunculate, so lobed or sub-divided that we could take them for groups of small diversiform sacs, fixed on the same peduncle. They are arranged in pairs in each of the intervals that separate the arms. Each of these ten complex utricals corresponds to one or two slits in the ventral surface on each side of the arms. The genital products that are first released into the cavity go through these slits.

By an exception without example in the other classes, the genital organs of Comatulids and Pentacrinus, indefinitely multiplied, are located on the integument of the ventral surface of each of the pinnules of the arms that become very developed at the time of fertilization. In Holothuroids, finally, except in Synaptids, which appear to be hermaphroditic, the genital organs are simple or ramified caeca, floating in the ventral cavity and opening to the outside by a common excretory duct above the buccal circle, between the tentacles. The testes are always white and form a dense bundle. The ovaries, on the contrary, are reddish, much longer, reaching sometimes the end of the body.

The eggs of Echinoderms, before fertilization, are covered with a thin chorion and contain a germinative vesicle with the germinal patch in a yellow, reddish or violet vitellus, surrounded by a thin layer of albumen. The spermatozoids have a body or rounded or oblong disc and sometimes pointed in front (*Spatangus*), with a very thin and very mobile tail.

SPECIAL FEATURES OF THE WAY OF LIFE AND ON THE PROPERTIES AND USAGE OF ECHINODERMS.

Free Echinoderms, according to their type of food, as we have said above, and according to their form of locomotion, should all live very near coasts and in shallow water, because there alone is found Fucus or the Molluscs that eat Fucus or sand with organic remains. Comatulids alone, although we find them also near the coast, can live at greater depth because it has surrounding water that contains the floating organic bodies. Pentacrinus, organized the same, have been found rarely and so far from the coast, or at such great depths.

Spatangoids and Synaptids live buried in fine sand. Urchins ordinarily stay in cavities of rock to be less exposed to the action of waves. Some even choose to live in a excavation of the rock already begun perhaps by an individual of the same species, continued by those

that temporarily live and excavate more by those who come afterwards. Comatulids, as we have said, live attached to marine plants. Some Holothuroids (*Pentacta*) scarcely change their place on the rocks to which they attach by their numerous feet. Other Echinoderms ordinarily live under rocks between Fucus or even with shelter at the bottom of the sea. Some are phosphorescent like the small Ophiuroid, named *Oph. noctiluca*, by Viviani. An Urchin of the Red Sea, it is said, produces a sensation of burning by simple contact.

None of these animals is parasitic, but some can serve as habitats for internal or external parasites. It is thus that Myzostoma, problematic helminth intermediary between Crustacans and Nematodes are always found attached to the ventral surface of Comatulids. J. Müller has found a new species of Mollusc, *Entoconcha*, in the interior of his *Synapta digitata*. Some fish (*Fierasfer*) have also been found parasitic, either accidentally or normally, in other large Holothuroids, and even in Asteroids (*Culcita*).

Some Echinoderms can serve as food for humans. These are Urchins of which we eat only the raw ovaries or testes and several Holothuroids of the Mediterranean that we eat cooked, in Sicily for example. And finally, Trepang that is fished around the Sunda Islands and that are very sought after in China and other oriental countries of Asia. It necessary to cite finally the use sometimes of Asteroids (*Asteracanthion rubens*) as fertilizer.

GEOGRAPHICAL DISTRIBUTION.

What we just said on the manner of life of Echinoderms and the mode of locomotion, already explains how each species, among these animals in general, must have a rather restricted area of distribution, either in the present time, or during the various geographical periods. Except for Crinoids, or even some Crinoids, that are inhabitants of coasts. This is why, in the oldest Paleozoic terrains, we see only Crinoids and no forms of the present world. This is also why each island far from the continents can still have today special species. Because they cannot cross large expanses of the sea, these species have had to remain isolated, if they have originated in the place where they live or undergone in place all the modifications that distinguish them today from species of the same origin. For the living species, the distribution is nearly uniform on all the coasts of the Oceans and the Mediterranean. The Caspians and the interior seas that are less salty are the only exceptions. Actually, the largest species are especially found in intertropical regions, but whenever we have been able to collect in each locality all the species of Echinoderms, we reach nearly the same number of 25 to 35 distinct species, unless this number is increased by purely nominal species that we would take as simple varieties. Thus Lütken (1857) counted 23 on the coasts of Denmark, Verany (1850) counted 26 in the Gulf of Genoa and Nice, Chierighini (1850) counted 23 in the lagoons of Venice. Actually, Forbes (1841) reported 55 species at Great Britain, but he included in this enumeration those of Ireland, England, and all neighboring islands that we cannot consider as a single locality. This probably also explains the number of 61 species attributed to the coasts of Norway by Düben and Koren. Many of the species enumerated in each locality should naturally by encountered in neighboring localities so that we can scarcely estimate more than 120 or 130 total species of Europe. From this base, we can certainly estimate the total number of living species at 1,300, namely: 250 for each of the two coasts of the Atlantic Ocean, 250 for each of the

two coasts of the Pacific Ocean and still 300 for the coasts of India. But of this total number, scarcely 700 are known today. These numbers would, moreover, be much higher if took as base the results of the expedition of Commodore John Roger in 1856 in the Pacific Ocean from the Seas of Japan to the Bering Strait, because it is said to have collected 70 Holothuroids, 66 Echinoids and 150 Stelleroids (Asteroids, Ophiuroids and Crinoids).

Separate from the Crinoids (Comatulids), of which we scarcely count one or two species in each locality, the four other orders of Echinoderms are nearly equally distributed. Thus, among the 45 species cited by Forbes, there are 13 Ophiuroids, 14 Asteroids, 12 Echinoids and 15 Holothuroids; among the 61 species attributed to Norway by Düben and Koren, there are 14 Ophiuroids, 18 Asteroids, 13 Echinoids and 14 Holothuroids; the 23 species from Denmark, according to Lütken, 7 Ophiuroids, 6 Asteroids, 6 Echinoids and 4 Holothuroids. But, while Verany, for Nice, and Chierighini, for Venice, would have observed the same relation in indicating for the number of Holothuroids, one, 5 out of 26, the other, 6 out of 23 Echinoderms, Grube, in 1840, in giving 45 as the number of Echinoderms that he had observed in the Mediterranean and Adriatic Sea, gave for Holothuroids a nearly double proportion, namely: 17 out of 45; while of this same number, the three other ordrs of Ophiuroids, Asteroids and Echinoids contained each 9 only/ We shall return to this evaluation in talking of the order Holothuroidea.

PALEONTOLOGICAL DISTRIBUTION.

If we want to evaluate the number of species from each of the periods from the formation of the crust of the terrestrial globe, we shall encounter first three kinds of difficulties.

The first is that the terrains of the different stages are not all equally accessible to investigations of naturalist; or that, like the Silurian and Triassic, they are exposed at only a small number of points, or that they have not been searched as much as the Carboniferous terrains, for example, or that, finally, like the most recent Tertiary terrains, they have been, in large part, they have been swept away by the Diluvium.

The second difficulty is that the different rocks were not, when deposited at the bottom of the waters, equally suitable for preservation or to the fossilization of the organic remains.

The third difficulty is that paleontologists who want to increase the distinctive characters of the terrains often increase the species beyond what zoologists want. Zoologists are not always content with an exterior difference between two fragments to be two species. But if, considering the circumstances mentioned above, we want to subtract the nominal species from the total number of species found in each stage and from those that are indicated particularly in a locality as belong to the same terrain, we arrive at two important results: one, the number of species is going to increase from the Silurian terrain to the present period; the other that, in each locality, the number of Echinoderms was, like today, from about 25 to 35. Considering that if the Holothuroids already existed, they could not have been preserved as fossils and that the Ophiuroids and Holothuroids have rarely avoided destruction because of the separation of their calcareous pieces.

Noting only the stages and localities that have been more completely explored, we see, starting from the oldest terrains, that of the 32 species from the Lower Silurian, only

12 are found in the state of New York. Of the 25 species of the Upper Silurian, only 15 are found at Wenlock. Of the 57 from the Devonian terrain, 34 are indicated in Eifel (Prussian Rhineland). But these two numbers must be decreased by several nominal species established by very incomplete fragments or by specimens too young and too different from adults. In each locality at Saint Cassian, that has been referred to the Triassic terrain, we count 44 species. but of the 34 Cidarids that are part of it, and that differ only by granulations on the surface, there are only 16 that are known only by isolated spines that very probably belong to species established by other fragments. Several other species being likewise questionable, from the zoological point of view, the total number must be reduced from 12 to 15. Of the 35 species of the Lower Oolith, only 11 are found at Bayeux and Harcourt. Of the 34 species of the Grand Oolith, 23 are found at Ranville and on the coast of Calvados. Of the 97 species of the Oxfordian terrain, 31 are indicated at Besançon. But in these numbers are several Cidarids and Millercrinus that we must consider as nominal species to be combined with some other. In the terrain of the same stage, in Bavaria, we count, on the contrary, only 25 species.

The Corallian terrain contains 68 species of Echinoderms, 42 in the vicinity of La Rochelle. But here again are several Cidarids and especially many *Millercrinus* that we cannot count as distinct species, so that the numbers of 68 and 42 are reduced to about 54 and 30.

The Neocomian, of the 47 species we attribute to it, 27 in the canton of Neufchâtel has given it its name.

The Tufeau, or Marl Chalk, so extended and so varied that we can subdivide it into two or three stages, has up to 105 species, but there are no more than 20 in Normandy, for example, and 15 only in the department of Lower Charente. Likewise, the White Chalk, which has 130 species in its vast extent, has only 22 at Tours, 21 at Royan and its vicinity, and about twenty at Maëstricht. But there is not a species common to the three locality and at most five or six common to both localities as still happens today.

For the Nummulitic stage, we count more than 75 species in all. We find only 22 at Biarritz.

For the Parisian terrain, the total number is 44, and the vicinity of Paris, so completely explored, has only 26.

Finally, for the Falunian or Middle Tertiary, where only fragments remain at many points and that, all together, has 83 species, a single locality, Turin, the richest in species, has more than 23 Echinoderms.

As for the last Tertiary terrain, or Subapennin terrain, which has still more restricted fragments, we cannot have an idea of the complete fauna of the period where it was deposited. The remains, in fact, only 20 Echinoderms, of which 10 only in the terrain of Sicily.

If we consider, no longer only the order of distribution but also the order of appearance of Echinoderms in geological times, we see that some genera and even entire families, which perhaps we can consider as orders in classification, have appeared in the first periods, to then disappear completely after the deposition of one or several characteristic layers of the terrains. Others that have appeared at a more or less distant time, have continued longer or even to the present in presenting successive modifications, which results in new species and even new genera. Others, finally, like the Spatangoids for example, have made their appearance only at the period of the Lower Oolith by one of their

tribes that disappeared there at the end of the Cretaceous period. These same Spatangoids then continued up to the present time by the tribe of Brissians that, originating in the last secondary terrains by special genera, even have other special genera in the Tertiary terrains. But with these, that are also some that continue to the present period with simple specific changes in company with genera that we do not find as fossils.

To have a correct idea of the mode of appearance and succession of the various groups of Echinoderms, it is necessary to take into consideration the facility for preservation that they have. Thus, the oldest Crinoids being those whose test and stalks are most solid have a greater facility to persist as fossils. From there, and their prodigious multiplication on the bottom of some seas of the Paleozoic and Triassic period, there result calcareous rocks appearing to be formed entirely if the remains of the stalks of Crinoids that we call star-stones, Trochitids, Entroquids. Echinoids, in general, are rather well preserved as fossils, often even the entire test with all the details of its surface. But more often there are fragments of the test and especially the spines that we find in abundance with the same spathic structure as the remains of Crinoids. Asteroids and Ophiuroids, on the contrary, are preserved entire only in extremely rare circumstances. Often even their form is revealed to us only by an impression or by some pieces remaining in place on the surface of the rock that received their remains before consolidation. But, most often, the pieces of the skeleton of thee animals are completely dissociated by the decomposition of their body and we can find in terrains otherwise so rich in fossil Echinoderms, only polyhedral pieces plated or scutellid species such as *Goniodiscus* and *Pentagonaster*. With greater reason, the Holothuroids have disappeared without leaving fossil remains. However, we regard as coming from some Holoothuroids (*Synapta sieboldiii*), small remains similar to those that Ehrenberg has named *Spongolithis* and, coming from the Tertiary terrain of Germany.

It is necessary to mention here again the replacement of the calcareous stalk and all its contents by silica that can have the same exterior form but that no longer has any indication of the internal structure because it is molded in the manner of all other plastic substances except for the very long duration of this process. It is also the external impression that we often encounter. If we start from the oldest fossiliferous layers to the present period, we find first exclusively Crinoids in the Lower Silurian terrain, and among the Crinoids, also exclusively, Cystidids that have completely disappeared at the end of the Paleozoic period. The other Crinoids, except the families of Pycnocrinids et des Comatulids, are nearly limited to the Paleozoic period. But all have not disappeared as the Polycrinids and some Cyathocrinids (*Rhodocrinus, Poteriocrinus*, etc.). In this terrain also have been found some Asteroids more or less from those of the following periods. The Upper Silurian contains species different from nearly all the genera of the lower terrain. The other genera, *Hemicosmites, Caryocystites, Sphaeronites, Agelacrinus, Palaeaster*, etc., have already disappeared. But with those that remain, we see appear new ones and even the families of Blastoids or Pentremites and Anthocrinids have made their appearance. We cite there even the first species of the order of Echinoids (*Palaechinus*). Observation for the Devonian period, which completely lacks the families of Polycrinids and Anthocrinids, and perhaps even those of Cystids, as well as many genera of Cyathocrinids, restricted to the Silurian terrain. Of this latter family, in addition to the genera *Rhodocrutus, Poteriocrinus* and *Taxocrinus*, that have persisted with different specific forms, we see appear many other new genera that, except *Cyathocrinus*, cease to exist at the end of the Devonian period. The entire families of Cupressocrinids and Haplocrinids that have made

their appearance at the same time, and the genus *Elaeacrinus* of the family Blastoidae that, itself, will continue, and the genus *Protaster*, alone representing the order Asteroids, also disappears with the Devonian period. To finish this enumeration, it remains for us to cite the genus *Archaeocidaris*, second representative of the order Echinoids and perhaps a species of *Echinosphaerites*, the only one of the family of Cystids that have been found in the terrain.

The Carboniferous period saw the continuation of different forms and ending with it of the Blastoid family and nearly all the Cyathocrinids. This latter family has produced a large number new general, notable *Actinocrinus, Amphoracrinus* and *Platycrinus*.

To this period also below the special and so remarkable genus *Melonites,* representing the Echinoid order with *Archaeocidaris, Perischodomus* and *Palaechinus* that accompany it. The Stellerids are represented only by a species of *Uraster*. We also list here a genus *Sycocrinus*, very imperfectly known and that is supposed to make part of the family of Cystids, but that is very doubtful.

The Permian terrain, the last Paleozoic period, is poor in fossils, as indicated by the name of Penean terrain proposed by Brongniart that contains two species of Echinoderms, the last of the genus *Archaeocidaris* of the Echinoid order, and the last of the genus *Cyathocrinus* and the tribe Cyathocrinian. The Crinoids that we shall see so numerous in the first secondary terrains and that are going to decrease in number to the present period, will have henceforth more evidently a digestive system and probably their reproductive organ located on the pinnules of their arms, like Comatulids and Pentacrinus of the present period.

The Muschelkalk or Conchylian limestone, which is the lower stage of the Triassic terrain, is characterized by the presence of the genus *Encrinus,* which has been so prodigiously multiplied that remains of their stalks, which we call Trochites or Entroques, often constitute, as we have said above, a large part of the calcareous rock. With *Encrinus* is found two or three other very close genera and consequently of the same family Pycnocrinids. With them are genera restricted to the Muschelkalk, *Apiocoma* and *Aspidura* of the Ophiuroid order. The genus *Acroura* of the same order seen here continues into the following terrains. It is the same with the genus *Pleuraster* of the Asteroid order and *Cidaris* of the Echinoid order that continue to the present period.

The limestone of Saint Cassian, which ends the Triassic terrain, is especially remarkable for the number of species of *Cidaris* and *Hemicidaris* that it contains, a number that has been exaggerated in establishing species based on isolated spines. In addition to these Echinoids, it contains some Crinoids. These are an *Encrinus* that is also found in the Muschelkalk, and two other species of the same genus and the special genus *Flabellocrinus*, and finally the genus *Pentacrinus*, destined to continue by a succession of different species up to the present period.

From the Jurassic terrain, *Encrinus* strictly speaking is no longer seen and the Lias, lower stage of this terrain, has in fact of Crinoids only the single genus *Pentacrinus*, represented by 5 of 6 species and characterized by his pentagonal stalk with an elegant star on the articular facets of each of its very multiplied articles. The Ophiuroids are represented by *Ophioderma* and *Ophiolepis*; the Asteroids by *Tropidaster, Crenaster* and *Luidia*. In addition, to the *Cidaris* and *Hemicidaris* that began in the Triassic, we see appear here *Diadema* and *Rhabdocidaris* of the Echinoid order and Cidarid family.

It is in the following stage, in the Lower Oolith, that we see appear for the first time, the two other families of Echinoids, namely: Spatangoids and Clypeastroids, one represented by the genus *Dysaster*, the other by the genera *Pygurus, Clypeus, Hyboctypus, Holectypus*and *Nucleolites*. Several new genera of Cidarids also appear with those of the preceding terrain, notably *Echinus* and *Diadema.* As for the order of Crinoids, in addition to Pentacrinus, it has at this stage the genus *Isocrinus* of the same tribe of Pentacrinian and the genus *Cyclocrinus* of the tribe Apiocrinian, tribe so richly represented in the Middle Jurassic terrain that it characterizes.

The Grand Oolith has thus abundantly *Apiocrinus* and *Millericrinus* of the tribe Apiocrinian, as well as *Cyclocrinus* that ceases to exist at the end of this stage. *Pentacrinus* continues to have 1 or 2 species and the Comatulids make their first appearance in the geological series. The Ophiuroids still have *Acroura*; Asteroids, *Crenaster* and in addition the new genus *Solaster*. The Echinoids, keeping 11 of the preceding genera, are enriched by the genera *Pygaster* and *Polycyphus*.

The Oxfordian stage has as new genera only *Desoria, Astrogonium, Eugeniacrinus* and *Balanocrinus*.

The Corallian stage has in addition the genus Guettardicrinus of the tribe Apiocrinian, some other Crinoids near *Eugeniacrinus* and several genera of Comatulids (*Solanocrinus, Comaturella, Pterocoma* and *Saccosoma*). Two new and special Ophiuroids (*Ophiurella* and *Geocoma*) also appear during the deposition of the Corallian layers, as well as two or three new genera of Echinoids.

Finally, the last layers of the Jurassic terrain, much less rich in fossils, still have about a dozen of the same genera of Echinoids, of which several (*Clypeus, Acrocidaris, Acrosalenia*) will disappear with this period. Then will have ceased to exist nearly all the Crinoids that will be represented in the Cretaceous terrains only by some *Pentacrinus*, of which a single genus still exists, a *Hemicrinus* of the Neocomian stage, by a *Masuputes,* by *Cyathidium* and by the enigmatic *Glenotremites* of the White Chalk, and finally by *Bourguetticrinus* that continues into the first Tertiary terrains, and by the Comatulids.

The genera of Echinoids are too numerous in all the Cretaceous terrains for us to be able to mention here. We shall say only that of the 50 genera, there are 26 completely special and characterized notably by *Ananchytes, Micraster* and *Salenia*. The Stellerids have 7 or 8 genera, 2 special, and the Ophiuroids have 2 or 3.

The Tertiary terrains have 38 genera of Echinoids, of which 15 are special and more or less characteristic, such as *Pygorhynchus, Lenita, Lagarum* and *Scutella*; 6 others that no longer exist today as *Pygurus* and *Arbacia;* while the 17 others are still living. The Asteroids have 3 genera and the Ophiuroids only one, not that these Echinoderms should not have been much more numerous in the seas of this period. Their preservation was much more difficult in the Tertiary terrains, ordinarily deposited in shallower depths or even on shores exposed to waves. The same observation applies to Crinoids that are represented only by very rare remains of *Bourguetticrinus* in the lower layers or by *Pentacrinus*, although there should have existed at the same time numerous species of Comatulids.

NOMENCLATURE AND CLASSIFICATION.

Paleontology that. for Echinoderms, more perhaps than for any other class of animals, gives indispensable insight for understanding the type of this class and its transformations over time has on the other hand complicated their study by the indefinite multiplication of species. Because these species have often been established according to a single, more or less altered fragment and cannot sufficiently characterize them from a zoological point of view. The species in fact, in its definition, should contain not only the present form, external and internal, but also all the modifications by which this form should pass during its successive development, and also all the modifications that it is susceptible to undergo by the influence of the ambient environment or exterior circumstances of climate, habitat, food, etc. Actually, very few species still are as completely known by naturalists, and most others, particularly fossil species, can ever be. But these considerations should suffice to determine ourselves to considerably restrict the number of species that we have to describe, and to simply mention the name of most of the species incompletely known, notably fossil species, for which we refer the reader to works of paleontologists and especially to the figures contained in these woks and most often indispensable to identify a fossil.

Another difficulty also encountered in our study is nomenclature and synonymy. A principle that appears rather generally accepted is that of right of priority for the name given an animal by an author. But the application of this principle, pushed to its ultimate limits, has inconveniences that have often believed necessary to avoid, whether it had as a result to substitute a non-euphonious and already accepted by usage, a name much longer and less harmonious, or by the authority of a name such as Lamarck, for example, seems to us to prevail over the right of priority of another, or that we think a name of two or three syllables should be preferred to a name of four or five syllables. This is the same reason that we prefer the names of *Pentremites, Codaster*, that have priority to the names of *Pentatrematites* and *Codonaster*, that we have wanted to substitute for them as grammatically more correct.

These observations apply especially to the study of genera or groups of species that, in our opinion, have been too much multiplied and that, unfortunately, have for most two or three synonymous names.

As for the grouping of genera into tribes, in families, and in orders, there are the difficulties of another kind that we dare not believe to have been resolved in cases. In fact, for a natural classification, it is necessary to characterize each of the groups of the same name by characters of the same value, and to choose for each of these groups characters subordinate to those of the higher group. However, for many of these groups, especially among fossil Crinoids, and, among the latter, for the oldest, our information is too incomplete to do anything but choose a provisional or simply indicative classification, in anticipation of some discovery that would permit erecting some tribes into families and some families into orders. On the other hand, as we shall see later, we have often willingly given in to the esteem inspired by the works of Agassiz, Desor, Pictet, Roemer and J. Müller, to use as much as possible the classifications or methodical arrangements proposed by these authors.

Accepting thus Echinoderms as a distinct class near Acalephs in the branch or sub-kingdom of RADIATES and from the definition give above, we separate this class into five orders or primary groups: 1° CRINOIDS, 2° OPHIUROIDS, 3° ASTEROIDS, 4° ECHINOIDS, 5° HOLOTHUROIDS, susceptible of dividing themselves into families or secondary groups, then into tribes and sections, and that we arrange them following their

appearance in the geological series, which agrees very well with those of their zoological relations. In the three first orders and a part of the fourth, the body axis is vertical; in the last family of the fourth order, the axis is inclined; in the fifth order, this axis is horizontal and this character distinguishes sufficiently the HOLOTHUROIDS, that, in addition always have the body elongated in the direction of the axis and lacks the regular test or symmetrical calcareous pieces except the buccal ring.

The CRINOIDS, with or without arms and with a calcareous test, are often lacking the digestive system, and when they have one, on the contrary, it is with a mouth located at the upper or apical pole and an anus on the same surface of the body. It is also toward the apical surface that, if they have arms, their ambulacral grooves are turned.

The OPHIRUOIDS and ASTEROIDS both have a vertical axis, depressed body, coriaceous, flexible, much wider than long, and the mouth at the basal or lower pole. But for the OPHIUROIDS, the 5 simple or ramified arms, without a visceral cavity, and supported interiorly by a series of ossicles comparable to vertebrate, produced abruptly from a discoidal body like tais of the lizard. Their digestive system always lacks, moreover, an anal opening. For the ASTEROIDS, on the contrary, the digestive system sometimes has a very small anal opening and a polygonal, usually pentagonal body with corners more or less prolonged in form of arms or rays, with a visceral cavity prolonged to the end of the corners or the arms, and in which extend caeca or appendages ramified from the stomach. As a consequence, here, there are not series of ossicles comparable to the vertebrae, but the ambulacral groove supported by a double series of symmetrical pieces that would be, rather, comparable to ribs. Always, in the two latter orders, the integument has spines or scales or distinct plates.

ECHINOIDS, finally, always with a mouth and an anus, are distinguished because their body, always symmetrical, ovoid, or spheroidal or discoidal and without arms, is surrounded by a calcareous test, inflexible on which are articulated spines.

We can summarize these characters in this way:

Vertical axis		
Mouth absent or located at apical pole. Body with or without arms. Without visceral cavity. Supported by a calcareous, inflexible test.		CRINOID
Mouth occupying the basal pole. Integument coriaceous, flexible, with or without calcareous plates.		
	Body discoidal, from which leave five arms without visceral cavity, supported by a series of vertebral ossicles.	OPHIUROID
	Body pentagonal or polygonal, with corners more or less extended in the form of hollow arms in which are extensions of the stomach	ASTEROID
Vertical or oblique axis. Body spheroidal, ovoid or discoidal, symmetrical, without arms, surrounded by a calcareous, inflexible test on which are articulated spines.		ECHINOID
Horizontal axis Body cylindrical, elongated, with a coriaceous integument of encrusted with calcareous pieces without regularity.		HOLOTHUROID

SECOND BOOK

1ST ORDER

CRINOIDS

(χρίνον, lily.)

DEFINITION

Body spheroidal, ovoid, sometimes turbinate or pyramidal, always having its axis vertical; surrounded by a test formed of polygonal plates, more of less thick, and having the name calyx; ordinarily with an articulated stalk, accrescent; sometimes sessile or even attached by all its lower surface, becoming free on the contrary in leaving is stalk; having ordinarily five arms more or less ramified, and always having their ambulacral grooves turned upwards.

Respiratory organs, internal and external, separate or together.

Mouth, when it exists, is located at the upper or apical pole; but many fossil Crinoids appear to have only the reproductive system of an animal (like Medusae), and not the complete animal! They then lack a special digestive system and were able to nourish themselves only by their stalk, or by absorption, or by the appendages of the surface.

REVIEW

Fragments of the stalk of Crinoids, particularly Encrinus and Pentacrinus, were noted very early in some rocks, in some layers where they are very abundant by the first collectors of objects of natural history. From the sixteenth century (1538) we see them mentioned by Agricola under the name of *Entrochus, Trochitus* and *Astroitus*. As the same time, they were designated by the name of *Encrinus* (from the Greek word *xpívov*, lily). The Crinoid we call thus is characteristic of the Muschelkalk. The name of *Pentacrinus*, on the contrary, was then given to the calyx of the same *Encrinus* lacking its arms and having all its pieces regularly arranged by five. And all these fossils were placed among the Judaic stones, stones of Judea, that are that are spines of *Cidaris*. A little later (1565), C. Gessner, in describing the same fossils, specifically named *Asteria* the fragments of the stem of our *Pentacrinus*, so remarkable by the figure of a star engraved on their articular facets. Jean Bauhin, in 1602, simply gave these fossils the German name of Sternstein (star stone). Worm, in 1655, named them *Judaic star*. A German author, Lachmund, in his *Oryctographia hildesheimensis*, 1655, gave the first rather complete figure of *Encrinus liliiformis*, that he named *Pentagonos.* Martin Lister, in 1673, in the *Philosophical Transactions of London,* n° 100, made known some other calyces of Crinoids (*Actinocrinus*), that he took for the roots of *Entroques* that he considered as marine plants, as well as the stalks of *Pentacrinus* that he described in the same collection, n° 412, in

1675. Several other English authors made similar publications, notably Lwyd of Lhwvd, called in Latin Luidius. This author described and figured in a very imperfect way in the 1st edition of his *Ichnographia*, in 1699, several fragments of Crinoids to which he assigned the names *Porpites, Entrochus, Volvola, Asteria, Stellaria, Modiolus* and *Astropodium*, which later had a very different meaning.

During the eighteenth century, until the remarkable work of Guettard, in 1761, the works on Crinoids, although very numerous, are still not very scientific. Some, as Langius (*Hist. lapId. figuratorum Helvetiæ*, 1708), regarded them as fossil plants. Others related them to Sea Stars or Polyps, some finally, like Volkman (1720), had taken the stalks of Crinoids for vertebral columns of fish. However, already in 1719, Rosinus, in his book *De lithozois ac lithophytis olim marimis*, etc., had shown that Crinoids are true animals similar to Sea Stars with ramified arms (*Euryale*), and that *Entroqus* are fragments of the stalk of these animals. A little later, in 1755, Ellis falsely believed to have found in the *Umbellularia*, which are *Alcyonarian* polyps, the living analog of *Encrinus liliiformis*. This error was the reason Linnaeus and Lamarck continued to class the Crinoids with a stalk among the Polyps.

The true living analog was found only near 1750 or 1755. This is *Pentacrinus caputmedusae*, sent dry from Martinique, under the name of *Palmmier marin* and described under this name by Guettard, in 1761, in the *Mémoires de l'Académie des Sciences* (year 1755, p. 224 and 318). This beautiful specimen, preserved first in the collection of Bois Jourdain, then in the collection of the Muséum d'histoire naturelle de Paris, was first considered unique. But today we know more than ten in various museums. It is according to a specimen much more complete and preserved in alcohol that J. Müller published his beautiful work in 1851. However, Guettard, starting from the study of *Palmier marin,* compared a large number of Crinoid fossils and proved that that they are not marine plants, nor Polyps, nor Sea Stars, but animals of different order that he did not seek to determine. Unfortunately, to the contrary of Lister, who took the tops for roots, he took for tops the roots of some Apiocrinids. The following year, Lister (Phil. Trans., v. LII, p. 425) described a second specimen of the same *Pentacrinus caputmedusae*, and named it *Encrinus sept stellato, ramoso dichotomo, stipite pentagono*.

For a long time, several Comatulids were described and figured either by Linck (*de Stellis marinis*), or even by Petiver (1695) and J. J. Baier, in 1708, in his *Oryctographia norica*, having described a fossil species. But they were then placed, as was done until the beginning of the nineteenth century, among the Sea Stars. It was Lamarck who gave them, in 1815, the name under which we know them. But before him, Leach and Freminville, had each made them a distinct genus under the names of *Alecto* and *Antedon*. It was only after the discovery by Thomson of the so-called *Pentacrinus europoeus*, in1827, and the demonstration most important by the same author, in 1837, of the identity of this *Pentacrinus* with a young age of a Comatulid that uniting the latter animal with the ancient Crinoids could be considered.

If, in thought, we go back to the eighteenth century, we see Linnaeus, in his various editions of his *Systema naturae*, up to 1766, despite all the previous works, persisted in classifying Comatulids with Asteroids, and stalked *Encrinus* with the Polyps in the genus *Isis*, because the stalk is also articulated. However, there is this important difference, that the articles of *Isis* always remain connected between themselves by a horny interval and those of Crinoids by articular facets variously sculptured and are often separate. Gmelin,

in publishing a long time after the death of Linnaeus, a thirteenth edition (1788) of his *Systema nature*, made no other change relative to the Crinoids than to unite under the same name of *Helminthotithus isidis*, the fossil Crinoids that Linnaeus had listed as species of *Isis.* However, many Crinoids were already known by mineralogists as petrifications, notably by Knorr, 1755–1769, Bourguet (*Traité des pétrifications*, 1749, and 2° édit., 1778), and by Walcost (*Descript. and fig. of petrifications*, 1775). A Cystid (*Echinosphaerites*) had even been described in 1772, by Gyllenhal. Before that, we had seen some attempts at classification, such as those given by Walch, or in the work of Knorr in 1769, or in the *Naturforscher*, in 1774–1776, that established under the name of *Enkriniter*, a group special for Crinoids with a stalk, and where the first defines rather well the genus *Pentacrinus*. Blumenbach (*Handbuch der Naturgeschichte*), in 1788, classed more methodically Crinoids among the Vers crustacés, with Asteroids and Ophiuroids. But the name *Echionoderms* was given to the class that contains the animals by Bruguière, in 1789, in the *Encyclopédie* (*Vers*, 1st vol.).

In the year 1815, we see Lamarck leave the stalked Crinoids among the Polyps and place his division of Radiaires échinodermes, at the top of the order of Stellerides, the Comatlids of which he describes eight species, either according to the previous author or according to the collection of the Museum that he had classified. Cuvier, in 1817, in his *Régne animal*, made a further step and placed *Encrinus* after his large genus *Asterias.* Between the Comatulids that end it and his large genus *Oursin.* The fossil Crinoids had been studied by Hisinger, in the *Mémoires de l'Académie de Stockholm* (1802), Fischer de Waldheim, at Moscow (1806–1811), Parkinson (*Organic remains*, 1811), Schlotheim, in various memoires (1813–1817), Wahlenherg, in the *Actes de l'Académie d'Upsal* (1818), Cumberland, in the *Transactions of the Geological Society of London* (1819), Rafinesque, in the *Journal de Physique* (1819), and Th. Say, in the American Silliman Journal (1820).

When Miller published, in 1821, his classic work (*A natural history of the Crinoidea*), in which he listed all the species previously known, he described only one living species and 25 fossils. He distributed them in 10 genera (including *Marsupites*) that had been preserved, except the separation of a *Cyathocrinus*, to make the genus *Taxocrinus*. A very happy idea of Miller, although false, was to assimilate he various pieces of their calyx to pieces of the skeleton of Vertebrates and to name *Bassin* (*Peluis*) the piece or pieces surround the basal pole, then successively the *costal, intercostals, scapulars, clavculars, brachials* pieces, those that form as whorls, or, the *ribs*, the *shoulder blades* (*scapula*), the *clavicles*, the *arms*, the *hands* and the superposed *fingers*.

The works of J. Müller on *Pentacrinus* and other Crinoids has led to abandoning these names for much more rational ones of *basals, parabasals, radials* (first, second, etc.), *interradials* and *brachials*, *axillairs* and *inter-axillairs*.

What must dominate, in fact, in the study of the test of Crinoids, is the consideration of the series of pieces that continue like rays up to the point where the arms begin to bifurcate, when these organs exist and are ramified.

However, the skeletal nomenclature of Miller has been followed by all the authors who came before J. Müller, particularly by Goldfuss who, in his *Petrefacta german*., has published a large number of genera and species previously unknown and who declared himself that this nomenclature is essentially flawed as there is no relation between the pieces of a Crinoid and the bones of a mammal.

Miller, however, with the aid of his nomenclature, was able to characterize very clearly his various genera of Crinoids. He first forms four divisions: 1° the articulata, which have the pieces of the calyx articulated with each other; 2° the semiarticulata, which have these pieces imperfectly articulated; 3° the inarticulata, which have these pieces of the calyx united by sutures and which are thought to be covered by a muscular layer; the coadunate, where these pieces, supposed to exist, are fused of ankylosed. We see first how this classification is vague. It is abandoned today, although it has been tried to give it more precision by adding the distinctive character of thickness of the plates in the first division, and thin in the second and third.

The *articulata* have the basin (*pelvis*) formed of five pieces and supporting five costal pieces. Those that have the stalk widened at the top and join the calyx are the APROCRINITES; those whose stalk is not widened at the top are the PENTACRINITES, if the fingers are formed of a single series and if the stalk is pentagonal; they are ENCRINITES if the fingers are formed of a double series of pieces and if the stalk is round.

The *semiarticulata* also have a basin of five pieces supporting five costal pieces. Their stalk is cylindrical, not widened at the top, and the fingers have only a single row of pieces. These are the POTERIOCRINITES.

The *inarticulata* are distinguished among themselves by the number of pieces of the basin. Some have five supporting five costal pieces; their stalk, not widened at the top, is cylindrical with radiate articular facets and their fingers have only one row of articles. These are the CYATHOCRINITES. Others have a basin of three pieces supporting five costals and one intercostal, these are the ACTINOCRINITES. A third genus of the *inarticulata* are the RHODOCRINITES, with a basin of three pieces supporting five intercostal pieces with which alternate five radials that completely separate from the basin; their stalk is round, not widened toward the top; the fingers are formed of a double series of articles. A fourth genus of *inarticulata,* that of PLATYCRINNITES, also has a basin of three pieces supporting only five wide pieces from which leave the arms and that, for this reason, Miller named the scapular pieces (*scapula*), and not costals. These Crinoids are thus recognizable at first glance by the simplicity of composition of their calyx. They have in addition a stalk not widened at the top, often elliptical and with fingers formed of a double series of articles.

The *Coadunata*, finally, of which we know only the basin, of a single piece fused to the last article of the stalk, are the *Eugeniacrinites*.

All these genera of Miller have been preserved, except changing the end *crénites* of their name into *crinus*.

Miller, in his book, also gave the description of the genus *Comatula* and the genus MARSUPITES. This is a fossil Crinoid from the English Chalk, lacking the stalk and that Mantell had named thus after Parkinson (*Organic remains*, v. 1, pl. 13) had described under the name of *Tortoise Encrinite*.

During the following years, the number of known species rapidly increased. Schlotheim added 4, Hinsinger 3; Goldfuss had already described 43 in his *Petrefact. german*., when, at the meeting of German naturalists in 1834, made known several others that he figured and described in volume XIX of the *Acta naturæ curiosorum*, 1838, and that, he said, then increased to 67 the total number of know species. Actually, several of these species were established from simple fragments of the calyx or the stalk. The number of genera was also increased by *Cupressocrinites, Eucalyptocrinites, Melocrinites* and

Solanocrinites of Goldfuss, genera that we accepted in changing their ending into *crinus*. We have, in addition, the genera *Gasferocoma* and *Glenotremites* of Goldfuss, *Pentremites* of Say (1820), *Echinosphaerites* of Wahlenberg (1821), *Echinoecrinites* of Meyer (1826), *Synbathocrinus* of Phillips (1836), *Comaster, Saccocoma* and *Pterocoma* of Agassiz (1836), *Aplocrinus* (*Haplocrinus*) of Steininger (1837), *Isocrinus* of Meyer (1837), *Caryocrinus* of Say (1838), *Tchehyocrenus* of Conrad (1838). We soon added in 1839, *Scyphocrinus* of Zenker, *Dimerocrinus* of Phillips, *Triacrinus, Tetracrinus* and *Dichocrinus* of Munster and *Guettardicrinus, Millericrinus* and *Bourguetticrinus* of D'Orbigny. This latter author had just separated them from *Apiocrinus*, in forming, with these four genera, the family Apiocrinides, in a review of the Crinoids that he has left unfinished. In the same work, D'Orbigny proposed substituting for the names used by Miller to designate the pieces of the calyx with basal, brachiales, accessory intermediaries, considering for these pieces the arrangement in whorls more than into rays.

We can thus already, in 1839, count more than 35 genera of Crinoids, even with suppressing those that have not been preserved to this day. This number that has recently reached more than 105, continues to grow, in 1840 by *Ctenocrinus* of Bronn; 1841, by *Carpocrinus* of Müller; in 1842, by *Stephanocrinus* of Conrad and of *Agelacrinus* of Vanuxem (the first example of a sessile Crinoid or even attached). In 1843, these are *Pseudocrinus* of Pearce and *Periechocrinus* and *Sagenocrinus* of the Austins.

In 1845 appeared the beautiful work in which Leopold de Buch established the family of Cystids (*Ueber die Cystideen*), in which with *Sphæronites* of Hisinger, which is *Echinosphaerites* of Wahlenberg, and *Sycocystites* of Buch, which is *Echinoencrinites* of Meyer, it contains three other completely new genera, *Hemicosmites, Caryocystites* and *Cryptocrinites*. He had taken for comparison *Caryocrinus*, that he left outside the Cystids as having arms. But the following year, de Verneuil gave a figure and a description of *Hemicosmites*, showing that this fossil was not as Buch indicated, and Volborth, in the *Mémoires de la Société minéralogique* of Pétersburg, showed that some Cystids have arms.

We must go back much further to resume the review of classification and organography of Crinoids from which we have separated in the enumeration of genera established since Miller. In fact, Meckel, in 1823 and 1826, described correctly the digestive system and its two openings in Comatulids. Delle Chiaje, in 1829, also published his important observations on these animals. Blainville, in 1834, in his *Manuel d'Actinologie*, definitively established, under the name of Asterencrinians, a distinct family to contain both the Comatulids and the Encrines or Crinoids.

We ourselves, in 1835, made known the remarkable fact of the development of the eggs at the base of the pinnule of Comatulids, making part of the same order as Asteroids and Ophiuroids.

J. Müller, in 1841, published two very important memoirs on Comatulids and *Pentacinus caputmedusae.* This was, for the Crinoids, the beginning of a series of works that would make known the genera *Carpocrinus, Coccocrinus, Ceramocrinus, Epactocrinus*, and ending by the beautiful memoir by the same author (*Ueber die Bau der Echinodermen*, 1853), in which is described the genus *Anthocrinus*.

Ed. Forbes, in 1848 (*Mem. of the geolog. Survey*), also published a remarkable work on the Cystids of England, with considerations on their relation to other Echinoderms. Two new genera, *Apiocystites* and *Prunocystites*, were established there at the same time.

D'Orbigny who, since his *Monographie des Apiocrinides*, had continued to occupy himself with Crinoids, gave, in his *Traité élémentaire de Paléontologie* (1850), a classification with the characteristic abbreviation of 66 genera, of which he established 15, namely: the 3 *Apiocrinides* of which we have spoken, in 1839, and 12 new to which he assigns the date of 1847, and which, nearly all, appear doubtful to us (*Phyllocrinus, Hemicrinus, Conocrinus, Cyclocrinus, Dimophicrinus*) or should be placed in other genera, like *Cupulocrinus*, which is *Taxocrinus* of Phillips, *Abracrinus*, which is *Carpocrinus* of J. Müller, and *Geocrinus*, which is *Periechocrinus* of the Austins. There remain thus, of the twelve last genera of D'Orbigny, only *Calliocrinus* and *Enallocrinus*. But the classification proposed at the same time by D'Orbigny, should better fix our attention as more complete than all those that have preceded it and can even give valuable indications that we often follow. We should recall first that this author uses to designate the pieces of the calyx, a nomenclature different from that of Miller and of J. Müller, and that of de Koninck, etc., that we use. We thus list in parentheses our synonymous names.

D'Orbigny divides the Crinoids into twelve families: 1° Saccosomides, 2° Marsupitides, 3° Comatulides, 4° Pentremitides, 5° Aplocrinides, 6° Cupressocrinides, T° Cystidés, 8° Polycrinides, 9° Melocrinides, 10° Cyathocrinides, 11° Apiocrinides, 12° Pentacrinides.

D'Orbigny still did not know *Anthocrinus* that Müller described only in 1853 and that had formed, for him, as for us, another family. The three last families contain all the Crinoids strictly speaking, with stalks and arms. D'Orbigny places them at the end of his classification immediately before the Polyps. He commences the series with Saccosomides, which he considers a link between the Ophiuroids and the Crinoids. "In fact," he says, "the arms here, as in the Ophiuroids, still do not have an upper canal." But the arrangement of the other families is not related to the series of affinities that we would have supposed, going from the Ophiuroids to the Polypiers. One of these families, moreover, has only one species, that of *Marsupitides*, and the family of Polycrinidae contains only three, that of Saccosomides contains four, that of Cupressocrinidae contains only the single genus *Cupressocrinus.*

1° SACCOSOMIPES have the calyx in the form of a purse, without stalk and without cirri; the arns, without upper groove, are slender, pinnat and biriufate.

2° MARSUPITIDES, fossils from the Chalk, also without stalk and without dorsal cirri, have the calyx covered with sixteen wide polygonal plates, of which a lower central (*basal*), five basals (*radials*), five intermediaries (*interradials*) and five brachials. They have five arms.

3° COMATULINES, living in part, fixed at a young age and becoming free later; the central piece (*basal*) is thick, conical and has a large number of ramules (*dorsal cirri*). "On this central piece, various pieces supporting five arms, then bifurcated one or several times."

4° PENTREMITNIDES, all fossil, with a thin stem, without arms, "have an oval calyx, solid, with five ambulacra united above." Each transverse striation has a "groove in the middle and a pore at the top."

5° APLOCRINIDES, all fossils from Paleozoic terrains, are, for D'Orbigny "Pentremitides with arms outside the ambulacra."

6° CUPRESSOCRINIDES, fossils of the Devonian terrain, with a "calyx widened, cup-shaped, composed of three series of pieces, five basal pentagonal pieces, five intermediary

pieces (*radials*), and five linear brachial pieces; five simple arms, fattened, wide, not divided, and a quadrilobed stalk." It is for D'Orbigny, of all the genera, the one that most recalls the form of Asterians.

7° CYSTIDES, fossils of ancient terrains, with "purse-shaped calyx, more or less spherical, composed of polyhedral pieces pierced on the upper part, with a central opening a second very near the first, and a third to the left of the central opening, formed of elevated valves; no arms; an articulated stalk."

8° POLYCRINIDES, containing the single genus *Eucalyptocrinus* of Goldfuss, or *Hypanthocrinus* of Phillips, fossils of the Upper Silurian terrain, hav a "cup-shaped calyx fomed of three series of pieces: five basal pieces; the arms formed of two double series of articles, not having been fixed by the visceral pouch, without being able to open.

9° MELOCRINIDES are all fossils of Paleozoic terrains, except the genus *Encrinus* that is a fossil from Triassic terrains. They a "calyx formed of thin plates, polygonal, suoperposed, composing a hollow bursiform ensemble that contains the lower two thirds of the visceral pouch; rest covered with testaceous plates found above the arms; tyee are always compose of two series of articles."

10° CYATHOCRINIDES, all fossils of Paleozoic terrains, have the "calyx formed of thin plates composed of a hollow bursiform ensemble that contains a large part of the viscera. The arms are always formed of a single series of superposed articles."

11° APIOCRINIDES, all fossils of secondary and perhaps tertiary terrains, form a "family characterized by it complicated root, its non-whorled stalk that is very long and rounded, its calyx formed of very thick plates superposed in series of five and composing a solid ensemble, cupuliform or pyriform, of which the hollow upper part only supports the visceral pouch without containing it."

12° PENTACRINIDES, near Apiocrinides by its "thick calyx, distinguished from it by its small rudimentary calyx; its pentagonal stalk with, here and there, whorled ramules; by the starred stalk, by the calyx not formed of articles of the stalk and containing no part of the visceral sac, and finally by very long arms." This family contains a living species and fossil species in all parts of the terrains after the Triassic.

De Koninck who, already in 1842–51, had published a description of fossils from the Carboniferous terrain of Belgium, resumed with Lehon the special study of Crinoids of this same terrain and having this time a much larger number of material, he was able to describe more or less completely no longer 15 species as the first time, but 53 of which, actually, as we have already said, many appear doubtful. These 53 species belong to 11 genera, of which 3 are new (*Mespilocrinus, Graphiocrinus* and *Forbesiocrinus*), and distributed in 5 families of CYATHOCRINIDAE, CARPOCRINIDAE, ACTINOCRINIDAE, PLATYCRINIDAE and BLASTOIDAE. These authors, describing only fossils of the Carboniferous terrain, where able to speak only in passing of the other families such as the Apiocrinidae and Cystidae; but we can judge that they accepted at least 10 or even 12 families. In addition, de Koninck announced that, in a later work, he would apply his terminology to all the genera of Crinoids, and that he would try at the same time to distribute the animals into natural families. We hope for the prompt publication of this work and, for the present, we say that what gives the most value to *Recherches sur les Crinoides* published in 1854 on the Crinoids of the Carbonifeous terrain of Belgium is the talent with which a nomenclature more rational than that of Miller and D'Orbigny, is

applied to the study of the pieces of the calyx of Crinoids, even the most complicated as *Eucalyptocrinus*, *Rhodocrinus*, etc.

The principle of this nomenclature, as the authors themselves say, must be attributed to J. Müller, who showed that these animals have the same radiate form as the other Echinoderms, we must start from there to choose the terms the most appropriate for the description of all the species. Consequenty, the names of *basal, sub-radials* (or *parabasals* of Mulier), *radials, interradials, axillaries, brachials* and brachial articles, should be preferred as always giving a correct idea of the location of these pieces and their relation to the general form. But what belongs completely to the authors is insisting on the importance of the pieces they call *anals* located on the irregular side of the calyx of some Crinoids that gives the bilaterally symmetrical form to these Crinoids instead of being regularly radiate. We do not accept, however, the name of *anal* pieces, no more than we can accept the name of *summit*, given by these authors to what is generally named the *calyx* of Crinoids. Without doubt, the name of *vault* is perfectly chosen by them to designate the convex or swollen upper part of the calyx. But for us, it is the vault of the calyx and not the vault of the summit, and the calyx, instead of being as for them, the lower part of the summit, is the entire summit in which we distinguish and upper part and a lower part.

Let us hasten to the *Traité de Paléontologie* of Pictet, who appears to have given the best classification of Crinoids, or at least the most complete of the period of its publication (1857) and we follow as much as possible. This author made the Crinoids an order of the same value as those of Echinoids and Stelleroids (this latter containing the two orders of Asteroids and Ophiuroids). He says “They have a body more or less spherical, pyriform or depressed and arms without relation to the digestive organs. All the surface is covered with a testaceous framework, thick, composed of pieces that touch each other exactly at their edges. There are never articulated spines. The mouth is always at the center of the dorsal surface so that the animal is in an inverse position to the Stelleroids. The anus is always distinct from the mouth and always lateral. Most Crinoids have ramified arms that are fixed and are attached to the ground by a pedicel that is more or less long, composed of articulated pieces.”

Pictet has formed the following nine families:

“1° COMATULIDAE or FREE CRINOIDAE, are never fixed in the adult stage and completely lack a stalk.

2° PENTREMITIDAE or BLASTOIDAE have a stalk and an oval calyx with five ambulacra united dorsally each with a median groove, a pore at the top and is striated transversally. Arms are missing.

3° CYSTIDAE also have a stalk, their calyx is bursiform, without ambulacra, composed of polygonal pieces, pierce with three openings, one of which is ovarian on the sides. There are sometimes short arms, sometimes no arms.

4° CUPRESSOCRINIDAE are fixed by a stalk; their top is similar to that of true Crinoids, butth arms are flattened, wide, not divided, like the rays of an Asteroid, and come together to form a pyramId.

5° POLYCRINIDAE are stalked and have ten ovoid club-shaped arms located in canals on the sides of the calyx; the latter are longer than they, protruding beyond them and forming a dorsal disk.

6° HAPLOCRINIDAE are stalked; they have very short and rudimentary arms, an a calyx composed of a small number of pieces, of which five triangular ones are arranged in a pyramid making a vault.

7° ANTHOCRINIDAE have a stalk and a well-developed calyx; their arms are in the form of five large, reticulated leaves.

8° CYATHOCRINIDAE are normal Crinoids with root, stalk and calyx having well-developed and free arms. The calyx is formed of numerous pieces, not very thick, touching at their narrow edges and surrounding a vast cavity that encloses the major part of the visceral sac. There is never an opening on the sides.

9° PYCNOCRINIDAE are also normal Crinoids with root, stalk and calyx having well-developed and free arms. The calyx is composed of very thick pieces, touching by wide surfaces and leaving in the interior a very narrow cavity and supports without enclosing the visceral sac. There is never an opening on the sides.

Of these nine families, the first and the two last only are sub-divided into tribes, of which several correspond to families in the classification of D'Orbigny; such are the three *Comatulians* tribes, *Saccosomians* and *Marsupitians* of the first and *Pentacrinians* of the latter. Two other tribes of the latter family, *Apiocrinians* and *Eugeniacrinian*s, together compose the family of *Apiocrinidae* of D'Orbigny. The tribe of *Encrinian*s, which completes this same family of PYCNOCRINIDAE, has been correctly separated from the family of *Melocrinidae* of D'Orbigny, which thus becomes more homogeneous. But then it differs from the *Cyathocrinidae* of the same author only by the arms with two series of articles in one and a single series in the others. As this character is only of very secondary value and even often transitory, Pictet has correctly united them into his family of CYANTHOCRINIDAE that he sub-divides into four tribes:

1° *Cyathocrinians*, the only ones that have five sub-radial pieces (*para-basals*), alternating with the radials that they separate from the basals.

2° *Actinocrinians* "have a vast calyx composed of numerous pieces; we count three (and sometimes four) basals, three radials under each of the five rays, and numerous inter-radials; the calyx is often increased by the fact that the first brachials are part of is walls. There is often an anal in the row of radials."

3° *Carpocrinians "*have a smaller and short calyx, to which the brachials do not contribute; we count three or four basals and a relatively large number of radials (often four in each ray)."

4° *Platycrinians* "have a calyx compose of a small number of pieces; we count only three (rarely two) basals, two radials in each ray (rarely three), a single interradial in each interval, and sometimes an "anal."

Pictet noted, moreover, that the four tribes of *Cyathocrinides* belong exclusively to the Paleozoic period, like the *Pycnocrinides* to the most periods.

Also in his work, Pictet has united the description of all 105 genera that had been previously published, and notably the ten preceding years, by de Verneuil, Roemer, Mac Coy, Müller, Hall, the Austins, Forbes, Bronn, Trovst, David Owen and Shumard, etc.

We shall return to this in speaking of these genera; we must add only here that Roemer, who has published numerous works on Crinoids, notably an excellent *Monographie des Blastoïdés* (1851), has, on his side, completed the enumeration and decription of genera of fossil Crinoids, in the last edition of *Lethæa geognostica* of Bronn, to whom he was associated for this work.

Finally, to complete a review of the Crinoids, it remains for us to say that, in 1857, D'Orbigny published the description and figure of a new genus of living Crinoids that he named *Holopus*, found near Martinique, but no other naturalist has been able to confirm this observation.

DESCRIPTION, FORMS, CALYX OF CRINOIDS.

Crinoids, generally more or less globular, nearly always today have at the lower part, at least if they are attached, the form of a calyx or cup. This form widens greatly in the Comatulids. It is narrowed, on the contrary, in the Apiocrinians, and becomes completely closed and over, or even spheroidal in Blastoids and Cystids. This lower part is always supported by five contiguous calcareous pieces as in Echinoids that is called the test of these animals, but in fact secreted in the very thickness of living tissue, and less thick because a larger visceral cavity must be enclosed by it. The upper part, when the calyx has remained flared, must have been fleshy as in Comatulids and *Pycnocrinids* in general, and have secreted only thin plates near its surface. But in *Cyathocrinides*, it has secreted contiguous plates like those of the lower part, although less regular and relatively much more numerous and always in variable number. These plates, preserved in place by fossilization, form a vault and often also a tubular extension that we call a trunk, but that, as we shall see later, has no relation with the digestive system. It is thus on the lower part, except in the case of attachment (*Agelacrinus*), that the pieces of the test are more regularly arranged and called *basal pieces* for those that surround the basal pole and that correspond to the point of attachment of the stalk, either by these pieces all fused together, forming what is called the basin or centro-dorsal piece of Comaulids and of *Eugeniacrinus*, or they are distinct, five in number, as in most of the *Actinocrinians*, in *Apiocrinians, Encrinians*, etc., or that, because of some fusing, the normal number of five is reduced to four, three, or even to two pieces, or that the normal number of six in some Cystids (*Caryocrinus*) is reduced to four. Above these basal pieces and alternating with them, are usually five other pieces (radials) that are the beginning of as many rays often extended outside the calyx by more or less ramified arms, and formed themselves, as well as their ramifications, of numerous articulated pieces, either in one or two rows that come from these pieces, alternatively wider on the side where the pinnules are attached, causes thinning on the opposite side, cease to reach the other edge of the arm to which they belong. This difference thus cannot provide an essential character, no more than the fact of one or several fused basal pieces.

The *radial* pieces we just mentioned are two, three, four and even five in number in each vertical row, counting the last in each ray. This, having two beveled facets supports two branches of a ray that have been taken for distinct arms. The number of arms thus increases to ten, unless a larger multiplication increases by later subdivisions. The pieces of each branch preceding the second bifurcation are called first, second, third *brachial*, etc. and if some pieces are found inserted between the two branches of the same ray, we call them axillary pieces. In the same way, when other pieces, reaching the top, are intercalated between the radials of two adjacent rays, we call them *interradials.* But a more important particularity and even characteristic of the tribe *Cyathocrinians*, is the presence of a transverse or whorled row of para-basals, intermediary between the basals and the radials,

and alternating with each other. This causes the first radials, instead of resting on the basals and alternating with them, i.e., being opposite to their lateral sutures and to the sides of the pentagon that ordinarily forms these basals, are totally separated by the parabasals. They thus correspond to the basals themselves or to the tops of the pentagon that they form and have consequently their lateral sutures in the extension of those of the basals. These parabasals of J. Müller are called sub-radials by de Koninck and Lehon and by Pictet. But we prefer the first name, as it is not unambiguous and suggests that a whorl has been omitted or lost, as happens for flowers that have the pieces of a whorl opposite to those of a contiguous whorl instead of being alternate.

When, finally, one of the interradial spaces of a Crinoid, and particularly of a *Cyathocrinid*, is larger than the others, there are there one or several supernumerary pieces, called anal by the authors cited above, without it being demonstrated that these pieces have a relation of some kind with the anal opening.

THE STALK OF CRINOIDS AND THE ROOT.

The calyx of nearly all Crinoids is supported by a more or less long stalk, formed of pieces also secreted by living tissue that surround them and, consequently, of the same structure as the other parts of Echinoderms. The pieces or articles of this stalk are ordinarily very numerous, cylindrical and have radiating striations on their articulating surfaces. But, by exception, in *Pentacinus,* they are prismatic, pentagonal, or with five protruding corners and have on the articular surfaces a star with five branches or a rosette with five petals, formed by very numerous striations or points. By exception also, this stalk is elliptical, or compressed alternatively, in one direction and in the other. At each articulation in some *Platycrinus* and in *Bourguetticrinus,* these having at the same time a protruding rib, following the large diameter of each articulation, alternatively in front and in back, and from right to left, those having in addition radiating striations.

The stalk is ordinarily nearly the same thickness in all its length. Either it grows uniformly, or it ceases to grow in thickness as soon as the new articles are formed. These new articles ordinarily form below the calyx, but often also at several points of the upper end of the stalk, as well demonstrated by the more swollen articles that we see here and there on the stalk of *Encrinus*, for example, and that, separated by 5 to 7 articles at the lower part, are much less toward the top.

However, many Crinoids have a more or less complicated root, spread out and thickened on the rocks, and capable of growing by itself and nourishing the stalks and producing new ones. These Crinoids, such as *Cyathocrinides* and especially *Apiocriniens*, have the stalk much larger toward the base and progressively thinner toward the top so that seeing on one hand the calyx capable of growth and on the other hand, the stalk toward its base as well as the root, thickened by successive layers and more and more spread out on the rocks, we are tempted to believe that it has these two principal centers of nutrition, or that, at least, nutrition by absorption dominates toward the base and on the roots.

The stalk in addition frequently has numerous accessory rays that appear to form by gemmation and also contribute to nutrition by absorption. Finally, the stalk is ordinarily crossed all along its length by a canal that is round or pentagonal or with four or five lobes that communicate with the visceral cavity and that appear to serve for nutrition but that evidently cannot suffice. Finally, an exceptional form of stalk that is shorter and narrower toward the base occurs in Cystids.

SYSTEMS OF NUTRITION (DIGESTION, RESPIRATION, ETC.) AND AMBULACRAL OF CRINOIDS.

It is only in Comatulids and the only living *Pentacrinus* that we see a digestive system in the form of an irregular sac with a central mouth on the dorsal surface and an anus turned on the same side and located a short distance from the mouth. This anus is at the end of a protruding tube so that the expelled products are separated from the action of the cilia in the ambulacral groove that takes floating corpuscles to the mouth. The mouth, on the contrary, is found at the point of convergence of the ambulacral grooves.

By analogy, we can suppose a similar digestive system in *Pycnocrinides* whose dorsal surface is soft or that, at last, does not have the solid vault of *Cyathocrinides.* But, in them,

we cannot suppose that the ambulacral grooves of the arms are extended to the mouth, especially if we want this mouth to be the end of the tube that we call the trunk. This tube, if it were always open at the top, would instead be an excretory tube, or for water for interior respiration, or for eggs. The arms of *Cyathocrinides,* lacking a dorsal ambulacral groove, have had, like those of Comatulas and *Pentacrinus*, fleshy tentacles for absorption and cilia for respiration, in producing a current toward the calyx. Such a current penetrates by wide opening that we note at the base of the arms of *Cyathocrinides* (and of *Caryocrinus*), and that, even when they are partially covered by small plates that form a kind of operculum, still leave a sufficient passage. Everything proves, on the contrary, that the ambulacral groove cannot in any way extend to the end of the trunk.

de Koninck and Lehon (*Recherches sur les Crinoïdes*) consider the single opening of the vault of *Cyathocrinides*, that is at the top of a trunk or level with the vault as receiving the two ends of the alimentary canal, which appears to us very difficult to conceive. These authors, because of the difficulty of obtaining an entire trunk, are led to think that the end of the trunk is flexible and that the integumentary substance that separates the plates is dissolved so that the plates are isolated and scattered." They are not very disposed, moreover, to accept completely the assertions of the Austins, who said (*A monograph on recent and fossil Crinoidea*, 1843) about the trunk of *Actinocrinus*, that it has a system that permits it to search at the bottom of cells of Polypiers, the fleshy parts on which they feed, as if these Crinoids, by flexing their stalk, were able to constantly find Polypiers. de Koninck and Lehon willingly accept the other fact cited by the Austins: "that fossil Crinoids had univalve shells scattered in their arms, as if they had been buried in silt and killed when they were seized. This fact, they said, could indicate the use of the trunk whose structure was very favorable for its introduction into the shells that could be attacked only by the mouth and a certain depth in the testaceous part." They concluded that the trunk should be flexible, as they had previously supposed. As for us, these facts and this hypothesis do not appear very probable.

On the other hand, de Koninck and Lehon, who have not been able to obtain an end of the trumk of *Actinocrinus*, who have not been able to find in the existing works even a good figures of one of these appendages, and who have only two specimens of the genus *Platycrinus* with an entire trunk, declare in the same work (page 58) that the "two trunks of their collection dhow no certain indication of a mouth at their end." Then, while saying that the intact trunk was hermetically closed, they find "very probably that the plates of the end of the trunks could be raised at a point and allow the Crinoids to obtain, by suction, the softest part of some mollusks."

Later, the same authors say that it would be rash to say with too much certainty about the nutrition of Crinoids, and that because one genus has a trunk that this genus has the same way of life as another genus that also has a trunk. This part, moreover, varies considerably, they say, in form and proportion, and while it is narrow and very long, it is enormous, as in *Poteriocrinus crassus*, where it reaches up to 100 and 126 mm. in length and 63 mm in circumference. That of *Dendrocrinus,* if it is authentic, would be even more remarkable for its length.

What conclusion can be made of all this if not that the trunk is completely without relation with the digestive system? But if the trunk does not end in a mouth, we do not see in most *Cyathocrinides*, any other opening to which we can give this name. It is perhaps not the same in Cystids that are said to have two or three openings, one of which has been

named ovarian opening, nor in Blastoids that have still more numerous openings. But in these various cases, it appears to us more reasonable to relate these openings to respiration and reproduction.

How does nutrition occur in animals or portion of animals that we say have no digestive system? By absorption on all the surface as we see in the growing roots of *Apiocrinians*, and as seems to be shown in the points, tubercles the long spines that develop on various pieces of the test of some *Cyathocrinides*, *Dorycrinus* (pl. 3), of *Culicocrinus*, *Acanthocrinus*, etc., that, no receiving nourishing juices by the interior canals, can be nourished only by imbibition or by absorption. We have previously also given the opinion that the surface of these Crinoids, especially those with scattered granules or tubercles, could have had scattered appendages more or less analogous to the pedicellariae that are external organs of nutrition in Echinoids and Asteroids, and, moreover, fleshy tentacles, papillae, but without cilia that we see on the dorsal surface of the pinnules on the arms of Comoatoulids (pl. 1), can only be themselves, organs of absorption.

As for the organs of respiration, they are external, like the cilia of the ambulacral grooves that thus have a double function; or internal, like the parallel lamellae we see on the interior of Cystids (*Caryocrinus, Hemicosmites*, etc.) and Blastoids (pl. 2), and on which the exterior liquid enters either by holes on the surface or by some other openings attributed to the digestive as a result of ciliary movement, can leave by the openings that do not function for entrance such as those we see at the top of the ambulacra of Blastoids. We have already said that in *Cyathocrinides*, the current of the liquid, after having followed the axis of the arms, must also penetrate into the interior of the calyx.

The ambulacra or pseudo-ambulacra of Blastoids have thus been respiratory organs even though they have always had articulated pinnules that Roemer has seen on a siliceous specimen. It is the same with the pectinate losenges of Cystids and the so-called attachment arms of *Pseudocrinus, Agelacrinus, Eucalyptocrinus*, etc., that are formed by a multiple series of meshed pieces, having supported pinnules with cilia or having let water into the interior by holes or interstices.

J. Müller has recognized in Comatulids and *Pentacrinus*, the existence of a vascular system and a nervous system that we shall consider later in treating these animals in particular. We have nothing to add to what we have already said on the subject of locomotion, flexibility of the stalk and the arms, or agitation of these same arms in Comatulids.

REPRODUCTION, REGENERATION, GENERATION AND METAMORPHOSIS OF CRINOIDS.

All types of Crinoids with arms have examples of reproduction or regeneration of arms broken or destroyed by accident. Even in fossils we frequently see examples. The new arm is thinner and shorter than the others and narrower than the trunk on which it articulates, but it contains the same number of articles as the part it replaces. We can think that these articles will soon acquire the dimensions of their predecessors.

What we know about reproduction of Crinoids is limited to the knowledge from the fact of the development of the eggs or spermatozoids at the base of the pinnules of the arms

of comatulids, under the integument of the dorsal or ambulacral surface. We suppose these products spread out outside after the rupture of these too swollen integuments.

We can also suppose that it is the same in that have the dorsal part of the calyx soft and not covered with a resistant test. But in all other Crinoids, we are forced to admit that the eggs are located, at least temporarily, in the visceral cavity, sometimes so ample. This cavity, without a digestive system, should contain only the eggs and the respiratory system that should facilitate their development as we see in some Medusae (Rhizostomes). Actually, in *Cyathocrinides*, we can suppose that the eggs, at first produced in the pinnules of the arms, are taken by the current of the ambulacral grooves into the interior of the calyx with the water for internal respiration to undergo some later development, perhaps even to undergo some metamorphosis. In this way we shall explain better the abnormal dimensions of the so-called trunk of some *Cyathocrinides*, because it would be an incubatory pouch. It would have only a temporary opening for the release of the embryos or large, or how this opening would be closed by the valves. This valvular arrangement of an ovarian opening for the release of the products of generation even seems to be found generally in Cystids.

The eggs of Comatulids have the structure of those of other Echinoderms: a vitellus, with the vesicle and the germinal patch. Likewise, at the beginning of their development, they are covered with cilia by means of which they move freely. The embryo has been described by Bush (pl. 1, fig. 1), as a cylindrical body, three or four times longer than wide, rounded at two ends and with several zones of cilia.

It is much later that we then see the Comatulids in the form of a small pedicellate polyp, as a *Campanulair* (pl. 1, fig.2). The development of the pedicellate body has been followed to a small Comatula, still supported by a pedicel attached to the middle of the dorsal surface, so that Thompson, the author of this discovery in 1827 believe he saw a small species of *Pentacrinus* (*P. europoeus*). Blainville, after the description, believed even to have the form of a new genus that he called *Phytocrinus*. But Thompson himself, in 1837, recognized the true nature of these young Comatulids.

After that, we can think that Crinoids must have undergone also metamorphoses, but it is even probable that for the genera with roots grow and produce buds, like *Apiocrinians*, the metamorphoses had more the character of alternating generations.

GEOGRAPHICAL AND PALEONTOLOGICAL DISTRIBUTION OF CRINOIDS.

We have little to add to these two questions. The Comatulids, not very numerous, are widespread in all the seas and we know at least four species on the coasts of Europe. Some even go very far toward the North, along the coasts of Norway.

Pentacrinus caputmedusae has been found several times in the sea of Antilles and this is also where the *Holopus* of D'Orbigny comes from if, however, we are to consider it a CrinoId.

As for the paleontological distribution, we refer to what has already been said previously and repeat here only nine families of these fossil animals. There are seven that belong nearly exclusively to Paleozoic terrains, while of the three tribes of the eighth, there is one, Encrinians, that is restricted to the oldest secondary terrains (Triassic), one other

that is restricted to Jurassic and Cretaceous terrains, and a third *Pentacrinus* that continues from the end of the Triassic period up to the Present period.

CLASSIFICATION OF CRINOIDS.

The order of Crinoids contains genera so dissimilar that we often find only a common link that unites all Echinoderms. This is that provided by the fine structure of the test and by the more or less pronounced tendency for radial disposition and this other character of having the basal pole fixed with a stalk and always absolutely lacking a buccal opening.

Also, while accepting with some modifications, the nine families established by Pictet, we think that four or five of the better-known families could become distinct order when they have been sufficiently studied by successive sections made in different directions of the structure of specimens today too rare and too valuable for their owners to willingly consent to their destruction.

A sixth family studied similarly, that of Haplocrinides, could well be considered as formed only of young individuals of another group, Cupressocrinides for example. Cystidae, erected as a distinct order, would itself by subdivided into families according to the indefinite or limited number of pieces of the test, according to the presence of free or attached arms, and according to having peduncles or adherent by all their ventral surface. Until then, these differences serve to establish sections in the family Cystidae, kept as they are. We shall continue to place in the unique order of Cystids the six families in question with the *Cyathocrinides, Pycnocrinides* and the *Comatutides*. These contain only normal Crinoids, with a distinctly radiate form, always with five principal arms, more or less subdivided or ramified and with an ambulacral groove on the dorsal surfaces as on all their subdivisions. These Crinoid are ordinarily supported by an articulated stalk, at least temporarily. But several become free early, like Marsupitians and Comatulids. Another, on the contrary, *Cyathidium*, appears to have been always fixed and, also, to be propagated by gemnation.

These three families are distinguished among themselves, as we have seen, because the first (CYATHOCRINIDAE) has ambulacral grooves limited to the edge of the calyx and they do not reach the central mouth. The second, (PYCNOCRINIDAE) has the basal pole located at the top of the stalk and not by a centro-dorsal piece. The third, finally, (COMATULIDAE) is characterized by a centro-dorsal piece that appears to result from the fusion of all the basals with the top of the stalk and perhaps even the first radials, so that if we see some supplementary pieces between the radials, they are parabasals or even interradials

1° CYSTIDAE, by the multiplicity of diverse forms that they unite, are not as easy to characterize as at the time when Léopold de Buch established a distinct family with five genera that he then knew. They were supposed to be all stalked, lacking arms and ambulacra, all with three openings, one of which, located at the dorsal pole must be the mouth often extended in a kind of tube. Another, closed by valves and located laterally was named the ovarian opening. A third finally, was taken for an anus. Today, except for the character of the ovarian opening, covered with small values united into a pyramid, we can characterize them only by the negation of the characters of other families, notably by the absence of the quinary arrangement of the pieces of the test, by the absence of the five

ambulacra of the *Blastoides*, of the five grooves of the *Haplocrinides*, and the five multi-artticulated valves of the *Cupressocrinides*, etc.

2° BLASTOIDAE, or *Pentrémitidae*, lack the digestive system, like Cystidae and the five following families, the central mouth, or rather the hiatus, existing in some between the five ambulacral lobes and that could be incorrectly taken for a mouth, completely lacking in all the others. But they have an ovarian opening with opercular valves, and ten respiratory openings for the release of eater that enters by the holes of the five ambulacra. These five ambulacra, arranged with regularity like the petals of a flower, are located in a notch of each of the five radial pieces. They rest on the basal pieces reduced by two fusions to three. Interradial pieces fill the rest of the interval between the ambulacrals and complete the calyx that, except for the openings of which we have spoken, is closed above. Consequently, it is composed only of thirteen pieces in addition to the ambulacra.

3° HAPLOCRINIDAE also have the calyx closed on top and composed of a very small number of pieces (11,12, 14 or 18), of which each of the 3 or 5 basals and 5 interradials have an impression that appears to have been the place of insertion of an arm. But all these Crinoids are very small and it is possible to think that most are young individuals of *Cupressocrinidae* or *Platycrinidae*, whose form and number of pieces varies with age.

4° CUPRESSOCRINIDAE have, like several of the preceding, five basals, or rather parabasals, resting on the terminal and pentagonal piece of a square stalk, crossed by a quorilobed canal, five pentagonal radials alternating with the parabasals and surmounted themselves by a second thin radial thin like a lintel. Each supports a series of decreasing pieces, forming the side of a pentagonal pyramid. Each of these series that sometimes is called an arm, can be separated, like a valve, for the release of eggs. The number of its pieces increases with age. It has scattered granules that must have supported external appendages and are pierced with a hole to give access to water.

5° POLYCRINIDAE, without direction relation with any other family of *Crinoids*, have a very complex calyx, of which the five very small basals seem to be pushed in, in the form of a mamelon by the conical end of the stalk. The first five radials rest both against this end of the stalk and against the basals. They support five second radials separated alternatively from each other by as many interradials. Each secondary radial supports two arms attached along the sides of the calyx or rather two lanceolate pseudo-ambulacra that thus are ten and that are separated alternatively by intervals of 2°, 3° and 4° order or by axillaries. The vault is closed by the continuation of the interradials and the axillaries and appears to end by an opening for the release of eggs and for water for respiration.

6° ANTHOCRINIDAE are even more different, perhaps, from normal Crinoids, by the wide reticulated expansions of the arms and appears to have been able to open like the five petals of a flower, and to have been rolled up like these petals before blooming. The very complicated calyx appears formed of five basals, five or six parabasals and five first radials on which are superposed three other pieces or where are produced numerous articles that, by their multiplication and anastomoses constitute the foliaceous arms.

7° CYATHOCRINIDAE, 8° PYCNOCRINIDAE and 9° COMATULIDAE have been sufficiently detailed above. We thus can summarize this classification:

I. *Crinoids* not subject to the quinary mode of division, with a valvular ovarian opening. …….……1. CYSTIDAE

II. *Crinoids* subject to the quinary mode of division and without a valvular ovarian opening.

A. Calyx completely closed by the radial and interradial pieces, without a distinct vault or membranous wall above.

a. Radials with five petaloid ambulacra. ……..……. 2. BLASTOIDAE
b. Radioles with ten lanceolate arms-, or pseudo-ambulacrals attached to the sides. …… …… 5. POLYCRINIDAE
c. Without ambulacra or attached arms.
α. Radials also having an impression that should indicate attachment of an arm, and from which leaves a groove directed toward the top. ……3. HAPLOCRINIDAE
β. Radials each having a series of decreasing pieces, the series forming a side of the terminal pyramid of the calyx…… 4. CUPRESSOCRINIDAE

B. Upper part of the calyx occupied by a vault formed of numerous tessellated pieces

d. Five wide reticulated expansions instead of arms. …… 6. ANTHOCRINIDAE.
e. Five arms more or less subdivided and ramified, formed of numerous articles. …….…… ……... 7. CYATHOCRINIDAE

C. Dorsal part of calyx occupied by a fleshy integument, flexible.

f. Calyx closed ventrally by the upper end of the stalk …….. 8. PYCNOCRINIDAE.
g. A single centro-dorsal, occupying the bottom of the calyx. ……. 9. COMATULIDAE.

FIRST FAMILY. CYSTIDAE.

Calyx globulose or ovoid and having a stalk ordinarily short and thin below, or calyx that is depressed and attached to foreign bodies.

The number of pieces of the calyx (test) is indefinite or if it is definite, it does not pass 16 or 20 for the three lower rows that occupy more than two thirds of the surface. These pieces are never arranged in the quinary mode or by five, as in other Crinoids, but according to the binary or ternary mode, or by 4 to 6, completely without order. An opening closed by 5 to 8 triangular valves forming a small pyramid always seen in the upper hemisphere on one of the sides, called the *ovarian opening*; and a second opening located near the top, but not existing in all Cystids, has been called the *mouth*, like a third opening even less constant and near it has been called the *anal orifice*. But it is more probable that these latter openings, when they exist, serve for respiration. Sometimes the arms or

appendages that are irregular, free, fixed or variable in number, leave from the top or dorsal region. Other times, the attached arms or pseudo-ambulacra, two, four five in number, leave the top and should also serve for external respiration.

REVIEW.

CYSTIDAE or *Cystidae* were thus named by Léopold de Buch who was the first in 1845 (*Ueber die Cystideen*) to unite into a single distinct family the few species described before him and the few species that he himself had discovered. There then were 7 of them, distributed in his 5 genera *Caryocystites, Hemicosmites, Cryptocrinites, Sphaeronites* and *Sycocrinites*, of which the latter two must retake the names of *Echinosphaerites* and *Echinoencrinus* that had been given them previously by Wahlenberg and Meyer. However, de Buch did not want to include among his Cystids, *Caryocrinus ornatus* that, however, had served him for comparison to explain the structure of Cystids and that greatly resemble, in fact, *Hemicosmites.* But not having seen traces of the arms, or the arms even, seen successively by Volborth, de Verneuil, and by J. Müller, Forbes, etc., he took for an absolute character the absence of these organs and believed it necessary to separate *Caryocrinus* that evidently lacked them.

This latter genus, which we add as done also by Pictet, is thus the sixth of the family of Cystidae.

Previously also, in 1842 (*Geology of New York*), Vanuxem had established the genus *Agelacrinus*, so remarkable for its attached arms and its parasitism. And Pearce, in 1843 (*Proc. of the Geol. soc*. IV, p. 160), had described for the first time *Pseudocrinites* or *Pseudocrinus.* Volborth, in 1842 and 1844 (*Bulletin de l'Acad. de St-Pétersbourg*), had published important observations on *Echinoencrinites*, to which he attributed arm and later again (Verhandl. *d. miner. Gesellsch*., 1845–1846, p. 461, pl. ix and x), made more completely known the external structure of *Echinosphaerites* that he then separated from *Sphaeronites* and the genus *Protocrinites*, established also from facts correctly observed, established in 1841 by Eichwald. de Verneuil, in *Géologie de la Russie*, 1845, also brought correctly observed facts, particularly on *Hemicosmites*. Hail, 1852, in Paleontology of New York, had indicated the genera *Callocystites, Hemicystites* and *Heterocystites*. Forbes, in 1848 (*British Cystideæ Mem. of the geol. Surv.*, I, 2), presented very important considerations on Cystids in general and on the pectinte losenges that characterize several of them. Then, in listing the Cystids of England, he described two new genera, *Apiocystites* and *Prunocystites*. D'Orbigny, in his *Cours élémentaire*, 1850, made the genus *Calliocrinus* with *Eugeniacrinus eostatus* of Hisinger. Finally, J. Müller, in 1853, confirmed the distinction of *Echinosphaerites* and *Sphaeronites*, in attributing to the latter, as well as to his *Glyptosphaerites* and to *Protocrinus* of Eichwald, geminal pores. The following year, Müller, in the *Mémoires de l'Académie de Berlin* for 1853, confirmed the previous observations of Volborth on the arms of *Echinospherites*.

After the preceding details, and in adding the genus *Leucophthalmus* of Kœnig, *Heliocrinus* of the Duke of Leuchtenberg and *Cyclocrinus* of the Austins, that are too imperfectly known, we reach total number of 19 genera of Cystids, containing about 48 species. Let us still exclude the genus *Stephanocrinus* of Conrad that Roemer, who studied

it most completely in 1850 placed among the Cystids and that we believe on the contrary must be reported among the *Haplocrinides*.

DESCRIPTION.

Cystids have been described by De Buch as lacking arms and generally having three openings: namely, a mouth at the top or vertex, sometimes prolonged into a kind of trunk; an anal opening located near the mouth and that often cannot be found and that always appears doubtful to us; third, finally, an ovarian opening located laterally at some distance from the mouth and covered with triangular plates forming a clear pyramid by their by their meeting. The authors who came later or even earlier, such as Volborth, recognized that several of these Echinoderms had arms, either free or attached.

From our point of view, Cystids were not complete animals, but organs of reproduction. It is thus not necessary to attribute to them a mouth and an anus and, in addition to the ovarian opening and the corresponding internal structure is only an internal or external respiratory system. The upper opening, when it exists, is thus not necessarily a mouth and it functioned instead as a kind of entrance or exit of water that has entered by holes or pores of the surface and that was filtered by corresponding internal lamellae. If arms existed, either free as in *Caryocrinus* and *Hemicosmites*, or attached as in *Pseudocrinus, Apéocystites, Callocystites, Agelacrinus*, etc., they functioned exclusively for external respiration and had no relation with a buccal opening toward which they do not in any case direct the currants of the external liquid along the ambulacral groove of these arms. But when the arms are attached, they are formed of articulating pieces of rather meshed laterally and alternatively with each other, having perhaps external appendages and completely without communication with the interior.

It is necessary to mention here the ramified grooves that Volborth has described on the top of *Sphaeronites* and *Protocrinus*, and that appeared to him to lead to a mouth covered with irregular plates.

We have named *pectinate lozenges* (see Atlas, pl. 2, fig. 8) three special devices that evidently function in respiration that are found exclusively in *Pseudocrinus, Apiocystites, Callocystites, Prunocystites* and *Echinoencrinites*. These lozenges are arranged symmetrically, or nearly, on each size of the ovarian opening at the same level at a certain distance. The third is located near the base and diametrically opposite this same ovarian opening so that in a diagram of all the pieces of a Cystid in question spread out on the same plane, the three lozenges are at the tops of an equilateral triangle as shown by Forbes. Each lozenge, much smaller than one of the plates of the calyx, is composed of two parts in the form of a more or less rounded triangle on two contiguous plates on each side of a suture. Each triangle is itself surrounded by a protruding edge and has very regular deep striations directed in the direction of the small diagonal of the lozenge, i.e, perpendicularly to the suture that separates the two triangles. Under these striations, in the interior, are corresponding lamellae like those of *Caryocrinus*, and at the two ends of each striation are (*Echinoencrinites*), especially when the surface is worn, some oblong pore communication with the interior.

Geminal pores that probably have the same function are seen on *Sphaeronites* and *Glyptosphaerites* have given J. Müller a distinctive character for these genera of Cystids[1].

The surface of several Cystids has scattered granules or small tubercles completely like those that have pedicellariae of Echinoids. One can thus accept that there were appendages there serving the same function of pedicellariae, nutrition. This was done, in addition, by the entire surface as by the stem that is relatively larger in young individuals.

DEVELOPMENT OF CYSTIDS.

As for development of Cystids, it occurs not only by regular peripheral growth of each plate that thus has also a growing number of tubercles and pores on the exterior and of respiratory lamellae on the interior. But also in several, the number of plates is going to increase, either on all the surface (*Sphaeronites, Echinospheaerites*), or at the top or vertex, as in *Caryocrinus* that has, in addition, considerably more arms as it grows. Thus, young individuals, 7 to 8 millimeters long, have only three arms, those of 10 to 15 milimeters, have six to eight, and the larger ones have twelve.

PALEONTOLOGICAL DISTRIBUTION.

Cystids are the first Echinoderms to have lived on the surface of the globe, the first also to have disappeared. They belong exclusively to Paleozoic terrains and even, for the most part, to the oldest of these terrains. Thus, of the 19 or 20 genera that we have cited, one alone belongs to the Carboniferous (*Sycocrinus*). One only, having begun with the first Silurian layers (*Echinosphaerites*), continues to the Devonian terrain. All the others belong to the Silurian terrain and it is in the Lower Silurian exclusively that we find 10 of these genera. Most of these fossils are singularly localized and until new investigations have found them elsewhere, it is justified to think that some species belong specially to the Lower Silurian of Sweden and Russia.

CLASSIFICATION.

Many Cystids are still known only by specimens too imperfect or incomplete, or too few so that each species is missing having all degrees of development. Each year increases the number of fossils for these fossils, still so rare. They are seen in France only in the rich collection of de Verneuil who, himself, is far from possessing all the species described recently by American and English geologists or found exclusively in Sweden. We thus can establish for Cystids only a provisional classification. We first divide them into sessile or attached, and stalked, then, among the latter, then distinguish those which have the calyx form of an indefinite number of pieces or limited, at least on the lower part, and those that

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[1] These pores were seen and figured in 1848 by Forbes, and after the perfect figures given by this author, it could be believed that they belong to parasitic animals (near Botrylles), all the more as the two pores of the same pair sometimes correspond to two different plates. It is a question to be clarified later.

have free or attached arms. Finally, among these, the presence of pectinate lozenges provides a distinctive character. We thus have the following classification:

A. Stalked Cystids.

1. Pieces of calyx in indefinite number.
* Pores in series or scattered.
§ Six basal pieces, two, three or four irregular arms leaving from an extension of the vertex. …….. 1. ECHINOSPHAERITES.
§§ Four basal pieces.
† Ten radials and sub-radials. ……. 2. HETEROCYSTITES.
†† Six radials and sub-radials. …… 3. CARYOCYSTITES.
** Pores geminate; ramified grooves converging at the top.
§ Without defined basals or parabasals
…… 4. SPHAERONITES.
……. 5. GLYPTOSPHAERONITES.
§§ With defined basals and parabasals. …….. 6. PROTOCRINUS.

II. Pieces of the calyx in definite number, at least in its lower part.
* Without arms (?). …… 7. CRYPTOCRINUS.
** With free arms inserted at some distance from the vertex.
§ Without pectinate lozenges.
† Never more than three short, thin arms. …… 8. HEMICOSMITES.
†† Arms thick, whose number increases with age, from three to twelve …….. 9. CARYOCRINUS.
§§ With pectinate lozenges.
Arms very long, tentaculiform. …… 10. PRUNOCYSTITES.
Arms short (?) …….. 11. ECHINOENCRINTES.
*** With attached arms, leaving from the vertex, with pinnules or tentacles, and with pectinate lozenges.
§ Four basal pieces and five radials and subradials
† Arms swollen, with articulated pinnules ……. 12. PSEUDOCRINUS.
†† Arms located in grooves. …… 13. APIOCYSTITES.
§§ Four basals, eight radials and sub-radials. ……. 14. CALLOCYSTITES.

B. Sessile or attached Cystids. …….. 15. AGELACRINUS.

1ST GENUS **ECHINOSPHERITE** *ECHINOSPHAERITES.* — WAHLENBERG.

Atlas, pl. 5, fig. 5.

Calyx globular, stalked, formed of a very large number of polygonal plates arranged without order except the six basal pieces that rest on the stalk. On the upper part, it is ended by a small extension from which leave two, four or more usually three irregular articulated arms. On the side of the calyx, above the middle, is the ovarian opening covered by five

triangular plates united in the form of a pyramid and that has been considered wrongly as not being able to open. On these plates is a pore located near the top of each plate, as sufficient to give passage to the eggs.

The polygonal plates of the calyx have numerous pores in series for the entry of water and have protruding ribs in parallel series and that continue with those of the adjacent plates, in passing perpendicularly to the sutures, so that the entire surfaces is ornamented with stars in relief, or have a network of multiple meshes that ordinarily mask the sutures and the striations of growth. We recognize, moreover, that the number of these plates must increase with age. The stalk is cylindrical with a pentagonal feeding canal.

De Buch considers correctly *Echinospherites* or *Spheronites* as the symbol or type of Cystids because they are farthest from Crinoids strictly speaking. They have no regularity in the arrangement of the plates of the test. Their globular form suggests a nearly uniform development in all directions rather than in a determined direction as in other Crinoids.

Echinosphaerites, from which J. Müller separated *Sphaeronites* characterized by the geminate pores had been included in the latter name by Hisinger, in 1837 (*Lethœa sueica*), and it is under this name also that M'Coy, Forbes and De Buch have referred to it. But, much earlier, in 1821, Walhenberg, in the *Actes de l'Académie d'Upsal.*, had given them the name that we preserve, as done by J. Müller and Eichwald, Volborth, Verneuil and Pictet. With the exception of a single species that is Devonoian, *Echinosphoerites* is found in Silurian layers. But it is very rare to find complete specimens, Fragments, impressions, or even globular masses of spathic limestone have taken the place of the fossil.

1. ORANGE ECHINOSPHERITE. *ECHINOSPHAERITES AURANTIUM*. — WauL.

Atlas, pl. 5, fig. 5.

— WAHLENBERG (in Acta Upsal. VIIL, 1821, p. 52). — PANDER (Beitr. z. geogn. p. 141, pl. 2, f. 21, and pl. 29, f. 2, 3). — VOLBORTH, Mém. Sc. minér. de St Pétersbourg, 1845–1846. — DE VERNEUZ (Géol. de la Russie, t. IL, p. 32, pl. 1). — PICTET (Traité de paléont. IV, p. 205, pl. 99, f. 22). — *Echinus aurantium,* GYLLINHAL (Vet. Acad. nya Handl. 1772, p. 242, pl. 8, f. 4 and 5). — *Leucophthalmus strangwaysii*, Kònig. (Icon. sect. pl. 1, f. 1). — *Sphaeronites citrus*, HISINGER (*Lethoea suecica*, pl. 1, f. 21, 22). — *Sphaeronites aurantium*, DE BUCH (Ueber die Cystieen, 5845, p. 14, pl. 1, f. 20). — FORBES (British Cystidea, in Mem. geol. surv., 1848, t. II, p. 516, pl. 22, f. 1). — J. MÜLLER, in Mém. de l'Acad. de Berlin, 1854 for 1853, p. 179, pl. 6, f. 2–5.

Body or calyx globular, width 20 to 50 millim., with a round, thin stalk with a pentagonal feeding groove. Six small basal pieces (sometimes 5, 7 and even 8) surrounded by other larger or smaller plates, alternating without order and in such large number that toward the top twelve can be counted in a single row. Most are hexagonal, but there are also 7, 8, 9 and even more sides. Opposite the stalk is a vertical extension that develops into two or four, or more often three irregular arms. After this extension is sometimes, not very distinct, a small opening (that has been taken for an anus). On the same side, but much lower, although still in the upper hemisphere, is a large opening formed by 5 or rarely 6 valves united into the form of a pyramid. This is the ovarian opening that De Buch believes could not open and much simply releases eggs by a small hole pierced in each of the valves

near the top. But on one specimen, we have seen these valves moved that makes it probable the separation of the valves from each other.

The plates of the test are susceptible to increase in number and size. The surface of each is covered with striations perpendicular to their sides. After this, we see as many directions for these striations as there are sides to the plates. These striations pass in each direction from one plate to another without interruption so that lozenges are produced, strongly striated in the direction of the large diagonal. These striations end here and there by a pore that De Buch, incorrectly, we believe, said did not penetrate into the interior. Forbes, on the contrary, has seen papillae on an internal mold indicating pores.

We find it in the Lower Silurian terrain of England, Sweden and Russia.

Forbes thinks we should refer to the same species *Ech. granulatus* described by M'Coy after an internal mold in Ireland.

2. BALTIC ECHINOSPHERITE. *ECH. BALTICUS*. — Eichwald.

-— SCHLOTHEIM (in Isis, 1826, p. 314, pl. 1, f. 7).— Eichwald (Zool. spic., 1, p. 231, pl. 2, f. 12). — De Verneuil (Géoi. de la Russie, II, p. 25, pl. I, f. 9). — *Echinosphaerites arunea*, Vorborth (1845-46, Soc. min. de St Pétersb., p. 184, pl, 9, f. 2, 3). — *Heliocrinites balticus*, Eichwald (Sil. Esthl. 1840, p. 189, 191). — *Sphaeronites balticus*, Forbes (Brit. CystId. dans Mem. geol. Survey, II, p. 518, pl. 22, f. 3).

Calyx globular or oblong, covered with polygonal plates wider than those of *Ech. aurantium,* and remarkably ornamented with very protruding radiating ribs. These ribs, on most of the plates are six in number and joined with those of adjacent plates so that the entire surface is covered with a network of triangles and a complication of stars that do not allow perception of the true arrangement of the plates. However, Volborth thinks that this could be a simple variety of the preceding. As the number of plates increases with age, Forbes himself expressed the opinion that his *Caryocystiles davisii* could be only the young age of this species. It is found very incomplete in the Lower Silurian of Llandilo (country of Wales), England.

3. SPIDER ECHINOSPHERITE. *ECH. ARACHNOIDEUS*. — Forbes.

— *Sphaeronites*, Forges (Brit. Cyst., dans Mem, geol. Surv., IL, p. 518, pl. 22, f. 4).

Under this name, Forbes has described very incomplete specimens from the same locality, showing larger plates with much more visible and numerous striations. The same author also describes (ibid., fig. 2) and named with doubt *Sphaeronites* (?) *punctatus*, some remains of a Cystid resembling *Ech. aurantium*, except for the fine and nearly regular granules of the surface.

2nd GENUS. **HETEROCYSTITE**. *HETEROCYSTITES*.— Hall.

(εγεος, various, different.)

Under this name, Hall, in the *Paleontology of New York,* t. II, 1852, p. 220, pl. 49 A, fig. 3, has indicated a new genus differing from *Echinosphaerites* by its four basals that surmount two alternating series of ten rows. The rest of the calyx is formed by smaller plates of indefinite number and the arms are assumed to be missing. The sole species, described incompletely, is *H. armatus* of the Middle Silurian of America.

3re GENUS. **CARYOCYSTITE**, *CARYOCYSTITES*.— De Buch.

(xαpuov, black, χυσγη, bladder)

Calyx ovoid and oblong, stalked, without arms, formed of an indefinite number of pieces but considerably less than in the preceding genera, and having a more regular arrangement. Four basal pieces of which two are large and two are small. Lateral pieces [parabasals, radials and interradials (?)] forming three rows below the ovarian opening that, itself, is a little below the middle of the total height. Each plate has rows of pores starting from the center.

This genus, incompletely defined, contains two species of very different form which Hisinger has considered, however, as two varieties of the same *Sphaeronites*. It is found exclusively in the Lower Silurian terrain of Sweden and England. Forbes has referred to the same genus very incomplete specimens, of which he made 3 species with the names *C. litchi, C. pyriformis* and *C*. (?) *munitus*. This latter, as we see, with the indication of doubt. But, because of the geminate pores of their surface are instead species of *Sphaeonites*.

1. GARNET CARYOCYSTITE. *CARYOCYSTITES GRANATUM*. — De Buch.

— *Echinospharites granatum,* Waulensere (in Acta Soc. Upsal., VIII, p. 53). — *Sphaeronites testudinarius*, Hisinger (*Lethaea suecica*, p. 92, pl. 25, f. 9 a). — *Caryocystites granatum*, De Buch (Ueber die CystId., p. 17, pl. 1, f. 8, 9, 10, et pl, 2, f. 4. — Forbes (British Cystidea, in Mem. geol. Surv.. II, p. 512, pl. 21, f. 4).

Calyx ovoid, length from 20 to 50 mm, formed of plates larger and more regularly disposed than those of *Echinospherites*, four basal pieces, of which two are larger, contiguous, pentagonal and two smaller, quadrangular diametrically opposed. Six lateral plates (parabasals) on the surfaces of the hexagon formed by the four basals. Above are a second and third row of lateral plates alternating also, form the top. The ovarian opening is pentagonal and ordinarily protruding and covered by five valves. It is located on the extension of the line separating the two large basal plates. “The opening of the top” (the mouth according to De Buch) “is protruding in relation to the surrounding plates, but never forms a tube as in his *Spheronites*.” De Buch also indicates a rounded anal opening, very near the preceding to the right. The radiating ribs of each plate form, by extending with those of adjacent plates, striated lozenges whose tops unite six by six at more protruding

center of each of them. These ribs completely hide the sutures. After this description, composed in part from De Buch, and also after the figures given by this author, we see that this species, contrary to the generic arrangement, has a definite number of pieces of the calyx. But its affinity with the following species, which Hisinger considered as a simple variety, permits believing that the regularity mentioned here is fortuitous and should change with age.

Found in Sweden, England and Ireland in the Lower Silurian.

2. TORTOISE SHELL CARYOCYSTITE. *CARYOCYSTITES TESTUDINARIUS*.— De Buch.

Atlas, pl. 5, f. 9.

— *Sphaeronites testudinarius*, variety, Hisinger (*Lethaea suecica*, pl. 25, f. 9d). — *Caryocystites testudinarius*, De Buch, Ueber die Cystideen, p. 19, pl. 1, fig. 20.

Hisinger considered it a simple variety of *C. granatum*. Buch said it is a particular form that is not easily compared with the preceding. The calyx, very elongated and nearly cylindrical, is covered with large plates forming, however, three alternating rows of six each. But the regularity of this arrangement is much less evident, and the striations of the surface are finer, less pronounced and do not hide the sutures. The four basal pieces are not very distinct. The ovarian opening, located laterally a little above midway, is pentagonal, very visible, but it has lost its valves. Completely at the top is an opening, perhaps fortuitous, that Buch always took for a mouth, declaring the third opening anal. It is more difficult to find. The respiratory pores of the surface are arranged as on *Hemicosmites*, in rows of six going to the center of each plate at its corners.

It is found at Oeland, Sweden.

4th GENUS. **SPRERONITE**. *SPHAERONITES*, — J. Müller.

(σφιρα, globe, ball)

and 5th GENUS. **GLYPTOSPHERITE**. *GLYPTOSPHAERITES*.— J. Müller.

(γλυπγος, sculpted, chiseled.)

Calyx globular or spherical, like those of *Echinosphaerites*, but without defined basals and have a more united surface, with scattered geminate pores, without ribs or protruding stars and, on the other hand, instead of the vertical protrusion that has the arms, has a system of ramified grooves that, each starting from one of the 14 or 16 tubercles on the upper surface, meet, step by step, in five principal grooves that lead to the lines of function of the five irregular plates that have been thought to hide a buccal opening (?).

The stalk is hollow, cylindrical, formed of numerous articles and starts at a footing formed of tessellated plates and attached to the underlying bodies.

The name *Sphaeronites* was given by Hisinger in 1837 (*Lethoea suecica*) to globular fossils that had a reticulated surface that Walhenberg in 1821 had named *Echinosphaerites*, indicating thus their relationship with Echinoids and their spherical form. But, under this name, we then confuse two genera that have already been distinguished by Volborth, first (1845–1846), because of the details of the surface and particularly of the vertex. Then, J. Müller, in 1853 (*Archiv für Anatomie*, Pp. 220), characterized the genera *Sphaeronites* and *Glyptosphaerites* more clearly by the presence of geminate pores. However, there remained some uncertainty about the synonymy of the only authentic specimen of these genera. J. Müller, in fact, wants to take for type of the genus *Spheronite*, *Sphaeonites pomum* of Hisinger, whose figure does not correspond entirely to its characteristics. Volborth, on the contrary, left it among the E*chinosphaerites*, where it had previously been placed by Wahlenberg in 1821 (*Nov. Act. Reg. Soc. Upsal*, VIII, p. 54), and took for type the fossil that Müller later called *Glyptosphaerites leuchtenbergi*. This is *Sphaeronites pornum* of Eichwald (*Silur. Schich. in Esthl*., 1841, p. 189) that was described under the same name by the Duke of Leuchtenberg (*Beschr. n. Thierreste v. Zarskoje-Sjelo*, 1843, pl. 2, fig. 19). Volbortir named it *Sphaeronites leuchtenbergi* (*Abandl. d. Mineral. Gesell. zu St Pétersburg*, 1845–1846, p. 187, pl. 10, f. 4–7) and described it thus:

"Globular calyx, formed of a considerable number of polygonal plates, 14 to 80 mm. It is thus larger than all the Cystids. The plates do not protrude or very little. Their sutures, often very distinct, are on the contrary, sometimes difficult to perceive. These plates, of the same dimensions as those of *Echinospheaerites*, differing completely from it by the lack of striations forming lozenges on the surface characteristic of the latter genus. But they are pierced by geminate pores or arranged in pairs, surrounded by a protruding border and without visible order." These pores, that often can be seen only with the help of a magnifying glass, probably function, according to Volborth, for the passage of membranous tentacles. Many of the plates of the upper region have, at the center, a tubercle from which leaves a short groove that goes to one of the five grooves or principal grooves that puts all in communication with a buccal opening that Volborth indicates at the center and that is covered by five unequal plates forming together an irregular pentagon. "These grooves", he says, "are so analogous to the tentacles of *Pentacrinus caputmedusae* and of Comatulids that we are forced to assign a similar function to them and accept that they are intermediary between the mouth and the tubercles on the articulated arms."

No other indication of the supposed arms was found, and one could as well accept that these grooves were only occupied by fleshy tentacles and cilia as in the Comatulids.

This Cystid is rather rarely found in the Lower Silurian terrain in the vicinity of Saint Petersburg and perhaps also in Sweden.

The fragments represented by Forbes under the name of *Caryocystites pyriformis* and *Car. litchi*, and that are also covered with geminate pores, probably belong to the genus *Sphaeronites* (*Brit. Cystidea*, pl. 21, fig. 1 and 2).

6th GENUS. **PROTOCRINE**, *PROTOCRINUS*. — Eichwald.

(πρωγος, first)

This genus, named *Protocrinites* by Eichwald (*Sil. Schich. in Ehstl.*, 1841, p. 185), differs principally from *Sphaeronites* by its 3-4 basal plates and is 6–7 parabasals that are much larger and more regular than those of the rest of the calyx. But the upper part is equally ornamented with ramified grooves and the entire surface has scattered geminate pores. Only the grooves lead to a central irregular hiatus not covered with plates.

The only described species is *Protocrinus oviformis* Eichwald that appears to be identical with *Echinosphaerites pomum* of de Verneuil (*Geol. de la Russie*, 1843, p. 24, pl. 1, fig. 7), and that is represented in the already cited memoir of Volborth (p. 191, pl. 19, fig. 8, 9, 10, 11). It is a flattened spheroid, 7 to 35 millimeters wide. Its height is only 3/5 or even 2/5 its width. Its plates, much thicker and more swollen than those of *Spheronite*, give it a tubercular aspect. The pores, also geminate, larger and very visible to the naked eye, are surrounded by a rim in the form of a saucer that makes the surface appear very rugose. This *Protocrinus*, extremely rare, has been found only on the coast of Spitham in Estonia and at Pulkowa, near Saint Petersburg, in the Lower Siurian.

7th GENUS. **CRYPTOCRINE**. *CRYPTOCRINUS*. — De Buch, 1845.

(χρυπγος,hidden)

Calyx globular, formed of 14 plates, of which 3 basals, 5 parabasals and 6 radials and interradials, without pores, without arms and without pectinate lozenges, but with an ovarian opening covered with six triangular valves and an opening at the top that has been taken for a mouth.

This genus, established by De Buch for a fossil (*Crypt. cerasus*) that Pander had classed among the *Echinosphaerites*, has been increased with a species also found in the Lower Silurian in Russia and named by de Verneuil (*Paléont. de la Russie*, p. 34, pl. 1) *Cryptocrinus loevis*. De Buch had, moreover, thought that it should be united with the genus *Sycocrinites* of the Austins, and even that the two species described by these authors, *Sycocrinites jacksoni* et *Syc. anapeptamenus*, are identical to his species type. *Sycocrinites clausus* of the same authors is even more doubtful. It is very certain, however, that this genus is too imperfectly known and that the so-called buccal opening at the end of a trunk has perhaps no more of reality than that De Buch has attributed to *Hemiscomites* and *Sphaeronites* (*Echinosphaerites*). It is also very possible that the pores and the striations of the surface have disappeared because of fossilization or abrasion.

CHERRY STONE CRYPTOCRINE. *CRYPTOCRINUS CERASUS*.

Atlas, pl. 9, fig. 7.

— *Cryptocrinites cerasus*, De Buch, Ueber die Cystideen, 1845, p. 25, pl. 1, f. 13, 14, pl. 2, f. 5. — *Echinospheaerites loevis*, Panner, Beitr. zur Geogn. des russ. Reichs., p. 147, pl. 2, f.

24-26. — *Sycocrinites jacksoni* and *anapeptamenus*, Austin, in Ann. of nat. Hist. 1843, XI, p. 206. — *Cryptoerinus cerasus*, Pictet, Traité de Paléont., IV, p. 304, pl. 99, f. 24.

Calyx nearly globular or with the form of a cherry stone, width 14 mm, height 13 mm. with a basal that is smaller, rhomboidal and two larger, pentagonal, but always with dominant character of Cystids, that the pentagons cut in the middle could be divided into two plates equal to the third. Of the five plates of the second row, or parabasals, two remain on the pentagonal basals and the three others alternate with the three basals.

De Buch said that the anal opening, located a little to the right, between the ovarian opening and the mouth, is often not very visible. He attributed the absence of striations on the plate to abrasion of the surface.

This fossil has been found near Saint Petersburg, at Pulkowa and at Narwa, in the Lower Silurian terrain. The *Sycocrinites* of the Austins are said to come from the Carboniferous terrain of England (?)

8th GENUS. **HEMICOSMITE**. HEMICOSMITES. — DE BUCH.

(ημισυς, half, χομηγος, decorated)

Calyx ovoid, with four basals, six radials forming a transverse series and nine plates of which six interradials alternate with the preceding and three appear to be second radials. Above are nine other convergent plates to close the calyx with some small intercalary pieces. In three of the sutures or lines separating these pieces at the top, in the direction of the radial plates, are three impressions seen first by de Verneuil, and that were the insertions of three arms. At their base corresponded an ambulacral groove, leaving from the apical pore, where there appears to be an irregular opening in part covered by small intercalary plates. There is thus no trunk as De Buch thought. The ovarian opening, covered by five small triangular valves, is located laterally at some distance from the apical pole. Sometimes it is thought a third opening is seen nearer the first that has been called the anus. The plates of the test have striations parallel to their sides and rows of pores going from the center to each of the corners.

PEAR-SHAPED HEMICOSMITE. *H. PYRIFORMIS*. — De Buch.

Atlas, pl. 5, fig. 4.

— *Echinosphoerides malum*, Pander, Beitr., pl. 29, f. 1-3 (shown top to bottom). — *Hemicosmites pyriformis*, De Buch, Ueber die Cystideen, p. 20, 72. pl. 1, f. 1–12 (with a trunk that does not exist). — De Verneull (Géologie de la Russie, 1845, p. 31, pl. 1, f. 3 (very correct). — D'Orbigny, Cours élémentaire, p. 141, f. 290 (copied after the preceding). — Bronn and Roemer, Lethoea geognostica, 3e éd. — Pictet, Traité de Paléontologie, IV, p. 301, pl. 99, f. 10 (copied after De Buch). — Forbes, British Cystidae, in Mem. of the geol. Surv., IL, 2, p. 510, pl. 20 (after De Buch).

The composition of the test has the greatest similarity to that of *Caryocrinus*, and this is what first struck De Buch. The base is also formed of four basal plates, of which two

with five and two with four sides, which we can consider as the result of fusion of two pairs of plates of a whorl of six equal plates. Each plate has exteriorly tubercles arranged according to the lines going from the center of each to the corners, and pierced with a large pore that corresponds to each of the ends of the interior canal that, parallel to all the other canals of the same sector, passes from one plate under the other and that is found between two very protruding lamellae that must have been the seat of internal respiration. The intervals of the various groups of parallel lamellae are filled by lacunar mass that we can consider as the place where the ovaries were fixed.

The six large oblong radial plates form two groups each characterized by a special form. The three on and between the contiguous pentagons of the base end above by a hexagonal corner. Two of these plates enclose between them, at the top of their common suture, the ovarian opening. In the other half of the body, each lateral plate is truncated above and changed to a heptagon. Nine plates culminating in the fourth row curve and narrow toward the top to close the calyx. They leave between them only a very restricted interval occupied by the three insertions of the arms, by the three grooves that leave from them and by the central opening, to which the three grooves lead and which is surrounded and in part covered by very small irregular plates. After having mentioned as characteristic of *Hemicosmites*, the absence of pectinate lozenges, De Buch adds (*Ueber die Cystideen*, p. 21) "That which is still more characteristic is the beautiful systematic arrangement of the rows of tentacular pore on the plates. From the center of the lateral plates, a double row of pores goes to the upper corner, and a single row goes to each lateral corner. On the lower half of the plates, we do not note these rows, but only some pores scattered without order. The contrary is seen on the upper plates. Here, the lower half of the plates only has rows of pores and, as on the lateral plates, the median row of pores is double and the lateral rows are single. The basal plates have only some scattered pores." These pores, as in *Caryocrinus*, are related to vertical parallel lamellae ppm the internal surface of the test. We consider them as giving passage to the water that serves for internal respiration and as destined for the tentacles.

In addition, the specimen that has been figured in the work of de Verneuil on Russia, we have seen in the rich collection of this scholarly geologist, other specimens still more perfect, coming from the collection of De Würth, and showing still more clearly the first of the insertions of the three arms and the three culminating grooves that leave these insertions.

This fossil is found in the Lower Silurian of Russia, near Pulkowa, Narwa and Revel, and in England and in Ireland.

Ed. Forbes, who has found in England only the isolated plates of the preceding species, has proposed, with doubt, to form two other species of the same genus *Hemicosmiles*? *squamosus* and *Hemicosmites oblongus*? for other fragments coming from the same localities. He regards a very incomplete specimen of the latter as possibly being analogous to *Echinosphaerites oblongus* de Pander (Beitr. pl. 11, f. 22, 25?).

9th GENUS. **CARYOCRINE**. *CARYOCRINUS*. — Say, 1838.

(χαρυον, nut)

Calyx ovoid, with four basal pieces, six radials and two interradials above which are, by successive gemmation, three, then six, eight and finally twelve articulated arms with an ambulacral groove communicating with the interior by an opening located above the base of each arm. The dorsal part, or vault, has in the middle, or at the pole, a more protruding plate with six or seven sides, of which three larger correspond to three principal rays and to the three principal radials. On each of these sides, the central plate is applied against a hexagonal plate, whose middle is prominent, and following of which is another hexagonal plate, a little smaller, that goes to the arms. The intervals of these three rays are filled with by small plates without prominence. In one of these intervals corresponding to the suture e of the two large basal plates is, at the level of the arm or not much higher, the ovarian opening closed by five to eight small triangular plates, united in the form of a pyramid.

All the lateral plates have both growth striations parallel to their edges and protruding granules that, by their regular arrangement, represent sometimes radiating striations. On these plates are double rows of perforated tubercles going from the center to each of the corners. Some of these rows, particularly those of the middle zone, are incomplete or irregular, and at the interior, the unarmed plates have porous concretions that should correspond to the placement of the ovaries. There, on the contrary, where the rows of perforated tubercles are regular, the plates have on the interior rows of parallel lamellae, directed from one plate to the other, perpendicularly to the sutures and leaving between them canals, the ends of which correspond to two of these pores that must give access to water for internal respiration.

The stalk is cylindrical, short and with radiate articular facets.

The genus *Caryocrinus*. established by Say 1838, for a single, very remarkable specimen and characteristic of the Upper Silurian terrain of America, has been studied with much care by Léopold De Buch (*Ueber die Cystideen*, 1845), who, the first, noted the striking analogy of this fossil and *Hemicosmites*, and who was able to deduce from it the characters of his family of Cystidae. However, as we have already said, believing that the Cystidae must lack arms, it absolutely separates *Caryocrinus*. Following his example, D'Orbigny classed it among the normal Crinoids beside *Cyathorinus*. Pictet, on the contrary, assigned it to the appropriate rank beside *Hemicosmites*.

ORNATE CARYOCRINE. *CARYOCRINUS ORNATUS*. — Say.

Plates 2 and 3, fig. 9–14,

— Say, Journ. Acad. Philadelph., t. VI, p. 289. — L. De Bucx, Ueber die Cystideen, p. 1, pl. 1, f. 1-7. — Hall, Paleont. of New York, t. II, pl. A, 41, 49 and 49 B. — Roemer, in Lethoea geognostica de Bronn, 3e edit., p. 271, pl. IV, f. 7.— Pictet, Traité de Paléont., IV, p. 300, pl. 99, f. 18.

Caryocrinus ornatus is ordinarily wide, from 20 to 25 mm, and a fifth higher, but there are much smaller specimens and that, in this case, have a smaller number of arms. Those less than 8 mm in height have only three arms, but this number is going to increase with age and, and although Say and De Buch have seen only eight or nine at most, it is very certain that we have sometimes seen twelve. Pictet says even thirteen. It is the mode of successive production by gemmation of these organs that prevents give their exact position in relation to the plates of the calyx, as in normal Crinoids. Say has compared very correctly the form of *Caryocrinus* to that of a large acorn of the oak and has described exactly its composition.

The calyx has at bottom four basal pieces, of which two contiguous larger ones are pentagonal and the two other smaller ones are quadrangular. Below these basal pieces are six larger pieces or plates nearly perpendicular that form in large part the sides of the calyx. Four of these plates alternate with the basals and the two others, which are pentagonal, result on the upper horizontal side of the two large basals. Between them, on the suture of these same basals, is a third large hexagonal plate and, opposite it, on the suture of the two small basals, is a fourth large hexagonal plate. The fifth and sixth plates of this series are heptagonal or with seven sides. They correspond to the sutures between the small and large basals, so that the bilateral symmetry that will dominate the ensemble is already very visible in the two first rows of plates. Those of the second row, of which we just spoke, have been called *intermediaries* by D'Orbigny and *sub-radials* by Pictet, which is the same thing, and the plates of the third row have been called *brachials* by one and *radials* by the other of these authors, distinguishing among the latter, eight in number, two intercalary plates (*interradials* Pictet) that, instead of having five sides or pentagonal like the six others, have one side less and rest on the upper side of the two heptagonal plates of the second row.

But this nomenclature of the pieces of the calyx is not incontestable and we could, starting with the ternary distribution of the small plates of the upper part (vault) or the original number of arms, find, at the same time, in the six pieces of the second row, three radials and three interradials. Each radial has two symmetrical brachials and each heptagonal interradial has a second quadrangular interradial, while the third interradial, which corresponds to the ovarian opening, would have remained hexagonal because of the abortion of the second interradial or the approach of the adjacent brachials. A similar effect on the basals of the same side, would have fused them by pairs to reduce to four the normal number of six of these pieces. Consequently, the two radials corresponding to these pairs of basals would have become pentagonal instead of being hexagonal like the one that is diametrically opposite the ovarian opening. What makes this interpretation probable is the arrangement of the pieces of the vault. We see, in fact, a central piece that is an irregular hexagon, with three sides alternatively larger, on which rests three other hexagonal pieces having a low cone in the middle. Three other pieces rest on these, following the same direction, so that three rays go to the arms above that correspond to the three plates that we propose to call *radials*. The ovarian opening is in the interval of two rays, and the remainder of the dorsal surface of the calyx is filled by smaller accessory pieces. We have represented (pl. 2, fig. 7) this arrangement of the upper pieces of the calyx spread out on a plane.

The internal respiratory lamellae are very protruding. If they had the form of canals closed to the interior and open only by the surface pores, these canals must have been much longer than wide. As for the two kinds of tubercles that Buch has observed on the surface,

some are crossed by a single very large pore. The others are covered by a spongy mass formed of small vesicles. It seems to us there is only obliteration of respiratory pores by extension of the surrounding tissue. The internal respiratory lamellae, or the flattened tubes of which they are part, have then ceased to function because of the development of spongy concretions that we see on the internal surface of the plates and that are probably related to the ovaries.

It should also be noted that the young individuals have a relatively very large stalk.

Caryocrinus ornatus, very commonly found in the Upper Silurian terrain of America at Lockport (New York), has also been found recently in England.

10th GENUS. **PRUNOCYSTITE**, *PRUNOCYSTITES*. — Forbes.

This genus, very imperfectly known and perhaps even very doubtful, was established by Forbs for a single specimen from the Upper Silurian terrain of Dudley, in England that he named *Prunocystites fletcheri* (*British Cystidae*, 1848, *Mem. geol. Surv*., t. I, p. 503, pl. 16). It has, embedded in limestone rock, a small ovoid calyx, width 5, length 6 millimeters, from the top of which leave arms or tentacles formed of a double row of articles and that, of different sizes, could well come from a completely different animal than a Crinoid. The calyx, which appears formed of four basals and two or three other rows of five hexagonal plates have toward the top in the visible portion a pectinate lozenge. It is supported on a stalk that is relatively very large and much thicker toward the top. We can suppose this is the young age of some other CrinoId.

11th GENUS. **ECHINOENCRINITE**. ECHINOENCRINITES. — Meyer, 1826

— *Gonocrinites*, Eichwald, 1840. — *Sycocystites,* De Buch, 1845. — *Echinoencrinites*, Vorborth, 1849. — *Echinoencrinus*, Forbes, 1848. — *Echinoencrinites*, de Verneui.

Calyx irregularly swollen, subcylindrical or ovoid, with four basals and three alternating rows of five pieces. A large hiatus taken improperly for a mouth on the upper part and whose edges, formed of much smaller pieces, appear to have supported articulated arms or tentacles. Ovarian opening formed by five or six small triangular pieces united in the form of a pyramid. Three pectinate lozenges. Stalk cylindrical, thick.

This genus, at first incompletely described according to insufficient species, has been better known after the works of Volborth and Forbes, but, however, there still remain uncertainties in his history. Thus, Volborth alone has been led to attribute arms to it and he has given the opinion that the fossil stalks named *Cornulites* by Schlotheim, could come from this Cystid. Forbes, on his side, having seen better preserved specimens, has been able to describe with care both the pectinate lozenges and the ovarian opening located in the extension of the hiatus at the top and the tubercles of the surface and, finally, an opening of a particular form, nearly a crescent, crossing the suture of two plates from the edge of the hiatus like he has seen in his *Apiocystites* and that he takes for the anus. However, he recognized himself that the species from England differs in several ways from those of

Russia. He designates the plates of the calyx in saying that there are 4 basals, 5 infra-ovarials, 5 centro-laterals, 4 or 5 super-ovarials amd 8 or 10 apicals.

Five species of *Echinoencrinites* have been described, three from the Lower Silurian terrain, i.e., 1° *Echinoencrinites senkenbergii* Meyer, 1826, that De Buch has named *Sycocystites* that comes from Pulkowa, near Saint Petersburg; 2° *Ech. striatus* Volborth, 1842, from Pawlosk in the same country; 3° *Ech. anatiformis* Hall, 1847, also from the Lower Silurian terrain in the state of New York in America; and two others from the Upper Silurian of Dudley and Walsall in England, these are *Ech. armatus* and *baccatus* of Forbes, of which we shall speak in a little more detail according to the species type of Meyer.

1. SENKENBERG'S ECHINO-ENCRINITE. *ECH. SENKENBERGII*. — Meyer.

— H. V. MEYER, in Kastner's Archiv. VIL p. 185, pl. 2, f. 1–5. — VORBORTH, Bull. sc. Acad. Petersburg, X, n° 19, pl. 1, f. 7–12, and pl. II, and *Bullet. Acad*. 1844, t. III no. 6.— *Echinoencrinus*, BRONN and ROEMER, Lethæa geognostica, pl. 4, f. 1, and pl. IV', f. 5. — *Sycocystites angulosus* vel *Senkenbergi*, DE BUCH, Ueber die Cystideen, 1845, p. 21, pl. 1, f. 15–19.

"This species." says L. de Buch, "is distinguished from all other Cystids by the large diameter of the stalk, by the ovarian opening that is very large and located very low in the lower half and not, as usual, in the upper half, by the elongated form of the mouth, by the very protruding striations and allowing to be seen only with difficulty the separation of the plates, finally by a finely striated basal plate and by a segment of plate that is striated in the same manner that is diametrically opposite and that is between the ovarian opening and the mouth (*pectinate lozenge* of Forbes).

The stalk is very thin at its lower end, with articles three or four times longer than wide. But near the calyx, the articles become rings whose diameter increases rapidly and that end by equally a third of the width of the calyx."

The four basals of the calyx form together a nearly perfect square. Each of them occupies one of the corners at the same time that the sutures correspond to the middle of the sides. The same basal plates sink deeply into the interior before attaching to the stalk, and one of them that corresponds to the ovarian opening has a trunk on the external corner in a way to receive on this trunk the base of the fifth plate of the second row (parabasal), while the four others correspond to the lines of separation of the basals and support on the sides of the square of the base. The five plates of the third row adhere to the preceding. Finally, five other smaller plates form a fourth row, surround this wide hiatus that has been taken for a mouth. All these plates are covered with very raised striations in the form of rods that intersect their sides perpendicularly in passing from one to the other as, moreover, in most Crinoids. The growth striations parallel to the sides of the plates, fill the intervals between rods of which we just spoke, but they are far for having the same protrusion.

Here is how De Buch describes the pectinate lozenges: "It is remarkable," he says, "that one of the basal plates always has striations perpendicular to the side, much finer than on the other plates, and that the striations extend onto the contiguous plate. Instead of three principal striations, there are ten. They appear, at first glance, to form a lozenge since these striations hide entirely the side of the plates that correspond to it small diagonal. The plate thus striated is ordinarily a little thicker and more convex than the adjacent ones. In going

from the base of the calyx by the point of the plate in question, it reaches the mouth that is oblong, exactly in this direction. On the other side of the mouth, and always in the same direction, is another lozenge finely striated in the same manner that is formed by the lower segment of the plate of the fourth row and by the upper segment of the plate corresponding to the third row between the ovarian opening and the mouth. These fine striations always end in a pore that goes into the interior of the plate and by which a tentacle could exit. It is worthwhile mentioning that cut passing through the finely striated basal plate by the large diameter of the mouth and the oviducal opening divides the entire form into two symmetrical parts. This form is compressed at the same time in this direction. This may come from the strong protrusion of the ovarian opening. The mouth, which is elongated toward the ovarian opening, is surrounded by a kind of lip from by the swelling of the plates that end there. On this lip are five of six holes arranged circularly and that are scarcely larger than those that, on the lateral plates, appear to have tentacles. Sometimes the wall is missing on the inside, and they are simple notches of the lip. It is very probable that, by these holes also leave tentacles. In fact, Volborth has also observed and figured them. He believes he recognizes in them arms of Crinoids. But how surprising would such an insertion be?.....(De Buch). It could very well be that they tentacles have been covered by small plates like the tube (supposed by De Buch) of *Hemicosmites* and *Sphaeronites*, and as the figures of Volborth suggest."

De Buch, not having seen any other anal opening, suggests that it could be located in the vast cavity of the mouth. He also thinks that *Echinosphaerites striatus* of Volborth (— Pander, *Beitr. zur geogn. des russ. Reichs*. 1830, pl 2, f. 50, 51, and pl. 28, f. 12) could be only a variety of the preceding species, from which it differs only by the more numerous and less protruding striations, both on the plates as on the pectinate lozenges, which have fifteen instead of ten.

2. BERRY-SHAPED ECHINO-ENCRINITES. *ECHIN. BACCATUS*. — Forbes.

— British Cystideæ, Mera. geol. Surv., II, 2, p. 506, pl. 17.

Calyx in the form of a berry, ovoid, oblong, narrower toward the base, length 12 mm, width 9 mm, with a stalk that is very thick at the top, where is diameter is 4 and a half mm. All the plates are rugose, reticulate, with striations or ridges on the surface. The ovarian pieces are large, and the mouth is oblong. The demi-rhombus of the basal plate is very small, not very distinct and without a rim. The other demi-lozenge, corresponding, on a plate of the second row or parabasal (*sub-ovarian,* Forbes), is on the contrary very prominent, oval, surrounded by a very raised smooth edge in a way to give it the aspect of a small cup, with six to eight transverse grooves. Each of the two plates of the third row (*centro-latero*, Forbes) contains a demi- rhombus completed by another demi-lozenge located on the contiguous plate of the fourth row (*supra-ovarian,* Forbes. These two latter lozenges are located at nearly equal distance from the ovarian opening, so that, taken together, the three lozenges are said to occupy the three corners of an equilateral triangle. It is also necessary to note that for the two upper rhombuses, it is the lower half that is the more developed. The buccal plates are arranged in a way to form a circle, or rather an irregular pentagon limited by the upper edge of the five plates of the fourth row (supra-ovarian). The buccal pieces are very prominent and tubercular. Their number appears to be

very variable, but on the better-preserved specimens, there are four on one side of the mouth and three on the other. In the middle of these is found the anal opening (Forbes), larger than usual, which could cause doubt about this interpretation. The rest of the opening, crescent-shaped, is supposed to be the mouth, but we have already explained this question several times.

The ovarian opening is narrow, located in a slight depression above the middle, surrounded by about a dozen small ossicles and closed without doubt by a union of small triangular valves as in other Cystids. Forbes has noted that below the pectinate rhombuses are parallel lamellae in the interior. These are probably analogues of the internal lamellae of *Caryocrinus* and *Hemicosmites*.

3. ARMED ECHINO-ENCRINITE. *ECH. ARMATUS.* — Forbes.

— British Cystideæ, ibId., p. 507, pl. 18 and 19. — Pictet, Traité de Paléont., IV; p. 299, pl. 99, f. 17.

Calyx irregularly ovoid, compressed laterally and notched, height 18 mm, length 15 and width 12 mm, with on the upper part a vast oblong opening, linear, that was willingly taken for a mouth. Stalk cylindrical, width 6 mm below the calyx. Each plate of the second row, or parabasals (*infra-ovarians*, Forbes) has a tubercle in the middle. The ossicles surrounding the mouth (oral pieces) are small.

Seen by wider surface, with its upper truncation, the calyx has a nearly quadrangular contour. All the plates have uniform granules, ranged nearly in radiating series. This is on the specimen that Forbes has especially noted the regular disposition of the three pectinate rhombuses and the singular crescent-shaped opening located in the thickness of the edge of the large terminal hiatus and that he took for an anus. He reports and represents several varieties according to the number of pectinate lozenges and the proportion of large tubercles on the plates, which are relatively smaller on the larger specimens.

12th GENUS. **PSEUDOCRINE.** *PSEUDOCRINUS.* — Pearce, 1848.

Calyx orbicular, with two corners or four truncated corners, or hollowed with straight grooves on which ae two or four arms formed of a double row of alternating articles susceptible to having themselves pinnules also formed of a double row of articles. Four basal plates, five in the second row or parabasals (*infra-ovarians*, Forbes), five in the third row or radials (*centro-laterals*), and five in the fourth row (*supra-ovarians*). Ovarian opening surrounded by a circle of eight to ten very small pieces and covered by six triangular valves approaching the pyramid form. Three pectinate rhombuses. Stalk thick, cylindrical, increasing in size toward the top.

The genus *Pseudocrinus* was first established under the name *Pseudocrinites* by Pearce, then studied more completely by Forbes who, in his beautiful work on the Cystidae of England (1848), in describing four species, two new, all from the Upper Silurian of Dudlev. It is one of the stranger forms among the Crinoids and among the Cystids in particular, of which this study must have modified the characteristics considerably. It is at

the same time one of the types that more completely known must motivate the establishment of a separate order in the class of Echinoderms. More than most other Crinoids, *Pseudocrinus* must be considered as an organ or reproduction and not as a complete animal, especially as there is no indication of any opening for a digestive system. It is very clear that the so-called attached arms do not have the same significance as in normal Crinoids and are respiratory organs.

1. TWO-BANDED PSEUDOCRINE. *PSEUD. BIFASCIATUS.*

— *Pseudocrinites*, Pearce, Proceed. geol. soc. Lond., IV, p. 160. — *Pseudocrinites bicopuladigiti*, Peace, in Athenoeum, n° 803. — Forbes, British Cystideæ, in Mem. geol. Surv., IL. 2, p. 496, pl. 11. — Pictet, Traité de Paléont., IV, p.298, pl. 99, f. 12.

Calice orbicular, width 20 mm, bilaterally compressed, with a thicker edge on which are two lateral linear arms, each with two rows of twelve to fifteen articulated tentacles. The stalk is very swollen near the calyx. The ovarian opening is a depressed pyramid of six triangular ovarian valves surrounded by eight small ossicles or small pieces. All the plates have ridges arranged in rays and intermediary rugose striations. They ae all more or less surrounded by a rim. The portions of the plates that contribute to forming the brachial edge of the body have no trace of radiating striations. But they are marked with rounded linear impressions that correspond to the ossicles of the arms. The intervals of these striations are completely smooth. There are three pectinate lozenges, each formed of two triangular or nearly kidney-shaped excavations, striated transversely, with a protruding rim and each located on a different plate. The lozenge nearest the ovarian opening is larger than the two others. The one at the base has about twenty-two striations. The arms lying along the ridges but not reaching the base, are formed of wedge-shaped ossicles, alternatively larger and straighter, arranged in a double row in a way that the wider of a row alternates with those of the other row. Each pair of ossicles, one wide and one narrow, form the base of a finger (or tentacle) also composed of small wedge-shaped alternating ossicles that decrease to the end. The length of the fingers is nearly four time the diameter of the arms, or two-fifths of the diameter of the body. The number of fingers or tentacles of each arm is from 12 to 16 according to the size of the specimen (Forbes). Neither the mouth nor the anus can be seen.

2. MAGNIFICENT PSEUDOCRINE. *PSEUDOCRINUS MAGNIFICUS*.

— *Pseudocrinites*, Forbes, British Cystideæ, p. 497, pl. 12.

Calyx orbicular, width 538 mm and the same height, compressed, bilateral with an edge on which are fixed two arms that extend from the top to the bottom, having a width a fifth part of a side, form of a double row of 54 articles, each of which has 34 fingers or tentacles 7 to 8 mm long and both formed of double row of articles. This species, of which Forbes had seen only one specimen, is much larger than the preceding, much more compressed, and distinguished in addition by elegant radiating ridges of its plates with intermediary rugosities and transverse bars. The number of fingers is greater, as well as

that of the striations (50) of the rhombuses that, in addition, are much more angular. Forbes says also that he saw, near the top, traces of an anal plate and anal opening.

3. FOUR-BANDED PSEUDOCRINE. *PSEUD. QUADRIFASCIATUS*.

— *Pseudocrinites*, Pearce, in Proc. Geol. Soc. Lond., IV, p. 160. — *Pseudocrinites quudricopuladigili*, Pearce, in Afthenæum, n° 803. — Forbes, British Cysticeæ, p. 498, pl. 13.— Bronn and Rozmër, Lethoea Geogn., pl. IV[1], f. 4 — Pictet, Traité de Paléont., IV, p. 298, pl. 99, f. 13.

Calyx ovoid, quadrangular, length 17 to 18 mm, width 15 mm, corners have four arms or lanceolate pseud-ambulacra, thick, that leave the top, width 5 mm in the middle and four times longer. Each arm is formed of two rows of 28 articulated pieces, transverse, with a double row of fingers or tentacles. Stalk, considerably thickened at top, is 7 to 8 mm wide at its junction with the calyx. It is very long. The four sides of the body vary in their dimensions. Sometimes they are nearly equal and more rarely there are two much wider. Three of the sides have a pectinate lozenge and the fourth has the ovarian opening that is very depressed, formed of six triangular valves. The opening at the top is not distinct. The fingers or tentacles, formed of a double row of articles, are folded toward the center of the arm without exceeding its width. They are, in addition, much thinner than those of the preceding species. All the plates are marked with rays and rugose striations.

4. OBLONG PSEUDOCRINE, *PSEUDOCRINUS OBLONGUS*.

— *Pseudocrinites*, Forbes, British Cystideæ, p. 499.

Under this name, Forbes designated a species that, he said, at first glance could be confused with small specimens of the preceding species but differ by its narrower form, especially at the bottom and by its four arms that are much narrower and even linear. The length of the calyx is 26 mm and its width 7 1/2 mm., The arm width is only 2 1/2 mm., which is also the width of the arms at their junction with the calyx.

13th GENUS. APIOCYSTITE. *APIOCYSTITES*. — Forbes.

(απιος, pear.)

Calyx ovoid, oblong, with four rounded corners that are truncated and sunken with a ramified groove, or laterally extended in lobes that are short, oblique and in which is an articulated arm of the same form. The four arms, inlayed in some way in the four grooves, go from the top to the base that is flat. Three of the surfaces have a pectinate lozenge and the fourth has below in its middle, the ovarian opening covered with six small triangular plates. At the top and outside the junction of the arms are two openings. One, with five lobes or digitations is considered the mouth. The other in an arc, was named the anus without reason.

A single specimen from the Upper Silurian terrain of Dudley served to establish the genus and for the description of the species type. Since then, another species, *Apiocystiles elegans* (Hall, Paleont. of New York, II, p. 242, pl. 51), has been found in the Middle Silurian of America. We believe it is necessary to list here a third species of the same terrain, *Apiocystites jewettit*, that Hall (Paleont. of New York, IL, p. 238, pl. 50) has made the type of his genus CALLOCYSTITES, and that is figured under the same name in the *Traité de Paléontologie* of Pictet (t. IV, p. 298, pl. XCIX, fig. 15). It is supposed to differ in the number of plates of the 2° row, which is 8 instead of 5. But as the specimen described is much larger, this difference could be only the effect of age. It is the same with the grooves of the arms that are sometimes bifurcated.

FIVE-HOLED APIOCYSTITE. *APIOCYSTITES PENTREMATOIDES*. — Forbes.

— Forbes, British Cystideæ, Mem. geol. Sur. II, 2, p. 501, pl. 15. — Pictet, Traité de Paléont., IV, p. 298, pl. 99, f. 14.

Calyx length 19 mm, width 11 to 12 mm, a little less thick, formed, like the preceding, of four successive rows of pieces, with four basal and three rows of five. These plates appear to have been covered with rays of granular striations, but abrasion has made them smooth.

14th GENUS. CALLIOCRINE. *CALLIOCRINUS*. — D'Orbigny.

(χαλος, beautiful.)

This genus, too incompletely known, was established by D'Orbigny in his Cours élémentaire and in his Prodrome de Paléontologie 1850, for a single specimen from the Upper Silurian of Gothland in Sweden, that Hisinger (*Lethæa suecica*, 1837, p. 90, pl. 30, fig. 14) had described under the name *Eugeniacrinites costatus*. He attributed to it a cup-shaped calyx composed of two rows of pieces, five of which were basals. He said it lacked arms, but the figure cited could make us believe there were five attached arms as in the preceding Cystids. Pictet (*Traité de Paléontologie*, IV, p. 301, pl. XCIX, fig. 20) reproduces this figure and also says that it has no arms, nor tentacles nor pectinate lozenges.

15th GENUS. AGELACRINE. *AGELACRINUS*. — Vanuxem.

(αγελη, fold.)

Calyx depressed, attached to the underwater bodies by its lower surface, covered on all its free surface by very numerous small polygonal plates and having in addition five attached, more or less curved arms that leave the apical pole, each formed by a double row

of alternating articles. The ovarian opening, covered by six small triangular valves, is located in one of the intervals of the arms. It is difficult to see, in the middle of the arms. an opening that merits the name of mouth.

This very remarkable genus differs from all other Echinoderms by the complete attachment of the calyx, which could make us suppose that the integument was flexible like that of some Holothuroids that are also covered by calcareous plates. If so, we would have even more reason to make it a distinct order from all other Cystids. As for the mode of nutrition, we cannot look for it in a stalk or root because they do not exist. Consequently, if the presence of the ovarian opening with its opercular pyramid and if the plated test are sufficient to place it with the other Cystids that do not have a digestive system, it is necessary to accept that nutrition was completely done by the surface. But, we repeat, the suggestion of a flexible integument makes probable a completely different organization.

The first fossil of this genus was described and figured by Sowerby (*Zoological Journal*, 11, p. 318, pl. 2, fig. 5), after a specimen taken from the falls of the Ottawa River in Lower Canada. This author, who took the ovarian opening for the mouth, placed it between the families of the Crinoids and the Blastoids. He said, "Its general form as we can judge from a specimen whose lower portion is completely missing, is a depressed spheroid, without any angular protrusion and, however, very obscurely pentagonal because of its probable division into 5 compartments, 5 equal arms that leave from the center and that all curve in the same direction. The surface is formed by a large number of imbricated plates. The mouth, which seems to have been surrounded by 2 or 3 rows of very small, imbricated scales, is located near the center, in one of the compartments larger than the others. The protruding arms on the surface, that decrease from the center to the end, are divided by a longitudinal groove into two equal halves, each divided by a large number of articles."

Vanuxem (*Geology of New York*, I, p. 168, 1842), in describing another species, *Agelacrinites hamiltonensis*, (p. 306) gave a not very satisfactory figure. "It is an imprint that shows six circular specimens attached on the same surface like so many medallions, widths of 5, 10 and 25 millimeters. They appear covered with small polygonal plates. From the center leave 5 arms comparable to those of an Asteroid and between two of which is an ovarian opening that Varuxem regarded as probably being the mouth of the animal. Like the preceding, this species is found in the Middle Silurian terrain of America where is also found the species that Hall (*Paleont. of New York*, II, p. 245, pl. 51) has described under the name of HEMICYSTITES PARASITICA, and which should not be separated from it. It is figured in the *Traité de Paléontologie* of Pictet, pl. XCIX, fig. 25, and in our plate 5, fig. 8.

Beyrich, in 1844, had reported the presence in Europe of one of these fossils and Roemer, described two under the names of *Agelacrinus bohemicus* and *Ag. rhenanus.* Then he described and figured a third species from America (*Lethaea geognostica*, pl. IV, fig. 6) a third species from America, *Agelacrinus cincinnalensis*

A last species finally, so different from the preceding that it could be made the type of a new genus, was described in 1848 by Forbes (British Cystideæ, Mém. geol. Surv., II, p. 521, pl. XXII). The only specimen known, coming from the Lower Silurian of the country of Wales, and very imperfect, has been named *Agelacrinus buchianus.* Its width is 34 millimeters and the height 15 millimeters, in the form of a flattened spheroid, and even

a little concave on top, with five arms or pseudo-ambulacra prolonged obliquely and below he swollen edge so that this Cystid cannot be attached like the other by its entire ventral surface. Perhaps it even had a peduncle.

SECOND FAMILY. BLASTOIDEA. — SAY.

(βλαση, bud)

Calyx ovoid or barrel-shaped, with five sides or five corners, more or less pronounced, corresponding to five petaloid or nearly linear ambulacra, divided by a median groove and composed of a larger number of small transvese pieces that make transverse striations.

The calyx itself, except the ambulacra, is formed of a very small number of very thick pieces, i.e.: three basals, five brachials receiving the end or nearly all the ambulacra in a deep notch, and five interradials that frame the ambulacra and complete with them the vault that often has a central hiatus that is taken for the mouth. There is always a pair of respiratory openings close together or nearly merged at the top of each inter-ambulacral interval. They have been wrongly taken for ovarian openings. And finally, an unpaired opening (ovarian), taken for the anus, often found united in the same cavity with a one pair of respiratory holes The ambulacra have in the intervals some pieces that compose it and that are of two kinds (poral and auxillary poral of Roemer) of pores that appear to communicate with the internal respiratory system. This is composed of a system of parallel lamellae or very compressed canals located below the ambulacra from which they are separated by a much narrower lanceolate plate.

Each ambulacrum appears to have (according to Roemer) a series of articulated pinnules inserted at each of its edges. The calyx is supported by an articulated stalk that is cylindrical and not very thick.

REVIEW.

This family was established by Thomas Say in 1824 for the genus *Pentremites* that he himself had formed with fossils known since 1811 by the work of Parkinson (*Organic remains*) under that name from *Kentucky fossil asteroid*s. In 1820, Schlotheim (*Petrefactenkunde*, t. I, p. 339) had described them under the name of *Encrinus florealis* but it was Th. Say who was the first to make known more exactly the external characters. Struck by the presence of five holes corresponding to the five pairs of respiratory openings, he expressed this character by the name *Pentremites* (by contraction of πεντας, five and τρημα, hole). Then, noting the similarity of the most common form with a bud, in Greek, βλατη, he gave the family the name of Blastoidea, which appears all the more correct, as we regard today these crinoids as fruiting organs. It has, in any case, priority over the name of *Pentremitides* that some have wanted to replace it.

Of this family, we first knew only the single genus *Pentremite*, whose species rather widespread in the Devonian and Carboniferous terrains were even already represented in the upper Silurian, and that disappeared completely after the Carboniferous terrains. But

more recently, in 1849, M'Coy has established for a fossil of the Carboniferous terrain, a new genus (*Codaster*) perfectly characterized by the absence of respiratory openings, that replaced by the lamellae that have come to the surface. Roemer, in his beautiful work on Blastoids (1851) was also led to form a third genus *Elaeacrinus* for a species of Pentremite (*P. verneuil* Troost) of the Devonian terrain that completely lacks the central hiatus that has been taken for a mouth in the true Pentremites and that is already so little distinct in *Codaster* or *Codonaster.* This genus *Elaeacrinus* is distinguished, moreover, also by the extreme cramping of its basals and also by the small extent of its radials, while the interradials, so small in most of the Pentremities, are here very developed and constitute, with the ambulacra, nearly all the surface of the calyx. Finally, two or three other very doubtful genera have been referred to this family. These are:

1° The genus PENTREMITIDEA was established by D'Orbigny according to the erroneous opinion that *Pentremites schultzii* and *P. pailletti* have only 2 rows of pieces, of which 5 are basals. While these species that, for other reasons of internal structure must probably later form a separate genus have, like the three preceding genera three rows of plates of which three are basals.

2° The genus PHYLLOCRINUS, also established by D'Orbigny (*Prodrome*, 4850, t. II, p. 110) for a fossil of the Neocomian terrain. *Phyllocrinus malbosianus* from Berrias (Ardèche) and Barèmes (Basses-Alpes), would be, he said, a Pentremite whose five ambulacrum is sunken and divides the whole calyx into five leaves, like free petals. Each ambulacrum would be supported by a separate piece. But it is extremely doubtful that we can leave, with the other Blastoids all of the Paleozoic terrains, this single species that is not figured and not described in detail, that is supposed to belong to the last period of the secondary terrains.

3° The genus ZYCOCRINUS, of Bronn (*Index palæontologieus*, 1848), first named *Astrocrinites* Austin (*Ann. and Mag. of nat. Hist*., 1843, t. XI, p. 206), who gave its characters as having a quadrangular centro-dorsal plate to which are attached four pairs of elongated plates which results for the ensemble in a lobed form. Four ambulacra corresponding to these four lobes. The mouth is said to be central and the anus lateral.

The descriptions and figures of Blastoids, and Pentremites in particular, were published before 1840 by Say, Goldfuss and Munster, Phillips (*Geology of Yorkshire*, 1836), by Troost (*Geology of Tennessee*, 1841), by De Koninck in 1842, then, in 1854, with Lehon. De Verneuil alone, in 1844, and with d'Archias in 1845, and by M'Coy (*British paleoz. foss*., 1849, and *Synopsis carb. foss*., 1851). Finally, Roemer, in a very remarkable monograph of this family (*Archiv für Naturg*., 1851) has described not only the 3 genera that we have listed after him, but also 21 species of Pentrémites that he wants to call *Pentatrematites* for a purely grammatical reason that we cannot accept. He also changes the name of *Codaster* of M'Coy to *Codonaster* that is more easily acceptable.

The most important part of the work of Roemer is certainly the study he made, with so much talent, on the structure of Blastoids. Unfortunately, he still wants to complicate the nomenclature by naming furcales the radials that, actually, are more or less forked, and deltoids, the interradials that never have the form of a delta and rarely those of leaves that have been named deltoids. De Koninck and Pictet, in the *Traité de Paléontologie*, have correctly not followed these innovations.

We add here that in the *Lethæa geognostica* of Bronn, Roemer makes at the same time of Blastoïdes or Blastoïdés, a family and one of three distinct suborders into which he divides the Crinoids.

DESCRIPTION, STRUCTURE, FUNCTIONS OF BLASTOIDS.

Blastoids, always recognizable with their five ambulacra, have however rather considerable differences in their form. Thus, while *Eloeacrinus* is a nearly regular ellipsoid and *Codonaster* has the form of a calyx nearly closed above by a nearly flat surface on which is sculptured a regular star, the Pentremites are elliptical or semi-elliptical, i.e., truncated below, others club-like or barrel-shaped, while those of *Codonaster*, *Pentremites Schultzii, Pailletti*, etc., are entirely contained in a dorsal surface that is not very convex or nearly flat. Likewise, they also vary in their width, because sometimes they are so widened that they touch and prevent the radials from being seen, and other times they are reduced to small bands with parallel edges. The surface of the plates is ordinarily covered with growth striations.

The central opening, when it exists, has completely the character of a simple hiatus, and each of the five lobes corresponds to a radial with the last two adjacent ambulacra approach each other or slide in relation to each other. The edges of these lobes are, moreover, marked with vertical striations that are the continuation of those in the curving rows on the median groove of the ambulacra.

The lamellae or compressed parallel canals that we see in the interior below the middle of the ambulacra of some *Pentremites*, are seen, on the contrary, filling, appropriately cut, all the inter-ambulacral spaces in the interior in *Pentremites schultzii* and *pailletti*. This arrangement is evidently a transition to that seen in *Codonaster* that has exteriorly inter-ambulacral spaces filled by a double system of rows parallel to the axes of the contiguous ambulacra and subsequently diverging from the middle of the inter-ambulacral space. However, these striations are the interstices of the lamellae equally parallel to the axes of the ambulacra in all the species of Pentremites and we must see there a respiratory system analogous to that we have seen on the internal surface of the plates of *Caryocrinus, Hemicosmites*, etc. These lamellae, or lamellar canals when the completely internal, receive the exterior liquid by the ambulacral pores and we can think that the double opening the ends each ambulacrum toward the center of Pentremites functions for the exit of the water used in respiration. However, these openings, instead of being united for the two halves of an ambulacrum, are, on the contrary, united with that of another demi-ambulacrum, and in each of the five common openings that are sometimes so characteristic around the apical pole, are two expiratory openings belonging to two different ambulacra, separated by the interradii piece that makes a small vertical partition between the two.

One of the five openings, larger than the others, has this peculiarity that, instead of two openings, it contains a third. The third, a little more exterior, must be that ovarian opening that we find completely isolated in *Codonaster*. Those that do not have openings for the exit of water must have been able to filter across the numerous pores of the striations of the inter-ambulacral spaces.

Roemer has reported, on a silicified specimen from America, appendages in the form of arms, or rather of pinnules, on the edge of the ambulacrum and directed upward or lying

on the ambulacrum. But as he did not see a structure completely similar to that of the ambulacra of Echinoids and Asteroids, he preferred the name pseudo-ambulacra that we do not accept. Finally, in *Elaeacrinus*, the central opening, elsewhere called a mouth, not only does not exist, but is replaced by supplementary polygonal plates that completely close the calyx in this area.

We have already said that the Blastoids are found exclusively in Paleozoic terrains and nearly exclusively in Devonian and Carboniferous terrains because we still know only a single species in the Upper Silurian terrain. Several seem localized in restricted areas and others very common in some localities, are extremely rare in others.

It is among the Pentremites that it is more usual to see the spathic limestone of Echinoderms replaced by silica that is molded so perfectly in the place of limestone, that it reproduces in all details of the surface. But it is not the same with the internal structure that, in this case, has completely disappeared.

Because this family contains only three very close genera, it is sufficient to distinguish them by saying:

1° That Pentremites have a central opening, surrounded by five other respiratory openings, each of which is double, except one that contains a third opening (ovarian).

2° That the only *Elaeacrinus* has five double openings and the ovarian opening, but completely without a central opening and, in this case, the double openings, instead of ending the inter-ambulacral areas, end, on the contrary above, at the ambulacra. It follows that: the ovarian opening, instead of being annexed to a pair of openings coming from the two ambulacra, are isolated between the two double openings.

3° That the sole *Codonaster* still has the ovarian opening, is completely lacking the five double respiratory openings and the median opening is doubtful.

1st GENUS. **PENTREMITE**. *PENTREMITES*. — Say, 1820.

Calyx ovoid with five sides or corners more or less pronounced, or calyx barrel-shaped with five petaloid ambulacra more or less wide or linear, leaving from the top and limited to the dorsal surface or descending laterally to the plane of the base. A wide pentagonal opening at the center of the top is surrounded by five double openings, sometimes distinct, more or less narrow, sometimes united into an opening or common round cavity, located at the top of each inter-ambulacral area. One of the double openings is always widened by the annexation of a single opening (ovarian) taken for the anus by authors. Ambulacra may have articulated pinnules along their arms.

We have nothing to add regarding the form and structure of Pentremites. We will say only that Roemer, who has made a special study, separates the species into four groups:

1° FLOREALES, having *P. florealis* Say for the type;

2° ELLIPTIQUES, having *P. ellipticus* Sow. For the type;

3° TRONQUES, whose barrel-shaped calyx, or in the form of an inverse cone, is truncated at the top, as in *P. pailletti* of Verneuil;

4° CLAVIFORMES, or club-shaped, containing only *P. reinwardtii*.

The latter alone is from the Upper Silurian terrain. Among the others, five or six are from the Devonian terrain. All the rest are from the Carboniferous terrain.

1st GROUP. FLOREALES.

1. FLOR AL PENTREMITE. *PENTREMITES FLOREALIS*.— Say.

Pl. 2, fig. 10.

Kentucky Asterial fossil, 1811, Parkinson, Organ. rem., V, 2, pl. 13.— *Encrinites florealis*, Schlotheim, 1820, Petref., I, p. 339.— *Pentremites florealis*, Say, 1820, in Journal of the Acad. nat. sc. of Philad., IV, no 9.— Sowerby, 1826, in Zoological journal, II, p. 311, pl. xi, f. 2.— Goldfuss, 1832, Petref. germ., I, p. 161, pl. 1, f. 20, b, e. — *Pentatrematites florealis*, F. Roemer, in Archiv für Naturg., 1851, p. 353, pl. 1v, fig. 1–4 and pl. v, fig. 8.

Calyx globular, length 13 mm, width 11 mm (or sometimes as wide as long), near flat below, except the protrusion of the point of attachment of the stalk. Basal pieces forming below a pentagon less than half as wide as the body. Radial pieces reaching two-thirds of the height. Lanceolate ambulacra, width 4 mm, descending nearly to the base, covered with very dense transverse striations (approximately 52) and divided by a longitudinal median groove. The transverse striations correspond to the pieces with pores. When they are erased by abrasion or atmospheric exposure, we see in the middle a smooth lanceolate plate less than half as wide as the apparent area and on its sides the sutures of the plates with pores. Finally, when all this exterior system has fallen naturally or removed deliberately, we see below nine to eleven longitudinal grooves separated by rods that are lamellae hollow in the interior, or greatly compressed tubes.

The openings of the top are rather large and round.

Roemer has indicated as characters the absence growth striations on the surface of the radial and basal pieces. But this is the result of the mode of fossilization of siliceous molds because we see these striations in better preserved specimens.

The floreal Pentremite is the most common of all the species. It fills some layers of the Carboniferous limestone in the Mississippi basin om the United States of America, particularly in the states of Kentucky, Tennessee, Alabama, Illinois and Indiana. It varies in its width relative to its length and especially in the extension of its base that, instead of being nearly flat, can become more or less conical, which brings this species near *P. pyriformis* of Say, to a point that Roemer does not believe absolutely incontestable the distinction of the two species. I share this opinion.

2. PEAR-SHAPED P.. *P. PYRIFORMIS*.— Say.

— Say, l. c. — Sowerby, l. c. p. 315. — Troost, in *Transact. of the geol. Soc. of Pennsylv*., I, p. 224. — *Pentatrematites pyriformis*, Roemer, l. c., p. 354, pl. 5, f. 9.

It differs from the preceding, as we have just said, by its more elongated form and also by its much greater dimensions, because it reaches a length of 40 mm and a width of 27. It can be found at the same time, but it is much rarer.

D. D. Owen (in the American Journ. of Silliman, vol. XLIII, 1824, p. 20, f. 3) has described, as a new species, a Pentremite different from this by its more angular contour. Roemer correctly considers this a simple variety. A siliceous mold listed under this name at the École des Mines as referring to the state of Alabama by De Verneuil in 1848, is certainly only the variety with the conical base of *P. florealis*. Its length is only 42 mm with the pedicel, and width is 40 mm.

3. FURROWED P. *P. SULCATUS*. — Roemer.

In Archiv für Naturg., 1851, p. 354, pl. 5, f. 7, and pl. 6, f. 10.

Atlas, pl. 2, fig. 14.

Calyx globular, length 51 mm (and up to 54 mm), and nearly as wide, a little truncated below. Ambulacra wide, lanceolate, framed by a protruding edge of radial and interradial pieces and separated by a deep depression of these same pieces so that, seen from below, the contour of the body is a star with five truncated arms. The radial pieces are strongly swollen below. The exterior surface, nearly entirely smooth, has only very fine growth striations on each piece. The form of the top and the ambulacra is the same as in *P. floreal*.

It is only in this species that Roemer saw in place, on a specimen partly embedded in the rock, numerous articulated filiform pinnules the left each of the pores (?). These pinnules, laid parallel, reach or pass a little the top of the ambulacrum. Roemer has collected the siliceous mold of this species in the same Carboniferous terrain of the United States, notably to the south of Belleville in the state of Illinois.

4. OVAL P. *P. OVALIS*. — Goldfuss.

— Goldf., *Petref*., I, p. 161, pl. 50, f. 1.— Phillips, *Palæoz. foss*., 29, pl. 14, f. 40 (?) (non *P. ovalis*, Say, in *Silliman Americ Journ*., II, 30). — *Pentatrematites ovalis*, Roemer, l. c., p. 355, pl. 7, f. 14.

Calyx nearly globular, length 9 mm, width 8 mm, slightly stalked. Ambulacra lanceolate, reaching the base and with (24) large transverse striations. They are separated by intervals the same width as themselves, which are covered with divergent rays from the bottom to the top and crossed with striations that are not very distinct. The basal pieces, in extending below, form a short peduncle.

This small species, very near *P. floreal*, is distinguished by transverse striations that are less numerous (24), ambulacra, and divergent rays on the surface.

The *P. ovalis* of Say, different from this one, is a simple variety of *P. florealis*. The original example, described by Goldfuss, coming from a kind of grauwacke of somber color, is part of the Carboniferous terrain in Germany, according to Ratingen.

5. PUZOS' P. *P. PUZOS*. — Munster.

— Munster, 1839, *Beitr. zur Petref*., 1, p.1, pl. 1, f. 5. -— De Koninck, 1842, *Anim. foss. du terr. carbon. de Belg*., p. 36, pl. F, f. 3. — Id. and Lehon, 1854, *Recherch. sur les Crinoïdes*, p. 195, pl. 7, f 2. — *Pentatrematites puzos,* F. Roger, l. c., 1851, p. 556.

Calyx very small, length 5 mm, width 4 mm, sub-ovoId. Base short, conoidal, ended on its ventral part by three small calluses that surround the articular surface and giving it a trilobed contour. Ambulacra lanceolate, narrow, composed of 12 to 14 pieces with pores, notably sunken, framed by vertical edges. Openings at the top in the form of narrow slits, place on each side at the end of the interradial pieces. Very fine growth striations, visible only with a magnifying glass, are on the basal and radial pieces.

This very rare species, of which there is still only one complete specimen among the other very numerous Pentremites of the Upper Carboniferous clay of Tournay, has been accepted with doubt by Roemer, who has been tempted to regard it as a young individual of one the species that are so abundant in the same locality, but De Koninck and Lehon persist in considering it as really distinct.

6. SWOLLEN P. *P. INFLATUS*. — Sowerby.

— Sowerby, *Zool. Journal*, II, 89, pl. 33, f. 2. — Phillips, *Geol. of Yorkshire*, 1, 207, pl. 3, f. 1–3. — *Pentatrematites inflatus*, Roemer, l. c., p. 357.

Calyx nearly pyriform, ended on top in a flattened pyramid with five sides. Ambulacra linearly, formed nearly exclusively by large pieces with pores and ending ventrally nearly in the middle of the calyx that is angular in this region. The basal pieces that, by their uniting, form the conical lower end of the calyx, nearly reach a third of the total length. De Koninck had referred to this species to Pentremite (no 8), in 1842 but he has rectified this determination.

Found in the Carboniferous limestone of Bolland (Yorkshire).

7. POINTED P. *P. ACUTUS*. — Sowerby.

— Sowerby, *Zool. Journ*., II, 89, pl. 33, f. 6. — Phillips, Geol. of Yorkshire, II, p. 207, f. 4–5. — *Pentatrematites acutus*, Roemer, l. c., p. 358.

Calyx pyramidal. Ambulacra wide and short, reaching nearly a third of the total length from the top while the suture of the basal pieces are found in the third from the base. The calyx enlarges uniformly from the base to the top.

Found in the Carboniferous limestone of Bolland (Yorkshire).

8. CARNATION P. *P. CARYOPHYLLATUS*. — De Koninck and Lehon.

P. inflatus (?), De Koninck, *Anim. foss. du terr. carbon. de Belg*., 1842, p. 38 {non Sowerby). — *Pentatrematites orbignyanus*, F. Roemer, l. c., 1851, p. 358, pl.7, f. 16. — De Koninck and Lehon, *Recherch. sur les Crinoïdes*, 1854, p. 197, pl. 7, f. 3.

Calyx pyriform, elongated, length 12 mm, width 8 mm. Conical base rather short, occupying only a fourth of the total length. Basal and radial pieces ornamented with very fine but very visible growth striations. Ambulacra oval-lanceolate, width 3 mm, with on each side 15 to 17 rather large pieces with pores, that are detached and fall very easily. The central opening at the top is rather large and the openings (respiratory) that surround it are slits located on the sides of the interradial pieces. The unpaired opening (ovarial) is large and oblong. It occupies nearly all the length of the corresponding interradial piece. Roemer has confused this species with *P. orbignyanus* (De Koninck) that differs by its ambulacra that are shorter and much less curved on themselves and located more shallowly. A horizontal section of *P. orbignyanus* is, moreover, pentagonal, while that of *P. caryophyllatus* is circular. This species is not very rare in Upper Carboniferous clay of Tournay, but it is difficult to have it in good condition.

2nd GROUP. ELLIPTICUS.

9. ELLIPTICAL P. P. ELLIPTICUS. — Sowerby.

— Sow., Zool. Journ., II, p. 318, pl. 14, f. 4. — Phillips, Geol of Yorkshire, II, p. 207, pl, 3, f. 6–8. — Morris, Cat. British foss., p. 56. — M'Coy, Synops. carb. limest. Foss. of Irel., p. 174. — Brit. palæoz. foss., 1851. II, p. 124. — F. Roemer, in Arch. f. Naturg., 1851, p. 360.

Calyx elliptical, slightly truncated below, length 13 mm, width 41 mm. Base very small, pentagonal, a little concave. Radial pieces very large, wider at the top. Interradials large, reaching nearly the center. Ambulacrals narrow, nearly linear. Surface of the calyx with nearly regular rows of small granules following the growth lines. These rows, more distinct, become nearly longitudinal near the top. The ambulacra are formed nearly exclusively of pieces with pores, between which the lanceolate plate allows seeing only a thin line. But the pieces with pores are fallen, the entire lanceolate plate is seen as a lintel whose sides are beveled, still having the impressions of the pieces with pores. The intervals that separate the ambulacra are flat or only slightly concave, which makes a section of the calyx pentagonal. The suture of the radial and interradial pieces are in the middle of the height. This character distinguishes sufficiently *P. eilipticus* from *P. derbiensis* and *P. oblongus*.

Found in the Carboniferous limestone of Preston (Lancashire), of Bolland (Yorkshire), as well as in the county of Derby and in Ireland. — The specimen from the École des Mines is spathic, length 12 mm, width 10 mm.

10. BELL-SHAPED P. *P. CAMPANULATUS*.— M'Coy.

— M'Coy, in Ann. and Mag. of nat. Hist. (1849), p. 249. — Brit. palæozoie foss. (1851), II, p. 123, pl. 3 D, f. 9. — *Pentatrematites campanulatus*, F. Roemer, in Arch. f. Naturg., 1851, p. 361, pl. 8, f. 4.

Calyx in form of a bell, having a flattened bases as wide as the body itself, length and width approximately 7 mm. Ambulacra narrow and ended in a point at the ventral end. Suture of the radial and interradial pieces found nearly at the middle of the height. Surface finely granular. If we supposed, says M'Coy, a *P. ellipticus* cut transversally at the lower third of the height, we would have a good representation of this species that, moreover, resembles the preceding by several characters and is distinguished by its smaller size and by the more pointed ambulacra.

Rarely found in the Carboniferous limestone of Derbyshire.

11. ANGULAR P. *P. ANGULATUS*. — SOWERBY.

— Sow., Zool. Journ., III, p. 89; pl. suppl. 33, f. 6. — Phillips, Geol. of Yorkshire, II, 207, pl. 2, f. 13. — *Pentatrematites angulatus*, F. Roemer, in Arch. f. Naturg., 1851, p. 362.

This species from the Carboniferous limestone of Bolland (Yorkshire) can be distinguished solely by its globular form from *P. oblongus*, which it greatly resembles.

12. P. OBLONG. *P. OBLONGUS*. — Sowerby.

— Sow., Zool. Journ., III, p. 90; pl. suppl. 33, f. 3–4. — Phillips, Geol. of Yorkshire, II, 207. — *Pentatrematites oblongus*, F. Roemer, in Arch. f. Naturg., 1851, 362.

Calyx ellipsoidal, truncated and concave below. Ambulacra lanceolate, nearly linear, extending from the top nearly to the base, formed of farther large pieces with pores, twenty-five in each row, with auxiliar pieces that are smaller but recognizable. Below these pieces with pores and entirely covered by them is a very narrow lanceolate plate. The intervals between the ambulacra are nearly flat, only a little sunken toward the lower part (according to Roemer who saw a specimen at the Museum of Bonn. According to Phillips, on the contrary, these intervals are concave and longitudinally striated.) According to this, the contour of the calyx is pentagonal. The basal pieces are very small and located entirely in the concavity of the base. The radials, on the contrary, are very large and form nearly all the calyx. The interradials, finally, are very small and do not have a sixth of the length of the calyx. Found in the Carboniferous limestone of Bolland (Yorkshire).

13. ROUND P. *P. ORBICULARIS*. — Sowerby.

— Sow., Zool. Journ., V, 456, pl. suppl. 33, f. 5. — Phillips, Geol. of Yorkshire, II, 207, pl. 3, f. 9. — *Pentatremites orbicularis*, F. Roemer, in Arch. f. Naturg., 1851, p. 363.

Calyx globular. Ambulacra narrow, nearly reaching the base. The position of the suture of the radial and interradial pieces in the middle of the calyx appears sufficient to distinguish this species from *P. angulatus*, which it resembles exteriorly. This character, on the contrary, is common with *P. granulatus*, which is less globular. Found in the Carboniferous limestone of Bolland (Yorkshire).

14. GRANULAR P. *P. GRANULATUS*. — Roemer.

Pentatremites granulatus, F. Roemer, in Arch. f. Naturg., 1851, p. 363, pl. 6, f. 13.

Calyx nearly globular, truncated above and below, and concave on the ventral surface, length or height 20 mm, width 24 mm. Ambulacra narrow, tapering to a point below and going down to the ridge that separates the sides of the calyx from its concave ventral surface. Basal pieces small and located entirely in the ventral concavity. Radials wide, reaching only a little above the middle of the sides. The interradials are consequently large and wide. The surface is coarsely granular. This species that, by its external form, is near *P. orbicularis* and *P. angulatus*, is distinguished by the granulations of its surface, by the median position of the suture of the radial and interradial pieces, and by its much narrower ambulacra below.

Found in the Carboniferous limestone of the United States at Shelbyville (Tennessee) and at Allen County (Kentucky).

15. DERBY'S P. *P. DERBYENSIS.*— Sowerby.

Sow., Zool. Journ., II, p. 316. — Phillips, Geol. of Yorkshire, II, p. 207, pl. 3, f, 10. — Morris, Cat, Brit, foss,, 56. -— M'Coy, Brit. palæoz, foss., 1851, Il, p. 124. — *Pentatrematiles derbiensis*, F. Roemer, in Arch. f. Naturg., 1851, p. 364.

Calyx sub-globular or a little pyriform, wider above, granular, length 43 mm, and as wide or sometimes a little less with an obscurely pentagonal contour. Base concave, pentagonal, with protruding angles. Basal pieces very small, contained in the concavity of the base. Radials ordinary, a little depressed, the corner of the notch very blunt. Interradials very large, nearly reaching the center. Ambulacra narrow, linear, protruding, representing a double row of dense globules because the pieces with pores rounded and contiguous, completely hide the lanceolate plate that they cover. Each side is flat in the middle, a little swollen at the edges. The reentrant corners of the transverse sutures are near the base less than a third of the total length. The surface is covered with granulations that are blunt and very dense like those of chagrin and forming irregular rows.

This species varies a little in its external form, the ventral half being narrower at the tip and the dorsal half more swollen in some specimens than in others. In some, the base is extremely narrow. The width varies considerably. The transverse sutures, located much below the middle, distinguishes this species from *P. orbicularis*. This character is even sufficient to distinguish it from all those of the same group.

Found in the Carboniferous limestone of Grassington (Yorkshire).

16. CRENELATED P.. P. *CRENULATUS.* — F. Roemer.

Pentatrematites, F. Roemer, in Arch. f. Naturg., 1851, p. 366, pi. 7, f. 15.— De Koninck and Lehon, Rech. sur les Crinoïdes, 1854, p. 201, pl. 7, f. 4.

Atlas, pl. 2, fig. 12.

Calyx globulose, with five rounded corners, truncated below, height 6 to 9 mm and nearly the same width. Pseudo-ambulacra narrow, a little narrowed toward the base and going down to the level of the base. They are in addition finely crenelated along the exterior edge and more widely on each side of the median line. They are composed of two rows of 25 to 98 rather wide pieces with pores, oblique and S-shaped. The lanceolate plate that they cover entirely is nearly linear, thick and keel shaped. When the pieces with pores are removed, we clearly see along the internal edge of the groove they occupy, a row of pores corresponding to the crenelations of other external edge. The three basal pieces are rather large and located in the same plane. There surface, as well as those of the radial pieces, is covered with other similar lines, with a small, pointed tubercle at each point of intersection. The very large radial pieces reach nearly the center of the top. The small interradial pieces, covered with transverse ridges, extend beyond the four small peripheral openings (respiratory) of the vertex and divide each into two very distinct halves. Each of the five peripheral openings of the vertex is separated from the central opening by an elegantly dotted border.

This species, which by its exterior form is very near *P. angulatus* but distinguished by its ambulacra, is very common in the Carboniferous limestone of Tournay in the calcareous spar state.

17. OBLIQUE P. *P. OBLIQUATUS*. — F. Romer.

Pentatrematites obliquatus, F, Roemer, in Arch. f. Naturg, 1851, p. 367, pl. 6, f. 11.

Calyx oblong, angular, prismatic, length 50 mm, width 45 mm. Radial pieces nearly rectangular, two times as long as wide. The smooth and strongly swollen exterior surface is formed of two nearly flat surfaces, inclined against each other like a roof. On the ventral end, their median edge is ordinarily cut obliquely by a triangular surface which gives the ensemble an asymmetrical appearance. The ambulacra that are narrow, linearly, nearly the same width everywhere, are located in deep grooves with very protruding edges that do not reach the middle of the radial pieces. The pieces with pores are relatively large, one and a half times as wide as long, finely crenelated along the median line. They are contiguous with those of the other row and thus completely hide the lanceolate plate that is very narrow. The side pieces with pores, also large, are half as wide as the pieces with pores. The pores are very small, scarcely visible.

Found in the Carboniferous limestone in the state of Indiana in the United States.

3° GROUP. TRUNCATED.

18. P. WITH SEQUINS. *P. PAILLETTI*. — DE VERNEUIL.

— De Verneuil, in the Bulletin de la Soc. géologique, 1844, I, p. 213, pl. 3, f. 4, 5. — D'Archiac and De Verneuil, ibId., II, 1845, p. 479, pl. 15, f. 10, 11. — *Pentremitidea pailletti*,

D'Orbigny, Prodr. de Paléont., I, 1849, p. 102. — *Pentatrematites pailletti*, F. Roemer in Arch. f. Naturg., 1851, p. 368, pl. 7, f. 17.

Atlas, pl. 2, fig. 13.

Calyx in the form of a funnel of a club truncated above, length 12 to 17 mm, width 7 to 10 mm. The three basal pieces, narrow, form a rounded, a little triangular peduncle, of the calyx and reach nearly to the middle of the total length. The five radial pieces, oblong, a little widened above, are not very deeply notched to receive the ambulacra, between which the calyx is strongly depressed on the sides along the vertical sutures so as to form a five lobed contour. The very small interradials are completely located on the dorsal surface or the vertex and form the tip of the triangular sectors that separate the ambulacra. These are short, three times narrower than long and located entirely on the dorsal surface. They are composed of large pieces with pores that detach easily. The lanceolate plate is missing (according to Roemer). The five peripheral openings of the vertex are separated from the center by a notable interval formed by the union of contiguous ambulacra. The surface of each plate of the calyx has growth striations that are not very distinct.

Very common in the Devonian layers at Ferrones (Asturias) in Spain. We cite also one specimen found in the Carboniferous terrain of Eifel (Prussian Rhine), but the following species from Belgium must be very distinct.

19. D'ORBIGNY'S P. *P. ORBIGNYANUS*. — De Koninck.

— De Kon., 1842, Deser. des anim. foss. du terr. carb. de Belgique, p. 87, pl. E. — De Konninck and Lehon, Rech. sur les Crinoïdes, 1854, p. 200, pl. 7, f. 3.

F. Roemer (in Archiv fur Naturg., 1851) has united this species to the preceding, *P. pailletti*, and has transported the name to *P. caryophyllatus* (n° 8).

Calyx in the form of an inverted pyramid, with a pentagonal contour, with the dorsal surface slightly swollen, length 17 mm, width 10 mm. The basal pieces form by their union a truncated cone whose length is a third of the total length. The radial pieces, much longer than wide, are curved laterally. Their surface, like that of the basal pieces, is covered with growth striations. The interradial pieces are small, a little longer than wide. The ambulacra, elliptical in form, do not reach half the length of the radial pieces. They form two rows of 14 to 16 ambulacral side plates. De Koninck attributes to them, in addition, a very thin lanceolate pieces that Roemer says is missing in the preceding species, whose pieces porales are moreover less numerous. The small peripheral openings of the top are represented by small slits and the unpaired opening or ovarian (anal opening of Koninck) is circular, rather large and hollowed out in, of which it occupies half the length. A

A single specimen of this species was found in 1841 by De Koninck in the Upper Carboniferous limestone of Tournay.

20. FIVE-ANGLED P. *P. PENTANGULARIS*. -— Bronn.

Platycrinites pentangularis, Miller, Crinoïdes, p.83.— *Encrinites pentangularis*, Schlotheim, Petref., IL, p. 97, pl. 26, f. 5 (after Miller). — *Pentremites pentagonalis*, Gilbertson, in

Sow. Zool. Journ., V, p. 457, pl. 33, f. 7. — Phillips, Geol. of Yorkshire, II, 207. — F. Roemer, in Arch. für Naturg., 1851, p. 371.

Forbes has figured incorrectly under this name (in Mem. geolog. Surv., II, part. II, p. 529) *Codaster* or *Codonaster acutus*. This very imperfectly known species, because of its state of preservation, has been indicated at a *Platycrinus* by Miller, who, in the figure that he gives, even adds arms. It is very near two other species with which, according to de Verneuil, should be united with it. However, according to Roemer, it is distinguished from *P. pailletéi* by its calyx that is much thicker and less elongated ventrally.

Found in the Carboniferous limestone of Bolland (Yorkshire).

21. SCHULTZ'S P. *P. SCHULTZII*. — De Verneuil and D'Archiac.

— De Verneuil and D'Archiac, Note sur les foss. du terr. paléoz. des Asturies, in the Bull. de la Soc. géol., 2^{e} sér., II, 1844-045, p. 479, pl. 15. f. 12 and 13. — *Pentremitidea schultzii*, D'Orbigny, Cours élém. de Paléont., II, p. 139, f. 287. — *Pentatrematites schultzii*, F. Roemer, in Arch. f. Naturg., 1851, p. 369, pl. 7, f. 18.

Atlas, pl. 2, fig, 15.

Calyx small, club-shaped, obscurely prismatic, truncated squarely above. The basal and radial pieces are covered with growth striations parallel to their edges. The five radial pieces that are depressed and reach the vertex are nearly square. The interradials that are seen only as very thin rods separating the ambulacra that, covering nearly the entire dorsal surface, and even hide these interradials for the most part. Each ambulacrum is formed of a lancet plate and two rows of linear ambulacral side plates that are rather large, 12 to 43 in each row and very small auxiliary rounded ambulacral side plates.

This species of Pentremite, as *P. pailletti*, shows even more clearly in transverse sections, the internal respiratory lamellae of which we have already spoken and that are here parallel to the ambulacral axis.

Found with *P. pailletti* in the Devonian terrain of Ferrones (Asturias).

4th GROUP. CLAVIFORMES.

22. REINWARDT'S P. *P. REINWARDTII*. — Troosr.

— Troost, in Trans. of the Geol. Soc. Pennsylvania, E, 2, p. 224, pl. 10, 1841. — *Pentatrematites reinwardtii*, Roëmer, in Arch. f. Naturg. 1854, p. 372, pl. 6, f. 12.

Calyx length 20 to 50 mm, claviform, with five sides, ended above by a pentagonal pyramid, on the corners of which are the ambulacra that are narrow, linear and not very sunken. The ambulacral side plates, relatively large and especially long touch the length of the median line of the ambulacra so that the lancet piece cannot be seen between them, although it still exists below as a lintel in the form of a roof. The auxiliary ambulacral side plates are not visible. They probably are very small. The central opening is scarcely visible. The surface of the calyx is smooth without visible striations.

This species cannot be confused with any other and the only one of the Silurian terrain and even of the upper layers. It was found first at Brownsport (Tennessee) and then in the marly layers near Niagara Falls in the state of New York. It is changed by fossilization into white spathic limestone.

Following the 21 species that he describes, Roemer cites, as incompletely known: 1° *Pentremites globosus*, Say, in the Journ. of the Acad. Philad., IV, n° 9. — 2º *Pentremiles dutertrii*, the Institut, 1844, 24 April. — 3° *Pentremites astraeformis*, Austin, in the Ann. of nat. Hist., X, p.111. — 4° *Pentremites ovalis*, Sandberger, in Leonh. and Bronn Jahrb., 1842, p. 596. — 5º *Pentremites gracilis*, Steininger (Die Verstein. d. Ueberg. der Eifel, 1849). — 6° An unpublished Devonian species from the falls of the Ohio near Louisville, which is near *P. pailletti*, in the section of Truncated, although the ventral part of the calyx is less narrowed in the form of a stalk. — Finally, two species, also unpublished, found by de Verneuil in the Devonian layers of Asturias with *P. pailietti* and *P. schultzii*.

2nd GENUS. ELAEACRINE. *ELAEACRINUS*. — ROEMER.

(ελιά, olive, λρνον, lily.)

Calyx ellipsoid, formed of three extremely small basals, five radials (*furcales,* Roemer) that are small, nearly square, and five interradials (*deltoidales* R.) that are very large with five ambulacra that are narrow, linear, leaving from the apical poles and descending to the base. Six holes or openings around the apical pole that are closed by small polygonal plates. Five of these holes, located at the upper end of the ambulacra are double. The sixth, which is large and elliptical, is located at the upper end of one of the interambulacral areas that is more swollen and more protruding than the others.

This genus, so well characterized by the complete absence or a central opening and by the arrangement of the openings of the vertex, is recognizable at first glance by the form of the olive shape of the calyx, which give it its name of *Olivanites* by Troost. This author had described it first in 1841 under the name of *Pentremites verneuilli*, this single species that serves us as type. He understood later (1850) that it must form a separate genus that it designated under this new name without characterizing it. Roemer, on the contrary, in 1851, studied it in detail, comparing it with other Blastoids and gave it the name that we keep. The numerous specimens that we have seen come from the falls of the Ohio, near Louisville (Tennessee), have a uniformly thick covering (1 to 1.5 mm), like that of an urchin, and the interior cavity, filled with limestone, leaves no trace of structure. We thus can find only details of the surface.

VERNEUIL'S ELAEACRINUS. *ELAEACRINUS VERNEUILLII*, — Roemer.

— Roemer, in Arch. f. Naturg., 1851, p. 379, pl.8, f.1, and Lethaea geognostica, pl. IV, f. 10.— *Pentremites verneuillii*, Troost, Geol. of the State of Tennessee, 1841, p. 14. — D'Orbigny, Prodr, paléont., 1, p. 102. — *Olivanites verneuillii*, Troosr, dans Proceed,

of the American assoc., 1850, p. 62. — *Elaeacrinus verneuillii*, Pictet, Traité de Paléont., IV, p. 294, pl. 99, f.10.

Calyx ellipsoid, length 25 to 30 mm and a fifth narrower with all the surface finely sculptured. Each of the five interradial pieces that form the sides of the calyx is divided, according to its length, by two grooves, into three bands, of which the two laterals have fine and dense transverse striations. The median band, equally wide its entire length, is covered with irregular impressions like the skin of chagrin. The median band of the interradial piece, which has the ovarian opening, is notably more protruding in the upper half of the calyx, which gives it a more clearly bilateral form. The ambulacra, very narrow, are formed of four rows of small pieces. The two lateral rows, resembling rows of small pearls, are formed by auxiliary pieces with pores that are relatively large, swollen in the form of tears. The two median rows are formed by pieces with pores, nearly equally large and nearly flat, that completely hide the lanceolate plate that supports them.

From the Devonian terrain of America. The specimens coming from the falls of the Ohio near Louisville (Tennessee), and spathic limestone. Similar ones have been found in the state of Ohio. But on the edge of Lake Erie, near Sandusky, are found siliceous specimens.

3rd GENUS. CODONASTER. *CODONASTER*. — M'Coy, 1849.

(χωοων, bell, ασγηρ, star.)

Calyx conical or in the form of a bell with five corners that are round, truncated above, formed of three unequal basal pieces, five radials (*furcales* R.) that are large, equal, nearly rectangular, and five interradials (*deltoids* R.) located in the dorsal surface plane.

The dorsal surface plane is a pentagon divided by fiv lanceolate ambulacra forming the branches of a star and leaving between them triangular interambulacral areas, of which one is smooth and has the ovarian opening (*anus* R.), while the other four are divided into two by a protruding ridge representing one of the branches of a second star alternating with the first. From each side of this ridge extend oblique grooves that are themselves parallel to the ambulacra.

At the center is an opening or poorly determined hiatus that is taken for a mouth.

This genus was established by M'Coy in 1849 under the name of *Codaster* by contraction of the Greek words indicating the form of a bell and star of its dorsal surface. Forbes had already spoken of it in 1848 (*British Cystideae* dans *Mem. geol. Surv*., II, 2, p. 529) under the name of *Pentremites pentagonalis* and had given a not very correct figure of it in the text for comparison with *Asterias*. Roemer, in making it known more correctly (1851), proposed to change the name of *Codaster* to *Codonaster*, which we have readily accepted to avoid a faulty interpretation of the synonymy.

As we have said before, there are no openings around the pole in relation to the ambulacra that are called ovarian and that are believed to function in respiration. This function, in fact, can occur by means of the pores of the interambulacral grooves and those of the ambulacra, while it could be supposed, as Roemer, that the ovarian openings were completely missing. The lamellae that separate the grooves extend notably into the interior,

like those of other Blastoids and some Cystids. The grooves have numerous pores independent of the structure of the test (PI. 2, fig. 47.)

The two species known are from the Carboniferous terrain of England.

1. POINTED CODONASTER. *CODONASTER ACUTUS*.— M'Coy.

Atlas, pl. 2, fig. 17.

Codaster acutus, M'Coy, in Ann. and Mag. of nat. Hist., 1849, IL, p. 250, and British palæozoïc. foss., 1851, in Geol. Mus. of Univ. of Cambridge, II, p. 123, pl. 5 D, f. 7,— Roemer, in Arch. f. Naturg., 1851, p. 9389, pl. 8, f. 2 a-d, and Lethaea geogn. pl. IV, f. 11. — Pictet Traité de Paléont., IV, p. 295, pl. 99, f. 11.

Calyx length 12 to15 mm, and width a sixth narrower. The basals reach nearly the middle of the height and are covered with growth striations, as well as the radials, at least those that abrasion has not removed, as occurs in most of the specimens.

From the Carboniferous limestone of Derbyshire.

2. TRI-LOBED CODONASTER. *CODONASTER TRILOBATUS*. — M'Coy.

Codaster trilobatus, M'Coy, in Ann. and Mag. of Nat. Hist., III, p. 251, and British palæozoic. foss., 1851, p. 386, pl. 8, f. 3 a-b.

Calyx length about 16 mm and width 11.5 mm, with radial pieces a third longer than the basals and at its base, three swellings that extend to the point of attachment of the stalk.

This species, like the preceding, could be only a simple variety.

THIRD FAMILY. HAPLOCRINIDAE. — D'Orbigny.

(απλοος, single, αρινον, lily.)

Calyx stalked, formed of a small number of very thick pieces, of which three or five basals, four or five radials, with an articular surface sometimes double and with triangular interradials in the same number as the radials. These alone or with accessory pieces, close the vault of the calyx and have between them grooves where arms could be housed, articulated on the radials.

Buccal, anal, ovarian, and respiratory usually absent or indeterminate.

Haplocrinidae, still very little known, although several were described more than 20 years ago, appear to be, for the most part, buds or very young individuals of some other

genera whose form they must have taken after unequal development of some piece of their calyx or by successive appearance of new pieces of the calyx. What supports this opinion is that nearly all of them are very small, width only 4 to 5 mm, or the size of a small pea and formed of thick pieces that leave no space between them for the visceral cavity. Also, some naturalists, like Roemer, have thought to unite them with Cupressocrinidae. However, several new genera described by J. Müller appear, if judgement is possible from the figures, do not agree with this point of view. It is the same with the singular genus *Stephanocrinus* that we believe is better placed here than among the Cystids where Roemer and after him, Pictet have placed them.

The family of HAPLOCRINIDAE, or APLOCRINIDAE, was indicated for the first time under the latter name by D'Orbigny in his *Cours élémentaire de Paléontologie*, 1852, t. II, p. 139, taking for type *Aplocrinus sphaeroideus* of Steiniger, or *Eugeniacrinus mespiliformis* of Goldfuss, saying that: "Aplocrinidae are Pentremitidae with arms outside the ambulacra. He meant by ambulacra, the five wide grooves of the vault. At the same time, he added a second genus, *Dimorphicrinus*, for *Platycrinites pentangularis* of Miller (*Nat. hist. of the Crinoïdea*, 1821, p. 83, pl. of page 81), which, he said, "is an *Aplocrinus* whose calyx is formed of two rows of pieces: five basal pieces, five brachial pieces." But other authors have made the same fossil a *Pentremites*. Pictet thinks that it should be referred to *Platycrinus*. D'Orbigny himself (*Prodr*., t., p. 155,156) placed it in duplicate among the *Platycrinus*.

Already, in 1844, Roemer described a second species *Haplocrinus* from the same Devonian terrain as the first. And also previously, in 1844, J. Müller (*Mémoire sur le Pentacrinus caputmedusae*) had been struck by a new character that could furnish, for the establishment of a new family, the presence of so-called arms in *Haplocrinus*. It is Müller himself who, later, showed in this fossil the presence of appendages that he took for arms. He also described, in the same collection (*Verhandl. der niederrh. Verein. Tahrg*., XI), three new genera *Coccocrinus, Ceramocrinus* and *Epactocrinus*, that should be part of the same family. If *Gasterocoma*, described by Goldfuss in 1838 in *Acta naturæ curiosorum* (XIX, p. 350, pl. xxxii, fig. 5) but not placed into any family, and the recent genus figured by Sandberger under the name of *Myrtillocrinus*, and *Stephanocrinus* of Conrad (1842), there are provisionally 7 genera in this family. Except for *Stephanocrinus* of the Middle Silurian of America, it contains only fossils from the Devonian terrain of the same region in Germany on the two banks of the Rhine.

Bronn and Roemer, in *Lethæa geognostica*, 3rd edit., made two families of the same value with three of these genera: 22nd *Haplocrinidae* for the genera *Haplocrinus* and *Coccocrinus*, and their 23rd *Gasterocomidae* for the genus *Gasterocoma*. They classify them together in a section characterized by the incomplete development of the arms among their Actinoids or normal Crinoids.

Several have a stalk that is quadrangular and crossed by a canal with four lobes or by four distinct canals corresponding to the corners as in *Cupressocrinus*, which can provide another connection. All, moreover, for the radials and the parts of the vault, are perfectly subjected to the quinary mode of division.

Seven genera can thus be distinguished:

I. With three basals.

* Three accessory pieces under three of the five radials that thus seem doubled. Interradials form a pyramid that is more raised than the radials. …… 1. HAPLOCRINUS.

** The five radials simple, greatly passing the five interrradials that close the vault without notable protrusion …… 2. STEPHANOCRINUS.

*** The five radials surmounted by a second; radial or brachial piece; the five interradials doubled or followed by a second interradial that borders the brachial groove and closes the vault …….. 3. COCCOCRINUS

II. With five basals.

* Five contiguous radials …… ……4. MYRTYLLOCRINUS.

** Two of the five radials separated by an intercalary piece (*anal*, Pictet)

† The five basals without a lateral opening ……... 5. CERAMOCRINUS.

† † Those of the five basals that are under the intercalary piece have a lateral opening. …… 6. EPACTOCRINIUS.
7. GASTEROCOMA.

1st GENUS. **HAPLOCRINE.** *HAPLOCRINUS*.— STEININGER, 1837.

(απλοος, simple.)

Calyx width 3 to 4 mm and a little higher, globular below and ended above by a lowered pentagonal pyramid; three basals forming a pentagon, on the sides of which are the five radials, namely: two without intermediaries and three others by means of an intercalary transverse piece, as if these radials had split. All these radials have, in the middle of their upper surface, a kidney-shaped depression that must be due to the attachment of an arm. The five triangular interradials alternating with them come together to close the vault. They leave on their edges a wide groove or gutter on which the arms were applied. They often show transverse depressions in relation with the articulations of the arm. — Cylindrical stalk.

No opening has been indicated.

To have a clear idea of the internal structure of these small fossils, it is necessary to be able to cut and polish them in all directions. But we have not been able to do this, and the specimens that we have not shown, even under the microscope, nothing more than other naturalists. We are convinced only that the interradials are of only one piece and that a small opening communicating with the interior should be found at the base of the arms.

Only two species have been referred to this genus.

1. HAPLOCRINUS IN THE FORM OF A MEDLAR. *HAPLOCRINUS MESPILIFORMIS*.

Atlas, pl. 5, fig. 9.

— D'Orbigny, 1850, Prodr. de Paléont., I, p. 102.— Pictet, Traité de Paléont., 1857, IV, pl. C, f. 2. — *Eugeniacrinites mespiliformis*, Goldfuss, Petref., pl. 64, f, 6. — Bronn, Lethæa geogn., 1837, pl. 4, f. 13. — *Haplocrinites sphoeaeroideus*, STIENINGER, in Bull. soc. géol. de France, VIII, p. 232, f. 19.

It is found in Eifel (Prussian Rhine). It is thought to have the interradials transversely divided, but these divisions are only superficial and often not very visible. The second species, *Haplocrinus stellaris*, Roemer (1844, Das Rhein. Ueberg., p. 63, pl. 5, f. 5), appears to differ only by its smooth interradials or without divisions.

2nd GENUS. **STEPHANOCRINE**. *STEPHANOCRINUS*.— Conrad, 1842.

(στέφανος, crown.)

Calyx irregularly prismatic, narrower at the base and widened above by its crown.

Three basals, five radials, forked or appearing notched up to the middle of their length for the insertion of the arms. But they should be considered instead as simply indented first by the brachial groove and susceptible of growing in height on each side of the brachial groove and joining to the corresponding extension of the adjacent radial in a way to form five triquêtres points that crown the calyx and that are each composed of two halves belonging to the two contiguous radials.

These radials make up nearly all the mass of the calyx. Each has a large groove directed toward the center, to leave a kidney-shaped impression that must be the point of attachment of an arm. Completely at the center are five pentagonal or triangular interradials, with corners of the base truncated that by joining their tops completely close the very small visceral cavity.

The internal wall of the calyx has, moreover, parallel lamellae similar to those that we already reported in Cystids and Blastoids.

A tubercle at the base of one of the points of the crown has been taken for an ovarian opening comparable to that of Cystids and the opening that is thought to exist in the center has been named the mouth. Two oblong plates that are parallel cover each of the grooves and go to the truncations of the interradials.

Stalk cylindrical, thin.

The genus *Stephanocrinus*, established by Conrad in 1842 for a fossil of the Upper Silurian of America was studied in more detail in 1850 by Roemer who believed it necessary to place it among the Cystids. Pictet, in his *Traité de Paléontologie,* classified it in the same way, attributing to it five sub-radials in addition to the three basals and five radials and indicating ten tentacles surrounding the mouth and composed of two rows of alternating pieces. As for us, on several beautiful entire or fragmented specimens, we have seen only the characters indicated above. We have not been able to entirely convince ourselves that the opening called ovarian by Roemer is analogous to that of Cystids, and finally the central opening that Roemer called mouth only with doubt (?), still to us more doubtful. We have seen clearly the growth striations on the external surface of the calyx and the other striations that cut them at a right angle, but we have also seen the small tubercles arranged vey regularly at the intersection of the striations and a fine granulation in the interval. We have also seen, in the grooves of the vertex, regular larger punctuations, especially along the edges and apparently indicating the pores that would have given access to the exterior liquid. Finally, we have seen in the interior, the parallel lamellae that we have mentioned.

The species type, *Stephanocrinus angulatus* Conrad, and a second species, *St. gemmiformis* Hall, 1852 (Palaeont. of New York, t. II, p. 351, pl. 83), come from the same Upper Silurian terrain at Lockport, near the falls of Niagara.

ANGULAR STEPHANOCRINE. *STEPHANOCRINUS ANGULATUS*. — Conran.

Atlas, pl. 3, fig. 4–6.

— Conrad, Journ. Acad nat. sc. Philadelph., VIII, p. 279, pl. 15. — Roemer, in Arch. f. Naturg., 1850, p.365, pl. 5.— Hall, Palæont. of New York, 1852, II, p.212, pl. 48.— Pictet, Traité de Paléont., 1857, IV, p. 304, pl. 99, f. 23.

Calyx length 10 to 22 mm, including the extensions of the radials with which it is crowned, width 5 to 112, irregularly prismatic, a little narrower at the base and widened at the top by its crown.

3rd GENUS. **COCCOCRINE.** *COCCOCRINUS*. — J. Müller.

(χοχχος, berry, grain)

Atlas, plate 5, fig. 10.

Calyx in the form of a flattened spheroid, a little pentagonal, formed of three basals and five radials occupying the sides of the pentagon and each supporting a small piece that is discoidal, notched, the should have attached an arm. The dorsal surface, not very convex, is formed near the edge, by these five discoidal pieces (second radials) and by the intervals that separate them. All the middle is occupied by second interradials that are supported by

the first and that leave between them wide grooves (brachiales?) corresponding to the middle of the radials. The entire surface is covered with granules.

The stalk was cylindrical.

This genus, very singular in appearance, was established on some very small specimens that were probably too young and whose internal structure was not studied at all. We can already see that this form could be transformed into a *Platycrinus* if the pieces of the vault, becoming more numerous with age, made the gutters disappear, except the hole or hiatus at the base of the arms of these Crinoids, whose arms, rudimentary at first, were developed more and more.

The only species is *Coccocrinus rosaceus* J. Müller (*Verhandl. d. Niederrhein. Ver*, Jabr. XI, p.20, pl. xx) of the Devonian terrain of the Rhine. It is described and figured also in the *Traité de Paléontologie* of Pictet (t. IV, p. 310, pl. c, fig. 3).

4th GENUS. **MYRTILLOCRINE.** *MYRTILLOCRINUS.*— SANDBERGER.

Calyx pentagonal, as resulting from the union by their bases of two truncated pyramids with rounded corners, formed of five basals and five radials outside the point of arm attachment and above the brachial gutter, going from this point to the center.

The basals surround the terminal pentagonal piece of the stalk, which is quadrangular and pierced like it by a central canal and of canals corresponding to the corners. If this piece represents the centro-dorsal plate of Comatulids, i.e., if it comes from the fusion of the true basals, then the five pieces that we have named thus, would be parabasals and we would see a new analogy between this small fossil and the supposed first age of some other CrinoId.

The only species indicated is *Myrtillocrinus elongatus* Sandberger (*Versteiner. Rhein. Schicht. Syst. Nassau*, pl. 35, f. 6. — Pictet, *Traité de Paléont*., t. IV, p. 311, pl. c, fig. 4).

The name of the genus expresses the resemblance of the fruit of *Vacciniun myrtillus*. It is a fossil of the Devonian terrain of the Duchy of Nassau.

5th GENUS. **CERAMOCRINE**. *CERAMOCRINUS*. —J. Müller.

(χεραμος, pottery.)

Calyx angular, composed of five basals and five very protruding radials, forming a whorl. But two of these radials are separated by a supernumerary plate (anal?) Each of these radials has a kidney-shaped impression that must have been the point of an arm attachment. Stalk with four rounded corners and crossed a quadrilobed feeding canal.

The only species of this genus is *Ceramocrinus eifeliensis* of Wirtgen and Zeiler (*Verhand. der Niederrhein. Ver*., Jahrg. XIL, p. 83, pl. 12. — Pictet, *Traité de Paléont*., t. IV, p. 310, pl. c, fig. 5). It is found in the Devonian terrain of Eifel.

6th GENUS. **EPACTOCRINUS**. — J. Müller. and 7th GENUS. **GASTEROCOMA**, — Goldfuss.

Calyx with five lobes that are formed by the radials with impressions where the arms were attached. Five basals, one of which has a wide opening and is surmounted by an interradial or unique intercalary piece (anal) located between two of the radials.

Stalk quadrangular, with a feeding canal with four lobes, or with four canals corresponding to the four corners.

These two genera, too imperfectly known, were established for two fossil species from the Devonian terrain of Eifel that had the greatest relation between them. They are considered different because *Gasterocoma* does not have a stalk, or only a stalk formed of a single article, which is extremely improbable because the absence of a perforation in the center is not sufficient proof that this article was unique. We also report the much more pronounced brachial gutter on the dorsal surface of *Gasterocoma*.

Epactocrinus irregularis of Wirtgen and Zeiler is described in the same collection as the preceding Crinoid (p. 84, pl. 12) and in *Traité de Paléont*. of Pictet, p. 3114, pl. c, f. 6.

Gasterocoma antiqua of Goldfuss is described in the *Acta nat. eur*. (1838), t. XIX, p. 350, pl. xxxii, f. 5, and in *Traité de Paléont*., t. IV, p. 311, pl. c, fig. 7.

FOURTH FAMILY, CUPRESSOCRINIDAE. — D'Orbigny.

(*Cupressus*, cypress.)

Calyx stalked, with five sides, convex below, elongated above in pyramidal form with convex surfaces or fastigiate (like the cypress). A single piece, centro-dorsal and pentagonal, ends the stalk and is found compressed between five pentagonal pieces that have been taken for basals, but that are instead parabasals, if the single centro-dorsal is the result of fusion of the true basals and not as the last piece of the stalk that is more or less quadrangular in all its extent. Five first radials that are pentagonal, transverse, alternating with the preceding pieces and each have a second radial that is more protruding but not very thick in the form of a lintel that is surmounted by a decreasing row of brachial pieces. The number of these pieces increases with age and together they form one of the sides of the terminal pyramid that are sometimes contiguous, sometimes separated by a transversally furrowed groove. No opening other than that resulting from the separation of the sides of the pyramid. Stalk with four round sides sometimes having accessory rays and crossed by five rounded canals that by their union sometimes form a quadrilobed canal.

The genus *Cupressocrinus*, or *Cupressocrinites*, established in 1832 by Goldfuss and later named *Halocrinus* by Bronn (1833) and by Steininger (1838), differs so completely from all the other Crinoids, that it well merits making alone a separate family. D'Orbigny,

the first, characterizes this family of Cupressocrinidae, as well as the genus itself, by: “An widened calyx, cup-shaped, composed of three rows of pieces: five pentagonal basal pieces, five intermediary pieces, and five linear brachial pieces. Five simple arms, flattened, wide, not divided. Stalk quadrilobed.” He added that it is of all the Crinoids, that which recalls most the form of Asteroids because he compares it to an Asteroid (*Asterias rubens*) whose five arms are have been raised and approach each other in a way to form a pyramid. But this comparison is manifestly erroneous, whichever arm of the arms of the Asteroid is raised.

Goldfuss, in 1838 (*Nov. Acad. nat. cur.*, t. XIX), adds to the three species he previously described three other species that brought the number to six, all from the Devonian terrain of Eifel. Since then, in 1843 and 1852, Roemer has added still two other species from Hartz, also Devonian. de Koninck and Lehon, in 1854, gave some new ideas on the structure of *Cupressocrinus* that he did not accept arms, not wanting to call thus the sides of the terminal pyramid that they said were each formed of a decreasing series of radial series. This point of view is because the authors only want to see arms in Crinoids after a first bifurcation of the series commencing with the radials. Pictet, on the contrary, in his *Traité de Paléontologie*, 1857, t. IV, p. 306, had accepted the family of Cupressocrinidae charactaerized by a “cup-shaped calice attached by articulated stalk and having simiple arms, flattened, side, not divided.” Bronn and Roemer, in *Lethaea geognostica* (3rd edit., 1850–1856), made CUPRESSOCRINIDAE the eleventh family of Actinoids or normal Crinoids and placing it in the section of Pedunculate (Seylida) between the Encrinidae and the Cyathocrinidae, contrary to their true relation.

GENUS. **CUPRESSOCRINE**. *CUPRESSOCRINUS*. — Goldfuss.

This genus composing alone the family of Cupressocrinidae, we have nothing important to add to its characteristics. It was also named *Halocrinus* by Bronn, after Goldfuss himself had given it the name that everyone has accepted today except the change of the end *crinites* into *crinus*.

D’Orbigny, in his *Cours élémentaire de Paléontologie*, p. 140, fig. 289, represented a *Cupressocrinus* with spines comparable to those of Asteroids and Ophiuroids in the groove that separates the two surfaces of the terminal pyramid. In the characteristic that we have transcribed, he says nothing of these appendages. Pictet, on the contrary, gives (pl. xcix, fig. 26) a figure of *Cupressocrinus* with this groove closed and without the least trace of spines or pinnules. In his 4th volume, p. 306, he says, on the contrary, that the arms, divided into transverse articles superposed and united to form the pyramid “have on the sides some small, very short pinnules. As for us, it has been impossible for us to see anything similar, neither in the collection of D’Orbigny, nor in that of de Verneuil, and paleontologists who have handled these fossils in even greater number have confirmed to us of never having seen these pinnules.

This genus contains only the 8 species mentioned below, all from the Devonian terrain. We must consider too doubtful two species indicated by M’Coy in the Carboniferous terrain, *C. calyae* and *C. impressus*.

1. Thick Cupressocrine. *CUPRESSOCRINUS CRASSUS*. — Goldfuss.

Atlas, pl. 5, fig. 42.

Cupressocrinites, Goldfuss, Petref. Germ., 1832, 1, p. 212, pl. 64, f. 4, and Nov. act. Acad. nat. cur., 1838, XIX, 1, p. 331, pl. 30, f. 1. — Bronn, Lethaea geogn., 1837, pl. 4, f. 9. — d'Orgieny, Cours élém, de Paléont., 1852, t. I, p. 140, f. 289. — Pictet, Traité de Paléont., 1857, IV, pl. 99, f. 26. — *Halocrinus pyramidatus*, Steninger, Bull. soc, géol. de France, IX, p. 295.

Calyx having acquired more than 400 mm in height including the pyramidal top and 40 mm in width. Arms convex in the middle, raised the length of the arms so leave between them a large grooved furrowed transversely formed transverse articles that can exceed 44 in number, each of which with a double pore on each side near the edge. Surface nearly smooth, have only some small smooth tubercles. Stalk quadrangular, more or less rounded or nearly cylindrical, transversed by a quadrilobed canal and with accessory rays.

From the Devonian terrain of Eifel (Prussian Rhine).

1. Elongated Cupressocrine. C*UPRESSUCRINUS ALLONGE*. — (Goldfuss).

Cupressocrinites, Goldf,, Nov. act. Acad., 1838, XIX, p. 331, pl. 30, f. 2.

This species, perhaps even larger than the preceding, is distinguished at first glance by its more elongated form, its completely granular surface ad its arms (or sides of the pyramid) less raised at the edges and consequently touching entirely and not leaving a groove between them.

The stalk is sometimes uniform and sometimes formed of alternatingly thick and thinner. In this case, the thicker articles have two rows of granules while the others have only a single row. It is crossed by five distinct canals, of which the median is wider, rounded-quadrangular and the others round.

The number of articles perhaps reach 20.

Fossil of the Devonian terrain of Eifel. Always colored black.

3. Shortened Cupressocrine. *CUPRESSOCRINUS ABBREVIATUS*. — Goldfuss.

Cupressocrinites, Goldf., Nov. act. Acad., XIX, p. 333, pl. 30, f. 4.

Calyx short and thick, width 30 to 55 mm, and height only fifth or sixth higher, so that the general form is ovoid. All its pieces have very pronounced growth rings. The basals and pieces of the arms, or of the sides of the pyramid are swollen into a protruding tubercle. The five articles of the arms decrease rapidly in size so to form a short and blunt pyramid that can appear to have ten sides according to the development of the median tubercles. Stalk quadrangular, rounded, formed of thick articles with quadrilobed anals.

From the Devonian terrain of Eifel.

4. Slender cupressocrine. *CUPRESSOCRINUS GRACILIS*. — Goldfuss.

Cupressocrinites, Goldf., Petref. Germ., 1832, I, p. 213, pl. 64, f. 5, and Nov. act. Acad. nat. cur., XIX, 1, p. 334, pl. 30, f. 5.

This species, described according to incomplete fragments, is characterized by it very elongated calyx in the lower part and smooth, however, despite the differences it must have had by the corresponding elongation of the arms. Goldfuss declares it very similar to the preceding species. It even has a median tubercle on each of the articles of the arms. Its square stalk, with rounded corners, is formed of uniform articles although alternatively thicker. It has a very pronounced gutter in the middle of each side and a quadrilobed canal.

From the Devonian terrain of Eifel.

We shall mention only the following species, of which the first two are from the same terrain of Eifel. Goldfuss has named *Cupressocrinus tetragonus* (Nov. act. Acad. nat. cur., XIX, 1, p. 352, pl. 50, f. 3), after a single small, incomplete specimen, a species thought to have a quaternary or by fours composition and not quinary like all the others. But this could be a teratological case or the result of an accidental deformation. The arms that, according to the figure appear to have been very elongated, form a prism rather than a pyramid and each of them is strongly swollen in the median line. The other species of Goldfuss is *Cupressocrinus tesseratus* (Petref. Germ., pl. 59, f. 11). The two species of the Devonian terrain of Harz described by Roemer are: *Cupressocrinus teres* (1843, *Die Verstein. des Hartzgebirges*, p. 8, pl. 5), and *Cupressocrinus urogalli* (1852, Issue. 3. *Geol. Kennt. des N. W. Hartzg*., in *Palæontographica*, II, p. 9, pl. 2).

FIFTH FAMILY. POLYCRINIDAE — D'Orbigny.

(πολυς many, multiple, χρξνον lily)

Calyx stalked, regular, oblong, rounded below where it is formed by a large number of pieces (40) in four alternate rows. It is nearly cylindrical in the middle where it has, attached to the sides, ten lanceolate arms, or pseudo-ambulacra. Finally, it is ended on top by a nearly flat surface or by a vault formed of numerous pieces and more or less prolonged into a tube.

Stalk cylindrical, formed of numerous articles, with radiate articular faces.

Five very small basals, pushed inside the interior of the calyx by the thin end of the stalk at the top of a cone formed in large part by the five much larger radials that appear in addition like six hexagonal plates surrounding the stalk on the outside. On these first radials are five very thin secondary radials, on these, three hexagonal radials, nearly as large as the first. They are separated by five heptagonal pieces, which are interradials and that seem to form with them a uniform whorl. On the terminal or dorsal side of the third radial and in the same direction is an auxiliary that is a narrow and elongated hexagon, on which is a second square auxiliary having itself a third auxiliary, always in the same direction. Likewise, on the heptagonal interradial is a second double interradial, resembling all together the first auxiliary, and is distinguished only by the vertical suture that divides into two and by its insertion on the heptagonal piece that alternates with the first radials. The double interradial also has a third square interradial, completely similar to the second auxiliary and above a fourth interradial similar to the third auxiliary.

The sides of the calyx are thus filled by the ten vertical ridges that are symmetrical and equidistant that form the auxiliaries and interradials of the three rows. The intervals left like grooves between the ridges are filled by the arms or pseudo-ambulacra of lancet for with a longitudinal median groove that is very pronounced and two other grooves that are longitudinal and unequally dividing into two each of the halves of the entire arm.

These ten arms, symmetrically arranged around the calyx have, at their base, two very thin transverse pieces of which the second is divided into two halves, from which each of the halves of the arms is formed by a double alternating series of traverse very numerous articles. Each arm, in addition, is supported on the dorsal side by a first pentagonal brachial leaving from one of the oblique dorsal sides of the third radial. But as, on the other hand, these brachials touch like the interradials, we are tempted to believe that they are in the same relation with each other.

The only opening appears to be at the center of the top of the dorsal surface of the calyx.

This family, so different from all the others, was established by D'Orbigny (*Cours élémentaire de Paléontologie*, 1852, t. II, p.141) for the single genus that Goldfuss had named *Eucalyptocrinus* in 1831, when he still knew only the ventral part of the calyx. Phillips, in 1839. Having seen a different species, made it the genus *Hypanthocrinus*, But Goldfuss had already in 1838 been able to complete the description of his *Euc. rosaceus.* Since then, we saw how the two genera must be united into one, essentially different from all other Crinoids. Later, Phillips described another species, *Hyp. granulatus*, from the Silurian of England. M'Coy, Hall and Bronn described still three more species what brought the total number to six of which only one *E. rosaceus*, is from the Devonian terrain of Eifel and the others from the Middle or Upper Silurian terrain of America, Sweden and England.

Bronn and Roemer, in the 3rd edition of *Lethæa geognostica* (4850–1856), named this family Eucalyptocrinidae and placed it twentieth in the sub-order of Actincides or normal Crinoides, among the stalked (Seylida) with well-developed arms whose vault or dorsal surface, is formed of immobile calcareous pieces. These authors gave for the exclusive character having the vault of the calyx raised above the tip of the arms that are, when in repose, in the folds or grooves of the vault.

GENUS **EUCALYPTOCRINE**. *EUCALYPTOCRINUS*.— Goldfuss, 1831.

(ευ, good, χαλυπτος, veiled, χρινον, lily.)

This genus alone makes up the family of Polyerinidae, we have nothing to add to its characteristic. We have said that it had been named by Phillips *Hypanthocrinus* (υπο, under, ανθος, flower). This name is still used in America. D'Orbigny said that "the arms formed of two double rows of articles appears to be fixed in the visceral pouch without being able to open.". Pictet, on the contrary (*Traité de Paléont*., t. IV, p. 308), says: "These arms, in long ovoid clubs, are lodged in corresponding cavities the length of the calyx." We have seen, on the beautiful specimens of de Verneuil, these arms fixed in the same way at those of *Pseudocrinus*, *Agelacrinus*, etc., consequently deserving more the name of ambulacra than that of arms.

de Koninek and Lehon, in their *Recherches sur les Crinoïdes* (1854), p.73, have made with success with *Eucalyptocrinus*, the application of their nomenclature for the pieces of the calyx of what they call the top. We have followed this in this nomenclature except for the second inter radial.

In addition to the two species of which we just spoke in detail, because we have seen them very clearly, the others are:

1st *Euc. granulatus* Phillips and *Euc. polydatylus* M'Coy (*Pal. foss*., pl. 1 D), from the Upper Silurian of England.

2nd *Euc. regularis* Bronn, from the same terrain in Sweden;

3rd *Euc. coelatus* Hall (Geol. of New York, 1843, n° 18, fig. 1, and *Paleont. of New York*), from the Middle Silurian terrains of America.

1. REDDISH EUCALYPTOCRINE. *EUCALYPTOCRINUS ROSACEUS*. — Goldfuss.

Eucalyptocrinites rosaceus, Goldf., Petref. Germ., 1831, p. 214, pl. 64, f. 7, and in Nov. Act. Acad. nat. cur., 1838, t. XIX, p. 335, pl. 30, f. 5.— Bronn, Lethæa geogn., 1837, pl. 4, f. 11, and 3e édit., with Roemer, 1850, pl. 4', f. 20. — Pictet, Traité de Paléont., 1857, IV, p. 307, pl. C, f. 1.

Calyx length 40 to 50 mm, from the base to the above the arms, width 25 to 28 mm, appearing regularly bumpy because of the protrusion of each of the pieces of the base. It is the same appearance that gives it the name of *rosaceus*, when, because of the poor state of the specimens, the general structure is so well hidden or veiled that Goldfuss was able to form the name of the genus from the words cited above. Fragments or the bases of the calyx are not very rare in Eifel, but it is not the same for complete specimens.

The upper interradials, in enlarging at the top, unite to form dorsally a nearly flat surface that is completed at the center by four to six polygonal plates and between which an irregular opening has been thought to be seen and even named the mouth, but is rather an ovarian opening.

From the Devonian terrain.

2. ELEGANT EUCALYPTOCRINE. *EUCALYPTOCRINUS DECORUS*.

Hypanthocrinus decorus, Phillips, 1839, in Silur. syst. Murch., pl. 17, f. 3. — Hall, 1843, Palæont. of New York, n° 18, f. 2.

The beautiful specimen of this species that we have seen in the collection of de Verneuil, is about 55 mm long, 18 mm wide, oblong ovoid, very smooth. Its top, instead of ending in a flat surface, forms a vault made of small polygonal pieces and appears to extend in a wide tube.

From the Silurian terrain of Dudley and Wenlock in England, Gothland, Sweden and America.

SIXTH FAMILY. ANTHOCRINIDAE.

Calyx nearly hemispherical below and has at its upper edge five wide reticulated expansions comparable in their extent to the petals of a flower (ανθος) and likely to fold back and roll up like petals. Botanists call the pre-flower twisted.

This family that we see indicated for the first time as completely distinct in the *Traité de Paléontologie* of Pictet, so much from other Crinoids that, as for the two preceding families, there is a temptation to make them a distinct order. Bronn and Roemer, actually (*Letheœa geognostica*, 1850–1856), had made it the 20th family of their Actinoides, distinguishing it only by its reticulated arms from other stalked Actinoides that area thought to have their vault or dorsal wall formed of immobile calcareous pieces. However, here we do not know the vault at all. This family is known only by the single fossil species from the Silurian terrain of Sweden, that J. Müller, in 1853, has made the type of his genus *Anthocrinus* and whose structure is still so enigmatic.

GENUS **ANTHOCRINE**. ANTHOCRINUS. — J. Müller, 1853.

(ανθος, flower)

Calyx composed of five (?) basals, five parabasals and five first radials between which is a single small interradial. Each of the five radials has three other pieces of which the two laterals, covering the median, each has two others on which superposed, multiplying more and more by bifurcated series a large number of times, articles that finish by becoming innumerable. These articles, articulated in each series by their terminal faces, have on each side, a small eminence by which they also articulate laterally with those of adjacent series so that there results a large net whose (unknown) contour should be

comparable to that of a flower. These five wide expansions are moreover found coiled in the fossil, like the petals of a flower bud with twisted inflorescence. One must conclude that they flower in the same way.

This very curious genus and whose fossil remains are very rare have been found in the Upper Silurian terrain of Gothland in Sweden, was established in 1853 by Müller who managed to obtain all the fragments that were given to him and who, with patience and talent, and in making sections in these incomplete specimens managed to understand a little the structure of this Crinoid that must have seemed completely incomprehensible.

LOVEN'S ANTHOCRINE. *ANTHOCRINUS LOVENI*.— J. Müller.

— J. Müller, 1853, in Mém. de l'Acad. de Berlin, 1854, pl. 8. — Pictet, Traité de Paléont., IV, p. 312, pl. C, f. 8.

The base of the calyx is not completely known. It is for this that the nuumber of basal pieces cannot be indicated with precision. We have seen no trace of stalk and we can still understand the destination of the pores that we see between the pieces of the calyx and in the very thickness of the pieces that compose the ramified extensions, which appear prolonged toward the internal surface.

SEVENTH FAMILY. CYATHOCRINIDAE.

(χυαθς, cut)

Calyx stalked or free, formed of more or less numerous plates, completely surrounding a rather spacious cavity to contain all the viscera. It is ordinarily covered by a vault formed of immobile calcareous pieces havings one or two distinct openings and sometimes prolonged in the form of a trunk.

Five arms formed of numerous articulated pieces, divided into two or several principal branches susceptible of sub-dividing themselves into branches and having in the latter sub-divisions pinnules that are also articulated.

Special openings are found below the base of the arms, establishing a communication with the interior.

This family, as we understand it according to Pictet, contains all the true or normal Crinoids of the oldest periods. It is distinguished from all the preceding by its arms especially and from the two following where the arms are also shown by the more spacious and more complete cavity that forms the test to contain the viscera. We also add that the pieces of the test, better meriting the name of plates, are generally much thinner than in the following family (Pycnocrinidae, from πυχος, thick). This consideration had struck Miller when he established his classification of Crinoids in 1821, and he distinguished under the name of Articulata our Pycnocrinidae, whose pieces are articulated by wide surfaces, while his Inarticulata (*Cyathocrinites, Actinocrinites, Rhodocrinites, Platycrinites*) and his semi-articulata (*Poteriocrinites*), that are all part of our Cyathocrinidae, having plates that are imperfectly articulated or simply joined by sutures.

Other excessively numerous genera have come, in the past thirty-six years, placed in the genera of Miller, and already, in 1852, D'Orbigny, who first in 1839 was occupied with other types with thicker tests, classed in his ninth (Melocrinidae) and tenth (Cyathocrinidae) families, all Crinoids with ramified arms whose calyx is "formed of thin arms." He distinguishes especially these two families because his Melocrinids has arms always composed of two rows of articles and the arms of his Cyathocrinids are formed of only one row of superposed articles. These were also believed to have all the calyx composed of thin plates in the form of a pouch and containing a large part of the viscera. These were the 19 genera (1) *Glyptocrinus*, (2) *Rhodocrinus*, (3) *Scyphocrinus* of Zenker, (4) *Cupulocrinus* of D'Orbigny, (5) *Ichthyocrinus*, (6) *Abracrinus* of D'Orbigny, (7) *Poteriocrinus*, (8) *Cyathocrinus*, (9) *Amblacrinus* of D'Orbigny, (10) *Caryocrinus* (that we place among the Cystids), (11) *Heterocrinus*, (12) *Triacrinus*, (13) *Taxocrinus*, (14) *Edwardsocrinus* of D'Orbigny, (15) *Symbathocrinus*, (16) *Atocrinus*, (17) *Dichocrinus*, (18) *Asterocrinus* of Munster, (19) *Tentaculites*. But 7 or 8 of these genera should be suppressed or transferred elsewhere.

Melocrinides of D'Orbigny, in addition to the double row of articles in the arms, are believed to have a calyx also formed of thin, superposed plates contain its it bursiform cavity, the lower two-thirds of the visceral pouch, while the rest, covered with testaceous plates, are above the arms. The contain 9 genera: (1) *Geocrinus* of D'Orbigny, (2) *Gilbertsocrinus*, Phillips, 1829, (3) *Ctenocrinus*, Bronn, 1840, (4) *Melocrinus*, Goldf., 1831, (5) *Actinocrinus*, Miller, 1821, (6) *Dimerocrinus*, Phillips, 1839, (7) *Enallocrinus* D'Orbigny, 1847, (8) *Platycrinus*, Miller, 1821, and (9) *Encrinus*, Miller, 1821. But the last genus differs from all the others by its thick and widely articulated pieces, that we have classed with Pycnocrinids. Consequently, there remain only the 8 first genera of Melocrinids to add to the remaining genera of the Cyathocrinids of D'Orbigny, which would form in all 18 or 19 genera to class in our Cyathocrinids.

Bronn and Roemer, in the last edition of *Lethæa geognostica*, 1851–56, have made these same Crinoids, increased by several new genera, their families of (1) Cyathocrinidae, (2) Poteriocrinidae, (3) Rhodocrinidae, (4) Platycrinidae, (5) Actinocrinidae, (6) Melocrinidae, (7) Ctenocrinidae, (8) Sagenocrinidae, that, in their classification, occupies the ranks of 12 to 19 and that correspond to the genera *Cyathocrinites, Poteriocrinites, Rhodocrinites, Platycrinites* and *Actinocrinites* of Miller, as well as the newer genera *Melocrinites* of Goldfuss, *Ctenocrinus* of Bronn, and *Sagenocrinus* of Austin.

Of these 9 families, the last 8 are thought to have a dorsal or ventral wall formed of immobile calcareous pieces, without this vault passing the arms, which distinguishes the family from the Eucalyptocrinidæ of the same authors, corresponding to our Polycrinids that have the vault raised above the arms. The first family, on the contrary, that of Cyathocrinidae, is thought to have a simply membranous ventral wall. These authors place it in another section, after the Encrinidae and the Cupressocrinidae, that appears to us to differ considerably.

Pictet, finally, whose classification we are nearly following here, have them, in his *Traité de Paléontologie* (1857) united into a single family, his CYATHOCRINIDES, that he divides into four tribes: 1st *Cyathocrinians*; 2nd *Actinocrinians*; 3rd *Carpocrinians*; and 4th *Platycrinians*.

Cyathocrinids thus comprised have the calyx formed of thin plates that are contiguous at their edges and contain it is lower cavity most of the viscera. The rest. Being covered

ordinarily by a vault formed of pieces that are polygonal, smaller and more numerous. This calyx always has five arms at the base, but promptly sub-divided into two, four, five or six principal branches what are often designated by the name of arms, which makes the number of these organs ten, twenty, thirty, etc. The vault below the arms usually has one or two openings. The calyx, finally, is nearly always supported by an articulated stalk, and is free only in the genera *Marsupites* and *Astylocrinus* that we provisionally make a fifth tribe.

Except for *Marsupites*, all the Cyathocrinids occur on sedimentary terrains prior to the Cretaceous and even Jurassic terrains.

As for the characters assigned by Pictet to his Actinocrinids, we naturally add those that come from our manner in the past of considering Crinoids as organs of reproduction lacking mouth and anus and having openings only for the entry and exit of water necessary for respiration and for the exit of eggs. These organs are, on one hand, the two that we just named and that De Koninck, Roemer and Pictet call mouth and anus. They are also, on the other hand, the openings we have already reported at the base of the arms. Of the two openings of the vault, the smallest, the less central, that we wanted to call anus, determines a notable enlargement in the interval it occupies in the area between two arms and the supplementary pieces. However, more or less numerous anal pieces are ordinarily found between the corresponding radials.

Of the four tribes established by Pictet, only the first, CYATHOCRINIANS, has five sub-radial pieces or parabasals alternating with the basals that they surround or surmount, and with the radials that are more exterior or above and that, consequently, are opposite to to the basals without touching them. These three kinds of pieces can thus be considered as forming three successive whorls.

The three other tribes of the same author are, on the contrary, lacking parabasals and have the radials alternating with the basals.

The second tribe, ACTINOCRINIANS, has a vast calyx composed ventrally of numerous pieces. The basals are three, rarely four, in number. Under each of the five arms is a row of three radials and the intervals containing numerous interradials. Sometimes an anal is seen in in one of these intervals. Sometimes also, the first brachials make part of the wall that is thus prolonged.

The third tribe, CARPOCRINIANS, is characterized by its smaller and shorter calyx, whose composition does not include the brachials. The basals are three or five in number. The radials are rather numerous (often four) in each ray. The interradials are less constant.

The fourth tribe, PLATYCRINIANS, is recognized first by the small number of pieces of the calyx that is only three, rarely two basals. Five large radials surmount each by a second much smaller piece that is called the second radial and can be better called brachial if it does not precede the bifurcation. Very rarely is also seen a third small radial and sometimes an anal.

A fifth tribe finally, MARSUPITIANS, contains provisionally the two genera *Marsupites* and *Astylocrinus*, both lacking a stalk but having, like Cyathocrinians, a whorl of five parabasals above the five basals that they separate from the five radials, resulting in five whorls alternating and superposed above a single centro-dorsal piece but, as we shall see later, we can equally consider the centro-dorsal piece as resulting from the fusion of all the basals, and the second whorl as representing the interradials. With the exception furnished by *Marsupites,* which are fossils of the Chalk terrain. all the other Crinoids of this family belong to Paleozoic terrains. This can cause doubts about the correctness of the

connection we propose. But, on the other hand, the absence of a stalk in the adult cannot be a sufficient reason relate this genus of Comatulids, whose centro-dorsal piece is so thick and so remarkably articulated with the radials that make the commencement of the arms.

1st TRIBE. **CYATHOCRINIANS**.

(χυαθος, cup)

Calyx large, formed of numerous pieces with five basals, five parabasals alternating, and five divergent rows of 2 to 3 radials. It is surmounted by a vault formed of smaller pieces. Stalk articulated, cylindrical.

This tribe, containing the three genera *Rhodocrinus, Poteriocrinus* and *Cyathocrinus* of Miller, corresponds in part to the family of Cyathocrinidae of Roemer that is thought to have the vault or ventral wall simply membranous and lacking calcareous plates and the contains, in addition, our Carpocrinians. But our tribe of Cyathocrinians corresponds in addition, also to the two families of Poteriocrinidae and Rhodocrinidae of the same author who attributed to them, correctly, a vault or ventral wall formed of numerous immobile calcareous plates. It corresponds, only in part, to the family of Cyathocrinidae of D'Orbigny, characterized as we have said, by its arms formed of a single row or articles. But it contains only 5 of his 19 genera, *Rhodocrinus, Scyphocrinus, Ichthyocrinus, Poteriocrinus* and *Cyathocrinus*, and contains also 2 of his genera of *Melocrinides*, that have arms formed of two rows of articles, *Dimerocrinus* and *Enallocrinus.* With these 7 genera, our tribe of Cyathocrinians contains 8 others, namely: *Tribrachiocrinus* M'Coy, *Acanthocrinus* Roemer, *Woodocrinus* and *Mespilocrinus* De Koninck, *Homocrinus, Thysanocrinus, Dendrocrinus* and *Lecanocrinus* Hall.

This divergence of opinions for the classification of these Crinoids is because their distinctive characters are more paleontological than zoological and, consequently, more or less artificial. It is certainly the same that we accept according to Pictet and that is furnished by the presence of sub-radials or parabasals. However, this character, if we can understand the physiological reason, is incontestably more fixed than that of arms formed of double or single rows.

1st GENUS. **RHODOCRINE.** *RHODOCRINUS*.— Miller.

(ροδον, rose, χρινον, lily.)

Calyx ordinarily globular, formed of numerous pieces ornamented with radial ridges and concentric striations.

Five small basals surrounded by five quadrangular united into a star and alternating with the basals and the radials that are found above and form five rows of three following the direction of the arms. The first radial has two facets that are articular, and oblique, on which are articulated the two branches of each arm. Between the radials are more or less numerous interradials. The vault is composed of very small pieces, the dorsal opening, not

prolonged in the form of a trunk, is a little eccentric. Stalk cylindrical with a central canal and five petaloid lobes.

This genus is easily distinguished from *Actinocrinus* by its parabasals and also from *Poteriocrinus* by its more globular form, and from *Platycrinus* by its much more numerous and nearly equal pieces around the calyx. It was established in 1821 by Miller who wanted to express by the name *Rhodocrinites*, some resemblance with a rose with a hundred leaves. This author, according to the nomenclature that he had imagined for the pieces of the calyx, attributed to *Rhodocrinites* a basin, *pelvis* formed of three pieces (instead of five basal pieces that their smallness prevented him from seeing), five intercostal plates (which we call parabasals) resting on the *pelvis*, and with which alternate five costals (our first radials). Miller adds that the cylindrical stalk, not thickened toward the top as that of *Apiocrinites* and without lateral accessory arms, is crossed by a food canal appearing as a flower with five petals on the articular surfaces that moreover are radial. Finally, as we have said, he classed it among his *Inarticulata*.

Only one well-authenticated species, *Rhodocrinus verus* from the Upper Silurian terrain of England, was described by Miller who also indicated a second under the name *R. quinquangularis.* But, ten or twelve years later, Goldfuss indicated or incompletely described five other species from the Devonian terrain of Germany (Eifel). Still later, Roemer described a seventh species from the same terrain. Other species from the Carboniferus terrain have shown more distinctly their five basal pieces. Phillips, in his *Geology of Yorkshire*, made it the genus *Gilbertsocrinus*, that does not differ otherwise from true *Rhodocrinus*, and he described first 3 species. *G. bursa, mamillaris* and *calcaratus* (*Geol. of York*, 1, p. 207, pl. 4, fig. 24, 23 and 22). This latter being especially remarkable for the pointed extensions from the ventral plates of the calyx.

M'Coy then described (*Synops. carbonif. Ireland*, p. 180, pl. 26, fig. 5) *G. abnormis.* Austin has described *R. costatus* and *granulatus* (*Ann. and Mag. of nat. Hist*., 1843), Portlock, *R. simplex*, both from the Carboniferous terrain of England, and De Koninck, in his *Recherches sur les Crinoîdes*, p. 103, has described *R. stellaris* and *R. uniarticulatus* that is figured in his work and in the *Traité de Paléontologie* of Pictet, pl. C, fig. 9.

D'Orbigny also has accepted the two genera *Rhodocrinus* and *Gilbertsocrinus*, according to the supposed difference in number of basals. But, accepting in addition that there would be arms formed of a single row of article and arms formed of a double row, he placed the latter in his family of Melocrinidae and *Rhodocrinus* in that of Cyathocrinidae. As, moreover, from his point of view, the pieces of the calyx form whorls or transverse rows and not rows directed like rays in the direction of the arms, he attributed to both seven rows of pieces, namely: basals, intermediaries (our parabasals), then four other rows between which are numerous accessory pieces. As we have seen, all these Crinoids belong exclusively to Paleozoic terrains, one only is from the Upper Silurian, five of six species are from the Devonian terrain, and about a dozen species are found in the Carbonoiferous terrain, particularly in England.

TRUE RHODOCRINE. *RHODOCRINUS VERUS*. — Miller.

— Miller, Crinoïd., p.106, pl. 1.— Scacoruetm, Petref. II, p. 101, pl. 28, fig. 3. — Goldfuss. Petref, p. 198, pl. 19, fig. 3.— Bronn, Lethæa geogn., pl. 4, fig. 2. — Edwards, Atlas du

Règne animal, Zooph. pl. 8, fig. 4, — Pictet, Traité de Paléont. IV, p. 314, pl. C, fig. 9 and 10.

Calyx nearly globular, with small basal plates, forming a regular pentagon on the sides of which are five parabasals, equally wide, quadrangular, narrower exteriorly, and receiving between their oblique sides the first five radials that are hexagonal and that support the second radials in the form of transverse hexagons. On these rest the third radials in the form of a pentagon having on their two upper oblique sides, two first brachials, each followed by a second brachial. On the parabasals are the first interradials that are rather wide, hexagonal, supporting a row three other interradials that are smaller and separated themselves from the radials by another series of irregular interradials. An auxiliary piece (or clavicle, Miller) separates the brachials, which forms five bifurcated rays from the third radials and whose intervals are filled by three vertical rows of more or less regular hexagonal innterradials. These plates, smaller and smaller toward the top, end by merging with the small plates with which the vault is covered.

All these plates are chiseled or ornamented with striations and protruding lines.

The stalk is cylindrical, with a central canal with five lobes. The articular faces of each article are marked by straight and deep radiating striations.

It is found in the Upper Silurian terrain of England, at Bristol, Mendip Hills, Mitchel Dean and Dudley.

We cite only the following species, more or less doubtful, from the Devonian of Eifel (Prussian Rhine).

Rhodocrinus gyratus Goldfuss, Petref., p. 198, pl. 60, fig. 4, whose stalk is cylindrical with the quinquelobed central canal and articular facets marked with very fine striations, obliquely arced.

Rhodocrinus quinquepartitus Goldfuss, ibId., p. 199, fig. 5, whose stalk is sub-pentagonal, with straight and very fine striations and whose central canal sends into each article five horizontal canals.

Rhodocrinus canaliculatus Goldfuss, ibId., fig. 6, whose stalk is pentagonal, canaliculate with a stalk that is pentagonal, canaliculate on one side with the central canal didymium and the rays of the articular facets unequal and clavate.

Rhodocrinus crenatus Goldfuss, ibId., p. 212, pl. 64, fig. 5, whose articles are crenelated on the edge.

2nd GENUS. **ACANTHOCRINE**. *ACANTHOCRINUS*. — Roemer.

(αχνθα. spine)

Calyx formed of numerous pieces, five basals, five parabasals and five radials, each surmounted by a 2° and a 3° radial forming five rays that are separated by numerous

interradials. The first brachials are fused to make part of the calyx. The basals and especially the first radials each have a long spine directed obliquely below.

F. Roemer established this genus in 1850 (*Leonhard and Bronn, neues Jahrbuch*, p. 679, pl. 6 B) for a fossil species from the Devonian terrain of the Rhine (*A. longispina*) that is figured in the *Traité de Paléontologie* of Pictet, pl. C, fig. 11. The spines that we have already seen in *Rhodocrinus* or *Gilbertsocrinus calcaratus* Phillips, evidently cannot furnish a character of the species and the sole generic differences with *Rhodocrinus* appears to be, according to this, only in the fusion of the first brachials to help form the wall of the calyx.

3rd GENUS. **POTERIOCRINE**, *POTERIOCRINUS*.— Miller, 1821.

(ποτηριον, drinking glass, goblet.)

Calyx is the form of a drinking glass, narrower toward the base where the five basals are ordinarily angled or bent. Above, alternating with them, are five parabasals, two larger, surmounted by five rather large first radials that are followed by second and third small and irregular radials.

Vault covered with numerous small hexagonal pieces and prolonged at the top into a tube that one wants to call a trunk.

Arms not very ramified, formed a a single row of very elongated articles (?).— Stalk cylindrical or pentagonal, formed of articles transversed by a pentagonal canal and having radiating striations on the edge of the articular faces. Stalk cylindrical or pentagonal, formed of articles crossed by a pentagonal canal and having radiating striations on the edge of the articular facets.

Under the name of *Poteriocrinites*, Miller established this genus in his *Histoire des Crinoides*, in 1821, and made it his second section, that of the *semi-articulata* whose calyx, in the form of a cup, is thought to be formed of imperfectly articulated plates. But for us, this difference is insignificant and the thin plates of POTERIOCRINUS appear to us to be united by sutures like those of other Actinocrinids. In addition, Miller characterized his *Poteriocrinites* by their basin (*pelvis*) formed of five pieces supporting five alternating costal pieces, by the cylindrical stalk, not thickened at the top, with a food canal he believed round and the articular surfaces radiated and the auxiliary lateral arms round, irregularly placed. Finally, by the fingers, or ramifications of the arms, formed by a single row of articles. This author included two species, *P. crassus* and *P. tenuis*, distinguished, as the name indicates, by the articles of the arms and their ramifications either thicker in one and thinner in the other. But a third species is also described by him under the name of *Cyathocriites quinquangularis* (p. 92, pl. 5) and characterized by its stalk that is pentagonal as well as the central canal and by the smooth surface of its calyx.

Phillips first, in his Geology of Yorkshire (1836), noted a pentagonal basin should necessarily support the row of pentagonal pieces that he previously been considered incorrectly to be lower and that, without this, could not be articulated with the cylindrical stalk. However, D'Orbigny, in his *Cours élémentaire de Paléontologie* (1852), still had not assigned three rows of pieces to *Poteriocrinus* that he placed in his family of

Cyathocrinidae, adding en ajoutant, according to the plates of Miller, that the articles of the arms are very elongated. But also, he rectified the assertion of this author on the subject of the central canal of the stalk that is pentagonal and not round.

Roemer, in his new edition of *Lethæa geognostica* of Bronn, has taken the genus *Poteriocrinus* as type of his family of Poteriocrinidae, that contains in addition several of our other genera of Cyathocrinians. Pictet, finally, who we follow here, has placed this genus in Cyathocrinians, between *Rhodocrinus* and *Cyathocrinus*.

As for two species of Miller that come from the Carboniferous terrain of England, Phillips has added five others from the same terrain, but at least two of these species are doubtful. Austin has increased this number by about ten. M'Coy has described five species. De Koninck, finally, has described several from the Carboniferous terrain of Belgium. Roemer (*Rheïn. Ueberg*., pl. III, fig. 2, and *Paleontographica*, t. I, p. 47, pl. 8, f. 4) has described two species: *P. fusiformis* and *P. minutus* from the Harz (Germany). Several others have been found in the Upper Silurian terrain of Dudley in England, notably *P. dudleyensis*, Austin (*Ann. and Mag. of nat. Hist*., 1843, t. XI, p. 195), and *Cyathocrinus capillaris* and *Goniodactylus* (Phillips, in *Silurian syst. de Murchison*, p. 671, pl. 17) that De Koninck considers true *Poteriocrinus*.

Finally, Hall (Paleont. of New York, t 1, pl. 28) has described *P. alternatus* and *gracilis* coming from the Lower Silurian of North America. But later he made it a genus *Homocrinus.* Consequently, this entire genus, limited to Paleozoic terrain becomes more numerous in going from the Lower Silurian to the Carboniferous.

1. SLENDER POTERIOCRINE. *POTERIOCRINUS TENUIS*. — Miller.

— Murer, Crinoïdea, p. 71 et al. — Scucorx., Nachtr., p. 94, pl. 25, f. 3. — Blainville, Man. d'Actinol., p. 260. — Bronn, Lethæa geogn., pl, 4, f. 8. — Edwards, Atlas du Règne anim. de Cuvier, pl. 7, f. 4.

Calyx ovoid-oblong, smooth, arms formed of very elongated articles (Miller), bifurcated after the first article. Articular facets of the stalked with very fine radiating striations. Carboniferous limestone of England, at Mendip Hills, Bristol.

2. THICK POTERIOCRINE *POTERIOCRINUS CRASSUS*.— Miller.

— Miller, Crinoïdea, p. 68 and pl. — Schloth., Nachtr., 1E, p. 93, pl. 25, f. 2. — Blainville, Man. d'Actirol., p. 260, pl. 29, f. 1.—De Koninck, Foss. Belg., pl. F, f. 4.

Calyx granular, having dorsal plates a little folded or ribbed toward the edge. Articular surfaces of the stalk with larger striations. Carboniferous limestone of England, Yorkshire, Somersetshire, and at Bristol, at Belgium at Tournay.

3. RAYED POTERIOCRINE *POTERIOCRINUS RADIATUS*. — AUSTIN.

Atlas, pl, 5, f. 3.

— Austin, Crinoïdea, pl. 8. — Pictet, Traité de Paléont., IV, p. 316, pl. C, f. 12.

Calyx conical ventrally and covered above by a vault prolonged into a long tube in the form of a trunk. Plates of the calyx ornamented with bundles of parallel striations, leaving from the center and going from one to the other, perpendicular to each of the sides. Five arms that are not very ramified, formed of nearly cylindrical articles that, toward the base, are wider than long and become as long as wide as the branches of the arms become thinner. First bifurcation commences after the sixth article of each arm. Carboniferous limestone of England.

4th GENUS. **HOMOCRINE**. *HOMOCRINUS*,—Hall.

(ομοιος, equal, similar.)

Calyx narrow, smooth and formed of three rows of five alternating pieces. Arams slender, simple or bifurcated, form of a single series of articles. Under this name, Hall in his Paleontology of New York, has wanted to establish a genus that appears to us too little different from *Poteriocrinus*, and in which the author himself classes incompletely known species that he had first described as belonging to the previous genus under the names of *P. alternatus* and *P. gracilis* from the Lower Silurian of America (New York, Trenton Limestone). In addition, he listed two species from the Middle Silurian (Niagara), *H. parvus* and *H. cylindricus* (Palaeont. of New York, t. II, p. 185, pl. 41).

5th GENUS. **THYSANOCRINE**. *THYSANOCRINUS*. — Hall.

(θυσανος, edge, fringe.)

Calyx with five basals, five parabasals and five rays composed of three radials that hav the arms that are separated by the interradials. Arms formed by a double series of alternating articles.

It again is a genus established by Hall in his Paleontology of New York (t. IL, p. 188, pl. 12), for four species of the Silurian terrain of America (Niagara), and of which the most remarkable, *T. aculeatus*, has been represented in the atlas of Pictet, pl. C. fig. 13. This genus differs especially from *Poteriocrinus* by its arms formed of a double series of articles.

6th GENUS. **DENDROCRINE**. *DENDROCRINUS*.—Hall.

(δενδρον, tree.)

Calyx in the form of that of *Poteriocrinus*, also having five basals and five parabasals, but only one of the latter pieces and not two is larger than the others. It also has interradials and the vault is thought to extend in a long tube formed of areolated pieces. The arms are long, slender, and branched without pinnules, like those of *Poteriocrinus*.

This genus, which we know only by the figure given by Hall (Palaeont. of New York, t. II, p. 193, pl. 42 and 43), and which represents an impression or a specimen embedded in rock would thus be especially characterized by a rectilinear disproportionate extension of the vault. But this extension, nearly as wide as the calyx and formed of parallel and regular rows of small polygonal plates, would be a wide band rather than a trunk as has been saId. But whatever the case, it seems to us equally difficult to understand until several specimens can be compared. The figure of the only species *D. longidactylus* has been reproduced in the atlas of atlas of Pictet, pl. C, fig. 14. It is a fossil from the Middle Silurian of America (Niagara group).

7th GENUS. **CYATHOCRINE**. *CYATHOCRINUS*. — Miller.

(χυαθος, cup drinking glass.)

Calyx in form of a cup, with five very small basals, five rather large parabasals of which four are pentagonal and the larger fifth an irregular hexagon. Five radials equally large having a much smaller second radial and sometimes even a third radial on which articulate the two branches of each arm. A single interradial is on the hexagonal parabasal.

Vault composed of a small number of pieces with a circular central opening (mouth (?) a little prolonged into a tube and a second lateral opening (anus?) above the single interradial

Stalk cylindrical, formed of a little thicker and nearly similar articles having radiating articular surfaces and a round central canal. — Roots spread out and ramified. Arms dichotomous, very ramified and very long, formed of a single series of articles.

This genus was established in 1821 under the name of *Cyathocrinites*, by Miller (*Syst. arrang. of the Crinoïdea*)) who placed it with *Actinocrinites, Phodocrinites* and *Platycrinites* in the section of Inarticulata, attributing to them exclusively five pieces of the basin (pelvis), or basal pieces. He completes its characters in saying that the basis supports five costal pieces (our parabasals) and that the stalk, not widened toward the top as in *Apiocrinites*, is cylindrical or pentagonal, with a round or pentagonal food canal, with radiating articular surfaces and auxiliary or accessory arms that are round and irregularly placed. It contains four species: *C. planus, C. tuberculatus, C. rugosus* and *C. quinquangularis*, the first alone having smooth costal or parabasal plates. It must remain in the genus and serve as type. The second, *C. tuberculatus*, following Miller, is distinguished only by its tubercular costal plates. But as these pieces are not here true parabasals, this species should be referred to the Carpocrinians in the genus *Taxocrinus*.

The third, *C. rugosus*, that Miller characterizes by its costal plates marked ridged angular striations, and by the canal of the stalk having five petaloid lobes differs even more. Austin has made it his genus *Crotalocrinus* that J. Müller compared to his *Anthocrinus*. The last species, *C. quinquangularis*, finally, that has smooth costal plates, pentagonal stalk as well as its central canal is a *Poteriocrinus*.

Goldfuss later described *Cyathocrinus geometricus* and *pinnatus* from the Devoian terrain (*Petr. germ*., p. 190, pl. LVIII, f. 5 and 7) and indicated a third, *C. pentagonus* (IbId., pl. LIX, f. 2) that is still very doubtful. Phillips, in his Geology of Yorkshire, described about ten of them, such as *C. calcaratus* and *C. mamillaris* (*Geol. of Yorksh*., p. 306, pl. 3, fig. 35 and 28) from the Carboniferous terrain, *C. macrodactylus* (*Pal. foss*., pl. 15, f. 41) from the Devonian terrain, which he later made a *Taxocrinus*, *C. pyriformis* (*Murchison Silur. syst*, pl. 17, f. 6) from the Upper Silurian that has become an *Ichthyocrinus*, and several doubtful species. Austin, M'Coy and De Koninck have also described several species from the Carboniferous terrain. M'Coy named *Phillipsocrinus caryocrinoides*, a fossil from the same terrain that D'Orbigny has represented (*Cours élém. de Paléont*., t. II, p. 145, f. 293) as type of the genus *Cyathocrinus*, but that not only belongs to a different genus but even to the tribe Actinocrinians. We can see, from this, how the characteristic of the genus must be a little different in D'Orbigny who assigned it "a cup-shaped calyx composed of three rows pieces: five small basal pieces, a row of fiv larter intermediary pieces, and five brachial pieces, a cylindrical stalk with irregularly placed ramules, and arms formed a single seies of short articles."

D'Orbigny then counted 22 species from the Upper Silurian to the end of the Carboniferous terrain and estimated the maximum of species was found in the Devonian stage. But many of these species, especially the oldest, have been transferred to other genera. There remain especially as true Cyathocrines, Devonian species described by Goldfuss and Roemer, and especially species of the Carboniferous terrain. There is even listed one species, *C. ramosus*, Schloth., from the Permian terrain.

1. SMOOTH CYATHOCRINE. *CYATHOCRINUS PLANUS*, — Miller.

— Miller, Crinoïdea, p. 85 et pl. — Schloth., Nachtr., II, p. 98, pl. 26, f. 6. — Blainville, Man. d'Actinol., p. 260, pl. 29, f. 2. — Bronn, Léthæa geogn., pl. 4, f. 6. — Pictet, Traité de Paléont., p. 318, pl. C, f. 16.

Calyx rounded, smooth, stalk cylindrical, crossed by a round or pentagonal canal, arms very long and very ramified, with 12 to 45 simple articles between each bifurcation.

Fossil from the carboniferous terrain of England.

2. GEOMETRICAL CYATHOCRINE. *CYATHOCRINUS GEOMETRICUS*.

— Goldfuss, Petref. Germ., p. 190, pl. 58, f. 5. — Phillips, Palæoz, foss. pl. 60, f. 41. — Edwards, Atlas du Règne anim. de Cuvier, Zooph., pl. 8, f. 3.

Calyx ornamented with wide radiating ridges leaving from the base and center of the parabasal pieces.

Fossil from the Devonian terrain of Blankenheim (Germany).

Cyathocrinus pinnatus (Goldf., *Petref. Germ*., p. 190, pl. 58, fig. 7. — Bronn, *Lethoea geognostica*, pl. 4, fig. 7. — *Plumose encrinites*, Parkinson, *Organ. remains*) is known only by fragments of the stalk that has radiated articular faces and by largely pinnate branches. It is a fossil found in the Devonian terrain of England and Eifel (Prussian Rhine).

8th GENUS. **DIMEROCRINE**. *DIMEROCRINUS*. — Phillips.

(διμερως, bilateral.)

Differs especially from *Cyathocrinus* by its two arms formed of pieces alternating in two rows. It also has a much larger interradial above that of the parabasals that differs from the four others.

This genus was established by Phillips in 1839 (in Murchison *Sur. syst*., pl. 17, fig. 7 and 9) for two fossil species from the Upper Silurian terrain of England (Wenlock) that he named *Dimeracrinus decadactylus*, or with ten fingers, and *D. icosidactylus*, or with twenty fingers, according to the number of primary divisions of the arms. D'Orbigny, in listing in his family of Melocriniae (*Cours élém. de Paléont*., 1852, t. Il, p. 142), gave for its characters having the calyx formed of four rows of pieces, of which three basals and five brachials. Previously, *Prodrome de Paléontologie* (1850), he had assigned it only three rows of pieces. At the same time, he listed in this genus as a third species, *Actinocrinus constrictus*.

9th GENUS. **ICHTHYOCRINE**. *ICHTHYOCRINUS*. — Conrad.

(ιχθυς- ιχθυος, fish.)

Calyx formed of five basals, five parabasals of equal size and five radials surmounted by second radials. Arms branched several times at equal heights, composed of wide articles in a single row and staying in contact in a way to form a regular pyriform group.

This genus, established in 1838 by Conrad (*Journal acad. nat. scient. Philadelph.*, t. VIII), was name thus because the proximity of the articles of the arms resembled in some way the scales of a fish. It has for type *Ichthyocrinus laevis* Conrad, from the Middle Silurian of America, described and figured in the work cited (p. 279, pl. 15, f. 16), as well as in Paleontology of New York of Hall (t. II, pl. 43, fig. 2), and in Traité de Paléontologie Pictet (t. IV, p . 319, pl.C, fig. 17).

Cyathocrinus pyriformis, Phillips (in Murchison *Silur. syst*., pl. 17, f. 6) and *Actinocrinus arthriticus*, Sowerby (in the same work, pl. 17, fig. 8), coming from the Upper Silurian of England (Wenlock), are also referred to this genus that appears exclusively restricted to the Silurian terrain. D'Orbigny, who places this genus in his family of Cyathocrinidae, gave for its characters "a bursiform calyx, composed of four rows or pieces: five basal pieces, two rows of five intermediary pieces, and five brachial pieces."

He lists two *Cyathocrinus* of Phillips, *C. goniodactylus* and *C. capillaris*, that we believe rather to be *Poteriocrinus*, and a latter species, *I. tesseracondactylus*, from the Upper Silurian terran of Sweden (Gothland) that had been described as a *Actinocrinus* by Hisinger (*Lethæa Suecica*, 1837, pl. 25, fig. 4).

10° GENUS. **LECANOCRINE**. *LECANOCRINUS*. — Hall.

(λεχανη, bowl.)

This genus, established by Hall in his Paleontology of New York (t. II, p. 199, pl. 44, 45 and 46), differs from *Ichthyocrinus* only by its basals numbering three. It contains *L. macropetalus, ornatus, simplex* and *caliculus* from the Silurian terrain of America.

11th GENUS. **WOODOCRINE**. *WOODOCRINUS*. — De Koninck.

(Wood, proper noun.)

Calyx in form of a broadly flared cup. With five basals surrounded by five equal parabasals between them. Five fist radials surmounted by two radials with two branches of each arm that are themselves bifurcated so that there are in all twenty equal banches. These branches are thick, formed of a single row of articles. They have pinnules directed toward the interior. De Koninck (*Recherch. sur les Crinoïdes*, p. 209, pl. 8) has established this genus for a single species, *W. macrodactylus*, from the Carboniferous terrain of England (Yorkshire), whose specific name is precisely taken from the thickness of the fingers or branches of the arms. This species is also figured in the atlas of Traité de Paléontologie of Pictet (pl. C, fig. 18).

12th GENUS. **SCYPHOCRINE.** *SCYPHOCRINUS*.— ZENKER.

(σχυφος, chiseled vase, concave; — calyx.)

Differs from *Cyathocrinus* by its basals numbering four and is distinguished by the striations that ornament its parabasals and radials and that form hexagonal figures. The stalk is round. The arms are branched, formed of a single row of articles that have numerous pinnules.

This genus was established in 1833 by Zenker (*Beitr. z. Naturgesch. der Urwelt*., p. 26, pl. 9) for a single species, *S. elegans*, of the Devoniana terrain of Bohemia and Elbersreuth. It is different from the genus named *Scyphocrinus* by Hall (Palaeont. of New York), as well as from *Schizocrinus* of the same author that D'Orbigny indicates as synonymous. These last two genera, in fact, make part of the tribe of Carpocrinians and differ from the true *Scyphocrinus*, like all the Cyathocrinians, by the absence of parabasals. This is the same character that prevents confusing this with *Actinocrinus*, despite their resemblance. D'Orbigny, who placed *Scyphocrinus* with his Cyathocrinids, attributed to it six rows of pieces, including five pentagonal basals, four rows of intermediary pieces and

pieces in a single alternating row on the arms. But, as we have said, this author confused several different genera.

(?) 13th GENUS. **MESPILOCRINE**. *MESPILOCRINUS*. — De Koninck.

(μεσπιλη, medlar.)

Calyx nearly globular, very abnormal, having three basals and five parabasals, of which four are similar and the fifth larger. Each of the five arms correspond to three radials directed obliquely so that the arms, following the same direction overlap each other and thus hide their ends. All the pieces appear fused together (?).

This extremely doubtful genus was established in 1854 by De Koninck and Lehon (*Rech. sur les Crinoides*, p. 111, pl. 2) for a very abnormal fossil from the Lower Carboniferous terrain of Belgium, at Visé, and that is figured also in the atlas of Traité de Paléontologie of Pictet (pl. C, f. 20). It is *Mespilocrinus granifer* De Koninck. A second species. *M. forbesianus* De Koninck, is figured also in the same work (pl. C. f. 19), according to Phillips who, in his Geology of Yorkshire (t. II, pl. 4, f. 5 and 6), described it as a young *Poteriocrinus* from the Carboniferous terrain of England. This opinion appears rather reasonable. The only other way to explain it is seeing it as a case of teratology.

(?) 14th GENUS. **ENALLOCRINE**. *ENALLOCRINUS*.— D'Orbigny.

(εναλλος, variable.)

This genus, no less doubtful than the preceding, was established by D'Orbigny (*Cours élém. de Paléontologie*, 1, p. 142) for two incomplete specimens, that Hisinger (*Petr. sued*., 1831, p. 23, pl. 5, fig. 9, and *Lethæa suecica*, pl. 25, fig. 1) had made his *Apiocrinites scriplus* and *A. punctatus*. D'Orbigny, who had previously (*Hist. nat. des Crinoîdes*, 4839, p. 94, pl. 16), had made it a *Millericrinus*, definitively placed them in his family of Melocrinidae, attributing to them "a short calyx, composed of three rows of pieces, five very depressed basals and five brachials." Pictet, who we follow here, has figured this genus in the atlas of his *Traité de Paléontologie* (pl C, f. 20) and was led to compare it to the Cyathocrinians, in attributing to it five depressed and linear basals, five large sub-radials (parabasals) and five brachials (radials) that alternate with each other. The arms and stalk are unknown.

(?) 15° GENUS. **TRIBRACHIOCRINE.** *TRIBRACHIOCRINUS*.— M'Coy.

(τρεις, τρια, three, βραχιων , arm, humerus).

This genus, which is supposed to be characterized by its three arms, also appears to be at least as doubtful as the two preceding. Its calyx, large and in the form of a cup, is composed of three basals, five parabasals, three radials corresponding to the three arms and separated by the same number of interradials, of which one larger is surmounted by one or two pieces similar to that called anals. M'Coy established this genus in 1847 (*Ann. and*

magazine of nat. Hist., t. XX, p. 228, pl. 12) for a fossil, *T. clarkii*, coming from the Caraboniferous terrain of New South Wales (Australia).

2nd TRIBE. **ACTINOCRINIANS**.

Calyx large, spheroidal, often wider than high. Ventral part broadly flared, sometimes nearly flat, formed of a large number of pieces, among which are not only three radials in each ray, but also arms or pieces that follow the first bifurcation. This same ventral part of the calyx contains three or four basals and five radials, between two of which is intercalated, for some and in the same line, an unpaired piece that has been called *anal*. Interradials, more or less numerous, increase still the number of pieces, and is continuous with the polygonal plates of the vault. But there are no parabasals and this is the essential difference that distinguishes these Crinoids from the Cyathocrians. They all have a rounded stalk.

This tribe corresponds to the *Actinocrinites* of Miller and to the genera that have come to be successively grouped around them, following the work of paleontologists, notably *Melocrinites* of Goldfuss. Consequently also, they correspond in large part to the family of Melocrinidae of D'Orbigny, especially when one removes the genus *Encrinus* that should form a separate tribe of the family Pycnocrinidae, and the genus *Platycrinus* that should be the type of a separate tribe. Two other genera of Melocrinids of this author, *Dimerocrinus* and *Enallocrinus*, have already been mentioned among the Cyathocrinians, and a third, Gilbertsocrinus, should be united with *Rhodocrinus* of the same tribe. Thus, of the nine genera classed by D'Orbigny in the same family as *Actinocrinus,* there remain only four belonging to the tribe that we consider: 1° *Actinocrinus*, Miller ; 2º *Melocrinus*, Goldfuss; 3° *Ctenocrinus*, established by Bronn in 1840 (*Neues Jahrb. für Mineralogie*); 4° *Geocrinus*, D'Orbigny, that must take the name *Periechocrinus* previously given it (1843) by Austin. To these 4 genera, Pictet, in his *Traité de Paléontologie*, adds 8 others, these are first: 1° *Pradocrinus* of Verneuil; 2° *Amphoracrinus* of Austin, first named *Amphora* by Cumberland, then named by Goldfuss *Melocrinites amphora*; 3° *Dorycrinus* of Roemer; 4° *Batocrinus* of Casseday, and 4 more or less doubtful or imperfectly known genera: *Saccocrinus* of Hall, *Sagenocrinus* of Austin, *Castanocrinus* of Roemer, and *Phillipsocrimus* of M'Coy. All these genera, moreover, belong exclusively to Paleozoic terrains.

F. Roemer, who has made known two genera that we just cited, divided all our Actinocrinians into two families: Actinocrinids containing the genera *Actinocrinus, Amphoracrinus, Dorycrinus, Batocrinus*, etc., and Melocrinids containing *Melocrinus, Castanocrinus* et *Phillipsocrinus*.

* *Three basal pieces.*

1st GENUS. **CTENOCRINE**. *CTENOCRINUS*.— BRONN.

(χτεις, χτενος, comb)

Calyx fusiform, composed of three basal pieces and three rows of five radial pieces with some interradials. Five free arms, not branched, composed of two rows of articles in a way that they appear double and having lateral pinnules like the teeth of a comb. Pieces of the calyx ornamented with radiating striations, very deep and very pronounced.

This genus, which contains three species of the Devonian terrain, was established in 1840 by Bronn for the *Ctenocrinus* type (Leonhard and Bronn, *Neues Jahrb*., p. 542, pl. 8). F. Roemer has recently described two others, *Ct. stellaris* that is figured in the last edition of *Lethæa geognostica* (pl. IV[1], fig. 19) and in the atlas of Traité de Paléontologie of Pictet (pl. CI, fig. 1) and *Ct. decadactylus* that appears to differ from the type by the number of divisions of the arms.

2nd GENUS. **PRADOCRINE**. *PRADOCRINUS*. — de VERNEUL.

(*Prado*, proper name of a geologist.)

Calyx elongated, elliptical, very large, formed of very numerous pieces that can be considered as forming, except for the basals, six transverse rows of 3, 6, 12. 18, 24 and 34 that comes from the rapid increase in the number of interradials, of which only one is found between two of the first five radials while we already see 7 in the row of the second radials, and so on so that the interval between two of the rays is always larger than the others. This interval corresponds on the vault to a larger opening that is called the anus. In the middle of the vault is another larger opening that is believed to be the mouth. Arms formed of a double row of articles.

This genus was established in 1850 (*Bull. soc. geol*., 2° série, t. V II, p. 184, pl. 4, fig. 11) by de Verneuil for a single species from the Devonian terrain of Asturias (Spain) that he dedicated to Bayle, *Pradocrinus baylii*, as he dedicated the genus itself to Prado. This species is also figured in the atlas of Pictet (pl. CI, fig. 2).

3rd GENUS. **SACCOCRINE**. *SACCOCRINUS*. — Hall.

(σαχχος, sack.)

This genus, established by Hall (Palaeont. of New York, t. II, p. 205, pl. 46) for a single species of the Middle Silurian of America (*Saccocrinus speciosus*) appears to differ from the preceding genera only by its arms that are bifurcated two or three times.

4th GENUS. **PERIECHOCRINE**. *PERIECHOCRINUS*.— Austin .

(περιεχω, to surround.)

This genus, established by Austin (*Ann. and mag. of nat. Hist*., 1843, t. XI, p. 204) for *P. articulosus* from the Upper Silurian terrain of Dudley (England), contains a second species of the same terrain, *P. costatus*, Austin that was previously described by Phillips (in Murchison, *Silur. syst*., 1839, pl. 18, fig. 4). D'Orbigny made them his genus *Geocrinus* (*Cours élém. de Paléont*., II, p. 141, and *Prodrome,* I, p. 46) that he characterized by a calyx composed of eight rows of pieces, of which three were basals and by its ars formed of two series of articles, as in other Melocrinidae. Ultimately, this genus, very near the preceding, also has a large calyx form of very numerous pieces and radials separated by smaller and very numerous interradials forming from the basals, ascending series that branch for the arms.

(?) 5th GENUS. **SAGENOCRINE** *SAGENOCRINUS*. — Austin.

(σαγηνη, seine, fishermen's net.)

This genus, established in 1843 (*Ann. and mag. of nat. Hist*., t. XI, p. 205) by Austin, according to very incomplete specimens, appears to be distinguished from the preceding especially by its numerous branched rays and by its very numerous interradials, extending like blades of scissors between the bases of the arms. The species type, *Sagenocrinus expansus*, Austin, was previously described as an *Actinocrinus* by Phillips (Murchison, *Silur. syst*., 1839, pl. 17, fig. 9). Both have been found in the Upper Silurian terrain of Dudley.

6th GENUS. **ACTINOCRINE**. *ACTINOCRINUS*.—Miller.

(αχτις, αχτινος, ray of light.)

Calyx globular, formed of a lower part, cup-shaped, more or less flared, from the border of which leave five arms already sub-divided in two, four, five, or six branches that are sometimes taken for arms. It is surmounted by a hemispherical or conoidal vault, ended ordinarily by a vertical extension in the form oof a trunk or vent. The lower part has three small basals whose ensemble nearly makes a pentagon, on the sides of which are six hexagonal pieces. Five of these pieces are the first radials from where leave the five series formed by second and third radials that surmount the arms that are promptly sub-divided. The sixth piece resting on the basals does not correspond to a ray and can be named anal.

Five interradials are outside in each interval of the rays so that there are six pieces in it that which corresponds to the anal.

The arms remain attached to the calyx by their base and are part of its wall and becomes free only after their second bifurcation.

The vault is formed of very numerous small plates, often swollen into a tubercle or prolonged into a blunt point. The pieces of the lower part are ordinarily ornamented with

striations or protruding ridges, radiating into a star and leaving from the center of each piece toward the center of adjacent plates.

The branches of each arm, formed of a double series of pieces, articulates not only with the brachial articles that each ray provides by sub-dividing, but also to the pieces of the vault that more or less cover their base, leaving some openings or interstices by which the current of each ambulacral gutter can penetrate into the interior.

The cylindrical stalk is slender and composed of unequal articles and appears ringed in some way. The central canal is pentagonal and the articular facets are radiate. The root was diversely spread out and attached to the rocks of the bottom of the sea. This genus, one of the best characterized today, was established first by Miller under the name of *Actinocrinites* (*Syst. of the Crinoidea*, 1821) who, classifying it among his Inarticulata, attributed to it a basin (pelvis) formed of three pieces, then five costals and an intercostal resting on the pelvis. Miller thus distinguished it from the genus *Rhodocrinites* that has fiv intercostals (our parabasals) resting on the pelvis, from which they separate the costals. His *Actinocrinites* have, in addition, a round stalk, not thickened toward the top. Its fingers (branches) are formed of a double series of articles. The articular facets of the radiated stalk and the accessory arms are round and irregular.

He listed then in this genus three species: *A. friacontadactylus, A. polydactylus* and *A. laevis*. The latter being doubtful, the two first are distinguished by the number of their fingers (branches of the arms) that are thirty in one of the greatest and more in the other.

Many other species of *Actinocrinus* have been described or indicated since the publication of Miller: by Goldfuss (*A. granulatus, Petref. Germ*., p. 193, pl. 59, fig. 4. — *A. cingulatus*, ibId., p. 195, pl. 59, fig. 4. — *A. nodulus*, ibId., fig. 9. — *A. muricatus*, ibId., fig. 8, and *Nov. Acta nat. cur*., t. XIX, 1838, p. 342, pl. 31, fig. 6. — *A. decadactylus*, ibId., fig. 5); by Phillips (*A. gilbertsont*, Geol. of Yorkshire, t. II, p. 206, pl. 4, fig. 19.— *A. fessellatus*, ibId. fig. 21. — *A. globulus*, ibId., fig. 26-29); by M'Coy (*A. costus, Synopsis carb. Ireland*, 1844, p. 181, pl. 26, fig. 2; and *A. pusillus*, ibId., fig. 4); by de Koninck (*A. fricuspidatus, Recherch. sur les Crinoïdes*. — *A. stellaris*, ibId., etc.); by Portlock (*A. icosidactylus, Ann. and Mag. of nat. Hist*., 1843, t. XI, p. 200); etc., etc. One must, moreover, also refer to this genus *A. expansus*, that Phillips wanted to make a separate genus, whose name (of ευρυς, large) is taken from it more widened form.

There are thus today about twenty species of *Actinocrinus* more or less completely known and all coming from the Carboniferous terrain. But many other fossils of the same terrain or earlier terrains have been described under the same name and should be referred to other genera, notably those whose arms are formed of a single row of articles. It is thus that *Act. arthriticus* Sowerby has become an *Ichthyocrinus*, that *Act. expansus* of Phillips is a *Sagenocrinus,* that *Act. simplex* of the same author (synonym of *Act. tesseracondactylus* of Hisinger) is a *Carpocrinus*, that *Act. constrictus* of M'Coy appears to be a *Dimerocrinus*, that *Act. moniliformis* of Phillips is the type of the genus *Periechocrinus* of which we have already spoken, ete., etc.

D'Orbigny, in 1852 in his *Cours élémentaire de Paléontologie*, and in 1850, in his *Prodrome*, counted only 8 species of *Actinocrinus*, including *Euryocrinus expansus* of Phillips, all from the Carboniferous terrain. He placed this genus, as we have already said, among his Melocrinids, attributing to it "a cup-shaped calyx composed of five rows of plates; three basal pieces, a first row of six intermediary pieces and a row of ten or twelve brachial pieces with bifurcated arms; many accessory pieces."

F. Roemer has taken his genus for type of his family Actinocrinidae, that includes, in addition, the genera *Amyphoracrinus, Dorycrinus, Batocrinus*, etc.

We believe it necessary to insist on the mode of insertion of the branches of the arms around the calyx and on the very evident openings that we see either above or next to this insertion as we have represented in our plate 2. These openings communicate with the interior by currents produced by cilia in each of the food grooves of branches of the arms.

1. ACTINOCRINE WITH THIRTY FINGERS. *ACTINOCRINUS TRIACONTADACTYLUS*. — Miller.

Atlas, pl. 4, fig. 6 and 8. — PI. 2, fig. 3.

— *New-Encrinite*, Parkinson, Org. rem., pl. 17, f. 3. — *Amphora*, Cumperland, Reliq. conserv., p. 37, pl. 3, f. 3, 4, and pl. A, £. 1, and in Trans. of the Geol. Soc., t. V, pl. 5, f. 2-7. — *Encrinus loricatus*, Schlotheim, Petref., p. 338, and Nachtr., II, p. 99, pl. 27.— *Actinocrinites triacontadactylus*, Miller, Crinoïd., p. 95 et pl. — Goldfuss, Petref. Germ., p. 194, pl. 59, f, 6. — Blainville Man. d'Actinol., p. 261. — Phillips, Gcol. of Yorkshire, II, p. 206, pl. 4, f. 16.— Edwards, Atlas du Règne anim. de Cuvier, Zoophyies, pl. 8, fig. 1.

Plates of the calyx ornamented with radiate ribs. Vault formed of protruding pieces or conoidal. The two branches of each arm sub-divided into three plates that makes 5X6 = 30 branches or fingers that appear to leave the calyx itself. Stalk formed of equal or inequal articles and, in this case, they are alternatively or two in two, wider and convex.

The name of *Amphora* given by Cumberland to this species and some others that he confused with it, comes from the general appearance of the calyx lacking its arms or fingers and that resembles the body of an amphora. The insertions of the sub-divisions of each arm, six in number, are unequal and form two groups nearly symmetrical, showing wide hiatus (pl. 2, fig. 3) that is obviously too wide to serve only for the passage of ligaments and vessels of each arm and that, moreover, does not belong exclusively to the articles of these arms, but also to the pieces of the vault. It is thus extremely probable that this wide hiatus establishes, as we have said above, a communication between the interior of the calyx and the currents produced between the interior of the calyx and the currents produced along each arm by the cilia of the ambulacral gutter. Consequently also, the vertical tube or vent that surmounts the vault and that has been called a trunk, must give issue to the water that had entered by the hiatus of the base of the arms.

Fossil of the Carboniferous terrain of England, at Bolland, (Yorkshire), Bristol, Kildare, etc.

2. ACTINOCRINE WITH MANY FINGERS. *ACTINOCRINUS POLYDACTYLUS*. — Miller.

— *Encrinus polydactylus*, Schlotheim, Nachtr., II, p. 100, pl. 27, f. 4. — *Actinocrinites polydactylus*, Miller, CrinoId., p. 103 et pl.— Phillips, Geol. of Yorkshire, II, p. 206, pl. 4, f. 17–18. — Bronn, Lethæa geogn., pl. 4, f. 4. — De Konick, Descr. an. foss. carb. Belg., pl. G, f. 3.

Plates of the calyx ornamented with radiating ridges and forming stars with five of six rays. The two branches or principal divisions of each are sub-divided into four or five, which brings to 40 or 50 the total number of these secondary branches (fingers, Miller) that seem to leave from the calyx itself.

Fossil of the Carboniferous terrain of England (Yorkshire) and Belgium (Tournay).

3. SMOOTH ACTINOCRINE *ACTINOCRINUS LAEVIS*. — Miller.

— Miller, Crinoïd., p. 105. — Goldfuss, Petref, Germ., p. 193, pl. 59, f. 3. — De Koninck, Descr. des anim. foss. du terr, carb, de Belg., p. 52, pl. G, f. 4.

Plates of calyx smooth, simply a little ridged at the edge. Articles of the stalk all alike, cylindrical or convex, or keeled.

Fossil of the Carboniferous terrain of England, Germany and Belgium.

We cite only again 1st *Actinocrinus granulatus*, Goldfuss, *Petref. Germ*., p.195, pl. 59, fig. 5; from Germany.

2nd *Actinocrinus gilbertsonii*, Phillips, *Geo. of Yorkshire*, XI, p. 206, pl. 4, f. 19. — From England and Belgium.

3rd *Actinocrinus tricuspidatus*, De Koninck and Lehon, *Rech, sur les Crimoïdes*. — Pictet, *Traité de Paléont*., pl. 101, fig. 4. — Represented also in out Atlas, pl. 4, fig. 7, according to these authors as showing more clearly the arrangement of the pieces of the calyx. — Fossil of Belgium.

4th *Actinocrinus stellaris*, De Koninck and Lehon, *Rech. sur les Crinoïdes*. — Bronn and Roemer, *Lethaei geogn*., pl. 4', fig. 18. — Pictet, *Traîté de Paléont*., pl. 101, fig 4. — Also from the Carboniferous terrain of Belgium.

7th GENUS. **BATOCRINE**. *BATOCRINUS*. — Casseday.

(βατος, kind of drinking glass.)

This genus, established in 1854 by Casseday from Louisville (United States), differs only from *Actinocrinus* because the insertions of the branches or sub-divisions of the arms form around the calyx a continuous zone instead of distinct groups.

The only two species described by the author (in *Zeitschr. der Deutsch. Geol. Gesellsch*., t. VI, p. 237, pl. 2) are *B. isodactylus* and *B. irregularis* of the Carboniferous limestone of Kentucky. The figure of the first is reproduced in the Atlas of Pictet (pl. 101, fig. 6).

8th GENUS. **AMPHORACRINE**. *AMPHORACRINUS*.— AUSTIN.

(αμφορευς, amphore, vase for storing wine.)

This genus that has for type one of the species that Cumberland confused under the name of *Amphora* and that Goldfuss (in *Nova Acta nat. curios*., 1838, t. XIX, p. 340, pl. 31, fig. 4) had made his *Melocrinites amphora* differs from *Actinocrinus* only because the opening of the vault that one has wanted to call the mouth, is lateral and not prolonged like a trunk. The unpaired interradial interval has six plates.

The species type, which is also figured in the atlas of Pictet (pl. 101, fig. 7), has been named *Amphoracrinus gilbertsoni* by Austin (*Quarter. Journ. geol. Soc*., 1848, t. IV, p. 292). It is a fossil from the Carboniferous terrain of England.

The same terrain has furnished M'Coy (*Palæoz. foss*., pl. 3 D) a second species, *Amph. atlas* and Roemer has found it in the Carboniferous terrain of America; a third, *Amph. americanus*, that is figured in the new edition of *Lethæa geognostica* (pl. 4', fig. 15).

9th GENUS. **DORYCRINE**. *DORYCRINUS*. — F. Romer.

(δορυ, lance, spear)

Atlas, plate 5, fig. 4–5.

Calyx spheroidal or polyhedral with a single eccentric opening (mouth?), lateral, on the vault, from where also leave six long spines.

Three basal plates form a nearly flat disk, two equal, larger and a smaller third.

Five radials of 1st, 2nd and 3rd orders form five ascending rows after the basals. The radials of the 3rd order being auxiliary, i. e, having on their two oblique upper sides with two brachials of the 1st order that support four others of the 2nd order. These latter, as in *Actinocrinus*, are notched above and show the corresponding openings with four branches of each arm that are detached after the death of the animal.

A single interradial piece of the 1st order is opposite the mouth. The interradials of the 2° order are seven in number, of which three above the single interradial of the 1st order

and one in each interval between the radials of the 2nd order. The interradials of the 3rd order are 13 in number, of which 5 in the interval corresponding to the single interradial of the 1st order and with the mouth, and two in each of the four other intervals.

Vault of the calyx formed of numerous plates, of which six much larger and thicker extend in long spines because of their continuous growth. Five of these spines diverge above the arms. The sixth is vertical, located a little eccentrically above the opening called the mouth (?).

This opening (mouth?) is thus accompanied laterally by two spines corresponding to the arms and surmounted by a third vertical.

Stalk cylindrical with radiating articular facets and a round central canal.

This genus was established in 1853 (*Archiv für Naturgeschichte*, XIX, Jahrg., 1, p. 213, pl. X) by Roemer for a fossil, *Dorycrinus mississipiensis*, of the Carboniferous limestone of the southern region of Illinois (United States). It is especially remarkable for its long spines of the vault of its calyx that are in some way the last degree of growth possible of the pieces of the test of Crinoids. We have already seen, notably on *Acanthocrinus*, on *Stephanocrinus*, and even on some *Actinocrinus*, some examples of growth of this kind, proving clearly that each of the pieces of test, like the stalk of Crinoids and the spines of Echinoids, have their own vitality that can serve to explain the exterior changes and even the integral development of some Crinoids lacking a digestive system. Without doubt, one could not find in the fossil state a *Dorycrinus* with all its spines preserved, but there what remained was sufficient for Roemer to complete the figure he has given and that we have reproduced because of its importance.

** *Four basal pieces*.

10th GENUS. **MELOCRINE.** *MELOCRINUS.*— Goldfuss.

(μηλον, apple, fruit.)

Calyx spheroidal, a little oblong, with four basals from where leave five rows of three radial pieces (1st, 2nd and 3rd radials). The third radials being auxiliary as in the preceding genus, i. e., terminated above by two oblique sides that support the brachials.

Numerous interradials of different orders are in the intervals of the rows of radials, and other similar plates constitute the very convex vault that is pierced by a central or eccentric opening that has been named the mouth.

Arms composed of two rows or articles.

Stalk cylindrical, crossed by a round or qinque-lobed canal.

This genus was established in 1831 by Goldfuss by his great work on Petrifications of Germany. He distinguished *Actinocrinus* especially by the number of basal pieces and attributed to it 5 primary costals that are hexagonal, surmounted by 5 secondary costal pieces of the same form between which are 5 hexagonal intercostal pieces and also hexagonal scapular pieces.

Goldfuss first described three species from the Devonian terrain of Germany.

1st *Melocrinites hieroglyphicus*, Goldf., *Petref. Germ.*, p. 197, pl. 60, fig. 1; characterized by the nodular plates of the calyx and the eccentric mouth — It is also figured by Bronn in his *Lethæa geognostica,*, pl. 4, fig. 10.

2nd *M. laevis*, Goldf., ibId., fig. 2; characterized by its smooth plates, but considered doubtful.

3rd *M. gibbosus*, Goldf., ibId., p. 211, pl. 64, fig. 2, which is distinguished by its bumpy plates and its central mouth.

Later, in 1838, in the *Nova Acta nat. curios*., t. XIX, Goldfuss described four others, namely:

4th *M. pyramidalis* (p. 339, pl. 31, fig. 1), characterized by its pyramidal form and by its central mouth (?).

5th *M. globosus* (p. 340, pl. 31, fig. 2), also having a central mouth, but more globular.

6th *M. verrucosus* (ibId., fig. 3), represented in the atlas of Pictet (pl. 101, fig. 8), having its plates with small tubercles and its eccentric mouth.

7th *M. amphora* (ibId., fig. 4) that is, as we have said, the type of the genus *Amphoracrinus*, because it has only three basals.

Some other species have been indicated, but all belong to the Devonian terrain.

D'Orbigny, in his *Cours élémentaire de Paléontologie* (1852), in taking the genus *Melocrinus* for the type of his family of Helocrinidae, characterized it by "its calyx composed of five rows of pieces: four basal pieces, three rows of five intermediary pieces, one row of ten brachial pieces and a good number of accessory pieces." He indicated, according to Goldfuss, six species from the Devonian terrain. But, in wanting to refer to the same genus *Marsupiocrinus dactylus* of Hall and *Marsupiocrinus coelatus* of Phillips, that are both of the Upper Silurian terrain, he was led to attribute too great a paleontological extension to true *Melocrinus.* In addition, the latter species that we cited is more appropriately listed among the Platycrinians.

(?) 11th GENUS. **CASTANOCRINE**. *CASTANOCRINUS*.— ROEMER.

(χαδτανον, chestnut.)

Roemer, in the *Lethaea geognostica*, in also accepting a family of Melocrinidae, divided into two the genus *Meloerinus* according to the position of the mouth, leaving the name only to species with an eccentric mouth and forming with the species with the species with a central mouth, his genus *Castanocrinus*. This includes *M. globosus, M. pyramidalis* and *M. fornicatus*.

(?) 12th GENUS. **PHILLIPSOCRINE**. *PHILLIPSOCRINUS*.— M'Coy.

(From the name Phillips, English geologist.)

This genus, very little known, established in 1844 by M'Coy (*Synopsis carb. of Ireland*, p. 183, pl. 26), appears to differ from *Melocrinus* only by the arms formed of a single row of articles. The species type, *Ph. caryocrinoides*, which comes from the Carboniferous terrain of Ireland, has been taken by D'Orbigny for a *Caryocrinus* and figured as such in his *Cours élémentaire de Paléontologie*, t. II, p. 145, fig. 293.

3rd TRIBE. **CARPOCRINIANS**.

Calyx very short, lacking parabasals and the wall of which does not correspond to the brachials.

Three or five basals on which rests the first five radials that are the beginning of the ascending series each formed of five radials.

This tribe, which it perhaps would have been better not to have been separated from the Actinocrinians, contains for Pictet 10 genera, of which 5 established by Hall in his Paleontology of New York, are known to us only by the figures he has given and appear to us very questionable. A sixth genus of the same author, *Lyriocrinus*, of which we saw a very nice specimen in the Gallery of Geology of the Muséum d'histoire naturelle de Paris, is, on the contrary, perfectly characterized. Of the four other genera, one, *Taxocrinus*, also well characterized is due to Phillips. *Forbesiocrinus* and *Graphiocrinus* were established by de Koninck and Lehon, and the latter, which gave its name to this tribe, *Carpocrinus*, was established by J. Müller (1841) for a species of *Actinocrinus* (*A. simplex* Phillips), that the Austins, on their side (1843) made the genus *Phoenicocrinites* and that D'Orbigny has taken for the type of his genus *Abracrinus* in 1852 (*Cours élémentaire*).

The 6 genera of Hall are from the Middle of Lower Silurian of southern America. *Carpocrinus* is from the Upper Silurian of England. The two genera of De Koninck and Lehon are from the Carboniferous terrain of Belgium and *Taxocrinus* alone is represented by different species in the Upper Silurian, Devonian and Carboniferous terrains.\

The only genera of this tribe that were known to D'Orbigny, *Taxocrinus* and *Carpocrinus*, under the name of *Abracrinus*, were classified by him in his family Cyathocrinidae, as having arms formed of a single series of articles.

Roemer also placed *Carpocrinus* in his family of Cyathocrinidae that is supposed to have the ventral and dorsal wall membranous and not fused by calcareous plates.

1st GENUS. **FORBESIOCRINE**. *FORBESIOCRINUS*. — De Koninck and Lehon.

(Forbes, name of an English naturalist.)

Calyx widened, formed of five bent basals and four radials in ascending rows for each of the five rays. In each of the intervals separating the rays are 12 to 13 interradials and more in the interval that one has wanted to call the anal side.

Arms formed of a single series of very thick articles, each having a point or median appendage above that makes one think of the ambulacral gutter being longitudinally divided into two. These arms sub-divided several times up to 60 branches.
This genus contains the single species, *Forbesiocrinus nobilis* that serves as the type and that comes from the Carboniferous terrain. This species, by its special characters had first struck Phillips who, uniting it with others, placed it in in his genus *Isocrinus,* but this name, as given previously by Herman Meyer to other fossils had to be changed to that of *Cladocrinites* (χλαδος, branch.) that itself had been used differently by Agassiz. Then Phillips included the species in question in his genus *Taxocrinus* that we are going to talk about. Finally, De Koninck and Lehon have found a distinctive character for the true *Taxocrinus*, the lack of interradial pieces and they instituted this genus in describing the species type in their *Recherches sur les Crinoides*, 1854 (p. 118, pl. 2, fig. 2). It is also represented in the Atlas of Pictet (pl. CI, fig. 9).

2nd GENUS. **TAXOCRINE**. *TAXOCRINUS.*— Phillips.

This genus, established by Phillips and more clearly circumscribed by the separation of *Forbesiocrinus*, thus differs from the latter in that it lacks interradials. Its calyx is more simply composed and it has in some way, at its base, only two rows of pieces, five basals and five first radials. Also, D'Orbigny, in placing it in his family of Cyathocrinidae because of its arms formed of a single series of articles, characterized it by its "calyx composed of two rows of pieces, five of which are basals." The articles of the arms do not have the appendages above as in *Forbesiocrinus*.

The species type, *Taxocrinus tuberculatus*, was first described by Schlotheim under the name of *Encrinus armatus* (*Nachtrag*. II, p. 98, pl. XXVI, fig. 7), then under the name of *Cyathocrinites tuberculatus* by Miller (*CrinoId.*, p. 88), and by Goldfuss (*Petref. Germ.*, p. 190, pl. LVIII, fig. 6), and by Edwards, in the atlas of the Règne animal of Cuvier (*Zooph*., pl. 8 fig. 2). Under the name that we preserve it, it is figured in the Atlas of Pictet (pl. CI, fig. 10). This species comes from the Upper Silurian terrain as well as *T. orbignyi* (M'Coy, *Palaeoz. fossil*., pl. 1 D). *Taxocrinus macrodactylus* of Phillips (*Geol. of Yorkshire* I, pl. 3) belongs, on the contrary, to the Devonian terrain of England. We should also consider a *Taxocrinus*, *Cyathocrinus rhenanus* Roemer.

Finally, *Poteriocrinus egertoni* and *P. nobilis* of Phillips are also *Taxocrinus* and come from the Carboniferous of England or Ireland, as well as *Taxocrinus polydactylus* MCoy (*Synops. carb. of Ireland*, 1844, p. 178, pl. 26, fig. 7).

3rd GENUS. **GRAPHIOCRINE**. *GRAPHIOCRINUS*, — De Koninck and Lehon.

(γραφειον, paint brush)

Calyx elongated, cylindrical, in the form of a brush, composed of five basal pieces and five ascending rows of two radials each without interradials. Five arms, each divided into two branches that are very long, simple and composed of articles alternatively thicker and thinner in a single series.

The only species known, *Graphiocrinus encrinoides*, comes from the Upper Carboniferous limestone of Belgium, was described in *Recherches sur les Crinoïdes*, of de Koninck and Lehon (1854, p. 115, pl. 4, fig. 15). It is also represented in the Atlas of Pictet (pl. CI, fig. 11).

4th GENUS. **CARPOCRINE**. *CARPOCRINUS*.— J. Müller.

(χαρπος, fruit.)

Calyx widened, formed of three basals on which are five ascending rows each with three radials, separated by some interradials.

Arms formed of a single series of articles.

This genus, established by J. Müller in 1841 in his *Mémoire sur le Pentacrinus*, p. 33, has for type *Actinocrinus simplex* of Phillips (in Murchison *Silur. syst*., 1839, pl. 18, fig. 8), that comes from the Upper Silurian of England (Wenlock). Afterward, as we have said, the Austins (*Annal. and Mag. of nat. history*) named it *Phoenicocrinites* and D'Orbigny (*Cours élémentaire*, 1850, t. II, p. 144) named it *Abracrinus* (from αβρος, elegant, delicate) and characterized by its "cup-shaped calyx composed of four rows of pieces, three basal pieces, two rows of five intermediary pieces and five brachial pieces." But with this species from the Upper Silurian, D'Orbigny wanted to classify *Actinocrinus pusillus* (M'Coy) from the Carboniferous terrain in the same genus, which sems necessary to preserve its generic name.

5th *Genus*. **LIRIOCRINE.** ***L****IRIOCRINUS*. — Hall.

(λειριον, lily, narcissus.)

Calyx very widened, in a flared cup, and very complicated, having five basals and five ascending rows of three to four radials separated by interradials. The first brachials contribute to form the edges of the cup and the two branches of each arm appear thus to leave from the calyx itself, which makes one believe that there are ten distinct arms, not branched, each formed of a double row of alternating articles and having pinnules toward the internal surface.

The sole species, *Liriocrinus dactylus* (Hall, *Palaeont. of New York.* I, p. 197, pl. 14) is also represented in the Atlas of Pictet (pl. CI, fig. 42). It is round in the Middle Silurian of the United States (Niagara). The name of the genus, derived from λειριον has been, inappropriately, written often as *Lyriocrinus*.

6th–12th GENERA. *SCHIZOCRINUS, HETEROCRINUS, CLOSTEROCRINUS, MACROSTYLOCRINUS* AND *SCYPHOCRINUS*. — Hall.

As we have said, these genera, established by Hall in his Paleontology of NewYork, are known only by the figures and descriptions of his author.

SCHIZOCRINUS (σχιξα, fissure, division) with five basals and five ascending rows of radials, each separated by interradials. The arms, regularly bifurcated and with lateral appendages, are composed of articles alternatively thinned from one side and the other. Hall (Pal. of New York, t. 1, p. 81, pl. 27) lists two species *Sch. nodosus* and *Sch. striatus*, both from the Lower Silurian terrain of America.

D'Obigny had regarded, incorrectly, this genus as synonymous with *Scyphocrinus* of Zenker, who, because of the presence of parabasals, is part of the tribe of Cyathocrinians.

Heterocrinus (ετερος, different, dissimilar) differs from the preceding by the absence of interradials on the calyx and lateral appendages of the arms whose articles are alternatingly quadrangular. Three species (1. c., p. 279, pl. 76) are indicated in the same Lower Silurian terrain.

Closterocrinus (χλωστηρ, χλωστηρος. spindle) with its calyx elongated, nearly fusiform, whose basals, supposed to be three (?) in number, support five rows of three radials each, separated by interradials. The arms, incompletely seen, are supposed formed of quadrangular articles. Hall (Pal. of New York, t. II, p. 179, pl. A41) indicates one species, *C. elongatus*, from the Middle Silurian range.

Macrostylocrinus (μαχρος, long; στυλος, column) has its calyx short, with three basals and five ascending rows of three radials each separated by some interradials. The arms are divided at their origin into two branches that are very long, simple and composed of a double row of alternating articles. The only species indicated is *M. ornatus* (Pal. of New York, II, p.204, pl. 16) from the Middle Silurian.

Scyphocrinus (σχοφιον, cup, drinking glass), very different from *Scyphocrinus* of Zenker of which we have already spoken, with a pyriform calix, with five basals and five ascending rows of four radials each, separated by not very numerous interradials. It contains a single species, *Sc. heterocostalis* (*Pal. of New York*, I, p. 85, pl. 28) from the Lower Silurian of the United States (Trenton).

4th TRIBE. **PLATYCRINIANS**.

Calyx urceolate or subcylindrical, formed of two or more often three basals surmounted by five first radials that are very large, forming nearly all the lateral wall and having in a notch on their upper edge a second radial that is much smaller (rarely surmounted by a third equally small radial), terminated by two oblique facets on which articulate the two branches of each arm.

The vault, often prolonged into a vertical trunk, is completely covered with calcareous polygonal plates, sometimes, in addition, a supernumerary plate that could be called anal, intercalated between two of the first radials, sometimes also there is an interradial between each radial toward the top.

This tribe corresponds to the genus *Platycrinites* of Miller and to the genera that are grouped around it, all characterized by the relatively small number of pieces of the calyx and the exceptional size of the first radials that suffices to distinguish it from other Cyathocrinids, in particular Actinocrinians and Carpocrinians that also lack parabasal or sub-radial pieces.

The very numerous species of this tribe can nearly all be referred to the genus *Platycrinus*, taking into account the possible fusion between the basals that, instead of three are only two in *Dichocrinus* and only one in *Symbathocrinus* and *Adelocrinus*, and also considering *Atocrinus* as *Platycrinus*, in which all the basals and the first radials are fused to form a calyx of a single piece. The different genera are then only simple sections of the principal genus.

It would also be the same for *Edwardsocrinus* and *Amblacrinus* of D'Orbigy, that differ from *Platycrinus* strictly speaking only by their arms formed of a single series and not a double series of articles, because this character, as we have seen several times, cannot have an absolute value.

Of the 10 genera that we can list in this tribe, there would be none that can be considered as very distinct, as *Hexacrinus* of Austin that has a supernumerary piece (anal) between two of the large first radials. In second place, *Culicocrinus* of J. Müller, that has a third radial superposed on each of the second radials and that has in addition five interradials ended in a point and helping to form the vault.

All the Platycrinians, in addition, belong to the Paleozoic terrians, in particular to the Devonian and Carboniferous terrains. Only *Marsupiocrinus coelatus* of Phillips, if it is really part of this tribe and not the genus *Melocrinus*, as D'Orbigny wanted, would belong to the Upper Silurian of England. But it is too imperfectly known, after incomplete species to be able to comment on this subject.

D'Orbigny, in attaching too much importance on the arrangement of the articles of the arms into one or two distinct series, had placed the genus *Platycrinus* alone in his family of Melocrinidae, and *Amblacrinus, Atocrinus* and *Dichocrinus* that, as we have said, are only sections of the same genus, he placed in his Cyathocrinidae. F. Roemer (*Lethæa geognostica*) made them a distinct family under the name of Platycrinidae.

1st GENUS. **PLATYCRINE**. *PLATYCRINUS*. — Miller.

(πλατυ, flat.)

Calyx cup-shaped, composed of three pentagonal basals and five large first radials, having in a notch of their upper edge a second much small radial on which articulate the two primary branches of each arm, often sub-divided itself into secondary or tertiary branachs with pinnules and formed of alternating articles in one or two series.

An interrdial is found above between each large radial and smaller plates, ordinarily hexagonal, cover all the vault of dorsal part of the calyx and is often prolonged into a tube or vent that is called a trunk.

Some distinct openings at the insertion of the arms communicate with the interior currents of the ambulacral gutters.

Stalk rounded or elliptical and, in the latter case, with a rib on the articular surface of each article, on which are always radiating striations near the edge.

The pieces of the vault are sometimes surmounted by a pointed eminence or a single or multiple tubercles, susceptible of growing like the spines of *Dorycrinus*, although to a lesser degree.

This genus, recognizable at first by the small number of pieces of its calyx and the width of its first radials, was established by Miller. (1821, *Crinoidea*, p. 74, pl. 1 and 2) under the name of *Platycrinites*. This author placed it in his section of *Inarticulata* because the plates of the calyx, rather thin themselves, touching only by the thin edge and not by the wide articular facet. He characterized it by its basin (*pelvis*) formed of three pieces and by the absence of costals and intermediaries, because he named scapular pieces (*Scapula*) those that we name first radials and that he considers as giving immediate attachment to the arms. He is thus led to say that, exceptionally here, the scapulars rest on the basin. Miller added that the stalk is not enlarged toward the top, have rays or accessory cirri, and that the fingers (branches of the arms) are formed of a double row of articles. Then he distinguishes his six species of *Platycrinites* because *P. laevis* and *P. rugosus* have an elliptical stalk with a round food canal while *P. pentangularis* has a pentagonal stalk as well as its food canal. As for the other three species, *P. tuberculatus, granulatus* and *striatus*, whose stalk he did not know, t they differ, as the name indicates, because the surface of the plates (scapula) is tubercular, granulr or striated.

Goldfuss, in his great work on the petrifications of Germany, then described or indicated *Pl. depressus* and *Pl. ventricosus*. Then, in 1838, in *Nova Acta nat. cur*. (t. XIX, pl. xxxi and xxxii), *Pl. pileatus, coronatus, hieroglyphicus, tabulatus* and *decagonus*, that, like *Pl. depressus*, do not have an interradial supernumary piece (anal). *Pl. brevis, exsculptus, ornatus* and *anaglypticus* that have a supernumary interradial piece should form the genus *Hexacrinus*.

Phillips, for his part, at the same time, or a little earlier in the *Geology of Yorkshire*, had described *Pl. ellipticus, laciniatus, gigas, elongatus, contractus* (synonym of *Pl. brevis*, Goldf.), and in 1839 (*Palaeozoic. fossil*.), he had described *Pl. interscapularis* and *tuberculatus*. The latter, being different from the species thus named by Miller, has received from D'Orbigny the name of *Pl. phillipsii*.

M'Coy (in *Ann. and Mag. of nat*. — *Synops, Carb. Ireland,* and *Palæoz. foss.*) made known *Pl. punctatus, similis, ornatus, triacontadactylus* and *expansus*, and at the same time *Atocrinus milleri*, all from the Carboniferous terrain of Ireland.

Roemer had also described in 1843 and 1844, *Pl. buchii* and *interscapularis* from the Devonian terrain of Germany and *Pl. rosaceus* from the same terrain that D'Orbigny places in his genus *Amblacrinus*.

Finally, the Austins have added *Pl. trigintadactylus, spinosus*, etc., from the Carboniferous terrain of England, and De Koninck and Lehon, still several others (*Pl. granosus*, etc.,) from the Carboniferous terrain of Belgium. D'Orbigny, in 1852 (*Cours élémentaire de Paléontologie*), already indicated 22 species of them, of which 7 from the Devonian terrain and the rest from the Carboniferous terrain, and still he separated the species that have the articles of the arms in a single row to make *Edwardsocrinus*, to which, it is true, he attributes five basal pieces, and *Amblacrinus*, of which we do not know the arms and to which, with the three basals, he attributes two other series of pieces, namely: five intermediate pieces that are our first radials, and five brachials that are our second radials. As for *Platycrinus*, he attributes to them "a calyx composed of two rows of pieces: three basal pieces and one row of five large brachial pieces. The rest of the visceral sac, formed of testaceous pieces. Arns with two rows of pieces. Stalk elliptical, with transverse articulation." The Austins wanted to preserve the name *Platycrinus* only for the species that have the vault prolonged into a trunk. They wanted to call *Centrocrinus* those that,

without the prolongation in the form of a trunk, have in the center of the vault the opening we have taken for a mouth, and *Pleurocrinus* those, also without a trunk, have this opening lateral.

1. SMOOTH PLATYCRINE. *PLATYCRINUS LAEVIS*. — Miller.

— Parkinson, Org. rem., IL, pl. 17, £. 12. — *Platycrinites laevis*, Miller, CrinoïId., p. 74, pl. 1 et 2. — Schlotheim, Nachtr., II, p. 94, pl. 25, f. 4. — Goldfuss, Petref. Germ., p. 188, pl. 58, f. 22e. — Phillips, Geol. of Yorkshire, II, pl. 204, pl. 3, f. 14, 15. — Bronn, Lethæa geogn., pl. 4, f. 3. — Edwards, in the atlas of the Règne animal, Zooph., pl . 7, f. 3. — de Konince, Descr. foss. Belg., pl. F, f. 1.

Calyx smooth, with rounded base, with the first radials elongated and the two branches of each arm bifurcated, which brings to 20 the total number of branches or apparent arms. Stalk elliptical, having a transverse rib, following the large diameter of each articular surface of the articles that are in addition bristly laterally with pointed tubercles or short spines.

Fossil of the Carboniferous terrain of England (Bolland, Bristol), Ireland (Dublin) and Belgium (Tournay).

2. PLATYCRINE WITH THIRTY FINGERS. *PLATYCRINUS TRIACONTADACTYLUS*. — MCoy.

— M'Coy, Synopsis carb. Ireland, 1844, p. 177, pl. 25, f, 2–7. — D'Orbigny, Cours élém. de Paléont., II, p. 143, f. 291.

Calyx smooth, prolonged above with a very large and very long trunk, whose size is more than doubt that of the ventral part. Arms divided first into two primary branches, subdivided themselves into two secondary branches, but of these, the more internal bifurcates still a third time so that each arm is divided into six branches with pinnules, and that the total number of these branches, which can be called with Miller fingers, is 30. All formed of a double row of articles. Stalk very compressed, with a small round central canal, a zone of radiating striations near the edge and a transverse rib on each articular surface.

Fossil of Carboniferous terrain of Ireland.

3. RUGOSE PLATYCRINE. *PLATYCRINUS RUGOSUS*. — Miller.

Atlas, pl. 2, fig. 1 a.

— Miller, Crinoïd., p. 79, pl. f. 1-24. — Schhlotheim, Nachtr., IE, pl. 25, f. 6, and pl. 26, f. 1. — Goldfuss, Petref. Germ., p. 189, pl. 58, f. 3. — Phillips, Geo. of Yorkshire, II, p. 204, pl. 3, f. 20.— Blainville, Man. d'Actinol., p. 262, pl. 29, f. 4.

Calyx length 49 mm, width 15 mm, sub-cylindrical. Radial plates swollen in the middle and more or less rugose or marked with divergent ridges or nodules. Arms divided into two branches, of which the internal only is bifurcated so that the total number of branches of each arm, or that of the entire calyx to 30. Stalk elliptical, smooth, having articular facets divided by median rib.

Vault formed of thick pieces, not very numerous, each having a conal protrusion or rounded tubercle. Lateral opening without prolonged.

This species, according to the position of the opening (mouth?) should be part of the genus or sub-genus *Pleurocrinus* (πλευρον, side) of the Austins.

Fossil of the Carboniferous terrain of England (county of Wales and Mendip Hills).

4. PLATYCRINE WITH HAT. *PLATYCRINUS PILEATUS*. — Goldfuss.

Atlas, pl. 2, fig. 1 6.

— Goldfuss, in Nov. Acta nat. Cur., t. XIX, p. 343, pl. 31, f. 7.

Calyx flared and covered by a depressed vault that overflows it like a bonnet. Radial plates thick at the top. Each plate of the vault with a round protruding tubercle. Opening of the vault lateral and prolonged.

Fossil of the Carboniferous terrain. It is part, like the preceding of the sub-genus *Pleurocrinus*.

2nd GENUS. **HEXACRINE**. *HEXACRINUS*. — Austin.

(six.)

Calyx formed of three basals and five large radials, between two of which is intercalated a supernumerary piece (anal?), not corresponding to one of the arms and nearly equal to the radials.

This genus differs from *Platycrinus* only by the supernumerary or anal piece that would make one believe in six radials instead of five, from where the name of *Hexacrinus*. It was established by the Austins (*Crinoîidea*, pl. 6) for *Hexacrinus expansus* and *macrolatus* from the Devonian terrain, the was added *Platycrinus interscapularis* of Phillips (*Palæoz. foss*., pl. 14). But Goldfuss had already indicated this difference for some *Platycrinus* having an interradial piece and his *PI. elongatus, brevis, exsculptus, ornatus* and *anaglypticus* (in *Nova act. nat. cur*., t. XIX, p. 345–348, pl. xxx1, fig. 1–5) appear necessary to also refer to this genus.

3rd GENUS. **CULICOCRINE**. *CULICOCRINUS*. — J. Müller.

(χυλιε, χυλιχος, chalice, cup.)

Calyx composed of three basals and five large radials, each with two large blunt tubercles and surmounted with second and third superposed radials. Five interradials ended by a point forming the vault, on the side of which is an opening (mouth?).

Arms formed of a double row of alternating articles.

J. Müller, in 1854 (*Verhand. der nat. Verein für Rheinl*., pl. 6, 8 and 9), established this genus for a single species, *C. nodosus*, from the Devonian terrain of the Rhine.

4th, 5th, 6th, 7th GENERA. *ATOCRINUS, SYMBATHOCRINUS, ADELOCRINUS* AND *DICHOCRINUS*.

All these genera, we have said imperfectly known, appear to differ from *Platycrinus* especially by the more or less multiple fusion of pieces of their calyx. Thus. *Atocrinus* (perhaps for *Atomocrinus*, from ατομος, undivided?) of M'Coy has the calyx of a singlel piece because of the more complete fusion and five articulated radials at the edge of the calyx has five bifurcated or trifucated arms. The single species, *A. milleri* (M'Coy, *Synops. carb. Ireland*, p. 123, pl. 25) from the Carboniferous terrain of Ireland is figured in the new edition of *Lethæa geognostica* of Bronn and Roemer (pl. IV', fig. 12) and in the Atlas of Pictet, pl. CI, fig. 17.

Synbathocrinus (συν, ensemble, indicated by fusion, βαθμις, base) of Phillips (*Geolog. of Yorkshire*, II, p. 206, pl. 4, fig. 12, 13) contains the only species, *S. conicus*, from the Carboniferous terrain of England (Bolland). It is characterized by its calyx, of which all the basals are united into a single piece, while the five first radials are distinct, terminated above on a horizontal line and, as in *Platycrinus*, with two smaller radials from where leave the branches of the arms formed of a single series of articles.

A. delocrinus (äôηλος, uncertain) of Phillips is very uncertain, as its name indicates and is represented only by a single species, *A. hystrix* (p. 30, pl. 16, fig. 42) from the Upper Devonian terrain of England that has, as the preceding, fused into a single piece.

Dichocrinus (διχαω, to divide into two) of the Count of Munster (*Beïtr. zur Petref.* 1, p. 2, pl. 4, fig. 8), has for type *D. radiatus* of this author, also figured by de Koninck (*Deser. foss. Belg*., p. 40, pl. E, fig. 6) and in the Atlas of Pictet (pl. CI, fig. 18) and that is found in the Carboniferous terrain of Belgium. But other species, all of the same terrain of Belgium, at Tournay, have been described more recently, 1854, by de Koninck and Lehon in their *Recherches sur les Crinoides* (p. 146, pl. 4). These are *D. intermedius, irregularis, expansus, granulosus, elegans* and *sculptus*. The Austins (*CrinoId.*, p. 47, pl. 5) have made known also a *D. fusiformis* from the Carboniferous terrain of England. All these species have the base of the calyx divided into two equal pieces on which are supported five rather large first radials between two of which is intercalate a supernumerary (anal?) as in *Hexacrinus.* Each of these large radials has an ascending series of three small radials, forming the beginning of an arm that is immediately divided into two branches. These branches themselves are formed of a single series of pieces, alternatively thicker on one side and the other.

(?) 5th TRIBE. **MARSUPITIANS.**

Free Crinoids, without a stalk, without dorsal cirri, with five arms. Calyx in the form of a purse or a cup, free and without a stalk (at least in the adult state), formed of thin plates that are joined by narrow sutures.

A single centro-dorsal piece, pentagonal, on the sides of which are supported five pentagonal pieces (basals?), surmounted by a second whorl of hexagonal pieces, alternates (parabasals?), above which are also, alternating, five radial pieces with the arms.

Vault appears covered with calcareous pieces.

This fifth tribe that should perhaps better form a separate family, is incontestably nearer the Actinocrinides in general and the Actinocrinians in particular by its thin and alternating plates as Comatulids, whose very thick centro-dorsal pieces, like the pieces of *Pynocrinides*, seem to result themselves from fusion of the basals and first radials.

If, moreover, we make Marsupitians a separate family that we would call Marsupitidae, we would no longer have in all the family of Actinocrinidae only fossils of Paleozoic terrains. Among the Marsupitians, the genus *Marsupites* is formed of three species belonging to the White or Upper Chalk, and the genus *Astylocrinus* is of the Carboniferous period. These two genera constitute all the tribe of Marsupitians.

The absence of a stalk in these two genera can be considered only a purely artificial character and not likely to motivate their union with the Comatulids. Because, on one hand, it is very reasonable that in the young age these Crinoids were stalked, and on the other, if we come to find a fossil that differs from *Marsupites* of *Astylocrinus* only by the insertion of a stalk in the middle of the centro-dorsal piece, it would still be with them that it would be necessary to unite it.

This latter consideration leads us to see in the centro-dorsal piece, the enlarged end of the stalk, as in *Cupressocrinus.* Then the first whorl would be formed of the basals that the hexagonal parabasals separate from the radials that form the third whorl and have the arms.

Two genera along constitute this tribe. One, *Marsupites*, as named by Mantell, but previously described under various other names by Cumberland, Parkinson and Schlotheim, contains three species from the White Chalk terrain. The other, described more recently (*Lethaea geognostica*) by Roemer, is *Astylocrinus* of the Carboniferous terrain. These two genera, that appear to differ essentially only by the arms simply bifurcated of *Astylocrinus* and that we believe to be branched in *Marsupites*, forms also, for Pictet, the tribe of Marsupitians. But this author, according to the sole character of absence of the stalk, places them in his family of Comatulids.

D'Orbigny (*Cours élémen. de Paléont*., I, p. 1438), who knew only the genus *Marsupites* and who accepted only a single species, made them his second family, that of *Marsupitidae* that he places between *Saccosomidae* and *Comatulidae*, as being of the same value and that he characterizes in saying: "These are free Crinoids whose calyx is in the form of a purse, composed of a central lower piece, five basal pieces, five intermediary

pieces and fine thin brachial pieces arranged in a way to contain most of the viscera. Five arms."

F. Roemer made them two families in his *Astylida* with a free calyx. These are his *Astylocrinidae* and his *Marsupitidae*.

1st GENUS. **MARSUPITE**. *MARSUPITES*, — Mantell.

(μαρσυπον, purse, sac.)

Calyx globular or in the form of a purse, formed of thin plates, a ventral pentagonal centro-dorsal, three rows or whorls of alternating plates, of which the dorsal, in a notch of their edge, have imperfectly known arms, but that, according to their remains, we believe were branched and divided at their origin. According to the debris that surrounods the base of these arms, we also believe that a vault, or dorsal part of the calyx, must have had calcareous plates.

This remarkable fossil, found first in the Chalk of England and also later in France, at Dieppe, Meudon, and in Poland, in Volhynie, etc., was named Encrinetortue (*Encrinites tortoise*) by Parkinson. But it was Mantell who gave it the name that we preserve today. And it was Miller who, following his *Histoire des Crinoides*, clearly characterized the genus *Marsupites*, and gave to this species the name *M. ornatus*. We have believed for a along time that all the fossil remains of *Marsupites* came from this single species. But Forbes wanted to distinguish under the name of *M. laevigatus* those whose test is less granular or even smooth (in Dixon, *Geology of Sussex*, pl. 20), and one has also wanted to make a third distinct species, *M. milleri* (Mantell, *Geol. of Sussex*, pl. 16) that appears to us to be purely nominal.

ORNATE MARSUPITE. *MARSUPITES ORNATUS.* — Miller.

— MILLER, Crinoïdea, p. 136 pl. — MANTELL, Geol. of Sussex, pl. 16, f. 10; 14. 19: *Encrinite tortoise*, PARKINSON, Org. rem., I, pl. 13, f. 24.— *Situtaria triangularis*, CUMBERLAND, Reliq. conserv., p. 91, pl. 7, f. 30–32. — *Marsupiles ornatus*, BLAINVILLE, Man. d'Actinol., p. 263, pl. 28, f, 5, — BRONN, Lethæa geogn. pl. 29, fig. 13. — PICTET, Traité de Paléont., IV, p. 291, Pl. 99, 14.

The specific name of this fossil comes from the granules in radiating lines making an ornate surface. These granules appeared to Miller proof of an exterior muscular envelope, but the test here, as in all other Echinoderms, must have been produced within the very thickness of the living tissue and these granules would have been instead points of attachment of some external appendages such as pedicellariae.

Fossil of the White Chalk, but always incomplete. In France, at Dieppe and Meudon; in England in the county of Sussex, at Lewes, Preston, Brighton, Westminster; and in Poland, in Volhynie, etc.

2nd GENUS. **ASTYLOCRINE**. *ASTYLOCRINUS*.—F. Roemer.

(α, indicating a lack, without, στυλος, column.)

Cup-shaped calyx, oblong, formed of a centro-dorsal piece and three alternating whorles of five large plates that are smooth or without granules or striations. The five dorsal plates have in the middle of their edge a second radial on which articulates the two simple branches of each arm. These branches themselves are formed of a single series of articles that have numerous pinnules toward the entire in a double row.

This genus was established by F. Roemer in the new edition of *Lethæa geognostica* of Bronn (I, p. 229, pl. IV', fig. 13) for a single species, *Astylocrinus laevis,* of the Carboniferous terrain of Illinois (United States of America). We were able to see only isolated plates whose surface appears to have been made smooth by abrasion after fossilization.

EIGHTH FAMILY. PYCNOCRINIDES.

(πυχνος, thick).

Crinoid fixed by a stalk and with arms that are bifurcated or branched several times, with a calyx composed of very thick pieces, joined by wide articulated surfaces and leaving in the interior a space insufficient for a visceral mass. Ventral and dorsal walls membranous, not consolidated by calcareous pieces.

The family Pycnocrinidae, thus named appropriately by Pictet, corresponds exactly to the section of articulated Crinoids (*articulata*) of Miller, i. e., it contains the three genera *Apiocrinites, Encrinites* and *Pentacrinites* of this author that, because of the increase in number of species in these genera or around them, have become tribes sub-divided themselves into genera.

Miller distinguished his three genera of Articulata, all having five pieces in the basin (*pelvis*), surmounted by five costal pieces (our first radials). Only the first, *Apiocrinites*, has the stalk enlarged toward the top and fingers (branches of the arms) form by a single row of articles. The second, *Encrinites*, has a round stalk, not enlarged toward the top and the fingers (branches of the arms), formed of a double row of articles. The third, *Pentacrinites*, also has the stalk not swollen toward the top, but this stalk is pentagonal, and its articular facets have the figure of a flower with five petals. Its fingers are formed of a single series of articles.

Such are nearly, also, the characters that serve us to distinguish our three tribes.

D'Orbigny, who had already in 1839 published a very beautiful monograph of Apiocrinians, constituting for him the family of Apiocrinidae, still listed this family in his *Cours élémentaire de Paléontologie*, in 1852, but he broke the homogeneity by including the genus *Eugeniacrinus* and some close genera that should form a separate tribe as we shall see later. At the same time, D'Orbigny made the distinct family of Pentacrinidae, corresponding to our tribe of Pentacrinians. As for *Encrinus*, he incorrectly placed it in his family of Melocrinidae, for the single reason that their arms (branches of the arms) are formed of a double row of articles and, although the pieces of their calyx are very thick, contrary to definition of Melocrinids that are thought to have thin plates.

F. Roemer, in his *Lethaea geognostica*, accepted among his Stylida or Crinoids with a stalk and arms that are strongly developed and a membranous ventral wall, the four families of *Pentacrinids, Apiocrinids, Eugeniacrinids* and *Encrinids*. But, unfortunately, he united also in the same section, the families of *Cyathocrinids* and *Cupressocrinids*.

Pictet, who we follow as much as possible, places in the family of *Pycnocrinides*, with the three tribes that we accept, the tribe of *Eugeniacrinians* that we place, on the contrary, among the *Comatulids*.

Encrinians belong exclusively to the Triassic period, and particularly to the Muschelkalk, in which *Encrinus*, *lys de pierre, ilium lapideum* or *liliiformis*, are especially abundant that they early caught the attention of collectors.

Apiocrinians, as we have said before, are characteristic of Jurassic terrains from the Lower Oolith, although they are still represented by some species in the Cretaceous and first Tertiary terrains.

Pentacrinians are the only ones of all the normal Crinoids that are represented by a living species, in the present period, and they appeared toward the end of the Triassic period and have representatives in all subsequent periods.

We shall thus characterize these three tribes, saying that the ENCRINIANS have the stalk formed of articles that are round, unequal, with radiated articular surfaces. The arms are divided one or several times into two single branches that could take for arms formed of o a double series of article having pinnules on the internal surface and usually coming together to form a pyramid.

The Apiocrinians have a very long stalk, thick toward the base by successive layers as well as the very complicated root stem from which it leaves and thicker again toward the top where it appears to contribute to forming the lower part of the calyx. The articles of the stalk are cylindrical with radiated or elliptical articular facets, with only one transverse side. The calyx is thick, with a very narrow visceral cavity. It has five basals and five ascending rows of radials, of which the last has two simple or ramified branches of each arm.

PENTACRINIANS have a more or less pentagonal stalk, with an impression of a star or a flower with five lobes on each articular facet. Their calyx, formed of five very small basals and five alternating rows of three radials is so small that they seem to form only at the end of the stalk and at the base of the arms. The arms, very long and very ramified, are spread out like a plum.

1st Tribe. **ENCRINIANS.**

Calyx very thick and short, formed of five small basals and five ascending rows of three large radials, of which the five upper ones each has on the two oblique terminal surfaces two similar branches of each arm or ray, with a double row of pinnules on the internal surface. These branches, formed of a double row of articles that have themselves often been taken for arms and they are sometimes bifurcated one or two times that makes 10 or 20 or 40 the total number of arms. Stalk very long, round, formed of swollen articles in the form of a bourrelet, and having all articular facets radiate.

The tribe of Encrinians has for type *Encrinus,* that nearly entirely constitutes it because the few genera that we group around it do not differ from it essentially and could be considered simply as sub-genera or sub-divisions. Perhaps, even, we could even see in the genus *Chelocrinus*, with its arms irregularly sub-divided, an example of teratological development of some *Encrine*, and in the genus *Dadocrinus*, a first stage of normal development of another. The same observation could be applied probably to *G. calathocrinus* of Meyer that is imperfectly known. And finally, a last genus, *Flabellocrinus*, was established by Klipstein on a fragment of a crushed stalk must simply be mentioned.

All the Encrinians belong to the Triassic terrain and particularly to the Muschelkalk.

1st Genus. **Encrine**. *ENCRINUS*.— Miller.

(χρινον, lily.)

Atlas, pl. 4, fig. 1.

Calyx enlarged, short and thick, concave below (at least in the adult stage) because the swelling of the radials made them very convex so that the five basals that have not undergone proportional growth are nearly entirely hidden. Five ascending rows of three very large radials of which the last or dorsal ends above in two wide oblique or beveled facets on which articulate two similar branches of each arm.

Arms short, ordinarily close together to form a kind of pyramid that resembles the *fleur du lys* still in bud. Branches of the arms simple or bifurcated themselves to form a double series of articles and having toward the interior a double row of articulated pinnules and arranged like teeth of a comb.

Stalk very long, cylindrical having here and there a swollen article in the form of a bourrelet. Articular facets radiate.

No accessory rays around the stalk.

This genus was established under the name of *Encrinites* by Miller in 1821. Blainville, on the contrary, wanted to leave the name Encrine, *Encrinus*, to the living species, Encrine head of Medusa, which is a true *Pentacrinus*, and he referred our typical species, *Lys de mer*, to his Pentacrinus under the name of *Pentacrinus entrocha*. D'Orbigny, as we have already said, has placed the genus *Encrinus* in his Melocrinids. He characterized it as: "Calyx enlarged, short, concave, composed of two rows of pieces: five basal pieces,

five brachial pieces receiving five arms formed of double alternating articles. Stalk round, radiate."

The best known species and which serves as type of this genus is *Encrinus liliiformis*, fossil of shell limestone or Muschelkalk. The articles or fragments of the stalk are extremely abundant in the spathic state in this limestone, have formally received the names of *Trochites* and Entroques (*Entrochus*) and the calyxes themselves have excited attention because of some resemblance with the flower, not completely open, of a lily, from whence the name of *Lys de mer, Lys de pierre, Lilium lapideum, Anthophorita*, etc., given to them. We have already said previously how the first methodical naturalists gave the name of *Pentacrinus* to the calyxes of *Encrinus* without their arms that gave them the quinary arrangement of their parts.

The calyx of Encrines necessarily changes form as the radial pieces continue to grow and become more and more convex to the point of nearly entirely hiding the basal pieces. The branches of the arms that have often been designated improperly as arms are formed of a double row of very distinct articles toward the top and resemble a double row of granules, round like pearls, from whence the specific name of *moniliformis*, given to this very species that we cite as type of the genus. But toward their base, these same branches are formed first of simple pieces, then nearly equally thick from one part to another. Then the pieces are alternatively narrower on one side and then narrower and narrower on this side until they no longer reach the opposite side. Then, these pieces more and more shortened on the thin side, mesh like wedges.

The cavity of the calyx, too small to contain all the viscera, cannot grow proportionally to the thickness of the radial pieces of the arms. It is thus necessary that here, as in Actinocrinids, nutrition must occur at least in part, independently of a digestive system. However, it is accepted that in Encrinians, the visceral mass, although relatively smaller, must contain a digestive system, covered in part by a soft and membranous ventral wall. It is also accepted by analogy that the eggs develop at the base of the ventral pinules of the arms and that these pinnules also serve as respiratory organs.

The stalk that is attached to the rocks by a thickening, elongates more and more by the production of new articles that especially occurs near the calyx. There, in fact, the articles swell into a bourrelet that, toward the base, are uniformly separated by seven or eight cylindrical articles. It is, shall we say, these articles are separated by one, two, or three cylindrical articles. When the number becomes considerable, there is often one that is more swollen in the process of becoming in its turn a new article in the form of a bourrelet.

The various species of Encrine, reported first by Miller, Munster, Schlotheim, Meyer, etc., were more completely studied in 1857 by Beyrich in the *Mémoires de l'Académie de Berlin*.

LILY OF THE SEA ENCRINE. *ENCRINUS LILIIFORMIS.* — Lamarck.

Atlas, pl. 4, fig. 1.

— *Lilium lapideum*, Ezuis, Corallines, pl. 37, f. K.— Knorr, Petref., E, pl. 11, f. a. — *Vorticella rotularis*, Esrer, Zooph. vortic., pl. 8. — *Isis entrocha*, Lnx., 1767, and Gmelin, Syst. nat., XIII ed., p. 3794, n° 4. — *Lily encrinite*, Parkinson, Org. rem., Il. — *Encrinus liliiformis*, Lamarck, Anim. sans vert., t. IL, p. 455, et 2e ed., &. II, p. 651. — Schlotheim, Petref., I,

pl. 11 a. — *Encrinites moniliformis*, Miller, Crinoïdea, p. 37 pl. — Goldfuss, Petref. Germ., p. 177, pl. 53, f. 8, et pl. 54. — *Pentacrinus entrocha*, BLainville, Man. d'Actinol., 1834, p. 257, pl. 28, f. 2. — *Encrinite lys de mer* (*Encrinus liliiformis*), M. Edwards, in the Atlas du Règne animal, Zooph., pl. 9. — *Encrinites liliiformis*, Bronn, Lethæa geogn., pl. 11, f. 1 and 11. — *Encrinus entrocha*, D'Orbigny, Cours élém. de Paléont., Il, p. 142, et f. 292, p. 144, and Hist. nat. des Crinoïdes, pl. 18. — *Encrinus liliiformis*, Pictet, Traité de Paléont., IV, p. 357, pl. 102, f. 4. — Beyrich, in Mém. Acad. Berlin, 1857, p. 1–51, pl. 1–2.

This species, we have said, is so abundant in the shell limestone, or Muschelkalk, that its fragments compose nearly entirely the thick banks that are named, in Germany, Trochiten-Kalk, limestone with Entroques.

It is a fossil found in France at (Var) and at Lunéville (Meurthe); in Germany in Wurtemberzg, in the duchies of Saxe-Weimar and Gotha, at Heilbronn, etc. It is also found in the limestone of Saint-Cassian, which is referred to the Upper Triassic stage and where it is accompanied by two other species that the Count of Munster names *Encr. varians* and *Encr. granulosus* (Beitrag. IV, p. 52, pl. 5). Meyer has also indicated *Encrinus aculeatus* (Paléontogr. I, p. 262, pl. 32, f. 1) in the Muschelkalk of Silesia. Some others form the two following genera.

2nd Genus. **Chelocrine.** *CHELOCRINUS*. — H. von Meyer.

This genus, as we have said, should rather be considered as a sub-genus of *Encrines*, and that several authors have not separated, is supposed to b characterized by more multiplied bifurcations of its arms, which have 20 or even more branches that others want to call arms.

H. von Meyer established this genus (in the *Museum Senkenbergianum,* 4837, II, p. 262, pl. 16, f. 8) for two species from the Muschelkalk of Germany. The first was originally described by Bronn under the name of *Encrinus pentactinus.* It is still found figured under this same denomination in the second edition of *Lethæa geognostica* (pl. XIII', fig. 1), but it is named *Chelocrinus pentactinus* by Pictet (*Traité de Paléont*., IV, p. 337, pl. 102, fig. 5). The other was described as an Encrine, *E. schlotheimii*, by Quenstedt (in *Archiv. für naturg.*, 1835, t. II, p. 223, pl. 4, fig. 1). This, of which we know only one specimen and whose hemispherical calyx has arms divided into two unequal branches, one simply bifidid, the other have one of its branches bifid itself, appears to us to represent rather a teratological case than a distinct species. A third species of the same terrain, *E. dubius* (Strombeck, in *Zeitschr. der Dentsch. geol. Gesell*, I, p. 157), is also indicated as belonging to the genus *Chelocrinus*.

3rd Genus. **Dadocrine.** *DADOCRINUS*. — H. von Meyer.

(δαδοω, to make or carry a torch.)

This genus was established by Meyer (in the journal *Géologie* of Leonhard and Bronn) for a small species, *Encrinus gracilis* (De Buch, in *Berl. Monatsbericht*, 1845, p. 27), that is also represented in the new edition of *Lethæa geognostica* of Bronn and Roemer

(pl. XII', fig. 2) and in the Atlas of Pictet (pl. 102, fig. 6). Its calyx, narrower and more uniformely ovoid allow the basal pieces to be seen, which could indicate that it still has not reached its development. Its arms are divided only one time into two branches that makes ten the total number of these branches as in *Encrinus liliiformis*.

Fossil of the Upper Muschelkalk of Silesia.

(?) 4th GENUS. **CALATHOCRINE**. *CALATHOCRINUS*. — H. von Meyer.

(χαλαθος, basket.)

Under this name, Meyer also established (in Leonhard and Bronn, *N. Jahrb*., 1848, p. 467, and in *Palæontographica*, I, p. 265, pl. 32, fig. 2), a genus that appears to us still more doubtful than the preceding. It contains a single species, *C. digitatus*, very small, whose calyx has the form of a basket or the capital of a column with arms curved into the interior as a hook. The plates of the calyx cannot be seen distinctly, and it can well be supposed that here again there is not an adult or completely developed CrinoId.

2nd TRIBE, **APIOCRINIANS**.

Calyx smooth, pyriform or barrel-shaped, prolonged ventrally by the swollen end of the stalk that makes the base and supports it. Five large basals, thick, surmounted by five ascending rows of three to five radials, also thick, whose upper ones end in two articular surfaces that are oblique or beveled, with the two simple or ramified branches of each arm.

Visceral cavity very small, prolonged ventrally into the axis of the last articles of the stalk.

Stalk very long, ordinarily smooth, rounded and without accessory rays, having radiate articular surfaces.

This stalk starts from a very large and very complicated root on the rocks that thickens like the lower part of the stalk by superposed layers and that appears capable of producing new calyxes by gemmation. Other times, the stalk is formed of elliptical articles have, like some merithalles of plants, their large diameter alternating in one direction and in the other and being able to produce accessory rays at each articulation.

This tribe, as we have said above, corresponds to the genus *Apiocrinites* of Miller, who was rightly struck by this exceptional character of the stalk swollen at the top to join the calyx of which it seems to form the base. It is precisely this that gives the calyx of several species the form of a pear (in Greek, απτος), and from which is derived the name of the genus *Apiocrinites* or *Apiocrinus*. D'Orbigny, 1839, in his beautiful *Monographie des Crinoïtes* that, unfortunately, he has left unfinished, established the family of Apiocrinidae, containing with the genus *Apiocrinites* of Miller, the genera *Guettardicrinus, Millericrinus* and *Bourguetticrinus* that he separated very appropriately. Later, in his *Cours élémentaire de Paléontologie* (1852), he added a genus *Conocrinus* that perhaps should not

be separated from. Then, without sufficient reason and contrary to his own definition, he united to his *Apiocrinids*, *Eugeniacrinus* and some adjacent genera that should form a separate tribe and that prevented him from appropriately limiting this family. He says "It is characterized by a complicated root, by a stalk that is without whorls, very long, rounded, by its calyx that is formed of very thick pieces, superposed in series of five and making an ensemble that is solid, cup-shaped and pyriform, whose sunken dorsal part only supports the visceral pouch without containing it." Now, without discussing the obviously false description of the visceral pouch, we can say at least that *Eugeniacrinus* has nearly none of the characters indicated above.

F. Roemer, on the contrary, accepts for these Crinoids two distinct families, Apiocrinidae and Eugeniacrinidae. Pictet also has made two tribes of his family Pycnocrinidae. We have already said that we place these two tribes into two different families. We shall return later them when speaking of the Comatulids.

Miller knew in 1821 only two species of *Apiocrinites.* But this number increases to six in the great work of Goldfuss (*Petref. germ.*) ten or twelve years later. Actually, all these species are not equally authentic. The number of species, either real or nominal, then grows so rapidly that D'Orbigny, in 1850, in his *Prodrome de Paléontologie*, counted 56 of them, of which 44 were *Millericrinus*. These were especially distributed in Oxfordian and Corallian terrrains and one was supposed to contain 23, the other 14 species. But it is evident that these numbers have been singularly exaggerated because, on one hand, many species were established on incomplete specimens or on simple fragments that could come from another more or less adult species. On the other hand, the author, dominated by the thought that each stage he accepted in the succession of terrains should contain only species different from those of other stages found himself led by this to multiply specific distinctions. At the same time also, D'Orbigny, 1850, established in Apiocrinids strictly speaking, his two new genera *Conocrinus* and *Cyclocrinus*, of which the latter at least formed with simple fragments of the stalk, should be considered as very doubtful.

Some years previously, Desor, in his *Notice sur les Crinoîdes suisses* (1845), had expressed doubts on the multiplicity of species of D'Orbigny. He himself indicated some new species and accepted the two genera of *Ceriocrinus* and *Pomatocrinus* proposed before by Koenig for species already known of *Müllericrinus*. If we go back further, we find in the *Dictionnaire des sciences naturelles*, the roots and the base of the calyx of *Apiocrinus rotundus*, described by Defrance under the name of *Astropoda*, because of radiate impressions of the articles of the stalk. Finally, we wanted to unite to Apiocrinians the genus *Balanocrinus* of Agassiz, that, with a calyx in the form of an acorn (βαλανος), with the articular facets of the stalk marked with a star in addition to a marginal crenelation.

All Apiocrinians are fossils, and none appear on the surface of the globe before the Middle Jurassic formation. It is in the Lower Oolith that we see appear for the first time two *Apiocrinus* and one *Millericrinus*. This latter genus continues to increase in number of species in the subsequent stages of the Jurassic terrain, notably, as we have said, in the Oxfordian and Corallian terrains. *Apiocrinus* becomes rather numerous in this latter terrain, as well as the only species known of *Guettardicrinus*. *Balanocrinus* has been found in the Oxfordian terrain. Finally, the genus *Bourguetticrinus* belongs to the Cretaceous period, and the genus *Coxocrinus*, if it is indeed incontestable, is found in the Lower Tertiary terrain.

The different genera of this tribe, all having five basal pieces (except *Conocrinus*), and distinguished by the number of radials. These pieces form three whorls, with numerous interradials, in *Guettardicrinus*; three whorls also, but without interradials, in *Apiocrinus*; and only one row in *Millericrinus* and *Bourguetticrinus*, which differs because the latter alone has articles compressed alternatively in one direction and in the other.

1st GENUS. **GUETTARDICRINE**. *GUETTARDICRINUS*.—D'Orbigny,1839.

(Dedicated to Guettard, naturalist of the 18th century.)

Atlas, pl. 4, fig. 4.

Calyx large, in the form of a cup, supported below by numerous enlarged articles of the stalk, that supports five basals and above five ascending rows of three radials. The lower radials are contiguous and form the second whorl of pieces. The second radials are separated by small interradials with which they form a third whorl. The third radials, finally, are also separated by interradials, end in two articular oblique facets on which are the first brachials, that are contiguous and form a whorl of ten pieces. Above is a similar whorl of second brachials. All these pieces being contiguous and contributing to form the wall of the calyx. Above the second brachials, each of the ten branches of the arms become free and bifurcate again after five other brachial pieces that bring to twenty the total number of branches they are wanted sometimes to be called twenty arms.

Articles of the stalk round, with a radiate articular surface.

This genus, remarkable for its more swollen and more complicate calyx than that of other Apiocrinians, was established in 1839 by D'Orbigny in his *Histoire naturelle des Crinoides* (p.15, pl. 1, fig. 2) for a single species of Corallian limestone of Angoulins (Lower Charente). It is *Guettardicrinus dilatatus* that is also represented in *Lethaea geognostica* of Bronn et Roemer (pl. 16, fig. 16) and in the *Atlas* of Pictet (pl. 102, fig. 7). It is one of the largest known species of Crinoids. The height of the calyx is 48 mm. Its greatest width is 84 mm. The diameter at the place where the the arm becomes free is still 76 mm. D'Orbigny characterized this genus in attributing to it "a cup-shaped calyx composed of numerous enlarged articles of the stalk and six rows of pieces up to the arms: five basal pieces; three series of intermedial pieces, accessory pieces, and two series of ten brachial pieces. At least twenty arms; round stalk, radiate in section." (*Cours élém. de Paléont*., 1, p. 146).

2nd GENUS. **APOCRINE**. *APIOCRINUS*. — Miller.

(απιος, pear.)

Atlas, pl. 4, fig. 2, 3 et 5.

Calyx barrel-shaped or in the form of a pear, supported by pieces that are progressively enlarged and very numerous from the top of the stalk that, leaving from a thick base and becoming first very thin, finishing by enlarging and acquiring the diameters of the calyx itself. Five basals, above which are alternating five ascending rows of three radials each, all contiguous laterally in a way to form as many whorls of five pieces. The last radial is ended by two oblique articular facets supporting the two branches of each arm. These become free immediately, on the contrary to those that occur in *Guettardicrinus* and consequently do not contribute to form by their base the wall of the calyx. These branches are composed of a single series of articles.

The stalk that is round, smooth, with accessory rays, and very long is thick at its base. It leaves from a wide root that is very large and very complicated, spread out on the rocks of the bottom and grows like the stalk itself by superposed layers.

The very numerous articles have radiated articular faces and are crossed by a round canal.

The ten branches of the arms formed of a single series of articles, are single or irregularly bifurcated and ramified.

This genus, established in 1824 by Miller under the name of *Apiocrinites*, is one of the oldest known. Defrance named it *Astropoda*. Parkinson and Cumberland, each in their turn, give it the name of Encrinite in the form of a pair (*Pear encrinite*), and united it in this same genus the species that D'Orbigny (1839) separated to form the genera *Millericrinus* and *Bourguetticrinus*. Miller, as we have previously said, characterized it essentially by the thickness and mode of articulation of the pieces of the calyx, which has a basin (*pelvis*) of five pieces and fingers formed of a single series of articles, and by the mode of swelling of the stalk at the top. He added that, above the basin are five ventral costal pieces, the fist having five scapular pieces. Blainville, in 1834 (*Manuel d'actinol*., p. 258), himself attributed to it "a body that is regular, circular, containing in a kind of cup or conical test, compose of three superposed rows of five scaphoid plates, each united everywhere and whose upper ones have, on the radiated surface, rays that are formed of a single series of non-pinnated articulations? — A round stalk, first as large as the body, decreasing little by little to its root. Circular articulations that are a little raised, pierced by a rounded hole that is radiated at their surface. — Some sparse auxillary rays." It is evident here that Blainville does not have sufficient information. He says himself of having studied this genus only of incomplete specimens coming from La Rochelle, and by the figures and descriptions of Miller. This is why he accepts accessory rays that do not exist in the true *Apiocrinus.* He describes the stalk as decreasing little by little to its root and he supposes rays (branches of the arms) without pinnules.

D'Orbigny (*Cours élément*, p. 146) characterizes it thus: "calyx cup-shaped, composed of numerous enlarged articles enlarged of the stalk and four series of pieces, five basal pieces, two series of intermediary pieces, accessory pieces and five brachial pieces

receiving ten bifurcated arms or none. Stalk rounded, radiated on its articular surface." This author observed (*Hist. nat. des Crinoïides*, 1839, p. 5) that in some species, the number of bifurcations of the arms can vary even in the same individual, and it cannot consequently offer certain characters.

In summary, in *Apiocrinus*, much more than in other genera of the tribe, the stalk at its top has the progressive enlargement that makes it in some way the true base of the calyx to which it gives this form of a pear that is so characteristic, and the stalk that is very long, round, smooth and without accessory rays, gradually thins and is again considerably swollen at the top, which particularly distinguishes these Crinoids from all those of other tribes. The number of radials and the mode of origin of the branches, which are free from their origin or from the first brachials, distinguish *Apiocrinus* from other genera of the same tribe. As for the presence of interradials in some and the bifurcation or ramification of the branches, of arms sometimes single in others, these are only characters of species. Of the six species of *Apiocrinus*, there are two that belong to the Grand Oolith and four to the Corallian terrain.

1. **Parkinson's Apiocrine**. *APIOCRINUS PARKINSONII*.

Atlas, pl. 4, f. 3.

— *Pear encrinite*, Parkinson, Org. rem., I, pl. 16, f. 11–14. — *Pear encrinîte*, Cumberland, Reliq. conserv., pl. 1, f. 6 and 12. — *Encrinus Parkinsonii*, Schlotheim, Petref., p. 332. Nachtr., pl. 24, f. 2 a f. — *Apiocrinites rotundus*, Miller, Crinoïd., p. 18 pl. — Goldfuss, Petref., p. 181, pl. 56, f. R. — *Apiocrinites parkinsonii*, Bronn, Lethæa geogn., pl. 17, f. 15. — *Apiocrinus Parkinsonii*, D'Orbigny, Hist. nat. des Crinoïdes, p. 25, pl. 4, f. 9-16, and pl. 5. — Edwards, Atlas du Règne anim. de Cuvier, Zooph. pl. 10, f. 1. — Pictet, Traité de Paléont., pl. 102, f. 8.

Calyx pyriform in its ensemble, but formed, in its two lower two thirds by the end of the thin stalk that enlarges rather abruptly toward the top to acquire the diameter of the calyx. A very small interradial between the upper radials. Branches of the arms unknown in their ensemble but supposed to be simple according to what is known of their base.

Fossil of the Middle Jurassic terrain (Grand Oolith); in France at Ranville (Calvados), Mamers (Sarthe); in England at Bath.

2. **Elegant Apocrine**. *APIOCRINUS ELEGANS*.

— *Encrinus orthoceratoides*, Schlotheim, Petref., p. 334, and Nachtr., II, p. 91, pl. 24, f. 1 af. — *Astropoda elegans*, Defrance, in Dict. des Sc. nat., 1819, f, XIV, pl. 14, f. 3. — *Apiocriniles elongatus*, Miller. Crinoïd., p. 33. — Goldfuss, Petref. Germ., p. 183, pl. 96, f. 2 a-h. — Blainville, Man. d'Actin., p. 259, pl. 28, f. 3. — D'Orbigny, Hist. nat. des Crinoïdes, p. 29, pl. 5, f. 9–15, and Traité élém. de Paléont., II, p. 146, f. 294.

This species, known only by the calyx without the arms, appears especially different from the preceding because the longer calyx seems to form the upper part of a truncate cone, compressing the basals and the three whorls of radials and that supports another more elongated part in an inverse cone formed of the end of the stalk that swells little by little in a continuous way.

Fossil of the Grand Oolith in France at Ranville (Calvados) and Béfort (Haut-Rhin).

2. **Roissy's Apocrine.** *APIOCRINUS ROISSYANUS.* — D'Orbigny.

Atlas, pl. 4, fig. 2.

— D'Orbigny, Hist. nat. des Crinoïdes, 1839, p. 20, pl. 3–4, and Cours élém. de Paléont., 1892, II, p. 146, f. 295. — Edwards, Atlas of the Règne anim. of Cuvier, Zooph., pl. 10, f. 2. — *Apiocrinus meriani* and *Ap. similis*, Desor, Notice sur les Crinoïdes suisses, 1845.

This beautiful species, of which we give a reduced figure after D'Orbigny, who was able to reconstruct it nearly entirely, reaches a total height of approximately one meter (950 mm). The calyx width, 32 mm and height separately 27 mm, has a total height of 50 mm without the arms, with the enlarged end of the stalk that serves as the base.

The calyx, more rounded and with a greater paunch than the preceding species, is also distinguished by its more numerous interradials. We see first a rather large one intercalated between each of the second radials that form a whorl of ten pieces, then a group of four small ones between each of the dorsal radials. Each branch of the arms is irregularly bifurcated after the sixth or eighth article, and the secondary branches that result can also be irregularly bifurcated. We see, on the figure, that several of these sub-divisions of the arm have been broken during the life of the animal. and has commenced to regenerate. The stalk, toward its base, and the very large root are manifestly formed of superposed layers and appear to have been produced by gemmation of new parts.

Fossil of the Upper Jurassic terrain (Corallian) at Pointe du Ché and Angoulins (Charente-Inférieure), La Chapelle (Jura), Tonnerre and Vauligny (Yonne), Chaleseuil (Doubs), Largue (Haut-Rhin).

4. **Murchison's Apocrine.** *APIOCRINUS MURCHISONIANUS.* — D'Orbigny.

Atlas, pl. 4, fig. 5.

—D'Orbigny, Hist. nat. des Crinoïdes, p. 32, pl. 6. — Pictet, Traité de Paléont., pl. 102, f. 9.

Calyx much smaller than that of the preceding species, nearly hemispherical and supported by a not very pronounced swelling of the stalk. The five basal pieces are proportionally much larger than the radials, and the en branches of the arms bifurcated one time.

Fossil of the Corallian terrain at Pointe du Ché (Charente-inférieure).

D'Orbigny mentions in his *Prodrome de Paléontologie*, 1850, t. II, p. 98 and 29, as found in the same terrain: 1° *Apiocrinus magnificus*, "magnificent species with globular, nearly spherical calyx, having basal pieces as wide as long, the arms bifurcated two times and the stalk smooth. — Found at Jarne, near La Rochelle."

2º *Apiocrinus insignis*, "species near *A. murchisonianus* and *magnificus*, but whose calyx is depressed in its ensemble and whose basal pieces are denticulated on the edges, which does not exist in the other species. The stalk is smooth and the roots are in groups.— Found at Estré, near La Rochelle."

5°*Apiocrinus rathieri*, "species near *A. murchisonianus*, but whose calyx is narrower, more pyriform, with several intermediary pieces. — Found at Tonnerre (Yonne) by Rathier."

M'Coy (Ann. and Mag. of nat. Hist., 1848, 2 ser., II, p. 406) also indicated another species, *A. exutus*, from the Grand Oolith of England.

3rd GENUS. **MILLERICRINE**. *MILLERICRINUS*. — D'Orbigny.

(Dedicated to Miller, author of History of Crinoïdes, 1821.)

Calyx short, supported by a not very pronounced swelling of the stalk, five basal pieces and five first radials only contribute to form the wall of the calyx. The second and third radials remain free and constitute the base of the arms that are simple or immediately bifurcated.

The middle and upper radials never joined by intermediaries.

Stalk round or pentagonal, having radiated articulated facets.

This genus, established by D'Orbigny, contained at first several species of *Apiocrinus* of Goldfuss, *A. obconicus* Miller and *mespiliformis*, then the number of real or nominal species established by D'Orbigny himself. This author characterized it in 1852 (*Cours élémentaire*, II, p. 147): "Calyx cup-like, composed of a few enlarged articles of the stalk and two rows of pieces: five basals and five brachial pieces. Five bifurcated or not arms, formed of single articles. Stalk round or pentagonal, radiated on its articular facet."

The main difference we see between this definition and that we have accepted comes from the manner of considering the articles following the whorls they form. Thus, D'Orbigny considers them, according to the rays that produce the arms. We understand that the second and third radials that are not counted by D'Orbigny as making part of the calyx because they form the base completely free of the arms. From this way of counting, *Apiocrinus* has four and *Guettardicrinus* six whorls. It also follows that for *Millericrinus*, we cannot in any case count more than five arms, while in the preceding genera, if we take for arms only the branches free at their origin or attached to the calyx by their first articles, this number would be ten or twenty.

This genus was previously divided by Koenig (*Icones fossilium sectiles*) into two others according to the form of the calyx: *Ceriocrinus*, whose calyx is wide with a flat base and vertical sides and *Pomatocrinus*, whose calyx if globular. The distinction, based only on the exterior base and not on the number of pieces and the mode of articulation of the arms

was accepted by Desor (*Crinoides suisses*, 1845) who preserved in addition the genus Millericrinus for species that also had two rings or two whorls of pieces of the calyx, nearer in form to *Apiocrinus parkinsonii*. But, like D'Orbigny and Pictet, we leave all these species in a single genus because of the difficulty of appreciating the differences that age gives to the exterior form of the calyx.

The genus *Millericrinus* is represented by a single species (*M. prattii*) in the Grand Oolith. Its species are then very numerous in the Lower and Upper Oxfordian terrains and in the Corallian terrain, although less numerous than the catalogs of fossils would make us believe. Then this genus disappears completely from the Paleontological fauna.

1. **PRATT'S MILLERCRINE.** *MILLERICRINUS PRATTII*. — D'Orbigny.

— D'Orbigny., Hist. nat. des Crinoïdes, p. 80, pl. 14, f. 23–28 (under the name of *M. obconicus*). — *Apiocrinus prattii* (Gray, 1828, in Morris Catal. Brit. foss., 2e éd. p. 72).— *Apiocrinus obconicus*, Goldfuss, Petref. Germ., p. 187, pl. 97, f. 5.

Fossil of the Grand Oolith of England at Lansdown, near Bath.

2. **MILLER'S MILLÉRICRINE**. *MILLERICRINUS MILLERI*. — D'Orbigny.

— *Encrinus putus*, Schlotheim Petrefact., p. 339, and *Encrinus milleri*, Schlot., Nachtr., II, p. 89, pl. 23, f. 2 a-f. — *Apiocrinites milleri,* Goldf., p. 185, pl. 97, f. 2. — *Ceriocrinus* (Koenig, Icon. foss. sect., and Desor, Crinoïdes suisses, p. 9). — *Millericrinus milleri*, Bronn and Roemer, Lethæa geognostica, pl. XV', f. 17.

Calyx discoidal, broadly pentagonal, supported by a slightly thickened top of the stalk. Desor affirms that this species, which alone is thought to constitute the genus *Ceriocrinus*, has for a stalk that which D'Orbigny has described under the name *Millericrinus alternatus* and *M. richardianus*, one from the Kellovian or Lower Oxfordian stage, the other from the Upper Oxfordian, as the species type.

It is found as a fossil in France at Mont Brégille (Doubs), Champlitte (Haute-Saône); in Germany (Wurtemberg); in Switzerland, etc.

3. **ROSE MILLERICRINE**. *MILLERICRINUS ROSACEUS*. — D'Orbigny.

Apiocrinus rosaceus, Schlotheim, Nachtr., Il, p. 90, pl. 23, fig. 4. — Goldfuss, Petref. Germ., p. 183, pl. 53, f. 3 c-d. — *Millericrinus rosaceus*, D'Orbigny, Hist. nat. des Crinoïdes, p. 81, pl. 15, f. 1,2.

Calyx bell-shaped, flared form, supported by the slightly swollen top of the stalk. Goldfuss, under the same name, has confused another species, *M. munsterianus*, whose calyx is more elongated.

Fossil of the Oxfordian terrain of Switzerland, from Wurtemberg and Alsace.

4. **NODOT'S MILLERICRINE**. *MILLERICRINUS NODOTIANUS*. — D'Orbigny.

— Hist. nat. des Crinoïdes, p. 59, pl. 12, f. 1-9, and Cours élém. de Paléont., Il, p. 147, f. 296.

Calyx very short and flared, formed of very swollen pieces. Radials larger than the basals.

Fossil of the Oxfordian terrain at Darois (Côte-d'Or), Champlitte (Haute-Saône) and Besançon; and in Switzerland (Basil).

5. **SPINY MILLÉRICRINE** *MILLERICRINUS ACULEATUS*. — D'Orbigny.

— Hist. nat. des Crincides, p. 89, pl. 16, f. 7–9. — Pictet, Traité de Paléont., pl. 102, f. 11.

This is one of the species of D'Orbigny to which must be united many other nominal species established only according to fragments of the stalk. Such would be, according to Desor (Crinoïdes suisses, p. 11), *M. echinatus, tuberculatus, richardianus* and *subechinatus*.

Fossil of the Oxfordian terrain in France at Besançon (Doubs), Neuvizi (Ardennes), Villers (Calvados), Gy (Haute Saône); in Switzerland and in Germany (Wurtemberg).

6. **SLENDER MILLERICRINE**. *MILLERICRINUS GRACILIS*.— D'Orbigny.

— Hist. nat. des Crinoïdes, p. 44, pl. 10.— Pictet, Traité de Paléont,, pl. 102, f. 10.

Fossil of the Corallian terrain of La Rochelle. The other species, nominal for the most part, attributed to the same terrain by D'Orbigny, are his *M. simplex* (Hist. a. Crinoïd. p. 39, pl, 12) from Pointe du Ché (Charente-Inférieure). — *M, polydactylus* (ibId. p. 44, pl. 9, fig. 1-8), from Pointe du Ché and Angoulins. — *M. fleuriausianus* (ibId. p. 46, pl. 8, fig. 1–4), from Pointe du Ché. — *M. crassus* (ibId. p. 48, pl. 8, fig. 5–7), from Pointe des Minimes, from near La Rochelle. — *M. elegans* (ibId. p. 49, pl. 8, fig. 8–11), at Angoulins. — *M. cupuliformis* (ibId. p. 51, pl. 8, fig. 12–15), from the same place. — *M. obtusus* (ibId. p. 79, pl. 14, fig. 9–11), Pointe du Ché. — *M. inflatus* (ibId. p. 76, pl. 14, fig. 12–14), from the same place, — *M. brevis* (ibId. p. 77, pl. 14, fig. 15–17), from the same place. — *M. angulatus* (ibId. p. 79, pl. 14, fig. 18–21), from the same place. — *M. goupilianus* (ibId. p. 85, pl. 15, fig. 14–15), from Ecomoy (Sarthe). — *A. radisensis*, represented only by stalks whose articles are smooth, thicker than those of other species and slightly convex outside, from Ecomoy and Ile de Ré. — *M. inaequalis*, represented by stalks rther similar to those of *M. dudressierianus*, but whose articls are narrower, more swollen and often spiny, with rays much smaller, from Pointe du Ché and Angoulins.

In addition, species of the Oxfordian terrain that we have reported above, D'Orbigny indicated again in the same terrain, his *M. conicus* (ibId. p. 52, pl: 9, fig. 8–9) from Champlitte (Haute-Saône), Lons le Saulnier, Poligny and Salins (Jura). — *M. alternatus* (ibId. p. 56, pl. 11, fig. 9–16), from Champlitte (Haute Saône) amd Neuvizi (Ardennes). —

M. duboisianus (ibId. p. 61, pl. 12, fig. 10–16). — *M. dilalatus* (ibId. p. 65, pl. 19, fig. 17–18), from Champlitte and Montbregille (Doubs). — 731. Beaumontianus (ibId. p. 64, pl. 12, fig. 19–23), or *Apiocrinus beaumontii*, Woltz, from Neuvizi, Chaleseuil near Besançon, Champlitte, Béfort (Haut Rhin), Villers (Calvados), and Switzerland. It is small and easy to recognize, says Desor, with its bell-shaped calyx and pentagonal stalk.— *M. mespiliformi*s (ibId. p. 66, pl. 12, fig. 1–11), which is a *Apiocrinus* of Goldfuss and a *Pomatocrinus* of Koenig and Desor, characterized by its globular calyx. It is a fossil of Wurtemberg and Switzerland. — *M. buchianus* (ibid, pl. 71, pl. 29, fig. 23–25), from Germany (Muggendorf). —— *M. goldfussii* (ibId. p. 72, pl. 14, fig. 1–4), from Mont Bregille (Doubs) and Switzerland. It is larger than *M. becumontianus* and is distinguished by its more elongated arms and its round stalk with regular articles. — *M. scalaris* (ibId. p. 74, pl. 44, fig. 58) from Mont Bregille. — *A. dudressieri* (ibId. p. 82, pl. 15, fig. 3–9) from the same place. — *M. calcar* (ibId. p. 84, pl. 15, fig. 16–19) from Besançon and Villers (Calvados). — *M. ornatus* (ibId. p. 87, pl. 45, fig. 29–52), from Neuvizi and Villers. — *M. regularis* (ibId. p. 88, pl. 46, fig. 4–6), from the same places. — *M. horridus* and *M. convexus*fromo the same places. The latter being represented by fragments of stalks with smooth articles but very convex and thus separated from each other by a groove.

Finally, D'Orbigny also indicated in the Lower Oxfordian that he named Callovian, in the departments of Orne, Sarthe, Côte d'Or and Haute Saône, five species, *M. richardianus, archiacianus, retiformis, bachelieri* and *pulchellus*.

4th GENUS. **BOURGUETTICRINE.** *BOURGUETTICRINUS.* — D'Orbigny.

(Dedicated to Bourguet, naturalist of the XVIIIth century.)

Calyx pyriform, composed of five basals and five first radials above which two other radials form the free base of the arms, from which the bifurcation begins at the third radial. The calyx is addition is supported by the notably enlarged end of the stalk. The stalk itself is distinguished from that of other Crinoids because it is elliptical, not radiated, compressed alternatiavely in one direction and in the other, with a protruding rib following the large diameter of each articular face. It is the end of this rib that sometimes leaves an accessory ray.

This genus, established by D'Orbigny in 1839, has for type *Apiocrinites elipticus* described by Miller in 1821 from Upper Cretaceous terrain of White Chalk and contains in addition three species of the same terrain and two others from the Lower Tertiary terrains, of which one, *B. thorenti*, formed for D'Orbigny a particular genus, *Conocrinus,* of which we shall speak later. This author assigned to his two species of *Bourguetticrinus* "a pyriform calyx, not concave, composed of the same pieces as in *Millericrinus,* a stalk that is compressed, elliptical, not radiate, with a transverse linear impression."

ELLIPTICAL BOURGUETTICRINE. *BOURGUETTICRINUS ELLIPTICUS*. — D'Orbigny

.

Atlas, pl. 2, fig. 5.

— *Bottle encrinite*, Parkinson, Organ. rem., II, p. 231, pl. 13, f. 75–76, and *Strait encrinite* (a young individual), ibId. f. 34, 35, and *Strag horn encrinite* (base of this Crinoid), ibid., f. 31, 38, 39, — *Encrinites ellipticus*, Schlotheim, Nach., p. 93, pl. 25, f. 4. — *Apiocrinites ellipticus*, Miller, Crinoïd., p. 33 pl. — Goldfuss, Petref. Germ., p. 186, pl. 57, f. 32, — *Bourguetticrinus ellipticus*, D'Orbigny, Hist, nat. des Crinoïdes, pl. 17, f. 1–9. — Bronn, Lethæa geogn., pl. 29, f. 12. — Pictet, Traité de Paléont., pl. 102, f. 12.

Calyx pyriform, smooth, appearing continuous with the top of the stalk that is swollen becoming cylindrical little by little and nearly club-shaped.

Fossil of the White Chalk, in France at Meudon, Sens, Fécamp, Dieppe and Tours; in England; in Westphalia and Maëstricht.

The other incompletely known species of the same terrain are:

B. aequalis, D'Orbigny, Hist. nat. d. Crinoïd. pl. 17, fig. 10–12; from Maëstricht.

B. cylindricus and *B. milleri*, M'Coy, Ann. and Mag. of nat. Hist, 1848, 2nd ser. II, p. 404; from England (Norwich).

The species of the Tertiary period are: *B. thorenti*, D'Archiac (Mém. Soc. Géol. 2e sér. II, pl. 5), which is the genus *Conocrinus* of D'Orbigny and *B. jondinensis*, Forbes (Tert. Echinod., in Palæont Soc. p. 56) from the clay of London.

D'Orbigny having seen in a recent bone breach in Guadeloupe some fragments of the stalk of a Crinoid with a non-radiate articular surface, had believed he could conclude they came from a still living species that he named *Bourguetticrinus hotessieri*.

(?) 5th GENUS. **CONOCRINE**. *CONOCRINUS*. — D'Orbigny.

This genus, still doubtful, was established by D'Orbigny (1850) in his *Prodrome de Paléontologie*, I, p. 333, on a very small Crinoid calyx, length about 10 and width 3 mm, coming from the Nummulitic terrain of Biarritz, and that he considered as formed simply of five radial pieces, lacking basals. Bronn and Roemer described it under the same name of *Conocrinus thorenti* in the last edition of *Lethæa geognostica* (pl. XXXVI', fig. 1). But D'Archiac who, first in 1846, described it under the name of *Bourguetticrinus thorenti* (*Mém. soc. géol*., 2° série, IL p. 200, pl. 6), claimed that it had distinct basals that would make it a true *Bourguetticrinus* because its stalk is also compressed.

6th GENUS. **BALANOCRINE**. *BALANOCRINUS*.— Agassiz.

(βαλανος, acorn.)

Agassiz gave this name to a calyx in the form of an acorn that he saw in the Museum of Basel and that, with the general form of calyxes of Apiocrinians, has this very remarkable peculiarity that the base has an articular surface completely similar to those of the stalks described by Goldfuss (*Petref. Germ*., pl. 53, fig 5.) under the name of *Pentacrinus subteres*, and that D'Orbigny named *Pentacrinus cylindricus* because Hofer, in 1768 (*Act. Helv*. IV, p. 193, pl. 4, fig. 30, 31) had described them under the name of *Trochites cylindricus*. Desor (*Crinoîdes suisses*, p. 12), while declaring that he had no certainty regarding this, thought that the stalks, named *Pentacrinus pentagonalis* by Goldfuss (*Petref. Germ.*, pl. 53, fig. 2, de), could belong to the same species and, at the same time, to the calyx named *Balanocrinus subteres* by Agassiz. All are from the Oxfordian terrain of France, Switzerland, Bavaria, etc. All their articular facets, in addition to the characteristic star of *Pentacrinus*, have their contour crenelated.

3rd TRIBE. **PENTACRINIANS**.

Calyx very small, thick, short, composed of a small number of articles surrounding the stalk that is always of equal thickness, more of less pentagonal, with articular facets marked with a star with five branches or a rose with five petals. The stalk has in addition numerous accessory whorls.

This tribe corresponds to the genus *Pentacrinites* of Miller and contains in addition the genus *Isocrinus* of Meyer and perhaps the genera *Extracrinus* of Austin and *Polycerus* of Fischer, if we accept them. It is the family of Pentacrinidae of D'Orbigny, who defined it by saying that: "near Apiocrinidae by its thick calyx that is distinguished by this small, rudimentary calyx, by the pentagonal stalk with whorls of ramules here and there, by the articular surface of the star ked stalk, by the calyx not formed by articles of the stalk and not supporting any part of the visceral sac, and finally, by its very long, very developed arms."

Roemer also made them a distinct family, characterized by its widely spread-out arms and not brought together in a pyramid as in *Apiocrinidae* and *Encrinidae*.

This tribe is especially remarkable by its great extension in the geological series from the Triassic terrains to the present time where it is still a living representative.

1st GENUS. **PENTACRINE**. *PENTACRINUS*.

(πεντε, five; πεντας¸by five, quinare.)

Calyx composed of five very small basals crowning the corners of the last article of the stalk and the first five large wedge-shaped radiales or in the form of an inverted pyramid attached to the sides of the stalk.

The first radials each have a second and third radial in the form of a horseshoe. The two oblique facets that end the latter have the two main branches of each arm. They bifurcate regularly one or several times. Then each of the definitive branches formed of a single row of articles and with a double row of pinnules emits a row of branches also with pinnules.

Stalk more or less pentagonal, with smooth or convex article, or granular or keeled depending on the species, always having on the articular surfaces an impression of a star or rose and having accessory rays that are rounded or prismatic, sparse or whorled, with more or less regularity.

This genus, established by Miller under the name of *Pentacrinites*, was placed by him in the section of Articulata because of the thickness of the pieces of the calyx and the broad articular surfaces and characterized by is stalk that was not enlarged at the top, pentagonal, with articular facets ornamented with a star or rose, and by fingers (branches of the arms) formed of a single series of articles. Miller already counted five species, of which the living species, *P. caputmedusæ*, had been studied by Guettard in 1755. *P. subangularis*, named previously by Schlotheim, *P. fasciculosus, P. basaltiformis* and *briareus,* all from the Lias terrain, had been previously described under various names by Parkinson and other, older authors. His fifth species, *P. fuberculatus*, is from the Lower Lias. He distinguished them because *P. caputmedusæ, basaltiformis* and *tuberculatus* have accessory rays, round, in single series, along the stalk that is tubercular in the last only and smooth in the first two that differ because one generally has its articles alternatively large and narrower, while the other has them uniformly equal.

P. subangularis alone has its auxillary rays round and in a double series the length of the stalk that is smooth, and *P. briareus* alone has its accessory rays angular or prismatic in single series along the stalk that is smooth. At the same time also, Miller added to characterize his genus *Pentacrinites*, that the cup-shaped body has a pelvis of five pieces, alternating with the first five costal pieces that themselves are surmounted by five secondary costal pieces. Above these, finally, are the five scapulary pieces with five hands or binary rays, sub-divided into fingers.

Numerous species of *Pentacrinus* were then subsequently described by Schlotheim, Goldfuss, the Count of Munster, Roemer, Desor, Leymerie, Micheloti, etc. D'Orbigny, for his part, added 13 or 14, and in his *Prodrome de Paléontologie* (1850), listed 37 fossil species, of which most, actually, are established only by fragments of the stalk.

D'Orbigny, in his *Cours élémentaire de Paléontologie* (1852, II, p. 149), thus characterized this genus: "Calyx composed of two rows of pieces; five small basal pieces; five large brachial pieces."

As we have aready said, the name *Pentacrinus* had been applied first to some calyxes of *Encrinus* lacking their arms and the name *pierres étoilées* had been given to the fragments of the stalk that are so abundant in some beds of the Lias.

We have also said that Blainville had given the name Encrine to *Pentacrinus caputmedusae* and that he placed the fossil Pentacrines with the true Encrines, in his genus *Pentacrinus*, of which the characteristic, according to this, must be incorrect. As for his genus, *Encrinus*, containing the only living species of which he had a specimen to observe, it attributed to a "cup in the form of a radial funnel, composed of a single centro-dorsal plate that is penta-lobed (this is the last article of the stalk), articulating with the five double

and dichotomized rays, with three articles that are simple and perfectly free at their base. A stalk composed of a large number of pentagonal articles that are pierced by a round hole at the center, with a radiate articular surface, with sparse whorls of accessory rays." It seems evident that it is because of an error in the manuscript that the articles of the stalk are said to have a radiate articular surface.

Austin has wanted to separate, in order to make a distinct genus under the name of *Extracrinus*, the species whose radial pieces are unequal, two smaller and three more elevated, representing in some way a higher series. It is on an even less important character, the multiplicity of the division of the arms, that Fisher has wanted to base another genus, *Polycerus*, that we do not accept.

The oldest Pentacrines are found in the limestones of Saint Cassian, which is supposed to belong to the upper beds of the Triassic. The most abundant remains and the most beautiful specimens come from 10 to 14 species found in the Lias. We then find some in all the stages of the Jurassic formation, notably in the Oxfordian terrain which has six. Then the Lower, Middle and Upper Cretaceous terrains each contain one, two or three special species. Finally, also, the Lower and Middle Tertiary terrains have also their particular species. As, moreover, we find today, although rarely, a living species at great depths of the Sea of the Antilles, it is thus permitted to assume that the genus *Pentacrinus* has not ceased to have representatives in the seas covering the surface of the globe since the last Triassic terrains.

1. MEDUSA'S HEAD PENTACRINE. *PENTACRINUS CAPUT MEDUSÆ*. — Miller.

— *Isis asterias*, Linné, Gmelin, Syst. nat., 13th edit., Verm., p. 3794, n° 5. — *Palmier marin*, Guettarad, 1751, in Mém. Acad. des Sciences, 1755, p. 224, pl. 8, 9 and 10. — *Encrinus, capite stellato, ramoso dichotomo, stipites pentagono equisetiforme*, Ellis, 1761, in Philos. Transact., 1764, pl. 13, f. 4. — *Palma animal*, Parra, Descript. hist. nat. pl. 70, p. 191, — *Pentacrinites caput-medusæ*, Miller, Crinoidea, pl. 41 pl. — Schlotheim, Nachtr., II, p. 104, pl. 29, f. 2. — *Encrinus caput-medusæ*, Lamarck, Hist. des anim. sans vertèb. 2 edit, t. I, p. 651.— Blainville, Manuel d'Actinol., p. 254. — *Pentacrinus caput medusa*, Edwards, in Atlas of the Règne anim. de Cuvier, Zooph., pl. 6, f. 2. — J. Müller in Mém. Acad. de Berlin, 1840, and, by extract, in Archiv für Naturgeschichte, 1840, p. 307.

Calyx very small. Stalk length 50 to 60 centimeters, 5 to 7 mm., pentagonal, with rounded corners, with whorls of five accessory rays, round, inserted in the middle of the side of the articles.

This Pentacrine, the only living species today, has been fished several times at great depths in the Sea of the Antilles. It was first described under the name of *Palmier marin* by Guettard, had been fished in the vicinity of Martinique. It made part of the collection of Boisjourdain, from where it passed to that of Joubert, then to that of the Muséum d'histoire naturelle de Paris where it is still with one or two other specimens. The second specimen, described by Ellis and preserved in the Hunterian Museum of Glasgow, cam from Barbados. That described by Miller came from island of Nevis and is found today in the British Museum as well as another specimen from Barbados. The Geological Society of London possesses one from Guadeloupe and Michelin, at Paris, has one of the same

provenance, preserved in alcohol. The Danish possessions in the Antilles also have furnished several, of which one is preserved in the museum of Copenhagen and another, very well preserved in alcohol served for the beautiful work of J. Müller in 1846.

Most of the old specimens were preserved dry in the museum and can scarcely give an idea of the organization of these Crinoids. Even Lamarck, who had seen both *Palmier marin* of Guettard and the Comatulids of the collection of the Museum, saw no relation between them, and placed the Pentacrine among the Polyps under the name of *Encrine tête de Méduse.*

Although the true relation of these animals has since been seen and indicated, notably by Miller in his Histoire des Crinoïdes, it was J. Müller who, by his study of *Pentacrinus caput-medusæ*, preserved in alcohol has shown the complete analogy of this Crinoid with Comatulids. In fact, the microscopic structure is shown here exactly as in other Echinoderms. All its parts grow by their surface and not by the development of smaller parts because the mesh of the calcareous network of this tissue is everywhere the same. The new articles are produced either by gemmation at the end of a series or by interpolation. The first case occurs at the end of the arms, the pinnules and accessory rays. The latter case occurs in the stalk, of which the dorsal end is distinguished by a smaller number of articles in each internode or between each whorl. Consequently, we frequently see in these shorter internodes, a very thin article in the process of formation, between two thick articles, while at the base of the stalk, all the articles are equal. This interpolation continues until the normal number for the articles between two internodes has been reached. But in the same manner, it can produce a new whorled article and a new whorl. All the other articles thus produced have their corners more pronounced and their sides often hollowed out by a groove, like the articles adjacent to the top. But toward the base of the stalk, growth of the tissue continues at the surface, the articles are more and more rounded, becoming a little wider.

J. Müller was able to recognize also that the membranous wall of the dorsal or ventral surface secreted, as in the Comatulids, reticulated calcareous plates that were thin, and that the digestive system had the same structure. He also saw, in the ambulacral gutter of the walls, a double system of vessels similar to that of Comatulids.

2. BRIAREUS' PENTACRINE, *PENTACRINUS BRIAREUS*. — Miller.

Atlas, pl. 5, fig. 1 (after Goldfuss).

— Parkinson, Organ. rem., II, pl. 7, f. 15–18, and pl. 18, f. 1–3. — *Encrinus bollensis*, Schlotheim, 1813, Min. Tasch. 7, p. 56, and Petref. p. 328, and Nachtrag., 11, p. 105, pl. 30, f. 1. — *Pentacrinites briareus*, Miller, Crinoïd., 56, pl. 1, f. 1–2.— Goldfuss, Petref. Germ,, p. 168, pl. 51, f. 3 a-m, and f. 8, — Blainville, Manuel d'Actinol., p.257. — Edwards, Atlas of the Règne anim. of Cuvier, Zooph., pl. 7, f. 1. — *Pentacrinus bollensis*, D'Orbigny.

Stalk pentagonal, with sharp corners, formed of smooth articles, alternatively smaller. Stars of the articular facets having lanceolate and narrow branches and very fine

and shortened marginal striations. Accessory rays of the stalk are angular or prismatic and forming a simple series.

This species is the type of the genus *Extracrinus* of Austin.

Fossil from the Upper Lias (Toracian stage of D'Orbigny) in France at Anduze (Gard), Langres (Haute Marne), Mende (Lozère), from Jura; Baveria, Bayreuth; from Wurtemberg, Boll; England, at Lyme Regis, etc.

3. FASCICULOSUS PENTACRINE. *PENTACRINUS FASCICULOSUS*. — SCHLOTHEIM.

— Schlotheim, 1813, Miner. Taschenb. 7, p. 56, and Nachtrag. I, p. 166, pl. 30, f. 2. — Parkinson, Organ. rem., pl. 13, f. 48, 51 and 60. — *Pentacrinites subangularis*, Miller, Crinoidea, p. 59 pl. — Goldfuss, Petref. Germ., p. 171, pl. 52, f. 1 a. — Bronn, Lethæa geogn., pl. 17, f. 9 and 12. — *Pentacrinus fasciculosus*, D'Orbigny, Traité élém. de Paléont., II, p. 148, f. 297. — Pictet, Traité de Paléont., pl. 102, f. 13.

Stalk slightly angular, formed of smooth articles, alternatively smaller. Stars of articular facets having wider, obovate branches. Accessory rays of the stalk round, forming a double series.

Fossil of the Middle Lias, in France at Pouilly (Côte d'Or), Vieux Pont (Calvados); in Baveria; Wurtermberg, at Amberg and Bull; in England, at Pyrton Passage and Lyme Regis, etc.

4. BASALTIFORMIS PENTACRINE. *PENTACRINUS BASALTIFORMIS*. — Miller.

— Parkinson, Organ. rem., II, pl. 13, f. 54.— Schlotheim, Nachtr., II, p. 106, pi. 30, f. 3. — Miller, Crinoïd., p. 62, pl. 2, f. 2-6. — Goldfuss, Petref. Germ., p. 172, pl. 52, f. 2 a, 7. — Bronn, Lethaea geogn., pl. 17, f. 11. — *Pentacrinus scriptus*, Roemer, Die Verstein. d. Nordd., pl, 12, f. 12.

Stalk pentagonal, with sharp angles, smooth or granular, with equal articles. Stars of the articular facets having their branches obovate, with larger marginal lines, separated, and longer lateral lines that are a little arced.

Fossil of the Lias of France, at Mende (Lozère), Lyon, Salins (Jura); in Bavaria; Wurtemberg; England.

5. COMMON PENTACRINE *PENTACRINUS VULGARIS*. — SCHLOTHEIM.

— Schlotheim, 1820, Petref., I, p. 327, pl. 1, f. 6. — Parkinson, Organ,. rem., II, pl. 13, f. 57, 64, 66, and pl. 17, f. 6, 8. — *Pentacrinus scalaris*, Goldfuss, Petref. Germ., p. 173, pl. 52, f. 3, and pl. 60, f. 10.

Stalk bluntly pentagonal or keeled or smooth or granular with 4 nearly equal articles. Stars of the articular facets with lanceolate branches with large and straight marginal lines.

Fossil of the Lias in France, at Croisille, Fontaine Etoupefour (Calvados), Saint Maixent (Deux Sèvres), Tuchan (Aude), Asnières (Sarthe), Culture (Lozère), Near Crépiat (Ain); in Bavaria, at Amberg; Wurtemberg at Boll.

6. MONOLIFEROUS PENTACRINE. *PENTACRINUS MONILIFERUS*. — Munster.

— Goldfuss, I, p. 173, pl. 53, f. 3.

Stalk bluntly pentagonal with equal articles surrounded by a ring of granules. Stars of the articular facets wedge-shaped, obovate, with marginal lines that are rare, large, continuous and transverse, and those of the end divergent.

Fossil of the Lias. In France, in the surroundings of Digne (Basses Alpes); in Bavaria, at Bayreuth.

The last five species belong exclusively to the Middle or Upper Lias terrain, with *P. laevis* (Miller, Crinoïd, p. 115), *P. subsulcatus* Goldfuss, *P. dichotomus* of M'Coy, *P. liasinus* and *P. oceani* of D'Orbigny, one slenderer and more uniformly smooth than *P. pentagonalis* of the Oxfordian terrain. It is necessary to add, for the Lower Lias, *P. tuberculatus* (Miller, Crinoïd. p. 64, pl. fig. 1–2) that is found in France at Lyon, Metz, Chaudon (Basses Alpes), Salins (Jura) and England.

The species of the limestone of Saint Cassian, dependant of the last Triassic terrains are: *P. subcrenatus* (Münster, Beitr. 1841, IV, p. 49, pl. 4, fig. 6), *P. propinquus* (ibId. fig. 9), *P. braunii* (ibId. p. 50, fig. 8), *P. laevigatus* (ibId. fig. 7).

D'Orbigny attributes to the Lower Oolith two unpublished species:

1° *P. bajocensis*, from Bayeux, Port in Bessin (Calvados), Draguignan, Nantua and Niort, whose articles are very narrow and with, every two, a tubercle on the corners and in the groove sedparating them.

2° *P. inornatus*, from Draguignan and Guéret (Creuse), entirely smooth, with a round stalk.

The same author also indicates in the Grand Oolith two unpublished species:

1° *P. buvignieri*, from Montmédy (Meuse), Ranville, Luc and Langrune (Calvados) and the vicinity of Grasse (Var).

2º *P. nodotianus*, that appears to differ from *P. briareus* by its whorls that are not compressed.

The Oxfordian stage is thought to contain six or seven species: *P. cingulatus* and *subsulcatus* from Münster, described by Goldfuss (*Petref. Germ.*, pl. 55, f. 1 and 4), at the same time as *P. subleres* and *pentagonalis* of the latter author that we have already mentioned as possibly belonging to the genus *Balanocrinus*, then two unpublished species of D'Orbigny, *P. marcousanus* and *granulosus*, and finally, a *P. cylindricus*, indicated as

very rare by Desor (*Crinoïdes suisses*, p. 12) and that is distinguished from all others by its articles as long as wide.

P. alternans and *goldfussii*, Roemer (*Die Verstein. d. Nordd*., p. 18, pl. 47, f. 37 and 58) belong special to the Corallian terrain, one in France, near La Rochelle and Salins (Jura), and in Germany, at Hildesheim and the other only in Germany at Hoheneggelsen,

The Lower Cretaceus or Neocomian terrain contains *P. neocomiensis,* Desor (*Crinoïdes suisses*, p. 14), stalk very near that of *P. basaltiformis*, but smaller and strongly grooved, found in France, at Censeau (Jura) and Switzerland at Neufchâtel. Two other species, *P. annulatus* Roemer and *alternatus D'Orbigny*, are also indicated in the same terrain in Germany. Leymerie (1842, *Mém. Soc. géol*., pl. 14, f. 4) has described, under the name of *P. cretaceus*, stalks found in the gault at La Goguette (Aube) and at Grandpré (Ardennes).

The Tufeau Chalk has furnished *P. cenomanensis* D'Orbigny. Stalks formed of keeled and large articles on the sides. At Mans. — *P. sublaevigatus* D'Orbigny. With smooth stalks. From Hävre.

The White Chalk contains *P. carinatus* (Roemer , 1840, *Nordd. Kreiïd*., p. 26, pl. 6, f. 1), also named *P. scalaris* by D'Archiac (1857, *Mém. Soc. géol*., 2, p. 179), but very different from the species also named this by Goldfuss and belonging to the Lias. These are found at Cognac (Charente), Royan (Charente Inférieure), Périgueux, Tours; in England (Sussex) and in Germany (Hanover). The same terrain contains three other species of Roemer, *P. buchii* (ibId., p. 27, pl. 6, f. 2), from Rügen and Hanover, *P. lanceolatus* (ibId., f. 3) and *P. nodulosus* (ibId., f, 4). These two latter, which seem to be related are found in France at Tours and in Germany.

The Tertiary terrains, finally, have also furnished some remains, among which are cited *P. didactylus* from the Nummulitic terrain of Biarritz and Vicentin (D'Archiac, *Mém. Soc. géol*., 1846, t. II, pl. 5, f. 16–18); *P. oakeshottianus* (Forbes, Tert. Echin., in *Palaeont. Soc*., p. 35), *P. sowerbyi* (Wetherell, *Trans. Geol. Soc*., V, pl. 8, f, 4) and *P. subbasaltiformis* Miller from the clay of London; ?. *alpinus* D'Orbigny from the coarse limestone of Hautes Alpes at Fandon and *P. gastaldii* (Michelotti, *Descr. foss. mioc. Ital.* sept. p. 59, pl. 16, f. 2) from the Falunian terrain of Turin.

2nd GENUS. **ISOCRINE**. *ISOCRINUS*. — H. von Meyer.

(ισος, equal.)

This genus, which appears to differ from *Pentacrinus* only by the absence of brachial pieces also has a very small calyx, scarcely wider than the stalk whose articular facets also have the same star impressions. Its arms are divided at their base into two branches, bifurcated three times and have in addition a whorl of five accessory branches inside the arms.

It was established in 1837 by de Meyer (*Museum Senkenb*., I, p. 251, pl. 16, fig. 1–4) for a fossil of the Corallian terrain of Besancon, *Isocrinus pendulus*, that is also represented by Bronn and Roemer (*Lethaea geogn*., pl. 17', fig. 4) and by Pictet (*Traité de Paléont.,* pl. 102, fig. 14). Since then, in 1845, Desor (*Crinoides suisses*, p. 5) has indicated

a second species, *Isocrinus andreae*, from the Lower Oolith, has a calyx width of only 4.5 and very long arms. It also appears to have a round stalk.

NINTH FAMILY. COMATULIDAE.

Calyx stalked, sessile or free, formed below by a single and very thick centro-dorsal piece coming from the fusion of the basal and first radial pieces, having above a soft membranous integument. Five, rarely four arms, divided at their base into two branches, often bifurcated themselves one or several times.

This family contains the two families of Comatulids and Saccosomids of D'Orbigny, of which we make two tribes and in addition the genera *Eugeniacrinus, Tetracrinus* and *Hemicrinus*, that he inappropriately places in his family of Apiocrinids and which we make, like Pictet, a tribe of Eugeniacrinians. But while this latter author places the tribe of Eugeniacrinians at the head of his family of Pycnocrinidae and places, on the contrary, Marsupitians in his family of Comatulids for the sole reason that their calyx is free, I have believed it necessary to take into consideration the structure of the centro-dorsal plate, and see only a secondary character in the absence of a stalk in several of these Crinoids. In fact, in a same tribe, Eugeniacrinians, we have stalked species and others sessile or attached and the true Comatulids, free as adults, that had been stalked during the second stage of their development. They have, moreover, accessory rays or dorsal cirri that the Marsupitians lack.

Roemer made three distinct families of our three tribes and places them also into two different sections according to the presence or absence of a stalk.

Our three tribes are sufficiently characterized. The first, that of Eugeniacrinians, by its adherent or stalked calyx, never free. The two others, of which the calyx is free in the adult state, is distinguished because the Comatulians have cirri or dorsal rays which the latter, the Saccosomians, lack. It is also accepted that these do not have the ambulacral canal like the preceding, which brings it closer to the Ophiuroids that compose the following order.

The first and third tribes are exclusively fossil. The second, still widely represented in the living state, is fossil in the Jurassic terrain.

1st TRIBE. **EUGENIACRINIANS**.

Calyx sessile or stalked, short, formed for the most part by a centro-dorsal representing both the basals and he first radials, and on which the four or five arms must have articulated, but that are not preserved in the fossil state.

This tribe corresponds to the genus *Eugeniacrinites* of Miller, that forms alone, for this naturalist, the section of Coadunata, i. e., Crinoids of which all the pieces are fused together or ankylosed. Later, a second genus was added, *Tetracrinus*, established by the

Count of Münster, for Crinoids that differ only by having four articular facets of the arms. The same author added also a third genus, *Plicatocrinus*, and D'Orbigny a fourth genus, *Hemicrinus*, both quite doubtful. Finally, Steenstrop made known the curious genus *Cyathidium*, which gives us a second example of a Crinoid sessile or adherent by its dorsal surface like *A. gelacrinus* among the Cystidae.

All the Eugeniacrinians are fossils of secondary terrains. The first three belong to Oxfordian and Coralian terrains. The fourth, rather doubtful, as I have said, is indicated as coming from the Neocomian terrain. The latter is from the Upper Chalk.

1st GENUS. **EUGENIACRINE**. *EUGENIACRINUS*. — Miller.

(*Eugenia*, one of the botanical names of the clove or bud of a clove.)

Calyx small, short, thick, represented by a single centro-dorsal piece, having on its contour five double facets for the arms that are unknown. It is placed horizontally or obliquely at the swollen end of a stalk that is not very elongated the has the complicated root spread out on the rocks.

This genus, established in 1821 by Miller under the name of *Eugeniacrinites*, given this name for some resemblance of the species type. *E. quinquangularis* Miller, with the bud of the clove. This same reason was made by Knorr for *Caryophyllite*, and *Encrinites caryophyllite* by Schlotheïm, because the clove, named *Eugenia caryophyllata* by Thunberg, had been named also and even more generally *Caryophyllus.*

Several other species of the same genus and also coming from the Oxfordian terrain have been described by Goldfuss and Münster, or simply indicated by D'Orbigny. This latter author characterized thus the genus *Eugeniacrinus*: "Calyx small, not very concave, composed of a series of brachial pieces, stalked impressed on its articular surface."

The stalk, cylindrical and crossed by a round canal, is composed of a large number of annular rings.

All the species belong, as I have said, to the Oxfordian terrain.

1. CARYOPHYLLE EUGENIACRINE, *EUGENIACRINUS CARYOPHYLLATUS*. — Goldfuss.

Atlas, pl. 2, f. 4.

CARYOPHYLLITE, Knorr, Recueil des monum. des catastr. du globe, pl. 26, f. 20. — Clave encrinite, Parkinson, Organ. rem., II, pl. 13, f. 20. — *Encrinites caryophyllites*, Schlotheim, Petref., p. 332, and Nachtr., IL, p. 19, pl. 28, f. 5. — *Eugeniacrinites quinquangularis*, Miller, Crinoïd., p. 111 pl. — *Eugeniacrinites caryophyllatus*, Goldfuss, Petref. Germ., p. 163, p!. 50, f. 3 a. — Edwards, in Atlas du Règne anim. de Cuvier, Zooph. pl. 8, f. 6. — — Bronn, Lethaea geogn., pl. 17, f. 8.

Calyx straight, concave above, flat below. Stalk smooth, with articular facets punctuated at the edge.

This fossil, width 5 and length approximately 15 to 17 mm, is found in the Oxfordian terrain in France at Niort and Saint Maixent (Deux Sèvres) and near Mende (Lozère); in Bavaria at Bayreuth; Wurtemberg; Switzerland at Zurich, Randen and Schaffouse; and in England.

2. INCLINED EUGENIACRINE. *EUGENIACRINUS NUTANS*. — Goldfuss.

— *Encrinites caryophyllites*, Schlotheim, Nachtr., II, p. 102, pl. 28, f. 6b h. — *Eugeniacrinites nutans*, Goldfuss, Petref. Germ., p. 164, pl. 50, f. 4. — Edwards, Atlas du Règne anim. de Cuvier, Zooph., pl. 8, f. 6. — Pictet, Traité de Paiéont., pl. 102, f. 1.

This species differs especially from the preceding by its calyx inserted obliquely on the stalk, or inclined. The calyx, or rather the centro-dorsal piece, is pentagonal, excavated above and below. The stalk, smooth, with its articular facets radiate at the edge.

Fossil of the same terrain, in Bavaria and Switzerland.

3. COMPRESSED EUGENIACRINE. *EUGENIACRINUS COMPRESSUS*. — Goldfuss.

— Goldfuss, Petref. Germ., p. 164, pl. 50, f. 5.

Calyx inclined, excavated above and below, stalk a little compressed, smooth or rough, with radiate articular facets.

Fossil of the same terrain in Bavaria, Wurtemberg and Switzerland.

The other species, all of the Oxfordian terrain are: 1° *Eugeniacrinus pyriformis* (Goldfuss, Z. c., f. 6 a-c), have the calyx pyriform and excavated at the top. Fossil of Switzerland and Vérone.

2º *E. moniliformis* De Münster (Goldfuss, Z. c., pl. 60, f. 8), known only by its nodular or moniform stalk, with the articular faces radiate at the edge. Fossil of Bavaria and Switzerland.

3° *E. hoferi* De Münster (Goldfuss, Z. c., pl. 60, f. 9), also have the stalk moniliform, but with the articular facets marked with five or six nodules toward the center. Fossil of Bavaria and Switzerland.

And the following five species, indicated only by D'Orbigny:

E. angulatus, with pentagonal calyx, of which each suture forms a protruding corer. Fossil of Ile Delle (Vendée).

E. impressus, of which the calyx has a groove impressed on the sutures. Fossil of the same place.

E. crenulatus, which is distinguished from all the others by the large protrusion of the interior star of the calyx. Fossil of Chaudon (Basses Alpes).

E. alpinus, which differs by its cup-shaped calyx with a great depression on the external sutures. Fossil of the same place.

E. granulatus, which is distinguished from the preceding by its granular surface and without external grooves. Fossil of the same place.

Other species indicated from insufficient remains as belonging to other older or more recent terrains, are not true *Eugeniacrinus.* Such are *E. annularis* Roemer from the Lower Oolith that is a *Cyclocrinus* of D'Orbigny; *E. essensis Roemer* from the Tufeau Chalk that D'Orbigny made his genus *Lesocrinus* (Prodr. de Paléont., t. II, p. 180); *E. hausmanni* Roemer from the Lias; *E. sessiles* Münster from the Devonian terrain, etc. Some also have been referred to other genera, like *E. costatus* of Hisinger that has become *Calliocrenus* of D'Orbigny and *E. mespiliformis* of Goldfuss that has become *Apiocrenus* of Steininger.

2nd GENUS. **TETRACRINE.** *TETRACRINUS.* — Munster.

(τετρας, by four.)

This genus, I have said, differs from the preceding only by its radial pieces that number four and not five, which could be teratological fact.

It was established by the Count of Münster (*Beitr. zur Petref.*, 1, p. 99, pl. 11, fig. 3 and 4) for a single species, *T. moniliformis*, fossil of the same Oxfordian terrain of Bavaria at Streitberg and that is also figured in the *Traité de Paléontologie* of Pictet (pl. 102, fig. 2) and in the Lethæa geognostica of Bronn and Roemer (pl. XVI, fig. 15).

3rd GENUS. **PLICATOCRINE**. *PLICATOCRINUS*. — Munster.

This genus was established by the same author (*Beïtr. zur Petref*., 1, p. 89, pl. 11, fig. 5) for a fossil of the same terrain and on which a similar observation could be made. *P. hexagonus*, which is also figured by Pictet (pl. 102, fig. 3) and in Lethæa (pl. XV', fig. 48). A second species, *P. pentagonus*, is also indicated by the Count of Münster.

4th GENUS. **HEMICRINE**. *HEMICRINUS*. — D'Orbigny.

This genus, still more doubtful than the two preceding, is simply indicated by D'Orbigny as having "calyx enlarged, not complete, formed by three brachial pieces, the two other dependent of the enlarged part of the same stalk." It is, says the author, a *Eugeniacrinus* in which two pieces of the calyx are dependent on the stalk. The only species indicated, *H. astierianus*, comes from the Neocomian terrain of Lattes (Var). It has the "top or spoon supported by a stalk of which a part forms two pieces of the calyx."

5th GENUS. **CYATHIDIE**, *CYATHIDIUM*. — Steenstrup.

(χυαθος, cut)

Calyx attached by its dorsal surface to foreign bodies, consequently of very variable form, a single piece with five grooves going from the center to the edge and has very obviously the articular facets of the arms. Steenstrup established this genus in 1846 *(Bericht über d. deutsh Naturf. Versam. in Kiel*) for a fossil of the Cretaceous terrain of Faxoë and Seeland (Denmark), width of approximately 13 millimeters and one or two times as long. Most often it is fixed on thick shells of Gryphyids or on Polyps. Frequently young individuals are fixed as buds on the large. It is some kind of *Eugeniacrinus* without a stalk.

2ns TRIBE. **COMATULIANS**.

Calyx stalked in the young age but soon becoming free and then having on its dorsal or lower surface multi-articulated dorsal cirri or accessory arms by means of which it attaches to marine plants.

Centro-dorsal piece sometimes very thick, pentagonal and having on its contour articular facets of five free radials that have the arms that are bifurcated one or several times and that make, either alone or with small interradial pieces the centro-dorsal piece the cavity of the calyx.

Branches of the arms composed of pieces alternatively thick on one side and then the other, the thick side having a multi-articulated pinnule having here and there, in addition, syzygies, I. e, double or multiplying articles.

Upper or ventral surface covered with a soft integument, toward the middle of which is the mouth to which open the ambulacral gutters of the five arms, formed by the joining of those of the branches and the pinnules. Anus at the end of a fleshy tube, contractile, located in the interval of two of the ambulacral gutters.

Eggs produced under the ventral membrane of the pinnules.

This tribe contains both the genus Comatula of Lamarck and the genera that were separated from it and some fossil genera, the *Solanocrinus* and *Glenotremites* of Goldfuss, *Hertha* of Hagenow and *Ganymeda* of Gray, in which are recognized the pieces of the centro-dorsal plates of some Comatulians. The Count of Munster first proposed a genus *Comaturella* for a small fossil species. Then Agassiz (1836) separated more clearly the genera *Comaster, Pterocoma* and *Saccosoma,* the first also to see in the Glenotremites and Ganymeda a centro-dorsal piece of Comatula. D'Orbigny made, among the Crinoids, a distinct family of Comatulidae, containing the Comatulids of Lamarck, under the name of *Decameros*, previously given by Linck, the *Comaster* of Agassiz, under the name of *Comatula*, adding several *Solanocrinus* of Goldfuss, *Pterocoma* and a genus *Comatulina* for another *Solanocrinus* that he misunderstood. At the same time, he made a family separate from the Saccosoridae for the only genus *Saccosoma*.

J. Müller, in 1841, in making a special study of the Comatulids that he named *Alecto*, established the genus *Actinometra*, and later (1843), in continuing this work, specified better the characters of the genus *Comaster*, showing that *Comatula multiradiata* of Goldfuss, which is the type of this genus, differs greatly from the species thus named by Lamarck.

Pictet formed a tribe of Comatulians ini his family of Comatulids, and, like D'Orbigny, preferred the names of *Comatula* and *Decameros* to those that we accepted according to Agassiz, by including *Solanocrinus* in the first of these genera.

The genera *Comatula, Actinometra* and *Comaster* are still found living in various seas from the polar regions to the equator. We can refer to these same genera, fossils from the lithographic limestone from the Oxfordian or Corallian stages, and even from the Cretaceous terrain for the first. It is also in the same Jurassic terrain that have been found the fossils that were made into the genera *Solanocrinus, Glenotremites, Comaturella* and *Pterocoma.*

1st GENUS. **COMATULA**. *COMATULA*. — Lamarck.

Atlas, pl. 1.

(Coma, hair.)

Calyx formed by a single centro-dorsal piece on which articulate without intermediaries the five radials of the base of the arms that can make the visceral cavity.

Arms bifurcated above the 2° or 3° free radial and sometimes have on each branch one or several other successive bifurcations separated by 2 or 3 articles. This makes us believe that the number of arms is ordinarily ten and can perhaps be much greater in some species.

The genus Comatula is, of all the Crionoids, the most studied and it is particularly *Comatula mediterranea* that has been observed because this species is very widespread in the seas that border the coasts of Europe. Linck, in 1733 (*De stellis marinis*), in making a section of the sea stars under the name of *Decameros* that has been used very recently. Leach (1814) (*Zoological miscellany*), in England, gave it the name *Alecto*, and, near the same time, Freminville, in France, names it *Antedon.* But Lamarck, in his *Histoire des animaux sans vertèbres*, in 1816, having used the name *Comatula*, his authority has prevailed for a long time and it is only quite recently that we see the names of Linck and Leach preferred by D'Orbigny and J. Müller. However, as I have said above, some other genera have been formed with some species, living and fossil. These are *Comaster, Comaturella, Pterocoma*, of which I shall speak later.

Lamarck still separated Encrines or Crinoids from the Comatulids that he placed alone among the Echinoderms. But already, in 1817, in his *Régne animal*, Cuvier brought together these two groups of radial animals after Asteroids. Then Miller, in 1821, in his *Natural History of Crinoids*, definitively united Comatulids with other Crinoids. Meckel, in 1823 and 1826, in his *Archives d'anatomie*, had published important observations on the openings of the alimentary canal of Comatulids. Thompson, in 1827, having seen young still fixed by their stalk or peduncle, believed to have before him a true *Pentacrinus* that he described under the name of *P. europaeus,* and whose true nature he recognized in 1837. We ourselves, in 1835 (the *Institut*, p. 268), published part of our observaions, notably the very remarkable development of the eggs in the pinnules of he arms. J. Müller, finally, first in his memoir on *Pentacrinus caputmedusae*, in 1839, and later in his special memoirs, has increased considerably our knowledge about Comatulids.

The skeleton, or the calcareous part, has the same basic structure as in all other Echinoderms. It is a kind of network with rounded very small meshes fill be an organized living substance that functions incessantly to grow and that forms a living fleshy covering. This skeleton is composed essentially of a more or less thick centro-dorsal piece (pl. 1, fig. 7), sometimes even having a height much greater than the width, having on its contour five

wide articular facets for the free radials that are the base of the arms and that contribute to surrounding the visceral cavity. The five arms thus begin by two or three free radials, of which the last has exteriorly a double articular face and can, following J. Müller, be named auxiliary pieces in relation to the two branches that articulate on the two facets and are sometimes single, which could come from attributing ten arms to these animals, from where the name of *Decameros* and *Decacnemos*, or which are bifurcated one or two times after two or three simple articles that seem to bring the number of arms to 20 or 40. Each of these branches is formed of article with radiate articular facets (pl. 1, f. 8), alternatively their on one side and having on the same side a small multi-articulated branch that we name a pinnule.

Among the articles of the arms, there are some that J. Müller names *syzygies* and that, much thicker, have sutures that are still imperfect and are evidently commencing to multiply. These *syzygies*, to which Müller attaches a great importance for the distinction of species, have appeared to me, on the contrary, variable in number and distribution on the various branches of the arms, especially when one of these branches, probably broken and regenerating often occurs often. Thus, we see, on the same individual, syzygies separated by 4, 5, 6, 7, 8 and even 9 ordinary articles.

On all the dorsal surface, or its contour only, are seen dorsal cirri or accessory rays, articulated on as many small round facets and formed themselves of numerous nearly cylindrical articles, except the last that is a hook.

All the pieces of the skeleton are moved by muscles with smooth fibers and that are especially seen on the dorsal surface of the arms.

The visceral cavity contains only the digestive sac that has nearly the form of a bagpipe, with the mouth ordinarily at the center and the anus at the end of a contractile tube (pl. 1, fig. 3). Below this sac is a glandular mass that is the liver and the heart from which leave the vessels of the arms. The integument is soft, brightly and diversely colored more or less deep brown and red with whitish patches and, in its thickness are secreted thin irregularly reticulated and lacunar plates (pl. 1, fig. 6).

The branches of the arms and their sub-divisions, the pinnules, are edged with a double membranous festoon (pl. 1, fig. 9 et 11) completing, by rising, the ambulacral gutters that leave from each pinnule to go to the mouth in uniting with those of the secondary or primary branches. These ambulacral gutters, having exteriorly on each side a double row of fleshy, bristling with tentacles (pl. 1, fig. 9 and 10) of four rows of small cylindrical papillae. In the middle, between these double rows of tentacles is the ambulacral gutter strictly speaking, covered with cilia on all its surface and on the small soft floating strips that are seen especially on the ventral disc, there where the ambulacra reach the mouth (pl. 1, fig. 4). On this same ventral disk, the ambulacra are lined on each side by a row of deep red granules (pl. 1, fig. 3) that extend more or less the length of the arms. These red granules, seen with the microscope, are composed of a cellular utricle from which are seen

leaving at maturity an internal membranous sac filled with a very colored fluid (pl. 1, fig. 4). Thus is seen here a certain similarity with the double membrane of a grain of pollen.

Under the ciliary membrane of the ambulacral gutters of the arms are, according to J. Müller, two superposed vessels as in *Pentacrinus* and between the two a nerve cord that should go to a ring surrounding the mouth. One of the two is afferent, the other efferent. The first is supposed to give to this sac the functions of the heart lodged below the stomach sac and the glandular mass into which this same heart sends a perpendicular vessel.

Respiration takes place by contact of the living tissue with the exterior liquid and especially by the cilia of the ambulacral gutters that produce in the liquid a continuous current directed from the periphery to the center, or from the pinnules toward the mouth. This current suffices to take to the mouth the floating organic bodies of algae and microscopic animals. Also, we see from time to time, the anal tube swells by the arrival of the residue of digestion and that abruptly contracts to expel it. This residue, in the form of a brownish pulp, contains spicules of sponges, Bacillarians, etc.

The movements of Comatulids are habitually slow and have as a goal to attach their dorsal cirri to marine plants or to contract and extend the arms to look for new places the can furnish food. But sometimes, for the same goal, the Comatulid abandons the fucus to which is was attached and floats in the water, actively agitating its arms to look for a new station.

The eggs of Comatulids were first seen by me (*Institut*, 1835, p. 268) in the pinnules of the arms. Then by Miller and various observers. The vesicle and the germinal spot before maturity have been seen but artificial fertilization as in other Echinoderms has not been successful. W. Busch, in 1849 (*Müller's Archiv*, 1849, p. 400 and p. 439), having gone to the Orkney Islands during the month of July, was able to observe spawning the early development of the embryo of Comoatules that are very abundant. According to this observer, the eggs are already fertilized when they leave the pinnules and their opacity only allows recognition first of their exterior envelope separating little by little from the yolk that becomes oblong and covered with extremely fine cilia. Soon these eggs leave the mucous that surrounds them, like the fry of frogs, and that attaches them to the pinnules. They fall to the bottom of the vessel and show the oblong embryo, a little thicker at one end and thinner at the other, turning on its axis by means of cilia in the interior of its envelop that touches only at the two ends. A short time after the egg has left the pinnule, a very large tuft of cilia appears at the anterior end, a short distance back, on the surface that ordinarily turns below, a more ciliated place that is perhaps the mouth ?, then on the two sides of the body, three swellings equally spaced between which the animal appears a little narrower. The next day, transverse zones, clearer, are seen surrounding the body on the swellings and with larger bundles of cilia. The sixth day, a fourth ring of cilia forms behind the third (pl. 4, fig. 12). The skin begins to show a particular structure. A new clear patch or round cavity, then oblong, forms behind the mouth, cutting the ciliated zone in two. At this instant, the lateral swellings are recognized only by the bundles of cilia of the

corresponding zone and animalcule, which has some similarity to the embryo of holothurians, is deep yellow, 0.225 mm long, about a quarter of a millimeter, is visible to the naked eye. A little later, a network of calcareous appearance is seen in the integument and the ciliated zones around the latter form constrictions at the place of swellings that we first observed. The young larvae have not been preserved alive longer. But W. Busch has observed two animalcules that have appeared to him to incontestably represent two stages of later development. One has only the anterior ciliated zone and crawls by means of small feet or tentacles on the ventral surface around the large opening. On the other animalcule, according to the author, the latter ciliated zone has also disappeared. But the posterior part where the constriction has become more pronounced appears claws like those that, in Comatulids, end each of the arms, and two other similar claws joined at the anterior end. The same author finally believes to have found another stage of development of the Comatulid in an animalcule of the same place in the form of a star with five arms, or Asteroid, having at the end of each arm two claws between which he already saw the beginning of the division that should extend toward the center and produce an animal with ten arms. However, the author, in supposing that his last animal should change into the *Pentacrinus europaeus* of Thompson, which he was not able to observe himself, admits that he cannot explain how this form of a regular star comes from the preceding oblong larva.

As for us, it seems that this small star, no more than the oblong animalcule with claws (Kralle), is not necessarily the intermediary between the worm-like larva leaving the egg and *Pentacrinus europaeus*, especially as we have observed and drew at Toulon in May 1835 (pl. 1, fig. 15) a small zoophyte fixed by an articulated column and with a calyx of several pieces with some tentacles similar to those of Comatulids and that appeared to us more probable to be a *Pentacrinus europaeus* at the beginning of its stationary life. This stationary phase (pl. 1, fig. 15) was observed by Thompson in 1827 on the coasts of Ireland as I have said and was for him *Pentacrinus europaeus* that was later the genus *Phytocrinus* of Blainville. At this stage, the width of the Comatulid is scarcely 3 to 5 mm and seeing on the same support of other younger Comatulids (pl. 1, fig. 14), it was easily for Thompson to recognie that he had before him an embryonic form, especially as this naturalist had been the first to observe the metamorphosis of decapod Crustaceans. Then, finally, in seeing young Comatulids abandon their stalk and become free after having acquired doral cirri, Thompson could announce, in1837, that his *Pentacrinus europaeus* is only the first stage of *Comatula mediterranea*. We know today more than 27 living Comatulids, excluding species that are *Actinometra* or *Comaster*. They are found, as I have said, from the polar seas to the equator. There are three or four in the seas of Europe. As for the true fossil Comatulids, we can cite only the fossil found in the Chalk of Rugen, described by Hagenow (Leonhard and Bronn, *Neues Jahrbuch*, 1840, p. 665, pl. 9, fig. 8) under the name of *Hertha mystica* and figured in *Lethaea geognostica* of Bronn and Roemer (pl. XXIX', fig. 1) and in the *Traité de Paléontologie* of Pictet (pl. 99, fig. 3), It is in fact a centro-dorsal piece of

ComatulId. D'Orbigny also indicates two species of the Upper Neocomian at Gurgy (Yonne). These are *Decameros ricordeanus*, that he says is a "magnificent species whose calyx is depressed, granular below, with two rows of branches" and *Decameros denressus*, that is thought to have three rows of branches and a narrower ventral surface.

J. Müller has shown that the spermatozoa are lodged in male individuals at the base of the pinnules like the eggs in females. The same author also reports the complete absence of the madrepore plate and its dependencies in Comatulids that we find on the contrary in most other Echinoderms.

Delle Chiaje has taken for a madrepore plate a very singular parasite that Leuckart has made the genus *Myzostome* in 1838 (*Froriep. Notiz*. p. 49, 50, and *Isis*, p.613, pl. 1, fig. 9–10), and that Loven has studied, living, with more details (*Ann. des sc. nat*. 1842, t. XVIII, p. 291). As Thompson, the first, had seen there a parasite that he named *Epizoon* of Comatulids, J. Müller in 1841 (*Arch. f. Nat*., p. 147) was led to propose the name *Cyclocirra thompsonii* but the name *Myzostoma* has prevailed. Its body is circular, depressed, convex above and diversely colored has in front a trunk on its ventral surface that communicates with a branched intestine and on the sides ten fleshy feet that are short and with three hooks.

As I usually follow J. Müller for the description of species, it is appropriate to repeat what this author names *syzygies*, double articles composed of two parts separated by a suture but not mobile, one on the other and whose upper part is called *epizygal*. In his last work, Müller separates the Comatulids into two sections, one with ten arms (secondaries), the other with more than ten arms. Each section is divided into two: 1° species having a syzygy at the 1st and 2nd article of the arms and having their first pinnule on the epizygal of the epizygal of the first syzygy. 2° species that have a syzygy on the 3rd article of the arms and the first pinnule on the 2nd article. The second section is also sub-divided into two: 3rd species whose auxiliaries have a syzygy and that have 20 to 40 arms; 4th species whose auxiliaries are without syzygies. I believe it is preferable to first list the species of the seas of Europe and for those whose number of arms surpasses 10, to rank then according to the greater number.

*** Species with arms bifurcated a single time, or with ten branches.**

1. MEDITERRANEAN COMATULA. *COMATULA MEDITERRANEA*. — LAMARCK.

Atlas, pl. 1.

— *Stella* (*Decameros*) *rosacea*, Linck, De Stellis mar., p. 55, pl. 37, fig. 66.— Encycl. méthod., pl. 124, fig. 6. — *Asterias bifida*, Pennant, Brit. zool., p.63, n° 70. — *Alecto europaea*, Leach, Zool. miscellany. — *Comatula mediterranea*, Lamarck, Anim. sans vertèb., 2e ed., III, p. 210. — Goldfuss, Petref. germ., I, p. 201, pl. 61, fig. 1. — *Comatula*

rosacea, Blainville, Man. d'Actin., p.248. — *Comatula mediterranea*, Dusarni, Atlas du Dict. univ. d'hist. natur. Zooph., pl. 3.

Width from 80 to 400 mm, purplish color diversely nuanced and patched with white on the ventral surface. Centro-dorsal piece width from 4 to 5 mm, convex above and having on all its dorsal surface 22 to 26 dorsal cirri of about 20 articles, of which the last is in the form of a nail. These dorsal cirri multiply as the animal grows and the largest, near the edge, the very young still having only four to five articles. The articles at the base of these adult cirri are swollen, wider than long. The following ones become a little longer and those from the middle to the end are less than two times longer, rounded, wider toward the articulation.

The arms begin by two radials that are three times as wide as long and whose 2nd is auxiliary. They are bifurcated one time and have only ten branches or secondary arms, uniformly thinned toward the end and that, in all their length, are cylindrical and united below. Their articular facets are radiated (pl. 1, fig. 8). The pinnules are formed of 10 to 45 cylindrical articles, swollen at heir ends, at least six times longer than wide toward the middle of each pinnule, but shorter at the top and the base. These articles are bristly with short points that sometimes become small spines at the external dorsal edge under the fleshy integument.

Inhabits the Mediterranean and west coasts of Europe that are warmed by the great current (Gulf stream).

2. REAPER COMATULA. *COMATULA PHALANGIUM*. — Müller.

— *Alecto phalangium*, J, Müller, Arch. f. Naturg., 1841, p. 142.

This species, found at Nice in the Mediterranean has been named because of the length of its accessory rays that resemble the legs of the reaper.

The centro-dorsal piece is very narrow and nearly as long as wide, rounded below. It has laterally 25 to 30 dorsal cirri that are ordinarily proportionally long as the size of the animal and that are formed of 45 long and thin articles. The last is straight with spines on the internal surface. All these articles, with the exception of the first, are two times or two and a half times as long as wide.

The arms begin by three radials, of which the first is not very visible and the third auxiliary. The articles of the branches or the secondary arms are alternatively enlarged on one side like those of *C. mediterranean*. There are two to five articles between the syzygies of the arms. The first pinnules are very long, thin and filiform at the end. The ventral articles are short, no wider than long, but in going toward the end they become very long and thin, and finally five to six times as long as wide. It is 135 mm wide, with the naked disk. The

first pinnules are very long, thin and filiform at the end. Their ventral articles are short, no wideer han long, but in going toward the end they become very long and thin ad finally five to six times as long as wide.

It lives in the Mediterranean.

3. UMBRELLA COMATULA. *COMATULA PETASUS*. — Dugen and Koren.

— *Alecto petasus*, Dugen and Koren, *Archiv Skandin..Beitr*., 1845, 1, p. 436.

Approximately 50 dorsal cirri covering all the dorsal surface, a little compressed, formed of 11 to 14 articles a little longer than wide. Branches of the arm have syzygies of nearly four articles and having approximately 50 pinnules on each side, of which the first is very long, filiform and nearly twice the third.

It lives on the coasts of Norway.

3. SARS' COMATULA. *COMATULA SARSII*. — Duren and Koren.

— *Alecto sarsii*, Duren and Koren, Archiv Skandin. Beitr., 1845, 1, p.436.

Approximately 49 dorsal cirri covering all the dorsal surface, thin, compressed, formed of 13 to 20 articl3s of which the longest, from the 4^{th} to the 6^{th} are three times longer than wide and whose last has two nails. Branches of the arms most often have syzygies of about 40 pinnules of which the first four or five are filiform, two times longer than the following.

On the coast of Norway.

Nota. Barrett has recently described (*Ann. and Mag. of nat. hist*., 1857, t. XIX, p. 55, pl. 7, fig. 1) under the name of *Comatula woodwardia,* a large and beautiful species from the coast of England that appears different from the two preceding.

5. ESCHRICHT'S COMATULA. *COMATULA ESCHRICHTII*. — Müller

— *Alecto eschrichtii*, J. Müller, Archiv f, Naturg., 1841, p. 142.

Width 66 centimeters (2 feet) with the naked disk. Centro-dorsal piece hemispherical, as long as wide, having on all the dorsal surface about 400 cirri composed of 24 articles of which those of the middle are two times longer than wide and those of the ends as long as wide. Radial pieces very short, several times wider than high. Only two can be seen exteriorly of which the second is axillary. There are two or three, rarely four articles between the syzygies of the arm, whose articles are alternatively wider on one side and

becoming very short toward the end. The pinnules, in the thickest part of the arms are formed of articles that are wide and compressed, with a sharp posterior edge. Toward the end of the arms, there are only two ventral articles that are also wide. The others are rounded. The first pinnules are small. The others increase in length.

Found at Greenland.

6. KEELED COMATULA. *COMATULA CARINATA*. — Lamarck.

— Lamarck, Anim. sans vertèb., 2e éd., III, p.210. — Griffith. anim. Kingdom. Zooph., pl. 8. — *Alecto carinata*, Leach— J. Müller, Arch. f. Naturg., 1843, p, 199.

Width of 216 mm, with the disk naked. Approximately 35 dorsal cirri of 24 articles, without appendages. The articles of the arm are short, widened at the end of the external edge which makes them appear imbricated. They are keeled on the dorsal surface with a small tubercle at the end. There are two to five articles between the syzygies of the arms. The eight to nine pinnules of each side are a little larger and increase in length up to the 8th or 9th and the following decrease. The articles of the pinnules, particularly at the thickest part of the arms, are short, wider than long, flattened laterally with a sharp edge posteriorly.

From Mauritius.

7. ADEONA'S COMATULA. *COMATULA ADEONAE*. — Lamarck.

— Lamarck, Anim. sans vertèb., 2e ed., III, p. 211. — *Alecto adeonae,* J. Müller, Archiv f. Naturg., 1843, p. 135.

Width from 80 to 400 mm, 10 secondary arms, 20 dorsal cirri of 20 articles, of which the next to last has a small spine below. Three radial articles that, as well as the folllowing articles, are wide and with two sharp edges. It is the third article after the axillary radial that has the first syzygy and, after that, there are three to five articles between the syzygies. The pinnules of the arms are all long, but the first three or four are longer.

From the seas of Australia where it is often found attached on broad foliaceous expansions of the bryozoan polyp named *Adeona*.

8. SOLAR COMATULA. *COMATULA SOLARIS*. — Lamarck.

— Lamarck, Anim. s. vertèb., 2e ed., III, p. 209 (but not the species figured by Blainville).— *Alecto solaris*, J. Müller, Arch. f. Naturg., 1843, p. 135.

Width 336 mm (1 foot). 10 secondary arms. 20 dorsal cirri of 30 articles. Only two radial pieces are visible, including the auxillary, then three to four articles between the

syzygies, of which the epizygal is extremely thin. The pinnules are nearly equally long and decrease only slightly after the calyx, which gives the arms a feathery appearance. They are thick, having four corners appear toothed like a saw.

From the seas of India.

9. BRACED COMATULA. *COMATULA BRACHIOLATA*.— Lamarck.

— Lamarck, Anim. s. vert., 2e éd., II, p. 211. — *Alecto brachiolata*, J. Müller, Arch. f. Naturg., 1843, p. 135.

Width 100 mm, 10 secondary arms, 15 dorsal cirri forming a single row on the contour while the rest of the dorsal surface is free. They are composed of 54 to 56 articles. Each of the first two brachial articles, below the axillary radial, has a syzygy. Beyond, there are 5 to 6 articles between the other syzygies of the arms. The articles of the arms are alternatively very protruding from each side. The first pinnules are longer and appear saw-toothed at the end because of the protrusion of the last eight articles like those of *C. echinoptera*. The other articles of the pinnules are generally moniliform.

Lamarck indicated with doubt it comes from the Atlantic Ocean.

10. WINGED COMATULA. *COMATULA ECHINOPTERA*. — J. Müller,

— *Alecto echinoptera*, J. Müller, Arch. f. Naturg., 1841, p. 143.

Width 216, with scattered small hard papillae, cylindrical, 10 secondary arms. Flat centro-dorso piece with 20 laterally depressed dorsal cirri on its edge. Articles of the arms slightly imbricated at the base. Syzygies separated by 2 to 5 articles. The first pinnules of the arms are a little longer than the others. The last seven articles have on their dorsal surface a long protruding ridge that has teeth like a saw. The posterior edge from the 5th article of the first pinnule has a strong protrusion.

Of unknown origin. In the Museum of Berlin.

11. ROSY COMATULA. *COMATULA ROSEA*.

— Mus. Vienn. — *Alecto rosea*, j. Müller, Arch. f. Naturg., 1841, p. 143.

Width 155 mm, 10 secondary arms. Centro-dorsal plate completely flat with a marginal row of 48 dorsal cirri of 52 short articles that are wider than long. Those of the base are even two times wider than long. This base is at the same time enlarged and conical. Only two radial pieces are visible. The branches of the arm are thinner at their base and a little swollen like a spindle in the middle, to narrow again rapidly at the end. They have 4

to 5 articles between their syzygies. Their first article appears to have a syzygy like the next. Consequently, the first pinnule is on an epizygal article. The first pinnules have nothing remarkable. The longest is the fifth of each side. Where the arm is thickest and afterwards, the pinnules decrease little by little. Their articles are wider than long.

From Australia. In the museum of Vienna.

12. TESSELATED COMATULA. *COMATULA TESSELLATA*.—J. Müller.

— *Alecto tessellata,* J. Müller, Arch. f. Naturg., 1841, p. 144.

Width from 33 to 50 centimeters (one foot to one foot and a half), violet color, disk covered with small calcareous plates. 10 secondary arms. 20 to 25 dorsal cirri of 45 articles that are scarcely as long as wide, and of which the last 24 have a small spine. The first of the three radial articles of the calyx is very short. There are 7 to 8 and rarely up to 14 articles between the syzygies. The articles are very short, imbricated, with protruding keel. The 2nd. 3rd and even the 4th external pinnules the longest.

From the seas of India.

13. PURPLE COMATULA. *COMATULA PURPUREA*.— J. Müller.

— *Alecto purpurea*, J. Müller, Arch. f. Naturg., 1843, p. 132.

Width 135 mm, purple color. 10 secondary arms. Centro-dorsal piece very small, with 12 dorsal cirri of 12 articles, as wide as long. Two visible radials, very short, forming a syzygy. The first and sometimes the 2nd article of the arms have a syzygy. Beyond are often found 2 to 6 or more often 2 to 5 articles between the other syzygies. The articles of the arms are alternatively wider on one side and assembled in the form of a wedge. The first pinnule is on the epizygal article of the first double article. The pinnules decrease from the first to the third so that this is smaller. The others then increase progressively in length.

From Australia. In the Museum of Berlin.

14. MILBERT'S COMATULA. *COMATULA MILBERTI.*—J. Müller.

— J. Müller, Mém. Acad. de Berlin, 1849.

10 secondary arms. Centro-dorsal piece convex with 25 to 50 dorsal cirri of 35 articles, of which half with a transverse spine. The first or the most ventral of the radial pieces is extremely narrow. The articles of the arms are short. There are 8 to 9 between the syzygies. The 2nd, 3rd, and 4th pinnules are the longest

From North America. Studied by Müller in the Muséum d'histoire naturelle de Paris.

15. JACQUINOT'S COMATULA. *COMATULA JACQUINOTI*. — J. Müller.

— J. Müller, Mém. Acad. sc. de Berlin, 1849.

10 secondary arms. Centro-dorsal piece very convex, all its dorsal surface with 22 dorsal cirri of 55 articles of which the last have a spine directed forward and that all are wider than long. Three visible radials of which the first is very narrow. Articles of the ams short, three to six between the syzygies. The first three to four pinnules are larger.

From Céram. Studied by Müller at the Muséum d'histoire naturelle de Paris.

Nota. Müller (Arch. f. nat., 1841, p. 144) indicated under the name of *Alecto polyarthra*, another species of which he had observed only the arms that have 10 to 14 articles between the syzygies. The same author has placed in his genus *Actinometra Comatula solaris* of the museum of Vienna, and C. *pectinata* or *barbata*, that both have their arms bifurcated once or ten secondary arms.

** Species having the arms bifurcated two or more times and consequently having more than 10 secondary arms.

* *Less than 20 arms*.

16. COMATULA WITH LONG CIRRI. COMATULA MACRONEMA. — J. Müller.

— J. Müller, Mém. Acad. sc. Berlin, 1849.

13 to 15 arms. Centro-dorsal piece rounded, have 30 to 35 extremely long cirri or 60 to 70 articles, with a small swelling or button at the end. Each of the five primary arms, beginning by three radial articles, divide first into two branches, of which the thinner one remains single and the larger one is bifurcated a second time after the second article that then becomes an axillary brachial. There are ordinarily three articles between the syzygies. The articles of the arms toward the base are rounded. The following ones are more and more compressed and the furthest are very strongly keeled. The ridge that results is extended in a point to the external edge. The first pinnule is small. The following, much larger, decrease progressively.

From Australia. Studied by Müller at the Museum of Paris.

** *20 secondary or tertiary arms*.

17. COMATULA OF SAVIGNY. *COMATULA SAVIGNYI*. —J. Müller.

— Savigny, Descr. de l'Egypte, Zooph., pl. 1. — *Comatula multiradiata*, Audouin, ibId., explic. des planches. — *Comatula adeonae,* Blainville, Man. d'Actin., p. 249, pl. 26.

Width 96 mm, 29 branches or tertiary arms have numerous pinnules, nearly equal, that make them appear feathery. 30 dorsal cirri of 29 to 50 articles, of which the last is hooked and the 7 or 9 preceding have a small spine.

From the coasts of Egypt.

18. WHEEL-SHAPED COMATULE, *COMATULA ROTALARIA*. — Lamarck.

— Lamarck, Anim.s. vertèb., 2e ed., II, p.210. — *Alecto rotalaria*, J. Müller, Arch. f. Naturg., 1843, p. 136.

Width 270 mm, 20 to 22 tertiary arms. Dorsal cirri unknown or absent (?). Centro-dorsal piece has in the middle a pentagonal impression. The base of the arms or ray consists of two articles united by a syzygy, above which is found immediately the axillaries, also with a syzygy. The usual number of arms thus is 20 and it is only rarely that a new bifurcation is seen at the base of one or two of these branches. There are 5 but more usually 4 articles between the syzygies of the arms that are strong with lateral straight rays. The first pinnules are very long. The others decrease little by little to the end of the arm.

From Australia.— Museum of Paris.

19. FRINGED COMATULA. *COMATULA FIMBRIATA*.— Lamarck.

— Lamarck, Anim. s. vertèb., 2^{e} éd., III, p. 210. — Miller, CrinoId., frontispiece and p. 132. — *Stella chinensis*, Petiver, Gazophyl., pl. 4, fig. 6.— *Alecto fimbriata*, J. Müller, Archiv f. Naturg., 1843, p. 136.

Width 165 mm, 17 to 25 arms. 15 dorsal cirri of 22 articles, of which the last 8 have above a small pointed protuberance. The third radial article is an axillary without syzygy. Then, beyond, the third article is still a syzygy and sometimes also an axillary brachial of the origin of a bifurcation. But, beyond, it is each second article that is a syzygy and. further, there are 6 to 9 and even 12 articles beyond the syzygies. The pinnules are all nearly the same length.

From Australia. — Museum of Paris.

Nota. Lamarck, who appears to have confused at least two species, says that the rays with pinnules, scarcely longer than 81 mm (3 inches), are slenderer than in the preceding species and number 12 to 30. The articulations are a little ciliated at the edge.

20. ELONGATED COMATULA. *COMATULA ELONGATA*.

— Museum of Leyden. — *Alecto elongata*, J. Müller, Arch. f. Naturg., 1841, p. 146.

Width 216 mm, somber color. 20 tertiary arms, 15 to 20 dorsal cirri of 15 to 25 articles, of which the last 15 to 17 have a pointed hook in the form of a spur. The last article also has in addition a claw. The axillary articles are without a syzygy and between two consecutive axillaries there is a single article. Beyond the last axillary article, the third article has a syzygy and, further, there are 5 to 11 articles between the syzygies. The pinnules first increase in width, so that the 3rd is longer. Then they decrease. Their articles are round and smooth.

From New Guinea.

21. HAIRY-WINGED COMATULA. *COMATULA TRICHOPTERA*. — J. Müller.

— J. Müller, Mém. Acad. sc. de Berlin, 1849.

20 tertiary arms. Centro-dorsal piece relatively large, flat and a little concave, with a marginal row of 50 dorsal cirri remarkable by their tenuity and formed of 15 very compressed articles of the last only has a swelling, often even without a terminal hook. The first pinnules are large.

From Australia. Studied by Müller in the Museum of Paris.

22. REYNAUD'S COMATULA. *COMATULA REYNAUDI*.— J. Müller.

— J. Müller, Mém. Acad, sc. de Berlin, 1849.

90 tertiary arms. Integument of the ventral surface soft, centro-dorsal piece flat, with a marginal row of about 20 dorsal cirri of 40 articles that develop a small tubercle. There are three radial articles of which the 3es is axillary and double with a syzygy. Further, there are ordinarily seven articles between the syzygies. The 2nd and 5th pinnules are longer.

From Ceylon. Studied by Müller at the Museum of Paris,

**** From 26 to 40 tertiary or quaternary arms.*

23. PHILIBERT'S COMATULA. *COMATULA PHILIBERTI*. — J. Müller.

— J. Müller, Mém. Acad. sc. de Berlin, 1849.

26 tertiary or quaternary arms. Centro-dorsal piece flat in the middle having on its contour a row of dorsal cirri of 45 articles that are not longer than wide and that have, except those at the base, a swelling.

Three radials, whose ventrals are very narrow. The axillary radial does not have a syzygy. Above, up to the 2nd bifurcation, there are three articles, of which the 2nd is applied obliquely on the 1st and whose 3rd, or axillary brachial, has a syzygy. These twenty tertiary arms have again their 2nd article inserted obliquely. Some are bifurcated again a third time above their 3rd article that thus becomes thus axillary and has a syzygy. The 2nd article above the later bifurcation is also inclined on the preceding. The articles of the arms are then very short. The first two pinnules are small, the two following are large, and those that are beyond become smaller.

From Java. Studied by Müller at the Museum of Paris.

24 COMATULA WITH SHORT CIRRI. *COMATULA PARVICIRRA*. — J. Müller.

— *Alecto parvicirra*, J. Müller, Arch. f. Naturg., 1841, p. 145.

Width 165 mm, 27 tertiary and quaternary arms. 20 dorsal cirri or even more, every narrow and short, of 12 articles. The third radial article is axillary, with a syzygy. After this axillary radial, the third brachial article is a syzygy and at the same time axillary, then beyond, the third article is again a syzygy but sometimes only axillary. Further on, it is the 6th of 7th article that is a syzygy, and subsequently there are two to four articles between each syzygy. The pinnules are nearly uniform.

Habitation unknown. Indicated by Müller as at the Museum of Paris.

25. COMATULA FROM JAPAN. *COMATULA JAPONICA*.—

Mus. de Leyden.

— *Alecto japonica*, J. Müller, Arch. f. Naturg, 4841, p. 145.

Color brown. 27 tertiary or quaternary arms. Centro-dorsal piece width 4.5 mm at most with 50 dorsal cirri of 20 articles that are a little compressed toward the end and also wider there. The axillary radial is in part hidden by the base of the dorsal that would make one think that there were no other radial articles. Then, as long as the bifurcations continue, it is the third article after the preceding bifurcation that is axillary and that is at the same time a syzygy. The first articles after the first bifurcation touch laterally. The other syzygies

of the arms are separated by 8 to 9 articles. The first two pinnules are larger. The others decrease.

From Japan.

26. FLAGELLATED COMATULA. *COMATULA FLAGELLATA*. —

Mus. de Leyden.

— *Alecto flagellata*, J. Müller, Arch. f. Naturg, 1841, p. 145.

Width 350 mm (1 foot). 38 branches or rays. 35 long and thick dorsal cirri of 30 short and flat articles, of which the last, in addition to the terminal nail, also has an appendage in the form of a spur. The axillary articles are very short with syzygy. The syzygies of the arms are separated by 10 to11 articles that are alternatively thicker on one side and the other in the form of a wedge. The pinnules increase in size up to the 5th of each side and the first three are very long. The following ones decrease progressively.

27. COMATULA FROM TIMOR. *COMATULA TIMORENSIS*.—

Mus. de Leyden,

— *Alecto timorensis*, J. Müller, Arch. f. Naturg., 1841, p. 144.

Width h 216 mm. Color brown. 30 to 49 branches or rays. Centro-dorsal piece very small, being less than 2.25 mm (1 line) in diameter. 16 dorsal cirri of 14 articles that, toward the base, are longer than the other and thicker at the two ends. The 5th radial article is axillary, without a syzygy. As the bifurcations continue, each 3rd article is axillary and has a syzygy. For the remainder, there are ordinarily three articles between the syzygies. On the arms. the first pinnule, below the first brachial axillary article is three times as long as the second of the same side. The following ones are nearly equal to it.

From Timor.

28. ARTICULATED COMATULA. *COMATULA ARTICULATA*.—J. Müller.

— J. Müller, Mém. Acad. sc. de Berlin, 1849.

Arms very regularly bifurcated three times or forming 40 branches or rays. 20 to 30 dorsal cirri of 36 to 40 articles, occupying all the dorsal surface except the middle. 24 to 269 of these articles have a small spine. Three radials and then two articles between each bifurcation of the arms. The axillaries are inserted obliquely on the preceding article. The first syzygy is at the 3rd article after the last bifurcation. There are then 12 to 20 articles between the syzygies. The first pinnule is supported by the 2nd article after the last bifurcation. It is small. The two following are large. The others are then smaller. Their articles are cylindrical, not enlarged.

Müller also indicates he studied it at the Museum of Paris.

**** *More than 40 rays or quaternary or quinary arms.*

29. MULTIFIDE COMATULA. *COMATULA MULTIFIDA*.— J. Müller.

— *Alecto multifida*, J. Müller, Arch. f. Naturg., 1841, p. 147. — *Comatula multiradiata*, Lamarck, Anim. s. vertèb., 2e éd., III, p. 209.—Linck, De Stell. mar., pl. 22, fig. 34. — Seba, Mus., III, pl. 9, fig. 3-4. — Encycl. méth., pl. 195, fig. 3.

The five arms are divided nearly to their base by 8 to 10 pinnate branches that originate on the disk so that the number of these branches, ordinarily 44 or 45 and go to 50. There are 20 or more dorsal cirri of 14 articles, with a very small protrusions on the back of the last articles. Three radials, of which the 3rd axillary is without a syzygy, originate from there. The 3rd article is axillary and nearly a syzygy. Then, as the bifurcations continue, each second article is an axillary but without a syzygy. Further on, there are three articles between the syzygies. The articles of the arm protrude by a sharp ridge. All the pinnules are long. Between the five arms, at their base, are numerous calcareous plates that continue to the second bifurcation.

From the seas of India.

Nota. The name *Comatula multiradiata* having been given by Goldfuss to a species different from that of Lamarck and that has become the type of the genus *Comaster*, it appears necessary for J. Müller to change the name given by Lamarck. especially as the name *multiradiata* is thus applied to one of the species of the genus *Actinometra*.

30. COMATULA FROM NEW GUINEA. *COMATULA NOVAEGUINEAE*. — Mus. de Leyden.

— *Alecto novaeguineae*, J. Müller, Arch. f. Naturg., 1841, p. 146.

Width 216 mm. Color brown. 56 arms or rays originate from the bifurcation of the 5 primary arms. Centro-dorsal piece small, having at least 45 dorsal cirri. The 5th radial is axillary. The 40 secondary arms have three articles to the 2nd axillary. Then there is only one article between the other axillaries of the branches the bifurcate three or four times. No axillary article has a syzygy. Further on, there are only two articles between the syzygies. The two first pinnules are very elongated. The others become shorter. On each article of the pinnules are some small spines.

From New Guinea.

31. BENNETT'S COMATULA. *COMATULA BENNETTI*. — J. Müller.

— *Alecto bennetti*, J. Müller, Arch. f. Naturg., 1841, p. 146.

Width 350 mm (1 foot). Color brown, paler above. More than 70 arms. Approximately 50 dorsal cirri of 95 articles that are a little flattened. The arms, up to the 3rd bifurcation, are united by the integument of the disk. Each 4th article is an axillary without a syzygy. Each article has a protrusion outside the edge and is as if ciliated by very small spines. There are three to four articles between the syzygies of the arms. The first

pinnule is 40 mm long, the second is a little shorter, the third and the following are scarcely 13 mm. The articles at the end of the pinnules protrude into the interior in the form of a comb with small claws.

Origin unknown. At the Museum of Leyden.

Nota. Of 24 species of the Muséum d'histoire naturelle de Paris, there are six described by Lamarck, two by Duben and Koren and three by Müller, accepting that *C. brevicirra* is identical with his *C. parvicirra*. *C. glacialis*, reported from polar seas, corresponds without doubt to his *C. eschrichtii* from Greenland. Among the dozen others are certainly the seven species described by Müller in 1849 as he observed in this collection and probably also some of his *Actinometra*. The names from the Muséum that we have not cited above are *C. picta, monilis, polyactinia, moniliformis, inserta, simplex, dividua, dibrachiata, actinvdes, bicolor, scita* and *coccodistoma*.

2nd GENUS. **ACTINOMETRA**. *ACTINOMETRA* — . Müller.

(αχτις, αχτινος, ray; μητηρ, mother.)

This genus differs from the true Comatulids only by the position of the anus at the center and the mouth at the edge of the disk. As a result, the ambulacral gutters, instead of going to the mouth following the direction of the arms as in Comatulids are bent and follow the contour of the disk. This even made Müller first believe that the ambulacral gutters open into a circular and marginal canal. He later corrected this opinion, but we must conclude that this genus was not established on truly sufficient characters especially as we still have seen only dry specimens.

J. Müller proposed in 1843 (Arch. f.naturg., p.140) from the Museum of Vienna that he wanted to name *Actinometra imperialis* to distinguish it from *C. solaris* of Lamarck. Then he more clearly characterized it in the same collection in 1843, p. 132. Müller united in this genus *Asterias multiradiata* and *pectinate* from the Museun of Lund, as named by Retzius in 1805 and in which the latter corresponds to *Comatula pectinata* or *barbata* of other authors. Finally, in 1849 (*Mem. Acad. Berlin*), Müller, while preserving this genus, placed a fourth species, his *Alecto wahlbergii* of 1843.

1. IMPERIAL ACTINOMETRA. *ACTINOMETRA IMPERIALIS*.— J. Müller.

— J. Müller, Arch. f. Naturg., 1841, p. 140, and 1843, p. 132.— *Comatula solaris*, du Museum of Vienna.

Width 650 mm (2 feet), color orangish in the dry state. Disk covered with calcareous lamellae in the form of flowers, not showing grooves that in Comatulids go from the arms to the mouth. There is thus no mouth in the center, but on the contrary, a protruding anal tube. The five arms are bifurcated once and the secondary arms that result have the same ventral or ambulacral grove as in Comatulids. But this groove turns around and follows

circularly the edge of the disk to the mouth that is completely marginal. We can thus, as Müller said himself, see here only a dyssymetric effect coming from the exaggerated extension of the interambulacral area occupied by the anal tube.

The centro-dorsal piece is completely flat and has only on its external edge a single row of 14 dorsal cirri of 20 articles as wide as long. The articles of the middle of the younger cirri are longer than wide. The cirri are thicker at the base and then narrow and keep the same diameter for the rest of its length. There are three very short radials of which the 5th is a axillary radial and appears to attach to the 2nd by a suture. The first article after the bifurcation appears to have a syzygy. The first pinnule is on the epizygal, and the following article is again a syzygy. Beyond, there are two to five articles between the syzygies. The articles of the arms are flat below, alternatively thicker on one side and the other, or in the form of a wedge whose end is thinner and shows only a thin edge between the preceding and following articles. As a result, the intervals of these articles form a zigzag line on the back of the arms. The articles are shorter toward the base of the arms. The first pinnules is larger, the following, on the same side, although also large, is already a little smaller. The third is very small and the following are going to increase in length. The lower articles of the 2nd pinnule are distinguished by their enlargement. The other articles of the pinnules are, on the contrary, laterally compressed, wider than long, with a sharp lower border. The calcareous plates of the surface of the disk have small tubercles that are short, calcareous, in the form of a flower, with three foliaceous appendages.

2. PECTINATE ACTINOMETRA. *ACTINOMETRA* PECTINATA. — J, MÜLLER.

— J. Müller, Arch. f. Naturg., 1843, p.133. — *Asterias pectinata*, Retzius, Dissert. spec. Asteriarum, Lund., 1805.— *Stella* (*Decameros*) *barbata*, Linck, De Stell. mar., p. 55, pl. 37, fig. 64.

Width 270 mm. Arms bifurcated once and have only ten branches or secondary arms. Centro-dorsal piece concave in the middle, having at the edge 16 dorsal cirri of 13 articles, of which the last has a small internal spine and whose articles are scarcely as long as wide. The radials are extremely narrow. The arms are narrower at their base and wider toward the middle. Their articles, alternatively thicker on one side or in the form of a wedge, have on their lines of junction in zigzag and have a trace of a dorsal keel. The first, as well as the second article of the arms already have a syzygy. Then there are two to eight articles between the other syzygies. The first pinnule is on the epizygal of the first double article. The first two pinnules are of the same length and the second has its two lower articles extremely enlarged in back. The third pinnule is small. The following ones are larger and rapidly increase in length. Their articles are wider than long. On the dorsal surface of the arm are two lines that re black, longitudinal, regular, separated by a paler line.

J. Müller has observed this species in the museum of the University of Lund what it had been described previously by Retzius. We found all these character except the dorsal black lines of the arms and the disposition of the ventral surface of the disk, on the very altered specimen of the old museum of Rennes, coming from the collection of the president of Robien. The color appears to have been purple, the total diameter must have been 234.

It is here especially the characters that furnished by the syzygies appear to us not very constant.

3. MULTIRAYED ACTINOMETRA. *ACTINOMETRA MULTIRADIATA*.— J. Müller.

— J. Müller, Arch. f. Naturg., 1843, p. 133. — *Asterias multiradiata*, Retzius, Dissert. spec. Aster., 1805.

Disk showing on its ventral surface many small tubercles like the heads of small pins. Arms subdivided three times. Centro-dorsal piece flat, with a depression in the center and having on is contour 24 dorsal cirri of 24 articles that, ordinarily, are longer than wide, except on the younger and that can become, on the contrary, wider in the old ones. Only two radials are visible. They are narrow. Then come up to the second bifurcation three articles of which the 5th axillary with a syzygy, then two articles, of which the 2nd axillary with a syzygy to the 3rd bifurcation. Beyond are 7 to 14 articles between the syzygies. The articles of the arms are short and edged at the end by a row of fine spines visible with a magnifying glass. The first pinnule is on the 2nd article of the ten secondary branches. After each of the last bifurcations, the first pinnule is on the article that follows the axillary. The pinnules of the stem of the arms are large. The articles of the pinnules are short.

4. WAHLBERG'S ACTINOMETRA. *ACTINOMETRA WAHLBERGII*. — J. Müller.

— *Alecto wahlbergii*, J. Müller, Arch. f. Naturg., 1843, p. 131.

Width 135 to 160 mm. Color greenish yellow. Arms bifurcated two times or 20 tertiary arms. Centro-dorsal piece flat or even concave with 24 dorsal cirri of 17 articles on its contour of which the last 8 or 9 have a small spine on the internal surface. Their lower articles are wider than long, the following ones are longer than wide, and the last as long as wide. Only two radials are visible. After the first bifurcation, there are three articles up to the 2nd. The 2nd of these articles has a pinnule and the 5th a syzygy. There are then three to five articles between the other syzygies. The articles of the arm are short. The first pinnule is larger than the 2nd, which is larger than the 5th. At the stem of the arms, the last articles of the pinnules have a protruding keel.

From Port Natal.

3rd GENUS. **COMASTER**. *COMASTER*.— Agassiz.

(χομη, hair; αστηρ star.)

This genus differs essentially from true Comatulids only by the presence of a small interradial between each of the first free radials. It was established in 1836 by Agassiz for *Comatula multiradiata* Goldfuss that is different from the one which Lamarck had earlier named thus and that had been called *C. multifida* after J. Müller. Agassiz also gave for the character of his *Comaster*, the more multiplied of the arms. But as we have seen previously,

there are Comatulids whose arms are also multiplied as much. J. Müller, in 1841 (Arch. f. naturg., p. 140), in specifying the characters more exactly, called basals all those pieces are we call interradials. D'Orbigny, 1850 (*Prodrome de Paléontologie*), and in 1852 (*Cours élémentaire*, t. IL, p.138), accepted the same genus but applied the name *Comatula* to it, in giving, as we have said, to the true Comatulids the name of Decameros. He also characterized it by the presence of five small pieces that he named basals between the five brachial pieces. He added that the central piece is thick and has ten series of equal ramules (dorsal cirri). He was also led, after, to consider as centro-dorsal pieces or centrals of animals of the same genus, the fossils that Goldfuss had previously made (1831) his genus *Solanocrinite*. This latter author thought he had seen in these pieces, often longer than wide, the short stalk of Crinoids. But already, in 1841, Müller had noted that the more or less thickness of the centro-dorsal piece of Comatulids could not furnish a generic character because living Comatulids like *C. eschrichtii* and *C. phalangium* have a centro-dorsal piece scarcely as wide as it is long.

Pictet (*Traité de Paléontologie*, 1857, t. IV, p. 288), like D'Orbigny, prefers the name *Comatula* to that of *Comaster* and recognizes also that most of the *Solanocrinus* of Goldfuss also have the small intermediary pieces that he wants to name basals, but he does not specifically unite to the *Comaster* that he calls *Comatula*, *Solanocrinus jaegeri* that has, on the contrary, these large intermediary pieces that are so large that they completely separate the radials from the centro-dorsal plate. He has made, like D'Orbigny, these other *Solanocrinus* that have these very small intermediary pieces, a particular genus but he left it the name of *Solanocrinus* in recognizing that D'Orbigny who took for type *Solanocrinus costatus* that he named *Comatulina*, gave it an inexact characteristic by refusing it both brachial and basal pieces and claiming that the arms are articulated without an intermediary to the centro-dorsal piece. For me, considering the centro-dorsal piece as formed by the fusion of the basal pieces and perhaps even the first radials, I can see the intermediary pieces only as interradials and not basals like J. Müller, D'Orbigny and Pictet.

A single species of this genus lives in the seas of the Indies. The others are fossils from the Jurassic terrain.

MULTIRAYED COMASTER. *COMASTER MULTIRADIATUS*. — Agassiz.

Comatula multiradiata, Goldfuss, Petref. germ., I, p. 202, pl. xt, fig. 2. — *Comaster multiradiatus*, Agassiz, Mém. Soc. sc. nat. de Neufchâtel, 1836. — J. Müller, Arch. f. Naturs., 1841, p. 140.

Arms bifurcated three or four times, which makes the total number of branches or rays 50 or 60. The centro-doral pieces have at least 25 dorsal cirri of 25 articles. The base of the arms is composed of two radial articles, of which the second is the axillary radial, which has a syzygy like all the other axillaries. Above the axillary radial are three articles, of which the third is axillary, As long as bifurcations occur, three articles, the last axillary, are interposed between each of them. Above the last axillary are two single articles, then a syzygy that is separated from the following by five or nine articles and, finally, there are three to five articles between the other syzygies.

From the seas of India.

The fossil species of the genus *Comaster* and *Solanocrinus* are:

1º *Comaster costatus*, J. Mul—*Soleansrcrinites costatus*, Goldfuss, *Petref. germ*., 1, p. 168, pl. 50, fig. 7, and pl. 51, fig. 2.— *Comatula costata*, D'Orbigny, *Prodr. de paléont*., T, p.381, and *Traité élém*., ll, p. 158, fig. 286, and ibid , p. 139. *Comatulina costata*. — *Solaxocrinites costatus*, Bronn, *Lethœa geogn*., pl. xvii, fig. 14, and *Comaster costatus*, ibId., 3e éd, — *Solanocrinus costatus*, Pictet, *Traité de Paléont*., IV, p. 288, pl. 99, fig. 4.

Centro-dorsal piece, barrel shaped having 10 to 15 protruding vertical ribs between which are the insertions of the dosal rays. Very small interradial pieces.

Fossil from the Oxfordian terrain of France, at Besançon, and from Wurtemberg at Leidenheim and Giengen.

[Goldfuss describes his genus as having a cup-shaped form made of articulated pieces with the basin (pelvis) of five articles, but whose scapular pieces and rays are unknown. A stalk that is very short, pentagonal, rugose, crossed by a pentagonal and radiate canal at its base, hollowed on the sides with articular cavities for the accessory rays, and formed of indistinct or fused articles.]

2º *Comaster scrobiculatus*.—*Solanocrinités scrobiculatus,* Münster. —Scheuchzer, *Helv. hist. nat*., III, p. 598, fig. 167. — Goldfuss, *Petref. germ*., p. 187, pl. 50, fig. 8.

Centro-dorsal piece obconic, pentagonal above, rounded below. Very small interradial pieces.

Fossil from the Oxfordian terrain of Bavaria, at Streisberg and Thurnau.

3° *Comaster bronnii*.— *Solenocrinites bronni*, Munster, *Beitr. z. Petref*., p.104, pl. 44, fig. 7.

Fossil of Bavaria, at Streitberg.

4º *Comaster jaegeri*. —*Solanocrinites jaegeri*, Goldfuss, *Petref. germ*., I, p.168, pl. 50, fig. 9.— *Comatula jaegeri*, D'Orbigny, *Prodr. paléont*., I, p. 581. *Comatula* and *Solanocrinus jaegeri*, Pictet, *Traité de Paléont*., IV, p. 288, pl. 92, fig. 2.

Interradial pieces dilated and laterally contiguous, marked with a petaloid groove at their base.

The size of the interradial pieces has appeared to Pictet a sufficient reason to make a separate genus

Fossill of the Oxfordian terrain of Bavaria, at Bayreuth.

D'Orbigny also indicates:

1° *Comatula polydactyla*, known only by the arms, remarkable by their numerous ramules. Fossil in the Middle Oolith at Châtel Censoir (Yonne) and Luc (Calvados).

2º *Comatula depressa* from the Corallian terrain of Angoulins (Charente Inférieure). He says "It is a magnificent species that we possess with all its arms and that is distinguished from all others by its depressed arms, with pieces that protrude laterally with saw-like teeth."

GANYMEDA, — Gray.

It is here that it is necessary to mention that, according to Agassiz, the central dorsal piece of one of the preceding genera that Gray used to establish in 1824 (*Proceed. of the Zool. Soc. of Lond*.) for a bony piece, width of 3 mm, found on the coasts of England must come from a living animal. It is *Ganymeda pulchella*. Gray indicates thus the characters of the genus: "Body hemispherical, having a quadrangular depression in the middle of the dorsal surface. Mouth central on the opposite surface. No anus, nor ambulacra."

GLENOTREMITES, — Goldfuss.

The fossil that served to establish this genus, *Glenotremites paradaeus* (Goldfuss, *Petref. germ*., I, p. 159, pl. 51, fig. 1, and Bronn, *Letheaea geogn*., pl. 29, fig. 14, and Pictet, *Traité de Paléont.*, IV, p. 290, pl. 99, fig. 5), is even more paradoxical than the preceding. However, we must consider it also as a centro-dorsal piece of some Comatulid, as done by Agassiz and D'Orbigny who named it *Comatula paradaea*. It is found in the Chalk of Speldorf in Germany, Maëstricht. Goldfuss regarded it as an Echinoid without an anus. It is nearly globular, with five infundibular openings above alternating with five grooves around the median cavity. Its surface has, in addition, numerous depressions that must have served for the insertion of dorsal cirri or accessory rays and that have given it its name.

Goldfuss, in 1839 (*Petref. germ.*, p. 286, pl. 160, f. 18), described a second species, from the Chalk of Rugen, that has five small holes instead of the infundibular openings of the first.

COMATURELLA. — Munster.

Under this name, the Count of Münster, in 1839 (*Beitr. zur Petref*., p. 85, pl. viii, fig. 2), proposed forming a genus for an impression of a small fossil of the lithographic chalk from Solenhofen that shows only rays formed of long articulated pieces and without pinnules. This is *Comaturella wagneri*. D'Orbigny, in 1850 (*Prodr. de Paléont*., 1, p. 381), placed it in the genus *Saccosoma*, but one cannot establish sufficient zoological characters on such an object.

PTEROCOMA.— Agassiz.

(πτερον, wing, feather; χομη, hair.)

Agassiz, in 1836 (*Mém. Soc. sc. nat. de Neufchätel*, p.193), wanted to establish this genus for the imprints from the lithographic limestone from Solenhofen, previously described under the names of *Ophiurites pennatus*, by Schlotheim (*Pefref*., p. 326, pl. 28, fig.1–4), *Comatulites mediterraneaeformis*, by the same (*Nachtr*., 1, p. 47), *Comatula pinnata*, by Goldfuss (*Petref. germ.*, 1, p.203, pl. 71, fig. 3) and that had also been figured by Knorr (*Monum. des catastrophes*, pl. xi, xxxiv, à, f, 1, i, 1, n° 61). Bronn, in his *Lethaea*, in 1837 (pl. 17, fig. 17), named this fossil *Decacnemos pennatus*.

It is the *Pterocoma pinnata* of Agassiz, figured under the same name by Pictet (*Traité de Paléont*., pl. 99, fig. 4). But we cannot see the generic characters sufficient in these imprints that, according to the author "have pinnated rays so developed and bifurcated that the disk appears naked." Because several true Comatulids also have an extremely small disk. The fossil we are talking about has its five arms bifurcated a single time that gives it ten rays with pinnules that are equal, tetragonal, elongated. Its dorsal cirri are filiform and very long.

3rd TRIBE. **SACCOSOMIANS**

Although the genus *Saccosoma* of Agassiz that alone constitutes this tribe is, like the preceding, represented only by imprints from the lithographic limestone of Solenhofen and consequently its zoological characters cannot be completely indicated, we accept it as done by J. Müller, D'Orbigny, etc. J. Müller, in 1841 (*Arch. f. naturg*., p.139), made for *Saccosoma* a second section, Costata, among the free or stalkless Crinoids and characterized this section by a testaceous calyx with ribs and pinnules that are opposite instead of being alternate as in all the other Crinoids. Although this last character is not mentioned by other authors and would be contradicted by the figures they give where one sees true pinnules alternate two by two articles and other non-articulated appendages similar to the spines of Ophiuroids and inserted by pairs, or opposite, between the articles of the arms. It is without doubt these that J. Müller took for pinnules. D'Orbigny, in making a family of the Saccosomids, considered it as a link between Ophiuroids and Crinoids and claimed in fact "the arms, as in Ophiuroids, do not have the upper canal" or ambulacrum. He said "The calyx is bursiform, without whorls, arranged to bury in fine sediments while keeping the arms in the air." Bronn and Roemer also made a family of the *Saccosomids* among the free Crinoids, between the Marsupitids and the Comatulids. Pictet made his tribe of *Saccosomians* in his family of *Comatulidas* and gave for character: "the disk in form of a rounded pourch and uniform integuments not having distinct pieces."

In summary, we can say that the Saccosomians are distinguished especially from the Comatulians by the centro-dorsal piece in the form of a sac with protruding ribs that correspond to the arms and without traces of dorsal cirri.

GENUS ***Saccosome***, *SACCOSOMA*. — Agassiz.

(σαχχος, sac; σωμα, body.)

The genus *Saccosoma* composing alone the tribe Saccosomians, has nothing to add to the characters that we have given. We shall say only that this genus, little known zoologically, contains only three fossil species from lithographic limestone or schist of Solenhofen, making part of the Oxfordian terrain and where they are found in a the form of imprints between the layers of rock.

1. PECTINATE SACCOSOME. *SACCOSOMA PECTINATA*. — Agassiz.

— Agassiz, Mém. Soc. sc. nat. de Neufchâtel, 1836, p. 193.— Knorr, Monum. catast. Suppl., pl. 11, fig. 2–9. — Bayer, Oryet. Nov. pl. 8, fig. 4. — Monuüm., pl. 7, fig. 2–6. — *Ophiurités filiformis* (?) and *Asteriacites pennulatus*, Schlotheim, Petref., p. 325 and 326. — Parkinson, Organ. remains, II, pl. 1, fig. 15. — *Comatula pectinata*, Goldfuss, Petref. germ. I, p. 205, pl. 72, fig. 2.— *Saccosoma pectinuta*, D'Orbigny, Cours élément. de Paléont., 1852, t. II, p. 137, fig. 285. — Bronn and Roemer, Lethæa geogn., 3 éd., pl. 17', fig. 2.

Arms bifurcated a single time and thus forming 10 branches or secondary arms that have tentacles or spines that are non-articulated, short, geminate at the junction of the articles, from the base to beyond the middle. The last two thirds of these arms have on the contrary, other articulated tentacles, alternate and filiform.

Goldfuss, after whom we give these characters, adds, contrary to what other authors have said, that the five sides of the centro-dorsal piece have auxillary arms or very short dorsal cirri.

Fossil from the lithographic limestone of Solenhofen.

2. DELICATE SACCOSOME. *SACCOSOMA TENELLA*.— Agassiz.

— Agassiz, Mém. Soc. se. nat. Neufchâtel, 1836, p. 193. — *Comatula tenella*, Goldfuss, Petref. Germ. I, p. 204, pl. 72, fig. 1. — *Saccosoma tenella*, Pictet, Traité de Paléont., pl. 99, fig. 6.

We see on the imprints of this species only the tentacles or geminate spines that appear opposite. Goldfuss also attributed to them dorsal cirri that are very short and inserted on the five sides of the centro-dorsal piece.

Fossil from the lithographic limestone of Solenhofen.

3. FILIFORM SACCOSOME. *SACCOSOMA FILIFORMIS*.— Agassiz, *l. c*.

— *Comatula filiformis*, Goldfuss, Petref. Germ., I, p. 205, pl. 72, fig. 3.

The 10 rays or branches of the arms are simple with tentacles or spines that are geminate and very short and pinnules that are very long, filiform, alternate from the base to the end of these rays.

Goldfuss attributes in addition to this species, dorsal cirri that are very short, inserted on the five sides of the centro-dorsal piece.

Fosssil from the lithographic limestone of Solenhofen.

APPENDIX

TO THE REVIEW OF CRINOIDS

1º **HOLOPE**. HOLOPUS. — D'Orbigny.

(ολος, entire; πους, foot.)

D'Orbigny described, in 1837, in the Magasin de Zoologie (pl. 3), under the name of *Holopus*, a new genus of Crinoid that he characterized thus: "Animal fixed to the ground by a root taking the form of the solid body to which it is attached. From this root or base leaves a foot or entire body that is short, thick, hollow containing the viscera and opening by a mouth that also serves the function of a anus. Placed in the bottom of an irregular cavity formed by the union of arms that are dichotomous, thick, stony, externally convex, hollowed into gutters inside, divided into numerous articulations and with, along its length, strongly compressed conical ramules." — The animal is moreover completely symmetrical and bilateral, instead of having five organs. The only individual observed was sent from Martinque by Sander-Rang and. for this reason, named *Holopus rangü*. It was thought to have been captured alive, but the description was made only the dry skeleton, height about 80 millimeters. Nothing is said about the basic structure of this skeleton that one could conclude it was an echinoderm. No other observation nor study was done after D'Orbigny. We ourselves were unable to see it in the collection of this celebrated paleontologist, purchased by the Muséum d'histoire naturelle. Also, after the description and the figure that had been reproduced in the Annales des Sciences naturelles and in the Archiv für Naturgeschichte (1839), we were strongly tempted to see something other than an echinoderm, a cirripede for example. However, most zoologists have accepted *Holopus* as a genus of Crinoid Echinoderm but even as the type of a distinct family called Holopides, Holopidae. But nowhere else in Crinoids have we seen, as in Cirripedes, instead of an articulated stalk, a hollow foot containing the viscera. We thus believe it is necessary to wait for new observations.

2º **Doubtful or little-known genera of CRINOIDS**.

We cannot mention here the genera, more numerous every day that, in recent times in America, England or in Belgium have been established on single fragments or on incomplete or non-adult specimens. These genera, as we have said before, whatever their importance from the paleontological point of view, do not have the same interests for

zoologists. We only recall that the ringed conical stalks, fossils from the Silurian terrain, named first *Cornulites* by Schlotheim, and that Miller has made the genus *Tentaculites*, have been regared by Volborth as coming from *Echinoencrinites*.

We cite finally, to end, the genera *Lageniocrinus, Hydreionocrinus* and *Pisocrinus* of De Koninck. The latter, from the Upper Silurian limestone of Dudley (England) has thus been name πισον, pea, because of its globular form. It contains two species, *P. pilula* and *P. ornatus* (*Bull. Acad. sc. Bruxelles*, 6 février 1858). *Hydreionocrinus* described in the same collection, takes its name from it resemblance to a watering can (υορειον) and contains three species from the Carboniferous terrain of Great Britain, *H. woodianus, H. scoticus* and *H. globularis*.

As for *Lageniocrinus* (λαγηντον, small vessel), described and figured in the work of De Koninck amd Lehon on Crinoids from the Carbonoiferous terrain of Belgium, at Visé, must simply be a nascent calyx that must be completed later by the production of supplementary parts, of arms, openings, etc. In fact, the specimen described, length only 6 millimeters and width 3.5, is completely closed and only composed of three basals, one smaller, and two whorls of five radials, of which the second ones, in the form of a curvilinear triangle, join at the top to form the vault.

THIRD BOOK

OPHIUROIDS.

(οφις, serpent; ουρα, tail.)

DEFINITION.

Marine animals, rayed, crawling on the bottom of the sea or on marine plants, formed of a leathery disk, bare or covered with scales, that contains all the viscera, and five very flexible arms, simple or branched, each supported by series of internal vertebral pieces, and bare or covered with granules, scales or spines, and fleshy tentacles for respiration.

No ambulacral gutters.

No feet with suckers, no pedicellariae.

Mouth located in the middle of the lower surface of the disk and opening directly into a stomach in the form of a sac without an anus. The mouth is circumscribed by five reentrant corners corresponding to the intervals of the arms and ordinarily with a vertical series of papillae or calcareous pieces with the function of jaws. It extends, moreover, along five slits also with papillae or calcareous pieces that correspond to the axis of the arms. From the end of each of these slits leaves a series of calcareous pieces in the form of vertebrae that fill all the interior of the arms, leaving in the middle of their lower or ventral surface a groove for the feeding vessels and laterally between their expansions, cavities with fleshy retractile tentacles.

The visceral cavity opening by one or two slits on the ventral surface of each side of the base of the arm, covered interiorly by cilia and containing the ten reproductive organs.

REVIEW

The Ophiuroids, very common on all the shores, were noted by fishermen very early because of their very unusual form and their arms so similar in form and movements to the tails of serpents or lizards. But the first naturalists, judging them only from the exterior, united them with Asteroids of Sea Stars, It is thus that Linck, in 1733 (*De stellis marinis*), was the first to describe and figure some Ophiuroids under the common name of *Stella*

marina, designating two of them under the names of *Stella lacertosa* and *Stella longicauda*, to express the resemblance of their arms with the tails of the lizard. Another, with long spines, was named *Rosula scolopendroides*, to express at the same time two other kinds of resemblance. However, the same author already distinguished by the name of *Astrophyton*, because of the ramified arms, the *Euryales* that, for us also, form a particular family among the Ophiuroidea. Seba, according to Linck, also figured several Ophiurois among the Sea Stars. Pennant, in his British Zoology (1776–1771) and 0. F. Müller, in his Zoologia danica (1788) descried still others under the name of Asterias and it is under this name that all the species of previously known Ophiuroids and Euryales are listed in the 13° edition of the *Systema naturæ* of Linné, published by Gmelin in 1789. It was Lamarck who, in his *Système des animaux sans vertébres* and in his history of the same animals (1816), established definitively the two genera *Ophiura* and *Euryale*, taking for type of one *Asterias ophiura* of 0. F. Müller and for type of the other, *Astrophyton* of Linck. At the same time, in his last work, he describes or indicates 6 species of Euryales and 18 species of Ophiuroids, of which 7 were already and described and figured by Linck, 1 by Seba, 3 by 0. F. Müller, and 7 unpublished. Also, he already divided the Ophiuroids into two sections according to whether the arms are round or flat. Sometime previously, Leach, in England, had wanted to substitute for the name *Astrophyton* of Link, the still longer name of *Gorgonocephalus* that could not prevail over the more euphonic *Euryale.* Delle Chiaje (1823–1827) described 2 other Ophiuroids from the Mediterranean, of which one, *O. cordigera*, was already described by Linck. Risso, at Nice, described several more or less distinct ones from the same sea. On the other coast, Fleming, in 1828 (Hist. Brit. anim.) in describing one from the coasts of England, *Ophiura bellis*, previously named by Pennant (Brit. Zool.), *Asterias sphaerulata*. Also, Blainville in his *Manuel d'Actinologie*, in 1834, was able to list 28 species of Ophiuroids, 3 unpublished, in sub-dividing them like Lamarck into two sections: one with very short and applied spines on the arms or rays; the others with long and non-applied spines. The same author also accepted the genus *Euryale* and formed from these two genera his family of Asterophydae, the second of his order of Stellerides, to which he assigned the following characters: Body small, discoidal, very flat, with in its circumference appendages more or less elongated, serpentiform, squamous, without lower grooves." This is thus our order of Ophiuroids. Blainville observed, moreover, that his Asterophydids differs really in several points of organization from the true Asteroids.

The following year (1835), Johnston (*Mag. of nat. Hist*., p. 467, fig. 42) made known a new species, *Ophiura neglecta*, from the coasts of England and, in 1836, Agassiz (*Mém. Soc. sc. nat. Neufchätel*), in his *Prodome* of a classification of the Echinoderms made the Ophiuroids the second family of the order of Stelleridae and includes there the Euryales subdivided into two genera (*Euryale* and *Tricaster*) and the Ophiuroids strictly speaking in five genera, of which three fossils (*Ophiurella, Acroura* and *Aspidura*) and two living, *Ophiura* and *Ophiocoma* that approximately correspond to the two sections of Lamarck and Blainville.

We ourselves, in 1840, in the 2nd edition of des Animaux sans vertébres of Lamarck, tried to bring the history of the two genera *Euryale* and *Ophiura* of this author up to date with the latest scientific knowledge. But already, in 1837, in a note on the Euryales, Agassiz had revived the two names of *Astrophyton* and *Gorgonocephalus* to establish the subdivisions of these animals. On the other hand, J. Müller and Troschel began publication

of the works they were to complete in 1844, in their beautiful work on the Asteroids (*System der Asteriden*). These authors, who still united the Ophiuroids and Euryales with the Asteroids, distinguishing them only as families, published in 1840 (*Archiv für Naturgeschichte*, p. 326) first essay of classification in which they divided the living Ophiuroids into five genera: 1° *Ophiolepis*; 2° *Ophiocoma*; 3° *Ophiothrix*; 4° *Ophioderma*, and 5° *Ophionyx*, containing 29 species. Already, the same year (ibId. p. 368), they added three new genera, 6° *Ophipolis*, 7° *Ophiomyxa*, 8° *Ophiocnemis.* But later they recognized that *Ophionyx* is the young age of *Ophiothrix*. Finally, in 1844, in their Système des Astérides, Müller and Troschel established three new genera for the Ophiuroids strictly speaking: *Ophiarachna, Ophiacantha* and *Ophiomastix.* This made 10 the total number of genera. At the same time, they accepted for the Euryales, the three genera *Asteronyae, Trichaster* and *Euryale* that, moreover, they placed between *Ophioderma* and *Ophiocnemis*. These 13 genera then contained 83 living species, to which it is neccesary to add 44 fossil species separated into 3 genera.

Forbes, in his Histoire des Astéries de la Grande-Bretagne (*A Hist. of Brit. Starfishes*, 1841), formed of the Ophiuroids, under the name of Spinigrades, the second order of Echinoderms containing 13 species in the 3 genera *Ophiura, Ophiocoma* and *Astrophyton.* And two years later, in 1843 (*Trans. of the linn. Society*), he proposed the establishment of several new genera, namely: 4° *Pectinura*, which corresponds to the genus *Ophiarachna*, 2° *Amphiura*, which is near *Ophiolepis*, and 3° *Ophiopsila*, which is near the genus *Ophiothriae*. He preserved, moreover, the name *Ophiura* to some of the *Ophiolepis* of Müller and Troschel.

In 1840, Grube, in a publication on the Echinoderms of the Mediterranean, had given new details on seven *Ophiures* already known and had described two new ones at the samae time as he wanted to restore to *Euryale* the name of *Gorgonocephalus*.

Even more recently, numerous species have been described by Sars, Lütken, Grube, Philippi, etc., and new genera have been proposed, namely: *Ophioplus* by Sars, which takes up the genus *Amphiura* of Forbes; *Ophiocten* and *Ophiactis* by Lütken, in addition to *Ophiopholis* and *Ophiopeza*. At the same time, we have wanted to establish for the more or less distinct fossil species the genera *Geocoma, Ophicoma, Protaster* and *Aplocoma.* On the other hand, numerous works have also been published on the anatomy of Ophiuroids. We cite especially those of Külliker (1841) on their reproductive organs; of Rathke (1841) on the stomach and ovaries; of Müller and of Krohn on metamorphosis, and Gaudry (1851) on the skeleton of these animals. The *Manuel d'Anatomie comparée* of Siébold must also be mentioned here as an excellent summary of what we know of these animals in 1848.

FORM, TYPE, SKELETON AND INTEGUMENT OF OPHIUROIDS.

If the exterior form of Ophiuroids seems, at first glance, to make it necessary to unite these animals with Asteroids, a more attentive observation and especially the study of the interior structure, soon shows that these two orders differ as much between them as they differ from Crinoids and Echinoids.

In fact, here the visceral cavity is absolutely limited to the disk instead of extending into the arms as in Asteroids. And the arms, simple or branched, and without articulated pinnules are supported by a series of calcareous internal pieces, articulated in a series like

the vertebrae of the tail of a serpent or a lizard and that are without any similarity to the articles of the arms of Crinoids except their perfect symmetry, instead of have as in Asteroids, multiple articulated pieces under the integument on each side of the ambulacrum, which is completing missing here.

However, several naturalists, Meckel, Blainville, and especially Gaudry (*Ann. sc. nat*., 1851), have tried to assimilate the type so dissimilar of Ophiuroids to that of Asteroids and Echinoids. For us, as we have said previously, the general type of Echinoderms being reduced: 1° to the notion of the more or less depressed spheroidal form; 2° to the ability to secrete skeletal calcareous pieces that are uniformly reticulated; 3° to the radial disposition of parts, and 4° to carry out nutrition by the cilia of the external or internal surface. This type gives by derivation the Ophiuroids when the discoidal body has arms longer than those of Asteroids, sometimes branched, supported by a series of ossicles in the form of vertebrae serving only as locomotory organs, lacking grooves or ambulacral gutters as well as feet with suckers, and having lateral respiratory tentacles. Finally, here, contrary to what occurs in Stellerides, the integument lacks holes and respiratory organs.

The *skeleton* is especially remarkable by the form of ossicles in the form of vertebrae that fills all the interior of the arms. These pieces, in fact, have on the anterior and posterior surfaces, a transverse groove, a kind of articulated condyle, one directed vertically, the other horizontally so that two of these condyles are always crossing, bending is possible in all directions. These pieces, in addition, have two or several foliaceous discoidal expansions that are more or less bent that have between them cavities for the base of the fleshy tentacles. The basic structure of these calcareous pieces is in addition the uniformly reticulated structure common to all Echinoderms. We can even refer to this skeleton an elongated piece in the form of a sickle that is found in the visceral cavity on each side of the base of the arms in relation to the reproductive organs, and especially the small ossicles that are ordinarily on the edges of each of the five slits that leave the mouth in the direction of the arms and those that, superposed into a pile, make the protruding part of each of the five reentrant cornes that surround the mouth and function as teeth. The integument is always tough and made of a thick skin. It is sometimes bare (*Ophiomyxa*) or covered with very many calcareous granules (*Ophioderma*) or even covered with overlapping scales as in lizards (*Ophiolepis*). Similar scales often cover the dorsal surface of the disk, even more often, have one or several pairs of plates or shields that provide good characters for the distinction of species. In addition to granules, plates or scales, the integument has articulated spines that are more of less long, variously modified by serrations or hooks that have exactly the same reticulated structure as the spines of Echinoids. It is thus correct that they are covered with a ciliated epithelium and that also contribute to respiration. The same observation can be made in regard to the plates, scales, and in general, all the calcareous productions of the integument.

NUTRITION IN OPHIUROIDS.

Ophiuroids have an external and an internal respiration. This takes place in the general cavity of the body only, i. e., the disk because, as we have already said, this cavity does not extend in any way into the arms. It has as the principal agent the movement of the cilia of the epithelium that covers the internal surface as well as all the viscera. Water

penetrates into the interior of the body by one of the slits on each side of the base of the arms. by the one nearest the mouth and leaves by the furthest from the mouth. This opening or slit serves at the same time for the release of eggs. When there is only one slit at the base of the arms, the ends of this single slit play the role of the two particular slits whose position corresponds, while the middle replaces the others. As for external respiration, it is by special organs, the tentacles that are fleshy, hollow and tubular on each side of the arms, between the scaly plates and the lateral parts of the median gutter of each arm or each branch when the arms have this particular disposition, as is seen in Asterophydids. These tubular organs are most often protected by spines or special scales, whose number and form are very variable and are excellent specific characters. A vessel that extends longitudinally under the integument of the median gutter of the arm conducts the nourishing fluid into contact with the oxygen dissolved in the water. We cannot doubt moreover that the protuberances or mobile spines that arm the arms that we just mentioned above and that have a structure so similar to that of the protuberances of Urchins, cannot also contribute to external respiration by the cilia that covers their surface.

The digestive cavity opens by a mouth armed with spines or calcareous papillae that are to some degree a part of the skeleton and make teeth. The digestive tube strictly speaking consists of a kind of stomachal sac that occupies the center of the hollow disk of their body. Its periphery is divided into several culs-de-sac that are not very deep, by walls that protrude into its interior. But these recesses, that correspond to the rays, never extend into the latter. They are ordinarily ten in number, and n Asterophoydids are subdivided into smaller culs-de-sac. Ophiuroids have no annexes to intestinal canal. We never find them nor coeca strictly speaking, nor glands of any kind. This intestine is blind, i. e., there is no anal opening.

REPRODUCTION, REGENERATION, GENERATION AND METAMORPHOSIS OF OPHIUROIDS.

Although in most Echinoderms the sexual organs of males and females have an appearance and aspect nearly similar in the two sexes, especially outside the period of reproduction because, on the contrary, at this time we quite easily distinguish them by a difference in color of the organs. The testes and the ovaries consist of very complex lobulated and stalked utricles. They are arranged in pairs in the inter-brachial spaces of the disk and are then constituted of ten deeply incised organs, so that the lobes that result seem fixed on the stalk like special pockets. These pockets are sometimes divided into smaller lobules that are smaller and diversiform. In some cases, each testis or ovary is cut into lobes everywhere and made into a kind of ram's horn. This is what we see very well in *Ophiothrix fragilis*. The stalk that thus supports the genital organs is usually directed toward the buccal region, but we still do not know if the products of generation are expelled by the mouth or fall directly into the general cavity of the body and from there expelled outside by the respiratory slits. This is, in fact, the interpretation that seems more probable.

As for the products of generation, they consist of eggs, which give birth to vermiform larvae that, observed for the first time by J. Müller, were described under the name of *Pluteus paradoxus*. Krohn has observed two species of Ophiuroids whose embryos never transform into a larva with the form of a *Pluteus*, but metamorphoses into a radial being

nearly immediately after exit from the egg. One of these embryos is ciliated. It has an oval form. It posterior form, larger than the rest, gives birth to the Echinoderm, while the anterior part is resorbed little by little and ends by disappearing completely. The first rudiment of the Ophiuroid appears in the form of a disk whose free surface, i. e., that does not face the embryo, is destined to become the ventral surface of the definitive Echinoderm. This ventral surface has in its center, a depression that, later, will be the mouth. Soon after, five prominences are seen on the edge of the disk and show the radial nature. These are the five branches of the arms that begin to appear. Then the feet and tentacles are seen in the form of calcareous spinules with three branches or are deposited in the skin and the Ophiuroid is not slow to emerge and take shape in a distinct manner.

Ophiuroids, like most Echinoderms, enjoy the property of reproducing some of their parts. We see, in fact. Some of these animals whose arms, after having been mutilated accidentally, are reproduced in a way to replace the parts removed.

BEHAVIOR AND HABITS OF OPHIUROIDS.

Ophiuroids move by more or less abrupt contractions of their arms. These contractions produce a succession of undulations similar to those of the body of a serpent and do not at first make a well determined progress and movement of the animal, it is no less accomplished toward the goal of the animal. Some species enjoy an ability of very rapid locomotion and are noted by their agility. Some, like *Trichaster*, are enmeshed in the branches of Gorgonians and appear to live there, fixed by their arms, for a more or less long time, seizing passing animals like spiders in their web. Most species live in crevices of rocks, other on sandy bottoms, etc. We have cited a species of Ophiuroid that enjoys the singular ability of phosphorescence such as has been described by Viviani under the name of *Ophiura noctiluca*.

CLASSIFICATION OF OPHIUROIDS.

All Ophiuroids have five arms. In most, the arms are simple but sometimes they are branched, an essential character that permits us first of all to divide these animals into two large families: Ophiuroidae and Asterophydae. Then, consideration of the number of genital openings in the interbrachial areas gives the possibility of establishing some tribes. Finally, the various conditions of the skin, i. e., presence of absence of scales, papillae or spines, especially around the mouth, are the source of generic distinctions easy to observe.

OPHIUROIDEA.

A. Two or four genital slits.
a. Arms always simple. …….. OPHIURIDAE

B. Ten genital slits.
b. Arms simple or branched. ……. ASTEROPHYDAE

GEOGRAPHICAL AND PALEONTOLOGICAL DISTIRIBUTION OF OPHIUROIDS.

Ophiuroids inhabit nearly all the seas. The temperate regions of the globes of both hemispheres are, however, relatively richer than the topical regions. The generic forms appear less varied in the first while, on the contrary, the species seem increased in the second. Referring to paleontology, they appear for the first time in the Paleozoic terrains where they are represented by a single genus. We see them increase in the Triassic that has two genera. Then, in the Jurassic terrains where they exist in the same proportion, and finally in the Cretaceous terrains we are offered only a single genus. The Tertiary terrains offer us no species.

The Ophiuroids in the fossil state are seen only in the form of impressions between the layers of calcareous or schistose rocks. It is thus in fact that we find them in the lithographic limestone of Solenhofen.

They thus can be only imperfectly known. However, we can see particularities rather different from what we see in living species and that have required the establishment of distinct genera. Agassiz, the first, in 1836, established for species already figured by Goldfuss under the name of *Ophiura*, the genera *Ophiurella, Acroura* and *Aspidura*.

In 1847, D'Orbigny proposed the genera *Palaeocoma, Geocoma, Aplocoma* and *Ophiocoma* for species already described as Ophiuroids by Phillips, Munster, Roemer, Müller and Forbes. Finally, the last author established the genus *Protaster* for a fossil species from Silurian terrains. In summary, the oldest species of Ophiuroid is thus *Protaster* that is found in the Upper Silurian, the muschelkalk or concthhylian limestone containing four species, two *Acroura,* an *Ayplocoma* and an *Aspidura*. Three other species, a *Palaeocoma,* an *Ophiurella* and a species left with doubt in the Ophiuroids strictly speaking (Ophiuroid of Williamsson) belonging to the Lias. *Acroura cottaldina* comes from the Lower Oolith. *Ophiurella speciosa* and *carinata* (*geocoma* d'Orb.) are from the Oxfordian terrain. *Ophiurella bispinosa* is from the coral-rag (Corallian). The Cretaceous terrains furnish for the Neocomian terrain, *Acroura cornueliana*. Finally, four species are from the chalk terrain, the White Chalk (Senonian).

FIRST FAMILY. OPHIURIDAE.

Body discoidal, with five simple arms, often proportionally very long, articulated with the body and with very great mobility. These arms are solid, not hollow in the interior, without grooves ventrally, without connections with the intestinal canal. No oanus. Madrepore plates disappear with the adult age.

The family of Ophiuroidae constitutes a very clear group perfectly characterized by its simple non-branched arms attached to a relatively small disk. — This family has for

type the genus Ophiura, which is in fact the oldest known but from which a rather larger number of generic sections have been established recently. It is in considering the number of genital slits in the interbranchial areas, as well as the presence or absence of dental papillae around the mouth that we can distribute the genera that constitute the family Ophiuridae into three principal sections. In the first section, the number of genital slits is four. A second contains those that have only two and dental papillae. A third unites those that, with two genital slits, have a disk that is bare or covered with hard plates.

We owe to Müller and Troschel a very extended work on the family Ophiuridae. These authors have, correctly, established a rather large number of generic sections that have been accepted by all zoologists. — All these sections have been made at the expense of the genus *Ophiura* as understood by previous authors, Lamarck in particular. We can wonder why these gentlemen have not preserved the genus with the name *Ophiura* strictly speaking. We think, with Forbes and Lutken, that we must, in fact, preserve a genus *Ophiura* of which *Ophiura texturata* is the type. The numerous genera of the family Ophiruidae can be grouped as follows.

FIRST SECTION.

Four genital slits ……. G. OPHIODERMA.
OPHIOCNEMIS.

SECOND SECTION.

Two genital slits

A. Disk covered with hard plates. …… G. OPHILEPIS.
OPHIOPEZA.
OHIONEREIS.
OPHIURA.
OPHIOCTEN.
AMPHIUR A.
OPHIACTIS.
OPHIOSTIGMA.
PECTINURA.
OPHIOCOMA.
OPHIORACHNE.
OPHIOACANTHA.
OPHIONASTYX.

B. Disk bare …… G. OPHIOMYXA.
OPHIOBLENNA.
OPHIOSCOLEX.
OPHIOPSILA.
OPHIOTHRIX.

1st GENUS. **OPHIODERMA**. *OPHIODERMA*. — Müller, Troschel.

(οφις, serpent; δερμα, skin.)

Ophiura (pars), Lamarck.

Disk granular. Arms with papillae or spines on lateral parts, not very developed. Two genital slits, one after the other along each arm, on both sides of the interambulacral area, one near the mouth, the other at the edge of the disk. Buccal slis with large papillae.

The genus *Ophioderma* was established by Müller and Troschel (*Syst. der Asteriden*, p. 83), for species that had been confused with *Ophiura.* The type is *Ophiura lacertosa*, Lamarck.

Ophiodermas are remarkable for the simple and nearly smooth aspect of their body, because the granules and spines are so fine and regular that they give the arms everywhere the appearance of the skin of an Ophidian.

The number of known living species is not very great. Those that are fossils are even less numerous. They all come from the Lias.

1. LONG-TAILED OPHIODERMA. *OPHIODERMA LONGICAUDA*. — Müller, Troschel.

— *Stella lumbricalis longicauda*, Linck, t. XI, n° 17.— Seba, Thesaurus, t, V, f. 1–2.— *Asterias longicauda*, Rerzius, Dissert., p. 28.— *Ophiura lacertosa*, Lamarck, An. s. vert., 2e edit., t. III, p.28 0,—Encyclop . méthod., pl. 122, f.4, and pl. 123, f, 1. — *Asterias ophiura*, Delle Chiaje, Mem. tab. 20, f. 1. — *Ophiura lacertosa*, Bronn, Syst. der Urwalt., t. 11, f. 5.— *Id.*. Grube, Act., p. 116.— *Ophioderma longicauda*, Müller, Troschel., Syst. der Aster., p. 86, f 1.

Disk uniformly granular above and below. Buccal opening in the form of a star with five branches have well marked buccal slits surrounded by small plates arranged in series, the two lower one more developed making a point of support for a dental pile whose elements converge while decreasing toward the center of the mouth. At the origin of the arms, in each inter brachial space, is a large plate that is oval and traverse on which are the two lower genital slits. The two others are located more outside, near the edge of the disk. All four are arched, directed in the axis of the arms. The arms are rather long, thin and nearly cylindrical. They have below plates that are scaly and transverse that, at the base of the arms, are five times as wide as long and that often are irregularly divided into three or four pieces. The plates of the ventral surface are as wide as long and are rounded at the top. The lateral plates have a row of 10 to 11 papillae that are short, flattened and blunt, applied the length of the arms and not reaching the following row. Two small valvular scales, also flattened, protect the tentacular pores.

Sometimes, under the granules of the dorsal surface of the disk, we see at the origin of the arms two radial plates, separated from each other and approximately the width of the arms.

Color uniformly greenish brown or most often brown with yellow rings on the arms. The body itself sometimes has yellow patches.

Dimension.— Disk 25 mm, arms 410 mm.

Inhabits the Mediterranean.

2. ASH-COLORED OPHIODERMA. *OPHIODERMA CINEREUM*. — Müller, Troschel.

— Müller, Troschel, Syst. der Aster., p. 87.

Disk width 14 mm. Arms three and a half times as long as the diameter of the disk with narrow dorsal plates, only three times as wide as long and generally entire. The lateral plates have conical and pointed papillae with two valvular scales with each tentacular pore. Radial plates of the disk rather large.

Inhabits the Antilles.

This species that makes part of the collections of the museum of Vienna appears to be very near *O. longicauda.* According to observations of authors, it differs first by its proportionally shorter arms, then by its narrower and more entire dorsal plates while the radial plates of the disk are a little larger. Finally, the papillae of the lateral plates of the arms are more conical and pointed.

3. WAHLBERG'S OPHIODERMA. *OPHIODERMA WAHLBERGII.*— Müller, Troschel.

— Müller, Troschel, Syst. der Aster., p. 87.

Disk large with radial plates that are smooth and with sparse scales. These scales are round or oval, particularly on the contour of the disk and the ventral surface. Arms three times as long as the diameter of the disk with dorsal plates approximately three times as wide as long, generally not divided. The ventral plates are rounded at the top. Each side of the arms has transverse rows of seven papillae. They are small, truncated and do not completely go to the end of the following article. The tentacular pores have two valvular scales, of which the more external is located before the lowest of the papillae.

Dimensions. — Disk width from 24 to 50 mm.

Color uniformly brown.

Inhabits Port Natal.

This species was observed by Müller and Troschel in the museum of Stockholm.

4. ANTILLEAN OPHIODERMA. *OPHIODERMA ANTILLARUM*. — Lutken.

— *Ophioderma cinereum*, M. T. ? — *Ophioderma antillarum*, Lutken, Addit. ad Hist, OphiurId. p. 88, pl .1, f. 1.

Disk with rather large bare radial plates and small buccal plates, wider than long, rounded and obscurely trigonal, separated from oval papillae by a granular zone. Small plates bifid or more divided at their end, but always irregular, covering even the dorsal surface. The lateral part of the arms has series of nine or ten spines, not of which equals in length the dorsal plate.

Color grayish or varied from white and gray.

Inhabits the West Indies.

5. REDDISH OPHIODERMA. *OPHIODERMA RUBICUNDA*. — LUTKEN.

— Lutken, Addit. ad Hist. Ophiurid., 1858, p. 90, tab. 1, f. 2.

Disk with bare radial plates, smaller than in the preceding species (*0. antillarum*). Buccal plates larger, nearly touching the papillae of the same region. Dorsal plates of the arms entire. The lateral spines increase from upper ones to lower ones.

Color reddish, taking a varied disposition.

Species very near *O. antillarum*.

Inhabits Saint Thomas in the Antilles.

6. OPHIODERMA OF PANAMA. *OPHIODERMA PANAMENSIS*. — Lutken.

— Lutken, Addit. ad Hist, OphiurId., p. 91, 1858.

This species differs from *O. antillarum* by the non-divided dorsal plates of the arms and by its smaller lower row of spines.

Its color is olive green.

Inhabits Panama.

7. SCALY OPHIODERMA. *OPHIODERMA SQUAMOSISSIMA*. — Lutken.

— Lurken, Addit. ad Hist. OphiurId., 1858, p. 92, pl. 1, f. 7.

Disk with rather small radial plates and large buccal plates, on the contrary, wider than lone and separated from the buccal papillae by very narrow granular zones. Dorsal plates of the arms regularly divided. Seven lateral spines regularly decreasing from top to bottom, the last or lowest approximately equal to the diameter of a dorsal plate.

Inhabits the West Indies.

8. GREEN OPHIODERMA. *OPHIODERMA VIRESCENS*.— Luten.

— Lutken, Addit. ad Hist. Ophiurid., 1858, p. 92, tab. I, f. 4.

Disk with granular radial plates and buccal plates that area long and wide, triangular, but with blunt corners and covered with small plates with more or less granular surroundings.

Arms slender, laterally armed with eight or nine short and flattened spines, not quite equaling the diameter of the dorsal plates that are always entire.

Inhabits the Antilles, West Indies: Saint Croix, Saint Thomas.

9. OPHIODERMA ELAPS. *OPHIODERMA ELAPS*.— Lutken.

— Lutken, Addit. ad Hist. Ophiurid., 1858, p. 93.

This species differs from the preceding by the number of brachial spines, which are flat and seven or eight in number. They are moreover very close together and unequal. The upper ones equal the diameter of the dorsal plates, the lower ones, on the contrary, greatly exceed them.

Inhabits the West Indies.

10. SHORT-TAILED OPHIODERMA. *OPHIODERMA BREVICAUDA*. —-Lutken.

— Lutken, Addit. ad Hist. Ophiurid., 1858, p. 94, tab. I, f. 3.

Disk thick, covered with large, rounded granules. Buccal papillae wider than long, trigonal and rounded at one of their ends. Arms rather short, rugose, with non-divided dorsal plates and lateral plates with eight or ten very short and flattened spines, the lower ones being longer than all the others, but not exceeding the diameter of the dorsal plates.

Inhabits the West Indies, Saint Croix, Saint Thomas (Antilles).

11. SPOTTED OPHIODERMA. *OPHIODERMA GUTTATA*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, p. 95, tab. I, f. 8.

Disk covered with depressed granules and with buccal plates that are short, rounded or slightly trigonal, but nearly equal in length and width. Arms smooth, with dorsal plates irregularly divided. 9 or 10 lateral spines that are thin, pointed, nearly equaling the height of the plates.

Inhabits the West Indies, Saint Thomas (Antilles).

12. SNAKE OPHIODERMA. *OPHIODERMA SERPENS*. — Luken.

— Lurken, Addit. ad Hist. OphiurId., 1858, p. , tab. I, f. 6.

Buccal plates longer than wide, oval, a little wider on the external side. Buccal papillae elongated, trigonal, embracing the base of the arms, but then not very apparent. Dorsal plates of the arms deeply divided into two or three parts. Seven or eight lateral spines on each ring, very rarely united, exceeding the diameter of the lateral plates.

Inhabits the coasts of Brazil.

13. OPHIODERMA OF JANEIRO. *OPHICODERMA JANUARII*, — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, p. 97, tab. I, f. 5.

This species greatly resembles the preceding (*0. serpens*). Thus, the buccal plates and the small papillae are approximately the same, but we find at the base and on the sides of the arms, several conspicuous scales. The ovarian slits are also not very deep. Finally, the arms have 8 very thin spines strongly associated and nearly the same size as the diameter of the dorsal plates.

Inhabits the coasts of Brazil, Rio Janeiro.

14. VARIEGATED OPHIODERMA. *OPHIODERMA VARIEGATA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, p. 37.

Buccal plates, buccal papillae and slits of the disk as in *Ophioderma serpens,* Only the lateral spines of the arms are longer and on the contrary shorter than in *O. januarii*, Lutken.

Inhabits the west coasts of America. Realejo.

FOSSIL SPECIES

15. EGERTON'S OPHIODERMA. *OPHIODERMA EGERTONI*. — Broderip.

— Broderipr, Trans. géol. Soc., 2^{e} sér., t. V, pl. 12. — Id. Forbes, Proc. géol. Soc., t. IV, p.233.

Disk slightly flattened, subpentagonal, nearly rounded, with arms that are cylindrical, smooth and elongated, whose articles or vertebral ossicles are trilobed.

Fossil of the Lias of Bridport, England.

16. THIN-ARMED OPHIODERMA. *OPHIODERMA TENUIBRACHIATA*. — Forbes.

— Forbes, Proc. géol. Soc. t. IV, p. 233, f. 5. — Id., Charlesworth, Lond. Géol. York., pl. 2, f. 20. — Id., Pictet, Traité Pal., t. IV, p. 274.

Disk rather similar to that of the preceding species but the arms are much longer and slenderer, and the vertebral ossicles that constitute them are only bilobed instead of being trilobed.

Fossil of the Lias of England.

2nd GENUS. **OPHIOCNEMIS**. *OPHIOCNEMIS*. — Müller and Toschel.

Ophiura (pars), Lamarck.

Disk polygonal, having above very large radial plates that nearly occupy all the surface and separated from each other by rows of small spiniform scales. Buccal slits bare, without papillae. Arms very long, having five rows of spines of unequal size on the sides.

The genus *Ophiocnemis* was established again by Müller and Troschel (Syst. der Aster. p.87) for the species that had been confused with the Ophiurans. One of them was *O. marmorata*. — The strict characters of this genus are taken from the singular arrangement of the radial plates of the disk that, by their enormous development, their form and arrangement, give to this part of the Ophiurids a more remarkable appearance.

This genus contains only a single species coming from the southern seas.

1. MARBELED OPHIOCNEMIS. *OPHIOCNEMIS MARMORATA*. — Müller, Troschel.

— *Ophiura marmorata*, Lamarck, An. s. vert, 2e édit., t, III, p. 223. — *Ophiocnemis marmorata*, Müller, Troschel, Syst. der AsterId., p. 87.

Disk width 13 mm, nearly entirely covered above by the radial plates that are bare and separated from each other by very narrow bands of small plates, on each of which are one or several granules in small pits. This arrangement results in ten rays that divide the dorsal surface. On the ventral surface, the buccal plates are rounded outside and narrowed to a point toward the mouth. This point is accompanied by two pieces that form with it rounded part.

The dental papillae are serrated and do not form a regular row.

One of the genital slits is located laterally very near the arms. It is separated by a calcareous plate from the second slit that has two calcareous plates on the opposite edge, a small one very near the buccal plate, and finally a larger one all along its length. The interbrachial area is nearly entirely bare and has only some small spines forming a line near the edge. The arms, six times as long as the diameter of the disk have dorsal plats six time as wide as long, rounded toward the end and forming transverse band on all the back, in the middle of which is raised a small keel. The ventral plates of the arms are oval, more

than two times as wide as long, notched in front and in back. The lateral plates of the arms have five spines, of which the upper one is small. The second and the third are larger, the lower ones being very small. This species, marbled in white and gray, has on the nearly whitish arms, having gray bands each with an elongated paler patch.

Inhabits Australia, Peru and Lesueur, Museum of Paris.

3rd GENUS. **OPHIOLEPIS**. *OPHIOLEPIS*, — Müller, Troschel.

(οφις — λεπις, scale)

Ophiura, Lamarck (pars). — 1d., Forbes.— *Ophiopholis*, Müller and TroscjeL (pars).

Disk with bare scales above.

Buccal plates simple.

Buccal slits bordered with spines arranged in a single row, without being more numerous at the protruding corner that has dental pieces. One of these pieces, located at the top, is a little more developed than the others. Arns having laterally spines inserted on the lateral plates. Tentacular pores with one or two valvular scales.

The genus *Ophiolepis* was established by Müller and Troschel from the genus *Ophiura* of Lamarck. In the sense of these authors, the name *Ophiura* should completely disappear. The species that compose it should successively take place in new generic sections. It seemed to them, so to say, arbitrary to apply specially the name *Ophiura* to any of these species. However, this point of view was not followed by all zoologists. We see, in fact, that Forbes maintained the genus *Ophiura* in attributing to it as type *Ophiura texturata* of Linné and even added two other species that he made known at the same time. A little similar method was adopted by Pictet, only the latter includes all the genus *Ophiolepis* of Müller and Troschel as synonymous and attaches to the genus *Ophiura* different fossil species.

In this work, we accept in part the opinion of the Prussian scholars and we accept the genus *Ophiolepis* as they instituted it themselves. Only, with the example of Forbes, we keep a genus *Ophiura* strictly speaking. Understood in this way, the genus *Ophiolepis* forms a group very numerous in species that can be separated into three groups: the first for species in which the dorsal plates of the disk are surrounded by small scales; the second in which the scales do not exist; and finally. the third those that, in addition to scales, have spines on the disk. It is this third group that corresponds to the genus *Ophiopholis* of Müller and Troschel, which appears to have been abandoned by these authors.

** Species whose dorsal plates of the disk are surrounded by small scales.*

1. ANNULAR OPHIOLEPIS. *OPHIOLEPIS ANNULOSA*.— Müller, Troschel.

— *Ophiura annulosa*, de Blainville, Man. Actin., t. XXIV (Non Lamarck). — *Ophiolepis annulosa*, Müller, Troschel, Syst. der Aster., p. 89, pl. 8,

Disk width 22 to 24 mm, covered above with hard plates, surrounded by other plates even smaller. Among all these plates, we distinguish ten a little larger and oval. These are the radial plates strictly speaking. They are arranged in pairs in the direction of the arms. Between them there are three scales forming a longitudinal row in each interval, which is ended by two scale placed transversely at the base of the rays. In the interbrachial areas of the back we also see three longitudinal rows of scales, of which a median is little developed. The central has on the outside some smaller scales that are irregularly arranged. Arms two times or two and a half times as long as the diameter of the disk and rounded above. The ventral plates are very wide and rounded at the top. The lateral plates have six or seven spines that are very small, cylindrical, only reaching the middle of the following plates. The tentacular pores have two valvular scales. The buccal plates are small, longer than wide and ended by a triangular edge. Genital slits bordered by a long and wide cord of small plates.

Color a reddish brown above with transverse bands of dark violet on the arms and five patches forming a kind of star-shaped ring on the disk. The interbrachial areas of the ventral surface also have also their end of a dark violet.

Inhabits the seas of India, the Red Sea.

2. BANDED OPHIOLEPIS. *OPHIOLEPIS CINCTA* — Müller, Troschel.

— Müller, Troschel, Syst. der Aster., p. 90.

Disk width 14 mm, having on the dorsal side plates or scales all of the same size, in the form of tiles and surrounded by very small scales on their convex edge. In the middle of the disk is a single larger scale. Between the two radial plates, whose dimensions are greater than the others, are two scales or plates following each other and separated from the dorsal surface of the arms by two other scales located transversely next to each other.

The scales of the interbrachial areas are not formed of regular series. The buccal plates are small and as wide as long. They have a border of small scales at their external edge. The rim that surrounds the end of these plates is quadrangular and has two nearly parallel edges. The arms, two and a half times as long as the diameter of the disk, are rounded above. Their ventral plates of quadrangular, as long as wide, with the external edge nearly straight and with a border of very small scale. Each lateral plate of the arms has three or four conical spines, extremely small.

The tentacular pores are protected by two small valvular scales.

Color brown, with bands alternatively pale and obscure on the dorsal of the arms.

Inhabits the Red Sea.

3. OPHIOLEPIS WITH FEW SPINES. *OPHIOLEPIS PAUCISPINA*.— Müller and Troschel.

— *Ophiura paucispina*, Say, Journ. Acad. Sc. Philad. p. 149, t. V. — *Ophiolepis paucispina*, Müller and Troschel, Syst. der Aster., p. 90.— Id. Id., Lutken, Addit. ad Hist. OphiurId., 1859, p. 102, t. IL, f.2.

Disk width 5 to 6 mm, covered above with small concave plates, surrounded by even smaller scales. The arms have triangular plates above with an anterior corner with two very small scales that are also triangular, one on each side. The ventral plates have a very pronounced concavity in which are two small scales. Each lateral plate has two very small scales applied against the following plate, of which they do not reach the middle.

Color whitish, with dark rings on the arms.

Inhabits the coasts of Florida, Saint Thomas.

** Species whose dorsal plates of the disk are not surrounded by small scales.*

4. SPOTTED OPHIOLEPIS. *OPHIOLEPIS PUNCTATA*. — Müller and Troschel.

— *Ophiocoma punctata*, Forbes, Brit. Starfish., p. 37. — *Ophiolepis punctata*, Müller and Troschel, Syst. der Aster., p. 92.— Id., Gray, Cat. Brit. Mus., p. 24, n° 4.

Disk width 5 ½ mm, covered above with scales in the form of tiles, with one larger scales located in the very center. The radial plates are long, narrow, and triangular. They diverge from their base where they touch. On the ventral surface, the buccal plates are wide and oval. The arms, six times as long as the diameter of the disk, have dorsal plates that are oblong, keeled in the middle with a deep impression in front. The ventral plates as longer than wide. They have on each side five spines shorter than the diameter of the arms.

Color uniform reddish gray.

Inhabits the coasts of England.

5. SUNDEVALL'S OPHIOLEPIS. *OPHIOLEPIS SUNDEVALLII*. Müller and TroscheL

— *Ophiolepis sundevallii*, Müller and Troschel, Syst. der Aster., p. 93.

Disk width 11 ½ mm, covered above with scales in the form of tiles, with a large scale in the center, surrounded a some distance by five other scales forming a kind of rose, of which each branch corresponds to an arm. The radial plates are separated by a row of large scales. The ventral surface of the disk is also covered with small scales. There are only four spines on each protruding corner of the buccal slits. The two externals are pointed, while the two middle ones are blunt. Further back, toward the base of the arms, is a small scale. The buccal plates are very small and completely rounded.

Arm length 64, covered above with dorsal plates nearly two times as wide as long and rounded at their end. The ventral plates are quadrangular, and each lateral has four spines nearly as long as the diameter of the arms.

Tentacular pores with only one valvular scale.

Color yellowish red with a pale line on the dorsal side of the arms.

Total size: 138 mm.

Inhabits Spitzberg.

6. TENOR'S OPHIOLEPIS. *OPHIOLEPIS TENORII*. — Müller and Troschel.

— *Asterias tenori*, Delle Chiaji, Mem. an. s. vert,, tab. XXI, f. 7–11, — *Ophiolepis tenorii*, Müller and TroscheL, Syst. der Aster,, p. 93.

Disk covered above with scales in the form of tiles, with triangular radial plates that only in a point and differ little from the scales. The ventral surface of the disk has buccal plates wider than long. The arms have their dorsal and ventral plates longer than wide, convex at the end. The lateral plates have a row of four sharp spines, of which the upper is a little longer than the others. It nearly equals the length of a dorsal plate.

Color is greenish with white dots.

Total dimension: 27 mm.

Inhabits the Mediterranean.

7. IMBRICATED OPHIOLEPIS. *OPHIOLEPIS IMBRICATA*.— Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 93.

Disk width 23 mm, covered with scales in the form of tiles, not forming distinct rows and without particular radial plates, the latter being replaced by oblong spaces of shiny black fine granules. The ventral surface of the disk has buccal plates that are small and wider than long. There are two in the form of rods that border them toward the mouth. They are a little curved and nearly parallel. The buccal plate that has the madrepore tubercle is larger than the others and has four dissimilar pores. The arms, more than three times as long as the diameter of the disk, have quadrangular ventral plates a little wider than long. But instead of dorsal plates, they are covered with rather numerous scales, among which we can distinguish seven longitudinal rows. The lateral plates have three spines, of which the upper is shorter and the lower is longer and even passes the height of a ventral plates. The tentacular pores are protected by one or two valvular scales.

Color greenish, with some patches or dark lines on the disk and many alternating pale and dark bands on the arms that makes it appear marbled.

Total length: 155 mm.

Inhabits Mauritius, Seychelles and Timor.

8. DOUBTFUL OPHIOLEPIS. *OPHIOLEPIS DUBIA*.— Müller and Troschel.

— *Ophiura* ..., Savigny, Egypte Echinod., pl. 1, f. 3. — *Ophiolepis dubia*, Müller and Troschel, Syst. der Aster., p. 94, sp. 11.

Disk pentagonal, irregularly scaly above without distinct radial plates. Mouth with simple buccal slits, with rounded plates whose internals, a little larger, is also blunt and short. Arns very long and slender, having very rounded dorsal plates in front of quadrangular ventral plates that are longer than wide, notched at their base. The lateral

plates, well developed. Each has three or four erect spines, approximately the length of the dorsal plates.

Tentacular pores protected by a valvular scale, associated with one of the lateral spines.

Color brownish. The arms have patches or bands alternatively pale and dark, each spine with a kind of dark ring near its base. Each buccal plate also has a small patch darker than the others.

Inhabits the Red Sea.

9. SAVIGNY'S OPHIOLEPIS. *OPHIOLEPIS SAVIGNYI*. — Müller and Troschel.

— *Ophiura*. ....; Savigny, Descr. Egypte Echinod., pl. 2, f. 45. — *Ophiolepis savignyi*, Müller and Troschel, Syst. der Aster, p. 95.

Disk covered above with very small scales, with very large radial plates and close together in a way to leave between them only a single row of small scales. Buccal plates small, rhomboidal, with rounded corners and with two large triangular dental pieces. Arms having elliptical dorsal plates, two times as wide as long and quadrangular ventral plates, a little longer than wide, with slightly blunted corners. Each lateral plate has seven spines that are short, thick and blunt, approximately the length of an article of the arms. Two valvular scales to the tentacular pores.

Color: the radial plates of the disk are dark, a pale patch is seen toward the base of the arms, that have here and there dark patches. At the external edge of the buccal plates are also three small white dots.

Total width: 54 mm.

Inhabits the Red Sea.

This species and the preceding have a very great resemblance between them, principally in regard to their general form and, to some point, their color. But they differ in a very clear manner by the form of the plates of the arms and especially by the number of spines of the lateral plates. There are only 3 to 4 in *Ophiolepis dubia* while we count 7 in *Ophiolepis savignyi*.

10. ELONGATED OPHIOLEPIS. *OPHIOLEPIS ELONGATA*. — Müller and Troschel.

— *Ophiura elongata*, Say, Journ. Acad. Phil., vol. 1, p. 146. — *Ophiolepis elongata*, Müller and Troschel, Syst. der Aster., p. 95.

Disk covered above with small, imbricated scales, with two radial plates that are short and enlarged in each interbrachial space. The arms are very long and very thin. They are formed of articles that are short and covered with dorsal plates that are transversely oval and quadrangular ventral plates. Each lateral plate has three spines that are short and blunt, arranged in three longitudinal rows, the intermediary being more blunt and finely spined.

Tentacular pores with two valvular scales.

Total width …… 162 mm.

Disk …….. 5 ½,

Inhabits Charlestown.

11. RETICULATED OPHIOLEPIS. *OPHIOLEPIS RETICULATA*. — Müller and Troschel.

— *Ophiura reticulata*, Say, Journ. Acad. Sc. Phil. t. V, p. 148. — *Ophiolepis reticulata*, Müller and Troschel, Syst. der Aster., p. 95.

Disk entirely covered with small, imbricated scales. Arm length 88mm, with arms that have dorsal plates that are transverse, quadrangular, a little narrower at the end, with a row of small scales before the last row of spines. Ventral plates also quadrangular, with rounded and blunt corners, more or less notched at the end. The lateral plates have three rows of nearly equal spine, scarcely longer than half the diameter of the arms.

Dimensions: total width …… 102 mm.
diameter of the disk ……. 15 ½.
length of arms …….. 88.

Inhabits the coasts of Florida.

*** *Species that, in addition to scales, also have spines on the disk.* (Genus *Ophiopholis*. Müller and Troschel.)

12. SCOLOPENDRINE OPHIOLEPIS. *OPHIOLEPIS SCOLOPENDRINA*. — Müller and Troschel.

— *Bellis scolopendrina*, Linck, tab. 40, no 71. — Martins, Spitzb., tab. P, f. d, — *Asterias ophiura*, Fabric., Faun. Groenl., p. 371, — *Asterias aculeata*, Retzeus, Vet. Acad., t. IV, p. 240. — Id. Id., O.F. Mull. Zool. Dan., t. XCIX.— Id. Id., Linck, Gmel., n° 3166.— *Ophiura flemingii, O. ammothea*, Leach, Zool. Miscell., tab. 79, fig. 1–3.— *O. Belli*, Fleming, Brit. anim. — *Ophiocoma bellis*, Forbes, Wern. mus., t. VIII, p.126, and Brit. Starfish., p.53. — *Ophiolepis scolopendrina*, Müller and Troschel, Syst. der Aster., p. 96. — *Ophiopholis aculeata*, Lutken, Addit. ad Hist. Ophiur., p. 60 tab. II, fig. 15–16.

Disk covered with scales that are rounded, isolated, most arranged in ten radiating series from the center to the circumference, with intermediary granules that, toward the edge as well as on the ventral surface, are transformed into small tubercles or spines. Buccal plates very small, wider than long. Dental pieces with a wide surface, but whose two ends are sometimes divided into two parts that then take the appearance of papillae or spines. Three spines border outside each buccal slit. Arms three to four times as long as the diameter of the disk, having quadrangular ventral plates. Dorsal plates transversely oval and separated by a row of three small scales that thus form a lateral border. Lateral plates with five rows of spines, flat, blunt and vertical, a little shorter than the diameter of the arms. Each tentacular pore has a valvular scale.

Color brown or a reddish brown, with orangish transverse bands on the arms.

Dimensions: total width ……. 80 to 108 mm.
disk ……. 12 to 24.

Inhabits the northern seas of Europe.

13 OPHIOLEPIS WITH LONG ARMS. *OPHIOLEPIS BRACHIATA*. — Müller and Troschel.

— *Asterias brachiata*, Mont., Trans. Lin., t. VII, p. 84. — *Ophiocoma brachiata*, Forbes, Brit. Startish., p. 45. — *Ophiolepis brachiata*, Mulller and Troschel, Syst. der Aster., p. 96.

Disk covered with small, oval scales, arranged in ten radiating rows, alternatively narrow and wider. The narrowest touch in the interval of two radial plates that have a deep groove located at the end by which they nearly touch each other in converging toward the center. In the interbrachial spaces, the disk is made rough by the presence of a large number of small papillae. The buccal plates are nearly triangular. The arms, extremely long, are from 216 to 496 mm. They are more and more tapered toward their free end and each formed of 300 to 400 articles. These have a double groove below, near the disk. The dorsal plates of the arms have nothing particular. It is the same with the ventral plates. But the laterals are armed with eight or nine spines, very small and blunt, whose upper and lower are a little thicker than the others.

Color a red-brown or sometimes bluish ash gray.

Dimensions: total width:
Disk …… 15 mm.
Arms …….. 190 to 216 mm.

Inhabits the northern seas of Europe and more particularly the coasts of England.

14. BALL'S OPHIOLEPIS. *OPHIOLEPIS BALLII*. — Müller and Troschel.

Disk covered above with imbricated scales, with radial plates that are oblong, triangular, divergent from the center toward the edge and separated by a row of small, oblong scales. The ventral surface is also scaley, but we note in addition, here and there, between the scales, small isolated spines that we also find on the dorsal surface of the disk of adult individuals. Buccal plates small, rounded, with toward the mouth very small plates making a kind of border. Dental edges nearly bare, have only a scaly papilla on each side toward the end of the buccal slits.

Dorsal plates of the arm transversely oval but becoming triangular toward the end of the arms, the point of the triangle toward t heir bae, the opposite edge being on the contrary a little convex. Ventral plates quadrangular, a little wider than long, notched at the top but becoming pentagonal toward the end of the arms. They have one of their corners turned toward the mouth. The opposite side is bilobed.

Each lateral plate has four spines, of which the two median are longer. Their length exceeds a little the width of the ventral plates. Toward the end of the arms, the last spines are noticeably nearer the median line.

The tentacular scales have a valvular scale.

Color uniformly brownish.

Dimension: total width: 40 mm.

Inhabits the Mediterranean.

15. GOODSIR'S OPHIOLEPIS. *OPHIOLEPIS GOODSIRI*. — Müller and Troschel.

— *Ophiocoma goodsiri*, Forbes, Brit. Starfish., p. 57.— *Ophiolepis goodsiri*, Müller and Troschel, Syst. der Aster., p. 97.

This species, still doubtful and insufficiently known, would have the dorsal plates of the disk arranged in a way not to diverge. The dorsal plates of the arms are transversely oval and the ventral plates heart-shaped.

Color white with patches of dark red. The arms have edges or transverse fasces of the same color.

Perhaps it is only a variety of *O. rallii*, M. T.

Inhabits the coasts of England.

16. ROUGH OPHIOLEPIS. *OPHIOLEPIS ASPERULA*.— Phillips.

— Phillips, Archiv fur naturg., 1858, p. 207.

Disk covered below with imbricated scales, accompanied toward the edge, especially between the arms, with small, short spines. The radial plates are small, divergent and ten in number. Their intervals are covered with numerous small scales that form, going from the center toward the circumference of the disk, first three, then two, then finally only one row. The buccal plates are small. The arms are formed of 60 to 70 articles. The dorsal plates, transversely oval, are ordinarily one and a half times as wide as long. The ventral plates are nearly square. The lateral plates each have three spines that are cylindrical and blunt, nearly equal in length, and a valvular scale on each tentacular pore.

Color is ordinarily pale pink or crimson. The ten radial plates each have a white patch on the peripheral end. Sometimes the general color is darker, nearly blackish.

Dimension: disk: 14 mm.

length of the arms …… 51 mm

length of the arms under the spines …. 5.

Inhabits the coasts of Chile, island of Chiloé.

17. LINED OPHIOLEPIS. *OPHIOLEPIS LIMBATA*.— Grune.

— Grube, Archiv Weigm., 1857, p. 353.

Disk with five lobes, not spiny but with on the dorsal side a large number of small scales among which we distinguish some a little larger. The ventral surface also has some of them, but they are smaller and reduced to simple points. Radial plates apparent, some simply linear, those of the center larger and separated by rhomboidal scales. Dorsal plates of the arms transverse, trigonal, shorter than wide, with their upper edge slightly convex. Ventral plates nearly rectangular, not touching, a little wider than long. The lateral plates have three sharp spines nearly equal, a little smaller than the diameter of the arms. Tentacular pores with two valvular scales.

Color pale brown.

Inhabits Rio Janeiro.

18. OPHIOLEPIS WITH SIX RAYS. *OPHIOLEPIS SEXRADIATA*. — GRUBE.

— Grube, Archiv Weigm., 1857, p. 343.

Disk rounded, covered above with small, nearly equal scales and some small, sparse spines. Radial plates oblong, greenish, with a white part at the top, separated by series of small, very narrow scals. Arms with oval dorsal plates, obscurely trilobed anteriorly. Ventral plates ovarl, nearly orbicular and white. Lateral plates not very developed, scarcely visible from above, with very small spines, six on each plate, and smaller than the diameter of the arm. Those of the lower part are still shorter and blunter. Tentacular pores with a single valvular scale.

Color whitish varied with green on the upper part, the radial plates greenish with a white patch at the top. Spines of the arms also marbled with green and white.

Inhabits Honolulu (Hawaii).

It is necessary to add some species described and mentioned by Lutken in his beautiful memoir titled: Addit. ad OphiurId. Hist. 1858–59.

19. *OPHIOLEPIS IMPRESSA*. — Lutken.

— *Loc. cit*., p.101.

Inhabits island Saint Thomas.

20. *OPHIOLEPIS PACIFICA*. — Lutken.

— Lutken, *loc. cit*., p. 104, t. II, f. 4.

Inhabits Puntarenas.

21. *OPHIOLEPIS ELEGANS*.— Lutken.

— *Loc. cit*., p.105.

Inhabits island Saint Thomas.

22. *OPHIOLEPIS VARIEGATA.* — Lutken.

— *Loc. cit*., p. 106,

Inhabits island Saint Thomas.

23. *OPHIOLEPIS? JANUARII*. — Lutken.

— *Loc. cit*, p. 108, tab. II, f. 1.

Inhabits Rio Janriro.

24. *OPHIOLEPIS HISPIDA*.-- Le Conte.

Inhabits Panama.

25. *OPHIOLEPIS GRACILLIMA*. — Stimpson.

— Proceed. Boston Soc. of nat. Hist., vol. IV. — Lutken, Addit. ad Hist. Ophiurid., 1859, p. 117 (in note).

ESPÈCES FOSSILES.

26. MURRAY'S OPHIOLEPIS. *OPHIOLEPIS MURRAYII*.

— *Ophiura murrayii*, Forbes, Proc. géol. Soc., t. IV, p. 233. — 1d., Test., Echin. (Pal. Soc., pl. 4, f. 7). — Id., Pictet, Traité de Palæont., t. IV, p. 274.

Disk very wide in proportion to the arms, covered above with large scales and very large radial plates, wider at their external end and converging toward the center. The arms are relatively short. They are conical and extend from very large and triangular plates. The lateral plates extend onto the ventral plates of the ventral surface where they join on the medial line. These plates have numerous and rather large spines.

Fossil of the Lias of England.

27. GRANULAR OPHIOLEPIS. *OPHIOLEPIS GRANULOSA*. — Hagenow.

— *Aspidura granulosa*, Hagenow, in Leonh. and Bronn, Neues Jahrb., 1840, p. 660, pl. 9, f. 6. (Non *Ophiocoma granulosa* d'Orb., Prodr.) — *Ophiura granulosa*, Pictet, Traité de Palæont,, t. IV, p. 275.

Species mentioned for the first time by Hagenow under the name of *Aspidura*. The little that we know about the characters of this fossil does not permit preserving this association. We thus believe its relations are better expressed in attaching it to the genus *Ophiolepis*.

Fossil of the Upper Chalk (Senonian) of Rugen.

28. SUB-CYLINDRICAL OPHIOLEPIS. *OPHIOLEPIS SUBCYLINDRICA*. — Hagenow.

— *Aspidura subcylindrica*, Hagenow, in Leonh. und Bronn, Neues Jabr., 1840, p. 660, pl. 9, f. 7, — *Ophiura subcylindrica*, Pictet, Palæont. traité, vol. IV, p. 275.

We make for this species the same observations as for the preceding.

Fossil of the Upper Chalk (Senonian) of Rugen.

29. WETHERELL'S OPHIOLEPIS. *OPHIOLEPIS WETHERELLI*. — Forbes.

— *Ophiura wetherelli*, Forbes, Test. Echin. (Paï. Soc., pl. 4, fig. 7). — Id. Id., Pictet, Traité de Palæont., t. IV, p. 275, pl. 95, f. 12.

Disk pentagonal covered above with ten radial plates that are oval, joined in pairs in the interbrachial areas. — The plates, narrower toward the internal end, converge toward the center of the disk. All the center, as well as the spaces that separate the radial plates from each other, are filled with a large number of small scales.

Fossil of the clay of London (Parisian).

30. FURSTENBERG'S OPHIOLEPIS. *OPHIOLEPIS FURSTENBERGII*.

— *Ophiura fürstenbergii*, Müller, 1847. Aachen Kreideform., p. 6, pl. 1, f. 3. — *Palæocoma fürstenbergii*, D'Orbigny, Cours élém., t. II, p. 133, f. 283, and Prodr., t. II, p. 274.

This species, placed by D'Orbigny in his genus *Palaeocoma*, appears, according to the remark of Pictet, to have been the subject of an error of identification, because the figure given by D'Orbigny is very different from that of Müller and does not correspond at all to the generic diagnosis given by D'Orbigny himself when he had in view the typical species (*Palaeocoma Mülleri* d'Orb.). Finally, we make still another remark relative to the deposit of this species. It is that D'Orbigny places it in his Senonian stage, fossil of the Green Sandstone of Aix la Chapelle.

31. CUNLIFFE'S OPHIOLEPIS. *OPHIOLEPIS CUNLIFFEI*.

— *Ophiura cunliffei*, Forbes, in Mus. Soc. géol. and in Trans. soc, Lin., t. XIX, p.

Fossil of the Green Sandstone of India.

Ophiura libanotica, Koenig. Icon. sect, p. 2, f. 26, could equally belong to the genus *Ophiolepis*.

It comes from Micene beds ? of Lebanon.

4th GENUS. **OPHIOPEZA**. *OPHIOPEZA*.— Peters.

— Peters, Neue Ophiuren aus Mozambik in archiv fur naturg., 1852, p. 84.

1. YOLDI'S OPHIOPEZA. *OPHIOPEZA YOLDII*. — Lutken.

— *Ophiarachna cordifera*, Morch, Cat. Yoldi, n° 849, non Bosc. — *Ophiopeza yoldii*, Lutken, *loc. cit*, p. 98.

2. *OPHIOPEZA FALLAX*. — Peters.

— *Loc. cit*. — *Id. Id.*, LUTKEN, *loc, cit*., p. 98.

5th GENUS. **OPHIONEREIS**, *OPHIONEREIS*. — Lutken.

— Lutken, Addit. ad Hist, OphiurId., 1859, p. 110.

This genus, according to the indications of its author, lacks dental papillae, would have the disk covered with extremely fine scales. The radial plate would be nearly hidden. The oval papillae, five in number, have below some time. Finally, the long arms, rather wide, but narrow at their point of insertion with the disk, have lateral spines that are small, smooth and three in number. The dorsal plates are divided into three, of which the median is a hexagon. It contains until now only two species.

1. RETICULATED OPHIONEREID. OPHIONEREIS RETICULATA. — Say.

— *Ophiura reticulata*, Say, *loc. cit*., p. 148. — *Ophiolepis nereis*, Lutken. olim., — *Ophionereis reticulata*, Lutken, Addit. ad Hist. OphiurId., p. 110, tab. 3, f. 6, 1859.

Inhabits Saint Thomas.

2. TRILOBED OPHIONEREID. *OPHIONEREIS TRILOBA*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., f. 112. — *Ophiolepis triloba*, ejusd.

Inhabits Puntarenas.

6th GENUS. **OPHIURA**. *OPHIURA*. — Lamarck.

— Lamarck, An. sans vert. 2e édit.

Disk orbicular, scaly, smooth in appearance only with simple rays, scaly, extended on the very body of the disk and at their origin and applied laterally with spines on the upper edge. Ovarian openings with simple edges, open on the protruding lobes of the interbrachial disks.

This characteristic of the genus *Ophiura* differs necessarily from that given by Lamarck because we have seen a large number of species have been removed to become the types of particular genera. Thus restricted by Forbes, it contains only a very small number of species, of which *Ophiura texturata* is the best known type.

1. NATTED OPHIURA. *OPHIURA TEXTURATA*.— (Lamarck), Forbes.

— *Asterias ophiura*, Müller, Zool. Dun. Prodr., p. 235. n° 2840.— *Asterins ciliata*, Retzius, Diss., p.29, 1783? — *Stella lacertosa*, Lincx, p. 47, tab. 2, f. 4. — Knorr, Delic., tab. G, f. 1-2. — *Asterias lacertosa*, Pennant, Brit. Zool., t. IV, p. 63. — *Ophiura texturata*, Lamarck, An. s. vert., 2e édit., p. 221, — Encyclop. méthod., pl. 123, f. 2-3. — *Ophiura aurora*, Riss., Hist. nat., t. V, f. 29. — *Asterias cordifera*, Delle Chiaje, t. XX, f. 1–2.— *Asterias cordifera*, Grug, Aktin. Echin. Wurm., f. 18.—*Ophiura brachiata*, Fleming, Brit. anim., p. 488. — *O. Id.*, Jonnston, Mag. nat. Hist., t. VIIL, 1835, p. 465. — *Ophiura texturata*, Forbes, Wern. Mem., t. VII, tab. 4, f. 34. — *Ophiolepis ciliata*, Muuller and Troschel, Syst. der Aster., p. 91, sp. 4, pl. 7, f. 1. — *Ophiura texturata*, Forbes, Trans. soc. Lin. Lond., t. XIX, p. 146.

Disk width 45 to 20 mm, covered above with unequal plates in the form of tiles and without small intermediary scales. Radial plates large, very close together, separated however by a row of scales that go while decreasing toward the base of the arms but not present at a young age. In the middle of the interambulacral areas of the back is a row of scales a little larger, and on each side, a rather large number of smaller ones in the form of tiles. The buccal plates are very large, longer than wide and more extended than the distance that separates them from the edge. The edge of their end is very narrow. The first tentacular pore is located at the end of the buccal slit and like it, has on each side a ridge formed of spines at the base of the arms. The point of their union with the disk has a similar ridge that is repeated across the dorsal surface of these arms. The buccal slits have very sharp teeth on the protruding angles of the mouth. The arms, four times as long as the diameter of the disk, are slender and tapered for most of their free end. The dorsal surface has a thick keel in the area of the disk and has scales that, toward the end, are wider than long that, further on, are hexagonal, and finally, toward the end, are on the contrary, longer than wide, rounded at the end and angular on the opposite edge. They form a series interrupted by the lateral plates they encounter in the median region, forming a series of alternating indentations. Each of these lateral plates has three spines that are conical and very short, to which are added two or three wing-shaped papillae corresponding to the tentacular pore.

Color greenish, with darker transverse bands here and there on their arms. Some patches also exist on the disk.

Inhabits the seas of Europe.

This species is very common and is also one of the oldest known if, as has been established by Müller and Troschel, it corresponds to *Asterias ciliata* of Retzius. This latter name, in this case, should have been preserved, but as there still remains some doubt in this regardw and as moreover the name of Lamarck is more generally known, we have adopted it.

2. WHITE OPHIURA. *OPHIURA ALBIDA*.— Forbes.

— Forbes, Wern. Mem. t. VIII, tab. 2, f. 3–6. — *Id.*, Forbes, Trans. soc. Lin. Lond., t. XIX, p. 146, — *Id. Id.*, Lutken, Addit. ad Hist. OphiurId., p. 39, t. 1, f. 2.

Disk pentagonal with pectinate plates with sixteen denticulations at the origin of the arms. Arms convex, covered with triangular dorsal plates, the lateral plates being surmounted by four or five erect spines.

This species, very near the preceding, has even been united by Müller and Troschel, who had considered it the young age of their *Ophiolepis ciliata*. Among the different characters that we can invoke to separate them, it is necessary to cite the much smaller number of denticulations on the pectinate plates at the origin of the arms (16 instead of 20), the not very oval form of the dorsal plates of the arms, and finally, the greater number of spines on the lateral plates, 7 instead of 5, as exists in *O. texturata*.

Inhabits the Mediterranean, the Aegean Sea.

3. ABYSSICOLA OPHIURE. *OPHIURA ABYSSICOLA*. — Forbes.

— Forbes, Trans. of the Soc. Lin. Lond., t. XIX, p. 146, pl. 13, f. 8–14.

Disk covered with pentagonal ovarian plates. The base of the arms has two pectinate scales with five to nine denticulations. Arms keel with quadrangular dorsal plates and lateral plates surmounted by 3 or 4 spines.

Inhabits the Aegean Sea (Asia Minor).

4. PINK OPHIURA. *OPHIURA CARNEA*. — Sars.

— *Ophiura carnea*, Sars and Lurken, Addit. ad Hist, OphiurId., 1858, p. 41, pl. 1, f. 6 ab.

Disk thick, covered with shield-shaped plates, longer than wide. — Buccal slits with a double vertical row of scales covered with papillae on the sides. Arms short and thick, with very short spines. No valvular scales at the tentacular scales.

Inhabits the seas of the North.

Species Species very near *O. albida*, but is distinguished by its thicker disk and arms, by its more pronounced vertical slits of the disk, covered with papillae toward the edge, finally, by its very short spines and by a single scale at the tentacular pore.

5. SARS' OPHIURA. *OPHIURA SARSII*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, p. 42, pl. 1, f. 3–4.

Species distinguished by its buccal plates in the form of shields, longer than wide, scarcely equaling the distance that separates them from the peripheral edge. The papillae that fill the edges of the buccal slits are fifteen in number. Between the arms leave very small spines, equaling the lateral plates, that are joined by well-developed ventral plates. — Two scales at the ambulacral pores. This species have a greater similarity with the two preceding.

Inhabits Spitzherg.

6. RELATED OPHIURA. *OPHIURA AFFINIS*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, p. 45, pl. 2, f. 10 ab.

Disk thick, with slender arms. Oval plates in the form of shields, longer than wide, nearly equaling the distance that separates the edge from the disk, which is covered with small scales and at the center of several others forming a rosette. Papillae of the lateral slits are short and nine in number. Tentacular pores with a single protecting scale. No intrabrachial pores. Ventral scales of the arms are small and touch each other.

Inhabits the seas of the North, Greenland.

4. SCALY OPHIURA. *OPHIURA SQUAMOSA*. — Lutken.

— Lurken, Addit. ad Hist. OphiurId., p.46, tab. 1, f. 7 ab. — An *O. fasciculata*, Forbes, in Sutherland Journ, ?

Plates oval, medium, in the form of shields, wider than long or even equal in both directions.Papillae of the slits of the disk are very short, thick, often fasiculate. A single scale at the ambulacral pores. Disk covered with flattened scales of nearly equal size. Ventral plates of the arms heart-shaped. This species is also very near *O. albida*. It is with doubt that it is referred to *Ophiura fasciculata*, Forbes, *loc. cit*.

Inhabits the seas of the North.

5. NODULAR OPHIURA. *OPHIURA NODOSA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 48, tab. IL, f. 946.

This species is distinguished from the preceding by its oral plates that are of medium size, lanceolate, passing well beyond the distance that separates them from the disk that is covered with large scales. Its tentacular pores are protected by three or five rudimentary spines. Finally, its arms are short and thick, nodular, with rectangular ventral plates.

Inhabits the seas of the North, Greenland.

6. STUWITZ'S OPHIURA. *OPHIURA STUWITZI I*.—Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 49, tab. 1, f. 8ad.

Species remarkable for its oral plates that are narrow, pyriform, with on its sides a series of spines that are short and uniform that, with the ambulacral spine are sever in number. The arms, short and thick at their base, are deeply attached to the disk and have ventral plates that are oblong, small and protruding.

Inhabits seas of the North.

7. NOCTILUCA OPHIURA. *OPHIURA NOCTILUCA*. — Viviani.

— Viviani, Phosph. mar., 1805, pl. 1, f. 1–2.

We often find this species cited because of its phosphorescent properties. — It specific determination still leaves much to be desired and it is probably the young of another species. We ourselves have often seen small phosphorescent Ophiuroids, width of 102 and that are only young *Ophiothrix fragilis*.

7th GENUS. **OPHIOCTEN**, *OPHIOCTEN*. — Lutken..

(οφις, χτεις, *ad modum Amphicten*.)

Ophiura, Forbes? (pars).
— Lutken, Addit, ad Hist. Ophiurid., 1859, p, 125.

This genus still little known contains until now only a single species.

1. KROYER'S OPHIOCTEN. *OPHIOCTEN KROYERI*. — Lutken. — Lutken, loc. cit., p.52, tab. 1, f. 3. — *Ophiura sericea*, Forbes, Sutherl. Journ., vol. II, appendix ?.

Inhabits seas of the North.

8th GENUS. **AMPHIURA,** *AMPHIURA*.— Forbes.

Ophiura (pars), Johnston and Delle Chiaje.— *Ophiolepis* (pars), Müller and Troschel.— *Ophiocoma* (pars), Forbes. —*Amphiura*, Forbes, Trans. of Soc. Lin. Lond., t. XIX, p. 150.

Disk orbicular, scaly above, having at the center six plates in the form of a rosette.

Arms simple, scaly coming from the center of the disk, with sub-keeled lateral plates with simple and lanceolate spines. Small ovarian plates. Buccal slits with bare edges.

This genus, near *Ophiura* and *Ophiolepis*, still contains only a very small number of species, of which two have been united by Müller and Troschel with *Ophiolepis*. Forbes made known one fossil coming from the Oxford-Clay of England.

1. GOWNED AMPHIURA. *AMPHIURA NEGLECTA*. — Forbes.

— *Ophiura neglecta*, Johnston. Mag. nat. Hist. 1835, t. XLIL — *Ophiocoma neglecta*, Forbes, Brit. Starf., p. 30. — *Ophiura moniliformis*, Grube, Actin., p. 18.—*Amphiura neglecta*, Forbes, Trans. Soc. Lin. Lond., t. XIX, p. 150. — *Ophiolepis squamata*, Müller and Troschel., Syst. dcr Aster., p. 94 Sp 5.

Disk width 4 to 7 mm, covered above with nearly equal scales in the form of tiles with radial plates that touch each other all along their length. Small buccal plates, a little wider than long, rhomboidal, having their lateral and external corners very distinct with a very large border on the internal side. Three spines only, of which the first is very wide, are on each side of the buccal slits. Arms three times as long as the diameter of the disk. Rounded dorsal plates. Pentagonal ventral plates. The very extended lateral plats touch toward the median line of the dorsal and ventral surfaces, between the plates restricted to these two surfaces. The lateral plates have three or four separated conical spines nearly as long as the corresponding dorsal plates. Two valvular scales to the tentacular pores.

Color uniformly grayish.

Inhabits the coasts of England, the Mediterranean ?

This species is in some way the type of the genus *Amphiura*. It is in fact the oldest known. It was included by Müller and Troschel in the genus *Ophiolepis*, these gentlemen not believing it necessary to adopt that established by Forbes.

2. DELLE CHIAJE'S AMPHIURA. *AMPHIURA CHIAJII*.— Forbes.

— *Asterias filiformis*, Delle Chiaje. — *Amphiura chiajii*, Forbes, Trans. Soc. Lin. Lond., vol. XIX, p.150, pl. 14, f. 14–18.— *Id. Id.*, Lutken, Addit. ad Hist. OphiurId., 1858, p. 57, tab. 2, f. 12.

Disk strongly pentagonal, covered especially with small scales and, in the center of the dorsal surface, a group of six plates in the form of a rosette. Narrow radial plates that are close together and divergent, located near the base of the arms. Arms long and slender with lenticular dorsal plates. Ventral plates large and quadrangular. Lateral plates surmounted by four long simple spines, very sharp, along the length of the arms.

Color yellowish.

Dimensions: disk 20 mm, arm 45 mm, total length, 110 mm.

It is wrong that this species has been referred to *Ophiura filiformis* of Müller, and it is good that it has been given the name of Delle Chiaje, to whom Forbes dedicated it.

Inhabits the islands of the Archipelago (Asia Minor).

3. FLORIFEROUS AMPHIURA. *AMPHIURA FLORIFERA.* — Forbes.

— Forbes, Trans. of Soc. Lin. Lond., t. XIX, p. 150, pl. 16, f. 8–13.

Disk with a rosette at the center, formed of six large plates, including one median. Then, on the sides of the disk and the base of the arms, are five pairs of oval or shield-shaped radial plates. The arms are slender and have rather large quadrilateral dorsal plates. The ventral plates are tri-lobed and the laterals are accompanied by three spines that are very short, linear and applied.

Color grayish.

Diameter: total length 30 mm.

Inhabits Milo (Greek Archipelago) where it is captured at 100 fathoms depth.

4. HOLBOLL'S AMPHIURA. *AMPHIURA HOLBOLLII*.—Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1858, f. 55, t. IL, f. 13 ab. — *Ophiolepis sundvallii*, Müller and Troschel ?

Disk lobed, covered on both sides with small scales and on the middle of the dorsal surface wider scales arranged in a rosette. Lanceolate radial plates, united by a small group of small scales. Rounded buccal plates that are protruding, forming rays of a very pronounced star. Buccal papillae in two rows, with a larger plate at the end of the last dental pile. Ambulacral papillae or spines single on each side. Ventral plates of the arms are pentagonal, the dorsals are wide and oval. The lateral plates have four or five short spines.

Inhabits the seas of the North.

5. FILIFORM AMPHIURA. *AMPHIURA FILIFORMIS*.— Forbes.

— *Asterias filiformis*, Müller, Zool. Dan., no 2843, f. 122, f. 1–3. — *Ophiura filiformis*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 216 (non Delle Chiaje). Encycl. méth., pl. 122, f. 1–3. — *Ophiocoma filiformis*, Forbes, Brit. Starfish., p. 40. — *Ophiolepis fiiformis*, Müller and Troschel, Syst. der Aster., p. 94. — *Id.*, Gray, Cat. Brit. Mus., p. 24.

Disk covered with imbricated scales and deeply notched at the points of insertion of the arms, with lanceolate radial plates that are separated their entire length by a series of scales. The ventral surface has at the center a mouth that is nearly bare, having only a papilla or scale in back and two papillae beside each other in front and above the dental plates. Arms very long, extremely thin, measuring approximately ten times the diameter of the disk. We count 154 articles having dorsal plates that are a little convex at the end and pointed laterally, and quadrangular ventral plates. Each lateral plate has four or five conical spines, scarcely as long as the diameter of the arms at the base. The tentacular pores have two small valvular scales at the origin of the arms.

Color of the disk reddish brown above with the edge of the ventral surface black. The arms a yellowish brown with a black dot and a red longitudinal line on the two sides of each article.

Dimensions: total length …….. 120 to 140 mm

disk ……. 8 to 14
total length of the arms …….. 100

Inhabits the coasts of England and Norway.

6. ELONGATED AMPHIURA. *AMPHIURA ÉLONGATA*. — Say.

— *Ophiura elongata*, Say, *loc. cit*., p.146. — *Amphiura elongata*, Lutken. Addit. ad Hist. OphiurId., p. 115, tab. 3, f. 1.

Disk bare above, with very wide radial plates, very isolated. Plates that are oval, oblong transversely or slightly angular, surrounded by other smaller plates forming a complete circle like that in the genus *Ophiactis*. Ventral and dorsal plates of the arms very wide. Lateral plates short and three in number. A single papilla at the ambulacral pores.

Inhabits Charleston.

7. STIMPSON'S AMPHIURA. *AMPHIURA STIMPSONII*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 116.

Disk covered on both sides with small and imbricated scales. Radial plates narrow, elongated and divergent, more or less separated by a small group of scales. Arms medium-sized with a single papilla at the ambulacral pores and having on each side four or five blunt and coarse spines. This species, described only by Lutken is perhaps only a young of some other genus, in particular of *A. gracillima* Stimpson? that we simply mention here.

Inhabits Saint Thomas.

8. ROUGH AMPHIURA. *AMPHIURA SCABRIUSCULA*. — Lutken.

— Lutken, Addit. ad Hist. GphiurId., 1859, p. 118, tab, 3, f. 4.

Disk covered with dense spines and having above radial plates that are narrow, elongated, divergent and bare. Three buccal papillae arranged serially and accompanied by other spatulate and rhomboidal papillae. Arms with short spines, two small valvular scales to each tentacular pore. The dorsal plates of the arms are moreover oval and very wide. The ventrals are also wide, pentagonal or rectangular.

Inhabits the West Indies, St. Thomas.

9. BORDERED AMPHIURA. *AMPHIURA MARGINATA*.— Lutken.

— Lutken, Aüdit. ad Hist. OphinrId., 1859, p. 119, tab. 5, 48.

Disk circular, covered with erect papillae and have radial plates approximately twice as long as wide. The dorsal plates are rounded exteriorly and acuminate on the opposite side. Ventral plates of the arms pentagonal. The dorsals are very wide. The lateral spines number three, plus two smaller, flattened at each tentacular pore.

Inhabits Realejo (Puntarenas).

10. *AMPHIURA SEPTA*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 120.

Disk circular surrounded by erect papillae. Radial plates united. Buccal plates rhomboidal. Arms with three short spines and only one scale to each tentacular pore. This species is still doubtful and could be the young age of another.

Inhabits the West Indies. Saint Thomas.

11. HEART-SHAPED AMPHIURA. *AMPHIURA CORDIFERA*. — (Bosc.)

— *Asterias cordifera*, Bosc, Hist. nat. des Vers, t. IL, p. 113, tab. 16, f. 3. — *Amphiura cordifera* (Bosc), Lutken (non Morck, Cat. Yoldi.), Addit, ad Hist. OphiurId., 1859, p. 120, t. II, f. 2.

Disk entirely bare, with radial plates wide and united, or rather touching each other. Buccal plates narrow, rhomboidal. Arms having very wide ventral and dorsal plates Lateral spines very short, three in number. A single scale to each tentacular pore.

Inhabits the West Indies, Saint Thomas.

12. ORSTED'S AMPHIURA. *AMPHIURA ORSTEDII*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 121.

Disk entirely bare. Radial plates elongated, half united. Buccal plates united, rhomboidal, angular on the lateral parts. Arms with plates that are wide and oval, the ventrals being equally wide and pentagonal. Spines of the arms short, five in number. Ambulacral papillae two for each pore.

Inhabits the west coast of Central America. Puntarenas.

13. THIN AMPHIURA. *AMPHIURA TENERA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p.124, tab. 3, f. 9.

Disk small, not lobed, giving insertion of the short and thin arms. Radial plates very close together and even touching. Dorsal and ventral plates of the arms pentagoal. Spines short, three in number. Two valvular spines to each tentacular pore.

Inhabits West Indies, Saint Thomas.

14. *AMPHIURA PUNTARENAE*, — Lutken.

— Lutken, *loc. cit*., p. 125.

Inhabits Puntarenas.

15. PURPLE AMPHIURA. *AMPHIURA VIOLACEA*. — Lutkex.

— Lutken, *loc. cit*., p. 123.

Inhabits Realejo.

16. AMPHIURA WITH A SMALL DISK. *AMPHIURA MICRODISCUS*. — Lutken.

— Lutken, loc. cit., 1859, p. 123.

Inhabits Puntarenas.

These three species are very near each other. They have in common that their radial plates touch each other, that the buccal plates are rhomboidal and that they have three rows of spines on the arms.

Also belonging to the genus *Amphiura* according to Lutken.

Ophiolepis geminata, Le Conte, from Panama, *Ophiolepis chilensis*, Müller and Troschel, from Chili.

4. PRATT'S AMPHIURA. *AMPHIURA PRATTII*. — Forbes.

— Forbes, Proc. of the géol. Soc. t. IV, p. 233, f. 3.

Fossil of the Oxford Clay (Oxfordian) of England.

9th GENUS. **OPHIACTIS**. *OPHIACTIS*. — Lutken.

— Lutken. Addit. ad Hist. OphiurId., 1859, p. 125.

Disk neither notched nor lobed, with small scales and distinct and even rather large radial plates with a more or less large number of small spines dispersed on the back and the edge of the disk. Arns five or six in number, ordinarily thick and short, with keeled lateral plates with spines that are short, blunt, compressed and covered with asperities. Buccal plates not extended, nor do the interbrachial spaces and the sub-buccals touch each other and surround the mouth in a circle. Buccal papillae single or double, none below the teeth. A single ambulacral scale.

The genus *Ophiactis* was established by Lutken for Ophiuroids especially remarkable for the general aspect of their disk on which are extended very developed radial plates that nearly touch each other but between which are agglomerations of very small filiform spines. The number of species already reaches ten, some with five arms, others have six,

which already divides them into two groups. Then the character taken from the buccal papillae also divides them into two other correlated groups.

We are simply going to enumerate these species.

1. *OPHIACTIS KREBSII*. — Lutken.

   — Addit. ad Hist. OphiurId., 1859, p. 126.

   Inhabits Saint Croix and Saint Thomas (Antilles).

2. *OPHIACTIS MÜLLERI.* — Lutken.

   — *Loc. cit*., p. 127.

   Inhabits the East Indies.

3. *OPHIACTIS VIRESCENS*., — Lutken.

   — Lutken, *loc, cit*., p.128,

   Inhabits Central America (Puntarenas).

4. *OPHIACTIS ORSTEDII*. — Lutken.

   — Lutken, *loc. cit*., p. 129.

   Inhabits Central America (Puntarenas).

5. *OPHIACTIS ARENOSA*. — Lutken.

   — Lutken, *loc. cit*., p.129.

   Inhabits Central America (Puntarenas).

6. *OPHIACTIS KROYERI*.— Lutken.

   — Lutken, *loc. cit*., p. 13, tab, 5, f. 8.

   Inhabits Peru. We probably should still refer this genus *Ophiolepis simplex*, Le Conte, inhabits Panama, and *Ophiolepis asperula*, Phillips, inhabits Chili. But as there still remain doubts in regard to the latter species, we have kept it in its original genus.

7. *OPHIACTIS REINHARDTII*. — Lutken.

— Lutken, *loc. cit*., p.126, tab. 3, f. 7.

Inhabits the Nicobar Islands. Lutken gives with doubt a synonym of this species, *Ophiolepis sexradiata* of Grube.

10th GENUS. **OPHIOSTIGMA**. *OPHIOSTIGMA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 131.

Disk covered with scales. Radial plates hidden in some way under fine and dense granules. Sub-buccal plates wide, touching each other and forming a belt around the mouth. Buccal papillae three in number. No teeth. Ten genital slits. Arms thin, covered with plates with three rows of short, slender spines. It is again to Lutken that we are indebted for establishing this genus, which includes only two species.

1. THIN OPHIOSTIGMA. *OPHIOSTIGMA TENUE*. — Lutken.

— *Loc. ci*t. p.131, tab. 3, fig. 9. Habite l'Amérique centrale (Realejo).

2. MONILIFORM OPHIOSTIGMA. *OPHIOSTIGMA MONILIFORMIS*. — Lutken.

— *Ophiura isocantha*, Say, Journ. of Philad., t. V, p. 103. — *Ophiostigma moniliformis*, Lutken, Addit. ad Hist. OphurId., 1859, p. 132.

Inhabits Saint Thomas (Antilles).

11th Genus. **Pectinura**. *PECTINURA*, — Forbes.

— Forbes, Trans. soc. Lin. Lond., t. XIX, p. 144.

Disk orbicular, scaly and granular above. Arms simple, scaly, extended onto the disk at the ventral surface at their point of insertion. Lateral plates of the arms with a linear series of small equal spines, 8 or 9 in number. Genus still little known, also close to *Ophiure* strictly speaking and *Ophiolepis.* It is especially remarkable by the spines that surmount the lateral plates of the arms that are rather numerous, nearly equal and erect on the arms like the teeth of a comb. A single species has been described by Forbes under the name of *Pectinura vestita*. Müller and Troschel has joined it to *Ophiarachna gorgünia*.

1. COVERED PECTINURA. *PECTINURA VESTITA*. — Forbes.

— Forbes, Trans. of Soc. Lin. Lond., t. XIX, p. 144, pl. 13, f. 1–7.

Disk orbicular, covered with scales and extremely fine granules. Arms convex above, having large dorsal plates that are rounded above. Ventral plates smaller than the preceding but also rounded. Lateral plates arced, each surmounted by a linear series of small spines, nearly equal like the teeth of a comb.

Inhabits the Greek archipelago (Asia Minor).

12th GENUS. **OPHIOCOMA**. *OPHIOCOMA*.—Agassiz.

(οφις, coma, hair.)

Ophiura, Lamarck (pars).

Disk uniformly granular, even on the radial plates that are not bare. Buccal slits entirely bordered with strong papillae or spines that ordinarily end a kind of erect tuft at a right angle below the dental plates. The lateral spines of the arms ae smooth and very developed. The tentacular pores have one or two valvular scales.

The genus *Ophiocoma* thus characterized by Müller and Troschel and established by them (Syst. der Aster. 1842), is not completely identical to that first instituted under the same name by Agassiz for *Ophiura squamata* and *O. echinata*, Lutken. It is currently one of the most numerous of the family Ophiuridae.

* *Species with dentiform papillae above the teeth.*

1. HEDGEHOG OPHIOCOMA. *OPHIOCOMA ERINACEUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 98.

Buccal plates a little longer than wide, with rounded corners. Dentiform papillae in three rows. Arms with dorsal plates wider than long, convex at the end, with a corner directed toward the base and the lateral corners very sharp. Lateral plates with four spines, of which the longest is one and a half or two times the width of the dorsal plates. The two upper ones are a little longer than the others and also thick and blunter. Tentacular pores with two valvular scales.

Color blackish. The disk is marked with paler lines, sometimes radiating forming a kind of cross at the top of the arms, from which we see two small white dots located symmetrically at the base of the arms. Completely similar whitish dots can be seen over the entire dorsal surface.

Total width: 20 to 22 centimeters.

Inhabits the seas of India.

2. SERPENTINE OPHIOCOMA. *OPHIOCOMA SERPENTARIA*.— Val.

— *Ophiocoma serpentaria*, Val., Col. du Mus.— *Id. Id.*, Müller and Troschel. Syst, der Aster., p. 98. — *Ophiocoma crassispina*, Lutken, Addit. ad Hist. OphiurId., p. 142, tab. 4, f. 7.

Disk having on the ventral surface buccal plates scarcely longer than wide, rounded, a little depressed outside. The genital slits are bordered by a row of white granules in the form of small pearls. The intervals of these slits appear nearly bare but really are finely scaly without granules. This granulation begins only at the edge of the disk to extend in a uniform manner on the dorsal surface. Arms having wide and oval dorsal plates. The ventral plates, a little longer than wide, are quadrangular, rounded at the top and slightly notched on the sides. The lateral plates have four rows of spines, of which the upper ones are much more developed and blunter. They are also longer than the diameter of the dorsal plates. Tentacular pores with two valvular scales.

Color a tawny brown, having lateral parts of the arms whitish between the series of spines with a very fine network of deep brown lines.

Dimensions: total width 216 mm.

Inhabits the seas of the Antilles where it has been reported by Plée. Musée Paris. Rüse found it at Saint Thomas.

3. RÜSE'S OPHIOCOMA. *OPHIOCOMA RUSEI*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., p. 143, pl. 4, f, 6.

Oval buccal plates, a little angular, wider exteriorly and longer than wide. Arms with three or four rows of slender spines, the upper row being formed of longer spines. Ventral plates much wider than long.

Color consists of a deep reddish brown on which are a large number of whitish lines, irregularly sinuous and winding. The arms themselves have this color.

Inhabits the Antilles, Saint Thomas.

4. WENDT'S OPHIOCOMA. *OPHIOCOMA WENDTII*. — Müller and Troschel

— Müller and Troschel, Syst. der Aster., p. 99.

Buccal plates a little longer than wide, with a corner on their external edge. Dentiform papillae in three rows. The dorsal plates of the arms, wider than long, a little rounded at the top, with a corner on the opposite side and sharp lateral corners. The ventral plates are oval. The lateral plates have very long and rather thin spines, forming four rows on each side, the two upper ones are longer, nearly three times the diameter of the dorsal plates. The tentacular pores have two valvular scales at the base of the arms and at their point of insertion with the disk, but in the rest of their extent there is only one scale.

Color a uniform blackish brown.

Total length: 216 mm.

Inhabits ? Musée Berlin. Accordng to Lutken, it could be that this species was only *O. rüsei*; but this is very doubtful.

5. SCHOELEIN'S OPHIOCOMA. *OPHIOCOMA SCHOENLEINII*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 99.

Buccal plates a little longer than wide and rounded. Dental papillae in three rows. Arms having dorsal and ventral plates wider than long and nearly hexagonal. Lateral plates with short spines in four rows. They are of unequal length. The longer ones exceed a little the diameter of the dorsal plates. These are the lower ones. The upper ones are a little blunt and a little thicker. The tentacular pores, with the exception of those of the disk, have only a single valvular scale.

Color a blackish brown.

Total width: 436 mm.

Inhabits the seas of India.

6. SERRATED OPHIOCOMA. *OPHIOCOMA DENTATA*. – Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 99. — *Id, Id.*, Lutken, Addit. ad OphiurId., n° 7, f. 3, p. 141.

Buccal plates a little longer than wide and rounded. Dental papillae not very numerous and not very protruding into the mouth but forming a row between the teeth and the buccal papillae. Arms have quadrangular ventral plates with rounded corners, as long as wide and very wide and elliptical dorsal plates. Lateral spines in four rows and nearly equal.

The upper ones are only thicker, blunter, a little flattened and a little smaller than the lower ones. Tentacular pores with two valvular scales.

Color brown above and below, with paler places here and there on the arms. The spines are also partly paler.

Total length: 136 mm.

Inhabits the Nicobar Islands.

This species is very near the preceding, at least its general appearance. It has in the arrangement of its lateral spines a very notable difference in that the upper spines are small and thicker than the lower one while the contrary occurs generally for the preceding species.

7. TWO-LOBED OPHIOCOMA. *OPHIOCOMA BIDENTATA*.— Müller and Troschel.

— *Asterias bidentata*, Rertzius, de Stell., p. 33. — *Ophiocoma bidentata*, Müller and Troschel, Syst. der Aster., p. 99.

Buccal plates extremely small, rhomboidal, near two times as wide as long, with sharp lateral corners. Buccal papillae conical. Dental papillae not very protruding and forming a single row. Arms with ventral and dorsal plates so small that the lateral plates touch each other. The dorsal plates have a corner directed toward the base. The spines of the arms, in five or six rows, increase in size from bottom to top, the longest equaling two to three times the diameter of the arms. Each tentacular pore has a single valvular scale.

Color yellowish brown.

Inhabits the coasts of Norway.

8. NILSSON'S OPHIOCOMA. *OPHIOCOMA NILSSONII*.— Müller and Troschel.

— *Asterias tricolor*, Ritzius, Dissert. de Stell., p. 33. — *Ophiocoma nilssonii*, Müller and Troschel. Syst. dér Aster., p. 100.

Arms slender and thinning rapidly, with dorsal plates round at the top and ended in a sharp corner on the sides. Ventral plates quadrangular. Each lateral plate has five to six slender spines, all equally thin, but whose upper ones are longer and equal to the diameter of the dorsal plates. Tentacular pores each with two valvular scales.

Color generally brown.

Total length: 80 mm.

Inhabits seas of the North.

9. SWOLLEN OPHIOCOMA. *OPHIOCOMA TUMIDA*. — Müller and Troschel.

— *Asterias nigra*, Retzius, Dissert. de Stell., p.31. — *Ophiocoma tumida*, Müller and Troschel. Syst. der Aster., p. 100.

Buccal plates circular. Arms having dorsal plates rounded at the top, with the opposite edge angular. Lateral plates with spines arranged in four rows, i. e., four in number, the two upper ones being very thick, two times as long as wide and one and a half times as long as the diameter of the dorsal plates. The two lower spines are small and the same length, the lower one is flatter. Each tentacular pore is protected by two oval scales.

Color brown.

Total length: 156 mm.

Inhabits the Gulf of Genoa and the coasts of Norway ?

10. BLACK OPHIOCOMA. *OPHIOCOMA NIGRA*.— Müller and Troschel

— *Asterias nigra*, O.F. Müller, Zool. Dan., pl. 93. — *Asterias nigra*, Linné, Gmel. Syst. naf., p. 3168. — *Ophiocoma granulata*, Forbes, Wern. Mem., t. VIIL, p. 127, and Brit. Starfish., p. 150. — *Ophiocoma nigra*, Müller and Troschel, Syst. der Aster., p. 100, pl. 8, f. 1.—*Id.*, Lutken, Addit. ad Hist. OphiurId., p. 141, 1859.

Disk width 18 mm, with small buccal plates, wider than long. Papillae of the edge of the mouth thin and spiny. length 72 mm, with dorsal plates transversely oval and angular on each side. Ventral plates quadrangular. Lateral plates accompanied by five to six thin

spines, shorter than the diameter of the arms and two times as long as the diameter of the dorsal plate with the exception of the lower that is shorter. Tentacular pores with two valvular pores.

Color deep brown.

Total length 162 mm.

Inhabits northern seas of Europe.

11. SCOLOPENDRINE OPHIOCOMA. *OPHIOCOMA SCOLOPENDRINA*. — Agassiz.

— *Ophiura scolopendrina*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 233. — *Ophiocoma scolopendrina*. Agassiz, Prodr.—*Ophiocoma scolopendrina*, Müller and Troschel. Syst. der Aster., p. 101. — *Id.*, Lutken, Addit. ad Hist. OphiurId., p. 142.

Disk covered above with coarse and protruding granules and having below buccal plates a little longer than wide, truncated near the mouth. Dental papillae in three rows. Arms six times as long as the diameter of the disk, very strongly bristly with divergent spines and with ventral plates as wide as long, quadrangular, with blunt corners, a little notched at the top and on the sides, and prolonged below in a point that is covered by the plate of the preceding article. Dorsal plates of the arms two times as wide as long, rounded at the top in a blunt corner more or less distinct on the opposite side. Lateral spines arranged in four rows, the upper ones a little longer than the lower ones, but at the same time thicker, more blunt and a little flatter. Tentacular pores having two valvular scales.

Color brownish green, paler below, with darker bands on the dorsal surface of the arms. The plates are ringed or patched with color alternatively paler or darker.

Dimensions: Total length …… 216 mm.

. Id. of the disk …. 17 to 20.

Inhabits the sea of India, Mauritius and the Red Sea.

12. MOTTLED OPHIOCOMA. *OPHIOCOMA PICA*.— Müller and Troschel

— Müller and Troschel. Syst. der Aster. p. 101.

Disk having on the ventral surface, oval buccal plates, nearly two times as long as wide. Dental papillae in three rows. Arms four times as long as the diameter of the disk, having triangular dorsal plates, the point directed toward the base of the arms, the opposite edge being rounded. The plates are a little wider than long. The ventral plates have the form of ax-head near the disk and then wider at the top and notched on the sides. But, at some distance from the disk, these plates are widened hexagons while toward the end they form a nearly regular hexagon. Each lateral plate has five small spines, more than two times as long as the dorsal plates and a little longer than the diameter of the arms. Tentacular pores with two valvular scales.

Color: the disk is dark brown with a network of yellowish lines. The arms are paler yellow below with a row of round black patches the width of the arms and longer than the dorsal plates. Below they are whitish with gray patches.

Dimensions: total length …… 108 mm.

Id. of the disk …….. 12

Length of arms …… 48

Inhabits the Antilles? Musée Paris.

13. LINED OPHIOCOMA. *OPHIOCOMA LINEOLATA*.—Müller and Troschel.

— *Ophiura lineolata*, Dujardin. Mag. Zool., Guérin-Meneville. — *Ophiocoma lineolata*, Müller and Troschel, Syst. der Aster., p. 102.

Disk width 9 mm, having below buccal plates longer than wide, angular at the edge opposite the mouth. Arns four times as long as the diameter of the disk, very tapered, with quadrangular ventral plates and dorsal plates a little wider than long, round at the top and angular laterally. Each lateral plate has four to five spines, all nearly the same length, approximately equaling the diameter of the arms. And the upper ones are a little thicker at the origin of the arms. Tentacular pores with two valvular scales.

Color: dark brown with radiating white lines on all the disk and two whie dots at the base of each arm. Each buccal plate also has two white patches. The arms are brown with white transverse bands, separated by one or two plates.

Dimensons: total width ……. 81 mm.
Id. disk …… 9
Id. arms …… 36

Inhabits Mauritius.

14. OPHIOCOMA OF VALENCIA. *OPHIOCOMA VALENCIAE*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 102.

Buccal plates nearly round, scarcely longer than wide. Arms with quadrangular plates and triangular dorsal plates with rounded lateral corners and the edge opposite the disk a little convex. Each lateral plate has five conical spines, the most developed in the middle are as long as the diameter of the dorsal plate. Tentacular pores with a single valvular scale.

Color: yellow brown with dark bands on the arms.

Dimensions: total width …….. 162 mm.

Inhabits the Red Sea.

15. SCALY OPHIOCOMA. *OPHIOCOMA SQUAMATA*. — Müller and Troschel

— *Ophiura squamata,* Lamarck, An. s. vert, 2^{e} édit., t. III, p. 225. — *Ophiocoma squamata*, Müller and Troschel, Syst, der Aster., p. 102.

Disk granular, nearly smooth, with buccal plates longer than wide and oval. Dental papillae not very numerous, located above the teeth that are wide and sharp. Genital slits bordered by a series of very distinct granules. Arms having wide dorsal plates, wide, oval

and ventral plates a little longer than wide, quadrangular, slightly convex at the top and obviously notched laterally. Lateral plates with three or four rows of spines, those of the intermediary rows being much longer than the others and however scarcely longer than the dorsal plates. Tentacular pores with two valvular scales.

Color yellowish in the dried state with dark markings from space to space on the arms.

Dimension: total width: 243 mm.

Inhabits the Atlantic Ocean.

16. PAINTED OPHIOCOMA. *OPHIOCOMA PICTA*. — Müller and Troschel.

— *Ophiura picta*, Kuhl and Van Hassecr, in Mus. of Leyden.— *Ophiocoma picta*, Müllere and Troschel. Syst. der Aster. p. 102.

Buccal plates oval, sometimes a little angular, longer than wide. Dental papillae in three rows. Arms have dorsal plates as long as wide, nearly hexagonal, with their lateral corners very pronounced. Ventral plates quadrangular, a little narrower toward the base. Lateral plates each with four slender and small spines, of which the upper one is long and more than twice the diameter of a dorsal plate.

Color: disk yellowish above and surrounded by small brown patches, rounded or diversely associated with sinuous lines. Arms purplish above, with a median line a darker color. Spines whitish, with three or four narrow brownish rings.

Dimension: total width: 190 mm.

Inhabits Java.

17. STRONG-SPINED OPHIOCOMA. *OPHIOCOMA CRASSISPINA*. — Müller and Troschel.

— *Ophiura crassispina*, Say, Journ: of Philad., t.1, p. 147. — *Ophiocoma crassispina*, Müllerl and Troschel, Syst. der Aster., p. 103.— *Id. Id.*, Lutken, Addit. Ad Hist. OphiurId., p. 142.

Disk large, polygonal, entirely covered with extremely fine granules. Arms robust, having dorsal plates transversely oval, not angular and hexagonal ventral plates.

Lateral plates with four spines forming as many rows on the sides of the arms. Those of the upper row are claviform and blunt, especially in the area of the disk. Some are nearly oval, the lower ones are slenderer and as long as the diameter of the arms. Tentacular pores with two valvular scales.

Color dark purple, more or less varied with yellow on the arms. Lateral spines yellowish as is the ventral surface.

Dimension: total width: 216 mm.

Inhabits the coasts of Florida.

18. ARCTIC OPHIOCOMA. *OPHIOCOMA ARCTICA*. — Müller and Troschel,

— Syst. der Aster., p. 103,

Disk a little granular, with buccal plates very small, scarcely as wide as long. Buccal papillae conical. In place of dental papillae is a single unpaired buccal papilla under which are ordinarily the teeth that increase in width from the top to the bottom. Arms having dorsal plates as wide as long, rounded at the top and ended in a point toward the base. The ventral plates are hexagonal and separated by the lateral plates that touch each other. Each lateral plate has seven to eight very long and very thin spines. The upper ones are large and exceed three times the width of the dorsal plates. Sometimes above this large spine is a smaller young one. The lower spines decrease. The tentacular pores have only one valvular scale, except the first located at the base of each arm, which has two.

Coloro a greenish brown.

Dimension: total width: 160 to 190 mm.

Disk: 15 ½.

19. VARIABLE OPHIOCOMA. *OPHIOCOMA VARIABILIS*.— GRUBE.

— Grube., Weigm. arch., 1857, p. 342.

Disk with five lobes, covered above with imbricated scales. Buccal plates oval, narrower toward the side of the mouth. Arms with transverse dorsal plates, nearly oval and a little sharper toward their ends. Ventral plates of the arms sub-quadrangular. Lateral plates with three or four spines decreasing toward the base, the upper ones exceeding the height of the dorsal plates. Ambulacral pores with a single valvular scale.

Color of the disk brown above with sparse whitish patches. The arms are marbled above, with patches of milky white.

Inhabits (Hawaiian Islands).

20. ETHIOPIAN OPHIOCOMA. *OPHIOCOMA AETHIOPS*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p.145.

Buccal plates elongate ed, nearly rectangular, rounded interiorly. Spines of the arms most often four in number, moderately developed, nearly equal in length and reaching two or the adjacent articulations. The lower ones are compressed, the upper ones cylindrical.

Arns widened, flattened above and with dorsal scales that are very wide and acuminate on the sides and on the contrary a little narrowed in the middle. The ventral plates are nearly equal, both in length and width.

Inhabits Panama. Rüse.

21. DWARF OPHIOCOMA. *OPHIOCOMA PUMILA*. — Lutken.

—Lutken, Addit. ad Hist. OphiurId., 1859, p. 146, tab. 4, f. 5.

Buccal plates orbicular. Arms with four rows of spines. The upper two equal in length nearly three articulations. Ventral plates nearly as long as wide. A single papilla at each tentacular pore.

Inhabits Saint Thomas, Saint Croix. Rüse,

FOSSIL SPECIES.

22. GRANULAR OPHIOCOMA. *OPHIOCOMA GRANULOSA*. — D'Orbigny.
— *Ophiura granulosa*, Rosmer, Nordd. KreId., p. 28, pl. 6, f. 22.— *Ophiocoma granulosa*, D'Orbigny, Prod., t. II, p. 274. — *Ophiura pustulosa*, Müller, Monog. Petref. Ahac, KreId., f. 1, p. 6. — *Ophiocoma granulosa*, Pictet, Traité Palæont., p. 276, pl. 98, f. 14.

We have referred to the genus *Ophiocoma* a fossil coming from the White Chalk (Senonian) and that unfortunately is still little known. We cannot refrain from giving our doubts about this determination, but it seems to us that if the fragments we have been able to observe are complete, they would be very different from the living species up to now. In fact, the arms would be formed of a single row of large articles with only a small upper plate.

This species comes from the Upper Chalk of Hanover.

13th GENUS. **OPHIARACHNA.** OPHIARACHNA. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p.103.

Disk granular everywhere except on the ovarian plates that are bare as well as some isolated plates. Buccal plates divided transversely into a small, external piece and a larger internal piece. Buccal slits have dental papillae above the teeth. Arms with spines that are slender, conical and unequal. Tentacular pores covered with valvular scales.

This genus was establishd by Müller and Troschel for species that made part of the genus *Ophiura* of Lamark and of which *Ophiura incrassata* Lamarck is the principal type. It is distinguished especially from the latter as well as *Ophiocoma* by the enormous development of its buccal plates that are divided into two parts, one large, the other much smaller.

It contains to the present only a very small number of species that all come from equatorial seas.

1. THICK OPHIARACHNA. *OPHIARACHNA INCRASSATA*. — F. Müller and Troschel.

— *Ophiura incrassata*, Lamarck, An. s. vert., 2e édit., p. 122,— *Ophiarachna incrassata*, Müller and Troschel. Syst, der Aster., p. 104.

Disk sub-pentagonal, granular, without radial plates above, but with very fine scales hidden under the granulations. Buccal plates large, triangular, rounded exteriorly, a little wider than long, and whose large corner is directed toward the buccal opening. Buccal papillae are six or seven in number and rounded. Dental pile with two papillae in the form of a spine, located on each side of the teeth that are equally rounded and soft. Arms rather robust, especially at their base, convex above and with nearly rectangular dorsal plates with

straight edges, three times as wide as long toward the base of the arms and sometimes irregularly divided into two or several pieces.

Ventral plates of the arms quadrangular, a little convex at the top, notched laterally, with a protruding corner on each side of their base. Below these corners are notches that resemble in some way holes. Small, conical spines that are four in number on each side of the lateral plates form four rows that are very regular. Those of the lower row are half as long as those of the other three rows that are nearly equal. Tentacular pores have two valvular scales.

Color yellowish with dark rings on the lateral spines of the arms.

Total width: 200 to 523 mm.

Width of the disk: 40 to 55 mm.

Inhabits Java. Musée de Paris.

2. INFERNAL OPHIARACHNA, *OPHIARACHNA INFERNALIS*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 405.

Disk with ovarian plates that are triangular, cordiform, with another small semi-circular accessory plate Buccal papillae delicate, eight in number on each edge of the buccal slits. Truncated teeth except the last one inside that is pointed. At the bottom of the buccal slits of each side of the dental piles, a papilla in the form of a spine. The disk have above scales covered with fine granules, with the exception of some larger scales and in the form of plates that have a determined position. At the root of each arm are radial plates between which are small smooth scales forming a kind of triangle whose top is directed toward the center. A similar scale, also smooth, is also placed on the edge of the disk in each interbrachial region.

The arms have dorsal plates wider than long, convex at the top, with two lateral corners. The ventral plates are also convex at the top, notched on the sides and ended at the base by lateral corners.

Each lateral plates has eight to nine sharp spines that reach the middle half of the following plate. Tentacular pores with two scales, of which the exterior is smaller.

Color yellowish brown with dark transverse bands and narrow on the upper part of the arms.

Dimensions: total width …… 108 mm.

Id. disk …… 12.

Inhabits the sea of the Indies.

3. GORGONIA OPHIARACHNA. *OPHIARACHNA GORGONIA*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 105.

Disk covered with large scales that are covered with granules with the exception of the radial plates that are smooth. Triangular buccal plates with corners directed toward the mouth, the opposite edge being demi-circular. Each buccal slit has eight papillae. The teeth

are truncated transversely. Arns approximately six times as long as the diameter of the disk, having nearly rectangular dorsal plates two times as wide as long. Ventral plates also as long as wide, also nearly quadrangular but a little convex at the top and slightly notched on the lateral parts. Each lateral plate has six small, applied spines, only reaching the middle of the following plate. We observe ten at the base of the arms, but they decrease insensibly to three and even two toward their free end.

Color yellowish with large darker spots on the disk and transverse bands of the same color on the dorsal surface of the arms.

Dimensions: Total width …… 190 mm.
Disk …….. 14 to 15.

Inhabits the Antilles. Musée Paris.

4. OPHIARACHNE WITH SEVEN SPINES. *OPHIARACHNA SEPTEMSPINOSA*. — Müller and Troschel.

— *Ophiura septemspinosa*, Kuhl snf Van Hassecr. — O*phiarachna septemspinosa*, Müller and Troschel., Syst. der Aster., p. 1065, pl, 7, f. 2.

Disk covered with granules and with radial plates that are oval, black, shiny, some approximately twice the length of others. Buccal plates nearly round, a little longer than wide, some surmounted by a small mound that probably is the madrepore tubercle. Arms three and a half times as long as the diameter of the disk, having dorsal plates that are very wide, notched at the end and often divided into several pieces. Ventral plates as long as wide, nearly rounded at the end and prolonged in a point toward the base. Each lateral plate has seven divergent spines, of which the lowest, much longer than the others, reaches the end of the following plate.

Tentacular pores with two valvular scales.

Color brownish, deeper on the upper part.

Dimensions: total width …….. 216 mm.

Inhabits the Moluccas. Musée de Leyden.

14th GENUS **OPHIACANTHA**. OPHIACANTHA, — Müller and Troschel.

(οφις, αχανθα, spine.)

Asterias (sp.), Retzius. — *Ophiura* (sp.), Grube. — Müller and Troschel. Syst. der Aster., p. 106.

Disk covered with coarse tubercles or calcareous bodies that are dentalated and more or less close together. Buccal papillae in a single row along the buccal slits without forming a group above the dental pile. Spines of the arms large ad coarse, so divergent that they come together either on the median line of the upper part of the arms are on the ventral and opposite line.

Tentacular pores have valvular scales.

1. BRISTLY OPHIACANTHA: *OPHIACANTHA SETOSA*. — Müller and Troschel.

— *Asterias setosa*, Retzius, Dissert. de Stell., p. 30. — *Ophiura rosularia*, Grube, Actin., p. 20 (non Lamarck).— *Ophiacantha setosa*, Müller and Troschel. Syst. der Aster., p. 106, pl. 8, f. 2.

Disk width 13 mm, having on the dorsal surface and in the direction of the arms, ten bands of tubercles that are short, blunt and coarse. These tubercles are irregularly sparse, but do not extend to the center where there are similar scattered similar tubercles, only smaller. Buccal plates nearly two times as wide as long, rounded outside, on the edge of the buccal slits. The protruding corners of these slits form a blunt terminal part whose lateral parts, slightly notched are cut into sharp corners. The internal edge of these plates are accompanied by two other plates that are very narrow, curved and joined toward the middle. One of the buccal plates is swollen into a kind of tubercle, representing the madrepore tubercle. The dental papillae are long, conical, three or four on each side support the pointed teeth. Arms eight times as long as the diameter of the disk, with dorsal plates that are triangular, convex on their upper edge and having on the contrary their point directed toward the center. Ventral plates quadrangular, wider at the top, i.e., at the upper part, and separated by a bare interval in which the lateral plates touch as well as between the dorsal plates. Each lateral plate has seven to eight spines that are a little coarse, long, thin and pointed, of which the longest, on the upper part, is two and a half times the diameter of the dorsal plates, while the others are shorter and shorter toward the lower part. These spines diverge and nearly join on the dorsal surface of the arms but are not as close together toward the end. The contrary occurs on the ventral surface. The tentacular pores are protected by a single valvular scale.

Color a whitish gray. The arms have from place to place, brown articles. The interval is approximately four articles.

Inhabits the coast of Sicily.

2. SPINY OPHIACANTHA. *OPHIACANTHA SPINULOSA*. — Müller and Troschel.

Ophiacantha groenlendica, *Arctica* (*Ophiocoma*), Müller and Troschel., Arch. fur Naturg., 1844, part. II, p. 133. — *Ophiacantha spinulosa*, Müller and Troschel. — *Id.* Lutken, *loc. cit*., p. 65, tab. 2, f. 14.

Disk covered everywhere with very small, simple spines under which one distinguishes rather clearly a bed of small scales. No radial plates. The buccal plates are more than two times as wide as long. On each protruding corner of the buccal slits are inserted seven papillae, following which are occasional dental plates.

Arms three and a half times as long as the diameter of the disk, having heptagonal ventral plates, of which one of the corners is turned toward the base of the arms.

The dorsal plates are triangular. Their large corner is also turned from the same side. The lateral plates are joined above and below between the dorsal and ventral plates forming then two median sutures nearly as long as the interposed plates. These lateral plates have, in addition, five thin spines on each side, more or less coarse, whose upper one is several

times the diameter of the arms while the others successively decrease. Tentacular pores with a single valvular scale.

Color rather pale yellowish.

Dimensions: total width …… 54 mm.
Disk ……. 7.

Inhabits the coasts of Greenland.

15th GENUS. **OPHIOMASTYX**. *OPHIOMASTYX*.—Müller and Troschel.

(οφις, μαστιξ, whip.)

Ophiura, Lamarck. — Müller and Troschel. Syst. der Aster., p. 107.

Disk covered with small, isolated spines. Buccal slits with hard papillae that are grouped above the dental piles.

Buccal plates simple.

Arms spiny with, on the latera parts above each row of spines, a claviform piece dentalated several times at the end. Tentacular pores with valvular scales.

1. RINGED OPHIOMASTYX. *OPHIOMASTYX ANNULOSA*.— Müller and Troschel.

— *Ophiura annulosa*, Lamarck, An. s. vert., 2e édit., t. IIL, p. 222 (non *O. annulosa*, Bv.). — *Ophiomastyx annulosa*, Müller and Troschel, Syst. der Aster., p. 107, pl. 7, f. 4.

Disk covered especially by small, imbricated scales and having at the same time, above and below, cylindrical spines five times as long as wide. Small radial plates that are bare between the scales of the disk. Oval buccal plates, longer than wide.

Arms with nearly quadrangular ventral plates, wider at the top, and dorsal plates founded in the same region, ended laterally by a sharp corner but becoming quadrangular toward the free end of the arm. Each lateral plate on each side has three equal spines, a little longer than the diameter of the arms. However, at the base of these latter, the upper spine is much longer than the others. In addition to these spines, and above them, is on each row a kind of much larger spine and of a completely particular form. It is a little thicker toward the end and sub-divided in several serrations that are short and blunt. Tentacular poores with two valvular scales.

Color: disk brown, with small and numerous white rings. Dorsal plates of the arms brown, with a white border, as well as white marks in the middle. Spines of the arms and the disk vey regularly ringed in white and brown.

Dimension: total width: 162 mm.

Inhabits the coasts of Java.

SECOND SECTION. DISK AND ARMS COMPLETELY BARE.

16th GENUS. **OPHIOMYXA**. *OPHIOMYXA*. — Müller and Troschel.

Ophiura (sp.), Lamarck.

Skin entirely with neither granules nor scales, only spines on the disk as on the arms. Buccal plates rounded. Buccal slits with small, denticulated scales. Teeth of the dental piles also denticulate. Lateral spines of the arms in part covered with a bare skin and free only toward their top that is spiny.

1. PENTAGONAL OPHIOMYXA. *OPHIOMYXA PENTAGONA*. — Müller and Troschel.

Linck, tab. 27, f. 46. — Copied from Encyel. méth., pl. 123, f. 4–5. — *Ophiura pentagona*, Lamarck, An. s. vert., 2e édit., t. III, p. 226. — *Id.*. *Id.*, GRUBE, Actin. Echinod., p.17. — *Ophiomyxa pentagona*, Müller and Troschel. Syst. der Aster., p. 108, pl. 9, f. 3.

Disk sub-pentagonal, flattened and soft, covered above with some small, not very apparent scales. Buccal plates rounded, a little longer than wide.

Arms formed of 60 to 80 articles, with a shallow groove above that divides them into two parts. Dorsal plates small, with an interval between them equal to their length. These plates, by narrowing on each side, unite immediately to the lateral plates. Ventral plates cordiform or bilobed on their upper part. Each lateral plate has four or five spines that are cylindrical, divergent, then and bristly at the top. They are, in addition, much shorter than the diameter of the arms. Their number decreases from the base toward the end of the arms where there are only two.

Color brown, with white patches on the dorsal surface of the disk as well as the arms. These latter are sometimes paler and with dark bands.

Dimensions: total length ……. 490 mm.
Id. disk ……. 11 to 20
Id. arms …… 43 to 85.

Inhabits the coasts of Sicily.

Species previously well-known and already represented by Linck, placed by Lamarck in his genus *Ophiura*.

2. SHINY OPHIOMYXA. *OPHIOMYXA LUBRICA*. — Forbes.

— Forbes, Trans. of the Soc. Lin. Lond., t. XIX, p. 149, pl. 13, f. 15–22.

Disk pentagonal, smooth, coriaceous, having two short ovarian openings. Buccal slits with very fine and serrated spines.

Arms prolonged from their origin under the disk and have on the latter, at their base, two small, elongated radial plates coupled in pairs. Dorsal plates of the bilobed arms deeply notched at their base in front. Lateral plates very developed, having spines that are very

wide, flattened, and with denticulate edges, with series of small asperities on the largest part of their surface that makes them rough to the touch. These spines are four in number. Those of the lower row are a little larger than the others that are nearly equal.

Color yellowish.

Inhabits the islands of the Archipelago.

This nice species, remarkable for the smooth appearance of its disk as well as the upper part of its arms, in the form of it dorsal plates of the arms, a character restricted to it. But its lateral plates are still more curious because of their spines being strongly flattened, with asperities, and finely denticulated on their edges.

3. FLACCID OPHIOMYXA. *OPHIOMYXA FLACCIDA*. — Say.

— *Ophiura flaccida*, Say, Journ. Acad. Phil., t.V, p. 151. — *Ophiomyza cariboea*, Lutken, — *Ophiomyaea flaccida* (Say), Lutken, Addit. ad OphiurId., 1859, p. 138, tab. 5, f. 1.

Inhabits Puntarenas (Central America).

17th GENUS. **OPHIOBLENNA**. OPHIOBLENNA. Lutken.

— Lurken, Addit. ad Hist. OphiurId., 1859, p. 137.

Genus characterized by its bare disk, lacking scales, but have small, thin brachial plates formed with a soft skin, covering also the radial plates. Spines 7 in number, very slender, bare, rough. Ten genital slits. Buccal and ambulacral papillae lacking, as well as teeth.

ANTILLEAN OPHIOBLENNA. *OPHIOBLENNA ANTILLENSIS*. — Lutken.

— Lutken, Addit. ad Hist. GphiurId., 1859, p.137, tab. 4, f. 4.

18th GENUS. **OPHIOSCOLEX.** *OPHIOSCOLEX*.— Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 109.

Skin entirely smooth on the disk to the edges of the mouth, on the buccal papillae and on the arms. Buccal slits with papillae in the form of spines, as well as the teeth themselves. Arms laterally with spines that are completely smooth and enveloped their entire length by a skin forming a kind of retractile sheath.

Tentacular pores with protective scales.

GLACIAL OPHIOSCOLEX. *OPHIOSCOLEX GLACIALIS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 109, pl. 10, f. 1–2.

Disk covered with a soft, wrinkled skin that extends onto the buccal plates and to the papillae of the same region that it covers in large part. Buccal papillae thin like the spines. Buccal teeth form a single row.

Arms four times as long as the diameter of the disk with no plates nor scales, but having on the lateral plates transverse rows of three spines that are extremely thin and as long as the diameter of the arms.

Color yellowish.

Dimensions: total length …… 162 mm
Disk ……... 18

Inhabits Spitzberg.

19th GENUS. **OPHIOPSILA**. *OPHIOPSILA*, — Forbes.

(οφις, Ψιλος, bare snake.)

— Forbes, Trans. of Soc. Lin. Lond., t. XIX, p. 149.— *Ophianoplus*, Sars.

Disk orbicular, sub-pentagonal, smooth. Arms simple, long, slender, inserted and prolonged on the ventral surface of the disk, with laterally spines that are fine, lanceolate, six in number on each side.Radial plates elongated. Dental plates bare.

This genus, very near *Ophiomyxa* was established by Forbes. It is sufficiently characterized by its long and slender arms with, on the lateral parts, rows of flat spines. six in number.

It contains up to now only four species. *0. aranea* Forbes is the oldest known.

The genus *Ophianoplus* Sars corresponds to it.

The four or five species contained in this genus can be separated into two groups:

a. The row of buccal papillae interrupted in the middle.
0. annulosa (Sars).
0. marmorea (Sars).
b. The row of buccal papillae are not interrupted.
0. rüsei. — Lutken.

Species still doubtful, perhaps the young age of *O. aranea*? or the preceding species.

Inhabits the seas of the North.

1. OPHIOPSILA ANNULOSA. — Sars.

Ophianoplus annulosus, Sars, Mag. for NaturvId., t. X, p. 23, &. 1, f. 2–7. — *Ophiopsila annulosa*, Lutken, Addit. aû Hist. OphiurId., 1859, p. 136,

Inhabits the seas of the North.

2. OPHIOPSILA MARMOREA. — Sans.

— *Loc. cit.*— *Id.*, Lutken., *loc. cit*.

3. SPIDER OPHIOPSILA. *OPHIOPSILA ARANE*— Forbes.

— Forbes, Trans. of Soc. Lin. Lond., t. XIX, p. 149, pl. 14, f. 1–7.

Disk pentagonal, with blunt and rounded corners, slightly excavated at the insertion of the arms that makes a slight raised area on the lower part. The disk is in addition smooth above and has only, at the base of the arms, ten radial plates united in pairs. These plates are narrow, elongated and sensibly parallel.

Arms long, slender, with rather large quadrangular dorsal plates. Lateral spines well-developed, six in number on each side, forming a kind of small bundle. These spines are flattened, lanceolate. Those of the lower row are smaller and diverge on the ventral surface. The row that comes immediately above is more developed than the others.

Inhabits the Archipelago.

4. RUSE'S OPHIOPSILA. *OPHIOPSILA RUSEI*.— Lutken.

— Lutken, Addit, ad Hist. OphiurId., 1859, p. 136, tab. 5, f. 2.

Species having only five or six spines on the lateral plates of the edges, and dorsal plates bifid in part. The disk and the arms have black dots.

Inhabits the Antilles, Saint Thomas.

We lack sufficient information to establish the relation of the genus *Ophiasthrum* Peters, Neue Ophiur. an Mozambique, in Archiv fur Naturg., 1852, p. 84. It is the same with the genus *Ophiopeltis* Duben and Koren, Skandinav. Echinod. vetensk Akad. Handt., 1844, p. 256.

20th GENUS **OPHIOTHRIX**,, *OPHIOTHRIX*.— Müller and Troschel.

— *Ophiura* (pp.), Lamarck. — *Ophionyx*, Müller and Troschel. — Müller and Troschel, Syst. der Aster., p. 110.

Disk orbicular or slightly pentagonal, with a protrusion between the arms, covered with very fine and hairy spines, more or less developed, then some bare radial plates and covered like the rest with skin.

The mouth has only some brush-shaped or pinnate dental papillae either on the sides of the buccal slits or toward the end of the re-entrant angle of the mouth where it has the consistency of true teeth.

Arms simple, scaly laterally with spines that are bristly, divergent and hooked.

Tentacular pores having valvular scales that are not very distinct or even completely missing.

The genus *Ophiothrix* was established by Müller and Troschel for species that until then had been confused with Ophiuras. It contains a rather large number of species remarkable, in general, for the aspect of their lateral spines that are generally vertical and divergent. These species can be separated into principal groups and two secondary groups, according to those with hooks only at the end of the arms or on the contrary on all its length. Then, as a secondary character, consideration of the presence of mobile spines on the disk can be opposed to those with the presence of blunt and serrated rods, and finally, to the existence of granules of this same part.

* *Species with mobile spines on the disk.*

1. FRAGILE OPHIOTHRIX. *OPHIOTHRIX FRAGILIS*. — Müller and Troschel.

— *Asterias fragilis*, O.F. Müller, Zool. Dan., t. XCVIII, — *Id.*, Linné, Gmelin, p. 3168. — *Ophiura fragilis*, Lamarck, An. s. vert., 2e édit., t. III, p. .— *Asterias pentagona*, *A. cuvierii*, *A. tricolor*, *A. ferussaci*, *A. quinquemaculata*, Delle Chiaje. — *Ophiura fragilis*, Glavenhort Tergesa, p.104. — *Ophiura rosula*, Jouxsrox, May. N. H., 1836, p. 231, f. 26. — *Ophiura echinata*, Templeton, Mag. Nat. Hist., 1836, p. 237, f. 30.— *Ophiocoma fragilis*, Forbes. — *0. minuta*, Forbes, Brit. Starfish., p. 60–65. — *Ophiura rosula*, Forbes, Wern. Merm., t. VIIL. — *Ophiura angulata*, Say, Journ. of Acad. Philad., t. V, p. 145. — *Ophiothrix fragilis*, Müller and Troschel. Syst. der Aster., p. 110, tab. 9, f. 2.

Disk covered with thin spines, length 2 to 3 mm, between which are some granules armed with two or three points. Radial plates long, bare or with some thin spines. These plates are separated by a narrow spiny band. Buccal plates wider than long.

Arms eight times as long as the diameter of the disk, have quadrangular ventral plates that are notched at the top. Keeled dorsal plates, very convex, pointed at the top and having toward the middle a small granular tubercle. Each lateral plate with six to seven spines that are flattened, thin and denticulate. The first is often smaller, then the second and third are on the contrary longer and those that follow decrease to the last that is the smallest. Tentacular pores small, a little longer than the spines and ended in a kind of small head, even after desiccation.

Color rather variable. The disk is brownish or greenish, various patches. The arms are reddish or greenish brown with transverse orangish bands or bands alternatively pale or dark, the color of the bottom.

Dimensions: total length: …….. 50 to 190 mm.
Disk: …….. 5 to 10.

Inhabits the northern seas of Europe.

This species, the most common and perhaps the oldest known, has some varieties that have been described as different species by different authors. It is thus, e.g., that it is necessary to refer to *Asterias pentagona, cuvieri* and *tricolor, ferussani* and *quinquemaculata* of Delle Chiaje. It has even received other names, among others that of *O. rosula*, a name that for a long time was adopted by English authors.

2. SPINY OPHIOTHRIX. *OPHIOTHRIX ECHINATA*. — Müller and Troschel.

— *Asterias echinata*, Dellel Chiaje. t. XXXIV, f. 5. — *Ophicthrix echinata*, Müller and Troschel. Syst. der Aster., p. 111.

Disk covered with more or less long spines, extremely thin and thus called hairs, some of which are approximately ten times longer than wide.

Radial plates bare or covered with more or less numerous spines. Buccal plates small, wider than long.

Arms having ventral plates notched at the top. Some plates with keels, rhomboidal, with a corner at the top, one at the base and two lateral. The spines are nine in number on each side. These spines are unequal. Those of the middle, the longest, are two to three times the width of a dorsal plate. The lower ones are smallest.

Color bluish, sometimes with patches of the same color but darker.

Diameter total …….. 81 mm.

Inhabits the Mediterranean.

3. FOX'S TAIL OPHIOTHRIX. *OPHIOTHRIX ALOPECURUS*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster. p. 111.

Disk covered with very numerous spines. Buccal plates nearly rhomboidal, two times as long as wide. Radial plates nearly bare.

Arms having quadrangular dorsal plates as long as wide, notched at the top.

Lateral plates of the arms have six spines, of which the upper is longest and two times the transverse diameter of a dorsal plate. The three spines at the end are extremely small.

Color reddish.

Total width: 40 mm.

Inhabits the Adriatic.

4. HAIRY OPHIOTHRIX. *OPHIOTHRIX HIRSUTA*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 111.

Disk width 23 mm, covered with very small spines visible only with a magnifying glass and that, around the radial plates have scattered granules of short cylinders. Buccal plates triangular, wider than long. Genital slits located behind the buccal plates, separated only by a narrow bridge formed of two small divergent plates.

Arms very long, approximately ten times the diameter of the disk and having ventral plates a little longer than wide, slightly notched at the top, with lateral corners a little rounded. The dorsal plates are very wide, convex, with very pronounced lateral corners. Each lateral plate on both sides has ten spines, of which the upper and lower ones are very small, while the median ones are larger and have a length equivalent to the diameter of the dorsal plates.

Color bluish.

Dimensions: total width. …….. 480 mm.

Disk. …… 25.

Inhabits the Red Sea.

5. HAIRY OPHIOTHRIX. *OPHIOTHRIX COMATA*. — Müller and Troschel.

— Müller and Troschel., Syst. der Aster., p. 112.

Disk entirely covered above, as well as the radial plates, with very long bristles, equaling a third of the diameter of the disk. Dorsal plates of the arms are pointed. Ventral plates rounded laterally and crenelated at the top. Lateral plates have on each side five or six very thin spines, whose upper ones are five or six times in length the diameter of the arms while the lower ones are always decreasing.

Color reddish with a narrow line, paler on the arms.

Inhabits the East Indies? Musée de Vienna.

** *Species having on the disk small rods that are short, blunt or dentelated.*

6. OPHIOTHRIX WITH LONG FEET. *OPHIOTHRIX LONGIPEDA*.— Müller and Troschel.

— *Ophiura longipeda*, Lamarck, An. s. vert., 2e édit., t. IL, p. 224.— *Ophiothrix longipeda*, Müller and Troschel, Syst. der Aster,, p. 115.

Disk covered with rods that are short and blunt that, on the radial plates change into kinds of scatter granules and generally more abundant on the edges. Buccal plates quadrangular, proportionally rather large, as long as wide and having a smaller exterior segment, separated from the rest by a suture, all covered with small spines similar to those of the disk. The genital slits are located behind the buccal plates, separated from them by a kind of very wide bridge equaling the diameter of this buccal plate and formed of two narrow pieces located transversely in a straight line.

Arms extremely long, equaling approximately ten times the diameter of the disk and having quadrangular ventral plates with blunt corners and a little wider than long. The dorsal plates, two times as wide as long, are convex on their upper edge that is very flat and sometimes notched on the sides. Each lateral plate has six spines of which the upper ones are larger than the others, equaling nearly the diameter of the arms. The lower ones decrease to the last one that is very small.

Color: disk bluish above and speckled with darker spots on each dorsal plate. From place to place we see one of these dorsal plates more brightly colored.

Dimension of the total length. …… 509 mm.

Disk ……... 27.

Inhabits Timor, Mauritius.

7. RAMMELSBERG'S OPHIOTHRIX. *OPHIOTHRIX RAMMELSBERGII*. Müller and Troschel.,

— Müller and Troschel. Syst, der Aster., p: 113, pl. 8, f. 3.

Disk covered with small, short cylinders, of which the more developed are approximately four or five times as long as wide. Radial plates bare, except toward their external edge where they have some very circumscribed granules. Buccal plates very small, wider than long. Arms having quadrangular ventral plates with the terminal edge notched. The dorsal plates are keeled in the middle and nearly pointed at their free edge. Each lateral plate has eight massive spines, cylindrical, slightly flattened, of which the upper one is small, the middle one much larger and finally the lower ones even smaller than all the others. The longest one equals approximately two or three times the width of the dorsal plates.

Dimension: total width; …… 108 mm.

Inhabits? Musée Berlin.

8. SMOKY OPHIOTHRIX. *OPHIOTHRIX INFUMATA*. — Müller and Troschel.

— *Ophiura ciliaris*, Lamarck (pars), An. s. vert., 2^{e} édit., t. III, p. 224. — *Ophiothrix infumata*, Müller and Troschel. Syst. der Aster, p. 113.

Disk covered with small scales between the radial plates that are large and bare. On the scales are fixed small cylinders two times as long as wide. Buccal plates wider than long, rhomboidal, with the corners rounded. Arms having dorsal plates nearly two times as wide as long, with two lateral points and a convex terminal edge or most often notched. Ventral plates quadrangular, with rounded corners, a little longer than wide. Each lateral plate with six spines, of which the upper one is small, the second, on the contrary, very long, equaling two times the diameter of the arm. The third one is a little shorter. The others decrease rapidly. The two longest spines are distinguished in addition by their end that is very spiny and swollen into a small mass.

Color brownish, with dark lines on the radial plates. The arms have above transverse bands, either pale red or blue. The ventral surface is entirely brown, like smoky, rather pale as well as the end of the spines.

Dimension: total width. …….. 135 mm.

Inhabits? Musée de Paris.

9. CUSPIDATE OPHIOTHRIX. *OPHIOTHRIX TRIGLOCHIS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 114.

Disk covered with short spines, formed of two or three points that are also found on the radial plates but more sparsely. Buccal plates very small, rhomboidal. Arms with dorsal plates rounded at the top and quadrangular ventral plates. Each lateral plate has six or seven unequal spines. The upper ones longer, equaling approximately two and a half times the diameter of the dorsal plates. the others decrease in length.

Color violet.

Dimension: total length: …… 100 to 135 mm?

Inhabits the southern coasts of Africa, Port Natal.

10. PARASITIC OPHIOTHRIX. *OPHIOTHRIX PARASITICA*.— Müller and Troschel. — Müller and Troschel. Archiv fur Naturg., 1844, p. 384.

Disk entirely covered with small, short cylinders, even on the radial plates. Buccal plates small. Arms with quadrangular ventral plates, whose upper terminal edge is nearly straight. The dorsal plates are keeled with a tubercular swelling in the middle of the terminal edge. Each lateral plate has six or seven spines on each side, five of them are very long and are more than two times as long as the width of a ventral plate. They are in addition very spiny but not swollen in a mass.

Color pink with dark bands on the arms.

Dimension: total length …….. 27 mm.

Inhabits Australia.

This small species has been found between the spines of a Cidaris, probably *Cidaris imperialis,* the same one that offered one of us to make an observation on a particular mode of parasitism of a *Seylifer*. (Genus of gastropod mollusks)[1]

*** *Species having a granular disk.*

11. CILIATED OPHIOTHRIX. *OPHIOTHRIX CILIARIS*.— Müller and Troschel.

— *Ophiura ciliaris*, Lamarck (pars), An. s. vert., 2e édit., t. III, p. 234. — *Id.*, Encycl. méthod., pl. 124, f. 4–5.— *Ophiothrix ciliaris*, Müller and Troschel., Syst. der Aster., p. 114.

Disk covered above with granules that are also on the radial plates but more scattered. Dorsal plates of the arms strongly convex at the terminal edge where the more protruding median part is separated from the lateral segments by two dark red grooves that appear to make this edge tri-lobed. The ventral plates are quadrangular, a little rounded. The lateral plates have bristly spines toward their base, then very acuminate at their free end, and become in some way hair-like and with a silky aspect. Each plate has five of six of these spines, of which the second is a little smaller than the upper one and of which the others are going to decrease, although the length is approximately twice the width of the arms.

Color whitish or pale reddish, sometimes with dark transverse bands on the arms. The spines are a beautiful snow white or a slightly pink tint.

Dimension: total length: ……. 81 mm.

Inhabits the seas of India.

12. ASPIDISTRID-LIKE OPHIOTHRIX. *OPHIOTHRIX ASPIDOTA,*— Müller and Troschel.

— Müller and Troschel. Syst, der Aster., p. 115.

[1] Voyez Revue et Mag. de Zool. 1860, p. 118.

Disk granular, with smooth radial plates. Buccal plates small, wider than long. Ventral plates of the arms quadrangular. Dorsal plates without keel and having the terminal edge a little convex, without point s. Each lateral plate has eight or nine spines that are flattened and thin, of which the longest equals two times the length of the dorsal lates. The lower ones gradually decrease.

Dimension: total width: ……. 135 mm.

Inhabits the seas of India.

13. NEREIDID OPHIOTHRIX. *OPHIOTHRIX NEREIDINA*.— Müller and Troschel.

— *Ophiura nereidina*, Lamarcx, An. s. vert., 2^{e} édit., t. III, p.224. — *Ophiothrix nereidina*, Müllerl and Troschel. Syst. der Aster., p. 115.

Disk pentagonal, width 16 mm, covered with large scales above, having triangular and smooth radial plates, separated by a row of three narrow plates that are very long. Two or three similar scales are found contiguous to the first but without forming a distinct row in the interbrachial space. All the small intermediary scales are covered with granules and similar granules are found between the rounded scales of the central part. The disk is in addition covered above with small cylinders two or three times as long as wide. Buccal plates wider than long and so united with each other as well as with the first infrabuccal plats that they form a complete ring around the mouth. Arms extremely long, equaling approximately fifteen to sixteen times the diameter of the disk and with ventral plates nearly as long as wide. The dorsal plates are very wide, a little notched at the top. Each lateral plate has seven bristly spines, of which the upper one is small, the following three longer than the diameters of the dorsal plates, and finally, the three lower ones very short.

Color bluish. The radial plate blue, with white marks. All the scales of the arms are also blue, but edged with white or even a transverse white mark. The spines are paler.

Dimension: total width: …… 4 dcm.

Inhabits the sea of the South, Central America.

14. VIOLET OPHIOTHRIX. *OPHIOTHRIX VIOLACEA*. — Müller and Troschel.

— Müller and Troschel., Syst. der Aster., p. 115. — *Id.*, Müller and Troschel., Archiv fur Naturg., t. XI, 1843, p. 113.— *Ophiothrix caribaea*, Lutken, loc. cit., p. 150. — *Ophiothrix kroyeri*, Lutken, *loc. cit*., p. 150. — *Ophiura angulata*, Say, Journ. of Phil. vol. 1, p. 149. — *Ophiothrix hispida*, Ayres, Proc. Boston, etc., t. IV, p. 249. — *Id. violacea*, Lutken, Addit, ad Hist. OphiürId., 1899, p. 150, tab. 5, f. 1.

Disk width 4 mm, covered with small, pointed tubercles that are missing of more scattered on the radial plates. Buccal plates extremely small, wider than long.

Arms six times as long as the diameter of the disk, having long and pointed dorsal plates at their top. The ventral plates are quadrangular. The lateral plates have six to eight

spines two or three times as long as the diameter of the arms and very finely denticulated. The number of denticulations ordinarily varies from ten to twenty.

Color violet, with a white line on all the median and dorsal part of the arms that are edged with dark violet on the lateral part.

Dimension: total width …….. 54 mm.
Disk …… 4
Arms …….. 24

Inhabits the coasts of Brazil (Rio Janeiro).

15. GRANULAR OPHIOTHRIX. *OPHIOTHRIX GRANULATA*. — Müller and Troschel.

— *Ophiura granulata*, Johnston, Mag. nat. Hist., 1835, p. 596.— *Ophiothrix granulata*, Müller and Troschel., Syst. der Aster., p. 116.

Disk granular, without externally visible radial plates. Arms short, equaling approximately three or four times the diameter of the disk and having dorsal plates with a convex terminal edge. The ventral plates are quadrangular and the lateral plates each have six equal spines and two times as long as the diameter of the dorsal plates.

Color uniformly brown.

Dimensions: total length …… 130 to 180 mm.
Disk ……. 19 to 20.
Arms …… 54 to 80.

Inhabits the coasts of England.

16. SPINULOSE OPHIOTHRIX. *OPHIOTHRIX SPINULOSA*. — Müller and Troschel.

— *Ophiura spinulosa*, Russo, Hist. nat, Eur. mérId., t. V, p. 273, fig. 30. — *Ophiothrix spinulosa*, Müller and Troschel. Syst. der Aster., p.116.

Disk pentagonal with ten well-developed radial plates united in pairs. Arms rather large, not very extended, with dorsal plates that are convex, slightly angular at the top. Lateral spines three in number, equaling at least in length the diameter of the arms and covered entirely with small asperities.

Color a purplish black above and blackish brown below with white spots on the disk between the radial plates.

Dimensions: total length. 60 mm.

Inhabits the Mediterranean.

17. SUESON'S OPHIOTHRIX. *OPHIOTHRIX SUENSONII*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 148, t. IV, f, 2.

Disk pentagonal, divided into rays by the radial plates that are very wide, close together, occupying so to speak all the extent of the disk. Their surface is smooth and in the very narrow interstices originate spines that are not numerous, long, very thin in the

form of needles. Arms with lateral spines, ordinarily five in number on each side, near the median line. The spines are finely denticulate on the edge. We count ten to fifteen of these denticulations. Those of the lower row are in the form of small hooks.

Color reddish with a purplish black line in the middle part of the arms and extending to the center of the disk.

Inhabits the Antilles.

Species remarkable for the considerable size of the radial plates that occupy, so to speak, all the extent of the disk and also by the long aciculate spines with which it is dotted.

18. ORSTED'S OPHIOTHRIX. *OPHIOTHRIX ORSTEDII*. — Lutken,

— Lutken, Addit. ad Hist. OphiurId. (1859), p. 149, t. IV, p. 3.

Disk circular with very large radial plates but little visible. All the surface, and principally the intervals of the plates, having small spines forming radial zones. Arms having on its lateral parts numerous spines that are close together. We count six to nine, some straight, the others a little flattened and denticulated on the edges, and finally a lower row in the form of small hooks.

Color brownish with white curving transverse lines on the dorsal part of the arms. No longitudinal lines.

Inhabits the Antilles, Saint Croix and Saint Thomas.

19. SPICULATED OPHIOTHRIX. *OPHIOTHRIX SPICULATA*.— Le Conte.

— Lutken, Addit. ad Hist, Ophiur., 1859, p. 151.

Species still doubtful.

Inhabits Panama.

20. WHITE OPHIOTHRIX. *OPHIOTHRIX ALBA*, — Grube.

— Archiv fur Naturg., 1857, p. 344.

Disk covered above with small bristly spines, some longer, the others shorter, and above, with small and soft papillae. The radial plates are bare, nearly oval and separate each other by narrow bands of small spines. The arms have dorsal plates that are nearly rhomboidal, rounded and slightly keeled with a protrusion on each side. The ventral plates of transverse, sub-rectangular and a little rounded, their anterior edge being a little excavated and coarse. The latter plates are little visible, with plates that are blunt, flattened, most usually seven in number and decreasing from the upper part to the lower. Three or

four larger than the others nearly the diameter of the arms. Small denticulate spines that are difficult to see occupy the edges of the genital plates.

Color all white.

Dimension: total width: 50 mm.

Inhabits the Pacific Ocean.

SPECIES HAVING HOOKS ON THE ENTIRE LENGTH OF THE ARMS.

Müller and Troschel established in 1840 (Archiv Weigm. VI, p. 329), a particular genus of Ophiuridae under the name of *Ophionyx*, for a small species *O. armata*, Müller and Troschel, whose arms have particular mobile hooks immediately below the lateral spines. Later, in 1842, (Syst. der Aster.), the same authors reported to the same genus *O. scutellum*, Grube, nearly as small as the preceding. At the same time also, they considered belonging to *Ophionyx*, two large species figured in the great work of Egypt by Savigny. On the other hand, Kroyer having had the opportunity to examine *Ophioryx armata*, published the opinion (Isis, 1842, p. 952) that this species is only the young age of some other Ophiurid and probably a *Ophiolepis* that he wanted to name *O. aculeata*, that, first having hooks, lost them little by little from the base of the arms so that on an individual 160 mm wide they remained only at the end of the arms. Kroyer has in addition seen another individual from which one of the arms had been broken, was in the process of regenerating it and had especially the character of *Ophionyx*, while the rest seemed to belong to *Ophiolepis*. Kroyer, who was unaware of the new publication of Müller and Troschel, on the subject of larger species, therefore though he could conclude that the genus *Ophionyx*.was based solely on the transitory character of the young age of another genus. In their turn, Müller and Troschel, in 1845 (Weigm. Archiv, p.121), apparently ignorant of the observations of Kroyer, recognized that the hooks given as characteristic of the genus *Ophionyx*, could also be found in *Ophiothrix*, notably *O. fragilis, O. ramanelsbergüi, O. hirsuta, O. echinata*, etc., but only at the end of the arms and in their entire length. They made the conclusion that species thus armed should be part of the genus *Ophiothrix* as a simple section.

21. ARMED OPHIOTHRIX. *OPHIOTHRIX ARMATA*. — Müller and Troschel.

— *Ophionyx armata*, Müller and Troschel, Weigm. Archiv, t. VI.— *Id.*, Müller and Troschel., Syst. der Aster., 1842, p. 116, pl. IX, f. 4. — *Ophiothrix armata*, Müller and Troschel. 1843, Archiv Weigm., VIL, p. 121.

Disk with small, microscopic spines ended in three hooks above. Arms formed only of eight elongated articles, narrowed at their base and with dorsal and ventral plates that are elliptical, longer than wide, between which are united the lateral plates that are oblique, protruding outside and having a larger articulated hook with two points, above which are also two small simple spines.

Color whitish.
Dimension: total width: 4 to 6 mm.
Inhabits?

According to the statement of these characters, it is easy to judge the single example described by Müller and Troschel. It is a very young individual as Kroyer concluded. from his correct observations, as the first age of *Ophiolepis aculeata* or *scolopendrina.*

22. OPHIOTHRIX WITH SHIELD. *OPHIOTHRIX SCUTELLUM*. — Grube.

— *Ophiura scutellum*, Grube, Actin. Echin., p. 19. — *Ophionyx scutellum,* Müller and Troschel. 1842, Syst der Aster., f. 117.

Disk having at the center, on the dorsal side, a kind of rounded plate covered with small, imbricated scales that also cover the rest of the surface. Two radial plates separated by a row of small scales that occupies the base of the arms. The ventral side of the disk has very small spines that are more distinct toward the periphery. The buccal plates are wider than long, rhomboidal, with sharp lateral corners. Arm length 4 mm, having cordiform dorsal plates, slightly constricted toward the base, and quadrangular ventral plates sometimes with a slight notch on their terminal end. Each lateral plate has two long denticulated spines and in addition a small, curved hook with two teeth, much smaller than the spines.

Color brown.
Dimensions: total width ……. 10 mm.
Disk …… 2.
Arns …… 4.
Inhabits the Mediterranean.

This species has been observed by Grube, who found a single individual on a Holothurian. According to this circumstance and the characters indicated above, it is very probable that it is also a young of some other Ophiurid.

23. SAVIGNY'S OPHIOTHRIX, *OPHIOTHRIX SAVIGNYI*.— Müller and Troschel.

— Savigny, Descript. Egypt., pl. 2, f. 2. *Ophionyx savignyi*, Müller and Troschel. Syst. der Aster., 1842, p. 117. — *Ophiothrix savignyi*, Müller and Troschel. Archiv Weigm., 1843, t. V*I*.

Disk covered with fine and very short bristles. Buccal plates cordiform, having on each side at the external edge a quadrangular piece. Arms formed of very numerous articles, having dorsal plates that are nearly rhomboidal and keeled and ventral plates wider than long, notched at the top and rounded at their base. Each lateral plate has ten bristly spines,

of which the intermediary ones are the most developed. Below them are hooks with three teeth, much smaller than the spines and compressed.

Dimension: total width: 135 mm.

Inhabits the Red Sea.

24. SCORPION OPHIOTHRIX, *OPHIOTHRIX SCORPIO*. — Müller and Troschel.

— Savigny, Descript. Egypt., pl. 2. f. 3. — *Ophionyx scorpio*, Müller and Troschel. 1842, Syst der Aster., p.118.— *Ophiothrix scorpio*, Müller and Troschel. Archiv Weigm., 1843.

Disk covered with small, serrated spines, more or less long. Buccal plates wider than long. Arms formed of very numerous articles, having hexagonal and keeled dorsal plates and ventral plates longer than wide, rounded at the top and marked with a black spot. Lateral plates each with five spines of which the intermediary is longer with a hook with three teeth.

Color reddish brown with a row of black spots on the articles of the arms.

Dimension: total width: 81 mm.

Inhabits the Red Sea.

GENERA OF EXTINCT OPHIUROIDAE.

For a long time, some species of Ophiuroidae have been observed in secondary terrains. Schlotheïm described one from the Muschelkalk under the name *Asteriacites ophiurius*, and Blumenback made known a second from the same terrain (*Asteriacites scutellata*). Goldfuss, in his great work on the *Pétrifications d'Allemagne*, describes these two species under the names of *0phiura prisca* and *O. loricate.* He added two others from the lithographhic limestone of Solenhofen. Agassiz, studying in his turn all these species and some others described by English authors, tried to demonstrate that they could be referred to three distinct genera: 1° genus *Ophiurella*, whose disk is scarcely distinct; 2° genus *Acroura*, 0 differs from living Ophiures because its very slender arms have small scales instead of lateral spines; 3° genus *Aspidura*, whose disk is covered above by a star of 10 plates and whose arms, proportionally larger, are surrounded by imbricated scales. Since then, some new generic sections have been established by different authors, in particular by D'Orbigny in his *Prodrome*.

We know that all these species being known only by imprints or remains more or less embedded in calcareous rocks cannot be classified zoologically with the precision and clarity as living species. We thus are limited to describing briefly the genera and species.

21st GENUS. **OPHIURELLA**. *OPHIURELLA*.— Agassiz.

— Agassiz, Mem. de Neufchätel, 1836, p. 192.

Disk small, scarcely distinct. Arms long and slender with very elongated and filiform lateral spines.

This genus contains until the present only two species belonging to the Jurassic terrain.

1. SPECIOSE OPHIURELLE. *OPHIURELLA SPECIOSA*.— Agassiz,

— *Ophiura speciosa*, Munster, 1833, in Goldfuss, Petref. I, p. 206, pl. 62, f. 4 — *Ophiurella speciosa*, Agassiz and D'Orbigny, Prodr. 13^{e} and no 542. — *Id.*, Pictet, Traité de Pal., t. IV, p. 276, pl. 98, f. 15.

Disk bare? Arns lanceolate, linear, with octagonal ventral plates and lateral plates each with three to four subulate spines, longer than the diameter of the arms.

Fossil of the lithographic limestone of the mountains of Eisstadt and sometimes of Solenhofen (Oxfordian).

2. OPHIURELLA BISPINOSA.— D'Orbigny.
— Prodr., t. II, p. 28. — Pictet, Pal. t, IV, p. 227.

A species still not described that comes from the Corallian of the Pointe du Est.

22nd GENUS. **ACROURA**. *ACROURA*.— Agassiz.

Ophiuroids having arms with four rows of pieces between which are small scales arranged in transverse lines.

1. ANCIENT ACROURA. *ACROURA PRISCA*. — Agassiz,

— *Asteriacites ophiurus*, Sculoth., Petref:, pl. 29, f. 6. — *Ophiura prisca*, t. I, p. 62, f. 6. — *Acroura crispa*, pl. 98, f. 10. — *Id.*, Munster in Goldfuss, Petref. Germ., Agassiz, — *Id.*, Pictet, Pal., D'Orbigny, Prodr.

Disk covered with large radial plates. Arms subulate, nearly round, without spines, having hexagonal ventral plates and lateral plates.
Fossil of the Muschelkalk or Bayreuth (Germany).

2. COTTEAU'S ACROURE. *ACROURA COTTALDINA*.— D'Orbigny.

— Prodr., t. I, p. 320. Fossil of the Great Oolite (Bathonian) de l'Yonne.

3. NEARLY BARE ACROURE. *ACROURA SUBNUDA*. — D'Orbigny.

— Prodr., t. Il, p.28. Fossil of the coral-rag (Corallian) of the Pointe du Ché,

4, CORNUEL'S ACROURE. *ACROURA CORNUELIANA*. — D'Orbigny.

— Prodr., t. II, p. 110, — *Ophiura, cornuez*, Mem. Soc. géol., 1848, t. V, p. 238.

Fossil of the Neocomian terrain of Vassy.

23rd GENUS. **ASPIDURA.** *ASPIDURA*. — Agassiz.

— Agassiz, Mem. Neufch., 1836, p. 193.

Disk with a star of ten radial plates on the dorsal surface. Arms proportionally large, surrounded by imbricated plates arranged in four unequal rows, the two lateral ones larger, the two median ones smaller. No intermediary pieces.

This genus, special to the Conchylian stage, contains until now only two species.

1. ARMORED ASPIDURE. *ASPIDURA LORICATA*. — Agassiz.

— *Asteriacites scutlellatus*, Blumenbach, Spec. Archæol., p. 24, pl. 2, f. 10. — *Ophiura scutellata*, Bronn, Lethæa, p. 157, pl. 11, f. 23. — *Ophiura loricata*, Goldfuss, Petref. Germ. *I*, p. 207, pl. 62, f. 7. — ? *Id. Id.*, Williamson, Mag. nat. Hist., 1836, pl. 427, f. 64.— *Aspidura loricata*, D'Orbigny, Cours élém., t. II, p. 134, fig. 284. — *Id. Id.*, Pictet, Traité Palæont., t. IV, p. 276, pl: 99, f. 13.

Disk covered with plates above and below. Arms lanceolate, short, nearly round, unarmored, formed of 40 to 48 articles with dorsal plates that are hexagonal, small, compressed between the lateral plates that are very large and occupy more than two-thirds of the width of the arms.

Dimensions: total length. …….. 150 to 200 mm.
Width of the disk …….. 50.

Fossil of the Muschelkalk (Conchylian) of Wurtemberg.

D'Orbigny (Prodrome, t. I, p. 178, and 5–101, adds *Aspidura ludeni*, Hagenow, 1846. Palæontographica, n° 1, p. 21. From the same stage from Jena (Germany).

24th GENUS. **GEOCOMA**. *GEOCOMA*.— D'Orbigny.

Ophiura (pars), Munster. — *Ophiurella* (pars), Agassiz.

D'Orbigny established this genus (*Prodr*. t. I, p. 381) for a species of Ophiurid described by Munster under the name of *Ophiura carinata* and that Agassiz included in his genus *Ophiurella*. D'Orbigny, while recognizing the similarities that bring the genus *Geocoma* closer to *Ophiurella* states that it differs by the absence of small lateral pieces at the bae of the spine of the arms.

1. KEELED GEOCOMA. *GEOCOMA CARINATA*. — D'Orbigny.

— *Ophiura carinata*, Munster in Goldfouss, 1833, Petref., t. I, p. 206, pl. 62, f. 6. — *Ophiurella carinata*, Agassiz, Mem. Neufchât., 1836, p. 192. — *Geocoma carinata*, D'Orbigny, Prodr., t. I, p.381. — *Id. Id.*, Pictet, Traité Pal., t. IV, p.277, pl. 98, f. 17.

Arms long and subulate, with keeled and gibbous dorsal plates. Lateral plates with aciculate spines as long as he diameter of the arms.

Fossil of the lithographic limestone (Oxfordian) of Solenhofen.

25th GENUS. **PALAECOMA**. *PALAEOCOMA*.— D'Orbigny.

— D'Orbigny. Prodr., t. I, p. 240.

"Ophiurids with four rows of pieces to the arms without small intermediary pieces." D'Orbigny, who thus characterizes the genus that he established, gives as type *Ophiura milleri* Phillips from the Lias, then mentions two other species *Palaeocoma furstenbergü*, d'Orb., and *P. cunliffei*, d'Orb. from the Upper Cretaceous terrain (Senonian). According to the remark made by Pictet, the first of these two latter species does not have all the characters assigned by the author himself and should instead be placed among the Ophiures, i.e., *Ophiolepis*. The second, *P. cunliffei*, d'Orb., having appeared to us in the same case, we have included all in the genus *Ophiolepis* until further information.

MILLER'S PALAEOCOMA. *PALAEOCOMA MILLERI*. — D'Orbigny.

— *Ophiura milleri*, Pres, Geol. Yorks., pl. 13, f. 20. London Geol. Journ., I, pl. 8. — *Orhiurella Mülleri*, Agassiz, Mem. Neufchât. 1836, p. 192. — *Ophioderma milleri*, Forbes, Proc. Soc. géol., t. IV, p. 233. — *Palaeocoma milleri*, D'Orbigny. Prodr., t. I, p. 240.

Fossil from the Lias of Yorkshire (England).

26th GENUS. **Aplocoma.** *APLOCOMA*.— D'Orbigny.

— *Acroura* (pars), Munster. — D'Orbigny., Cours élem, de Palæont., t. II, p.134.

This genus, established by D'Orbigny for a species placed in *Acroura* by Munster, has been characaterized thus: "Genus near Croura by the form but with a single row of pieces in sautire on the arms." I.e., that the dorsal plates are curved into a Roman X.

The only species known is:

AGASSIZ' APLOCOMA. *APLOCOMA AGASSIZII*. — D'Orbigny.

— Acroura agassizii, Munster, Beitr. zur Petref., 1839, p. 87, t. XI, f. 2.— *Ophiura Agassizii*, Dujardin in Lamarck, An. s. vert., 2e édit., p. 229. — *Aplocoma agassizii*, D'Orbigny, Cours élem. t. II, p. 134.— *Id. Id.*, Pictet, Traité de Palæont., t. IV, p. 275, pl. 98, f. 11.

Fossil from Muschelkalk (Conchylian) from Laineck.

27e GENUS. **PROTASTER.** *PROTASTER*. — Forbes.

— Forbes, Mem. géol. Surv. Dec. 1.

Disk flattened, circular, covered with polygonal or crescent-shaped scales, imbricated. Arms narrow, simple, covered with alternating plates with short spines that, see at a great magnification, appear weakly articulated.

This extremely curious genus seems, by its different characters, intermediate to the Ophiuridae and Asterophydae. It is attached to the first by its simple arms, with a surface covered with scales, while it is attached to the second by its alternating brachial pieces and perhaps also by its articulated spines. Also, it is placed by this very fact in a different way by different authors concerned with it. Thus, Forbes and M'Coy placed it in the family Asterophydae while Müller and Troschel place it among the Ophiuridae. According to Zeiler and Wirtgen, the genus corresponds to that established by Goldfuss under the name *Aspidosoma.* But there are some appreciable differences, notably in the proportion of the arms that are slender in *Protater.* We still know only two species belonging to this genus. One is from the Upper Silurian terrain (Murchisonian), the other from the Devonian terrain.

SEDWICK'S PROTASTER. *PROTASTER SEDWICKII*. — Forbes.

— *Ophiura salteri*, Forbes (olim). — *Protaster sedwickii*, Forbes, Mem. géol. Surv., Dec. I, p: 4. — *1d*., M'Coy, Brit. Palæont. foss., p. 60. — *Id.*, Pictet, Traité Pal., t. IV, p. 277, pl. 98, f. 17.— ? *Aspidosoma goldfussii*, 1848, Verhandt. der Nieder, ver. — Zeiler and Wirtzen, *Id.*, 12e année, pl. 1, f. 1–3.

Fossil of the Upper Silurian (Murchisonian) of England. We refer to it also: *Protaster arnoldii* (*Aspidura arnoldii*, Goldf. Verhandt. der Nied. 1848, and Zeizer and Wirtzem, *Id.,* 12e an.).

From the Devonian terrain of Eifel.

SECOND FAMILY. ASTEROPHYDAE.

(*EURYALIDAE*.)

Disk more or less large, with radial sides and having five arms sometimes simple sometimes branched. Ten genital slits located near the mouth or in the interbrachial spaces.

This family, although still not very numerous, is extremely interesting. Its principal type and in some way original, is provided to us by the genus *Asterophyton* (*Euryale*), whose arms are divided or sub-divided many times. But it is evident that we should include some genera whose arms are less completely sub-divided or even not at all, but which all are related by a particular appearance in the form of the disk and especially by the number and position of the genital openings. As a result, this series is connected perfectly with that of the Ophiuridae by species with simple arms and that pass by intermediaries to reach successively to those whose arms are very divided as happens in several species of *Asterophyton*.

A. SPECIES WITH SIMPLE ARMS.

1ST GENUS. **ASTERONYX**. *ASTERONYX*. — Müller and Troschel.

(αστηρ, star; ονυξ, nail.)

— Müller and Troschel, Syst. der Aster., 1842.

Five arms not branched. No buccal plates. Genital openings located in pairs in a depression near the mouth in each interbrachial space. Madreporite tubercle with a rough surface, located in one of these depressions.

Mouth with papillae on the edges. These papillae form spines that increase in length and diameter from the base toward the protruding corner that supports them and on the maxillary surfaces where they take the place of teeth. Plates of the arms with hooks.

LOVEN'S ASTERONYX. *ASTERONYX LOVENI*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 119, pl. 10, f. 3–5.

Disk pentagonal with entirely bare skin, without scales nor granules, with a dorsal side of ten radiating sides, blunt and leading to protrusions, accompanying the base of the arms on the opposite surface. Buccal papillae conical, occupying the top of the interbrachial mamelons. Arms convex on their upper part, flat below, each side having a rounded edge above a papillary ridge. The very short spines are arranged in transverse rows of four and sometimes five each. Each spine on a small protrusion is armed with small hooks on its internal edge toward the middle of the arms. Each row of papillae or spines has a longer

one directed inward and passing the middle part of the arms, this large spine is covered with a soft skin and is armed with denticulations toward its end. The number of spines for each arm can be estimated at 300. The tentacular pores are simple, without valvular scales.

Color yellowish.

Dimension: total width: 35 cm.

Inhabits the coasts of Norway.

2nd GENUS. — **ASTEROCHEMA**, *ASTEROCHEMA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 155.

Disk very small, granular, marked with ten protruding ribs more or less elongated. Arms extremely long, slender, filiform and simple, covered with granules and slightly ringed.

Ten genital slits between the arms, short spines in a double row on each side of the ventral surface of the arms.

This genus, extremely curious, is in some way the first term among the series of genera constituting the family of Euryalidae. The extreme smallness of its disk, the extreme length of its nearly cylindrical arms give it a completely particular physiognomy that recalls the general aspect of Ophiurids, but all the other characters, in particular the number and arrangement of the genital slits are very like *Asterophyton.* The genus *Asterochema* still contains only a single species known a long time ago and described by Pallas under the name of *Asterias oligactes*, a species that Müller and Troschel had thought should be referred to their genus *Asteronyx*. Although we still know very little about their behavior and habits, we know that the species of this genus are generally similar to the Gorgonians, a circumstance that we shall find in nearly all the genera of this family.

SMALL ASTEROCHEME, *ASTEROCHEMA OLIGACTES*. — Parras,

— *Asterias oligactes*, Parras, Nov. Act. Acad. Petropol., t. II, p. 239, t. V, p. 33. — *Ophiura cirrosa*, Say, Journ. Acad. sc. Phil., t. V, p.152.— *Asterochema oligactes*, Lutken, Addit. ad Hist. OphiurId., 1859, p. 155, t. V, f. 3.

Disk extremely small, pentagonal, marked with ten protruding ribs, united in pairs corresponding to the base of the arms, and having a bilobed appears toward this part. Arms extremely long, slender, cylindrical, marked above by a median groove that occupies all the extent and below with a not very pronounced gutter on each side of which is a row of rounded and spongy tubercles. All the surface of the disk is covered with extremely fine granules.

Color yellowish.

Dimensions: disk …….. 10 mm.

Arms …… 14 cm.

Inhabits Curaçao (Pallas), Saint Juan (Lutken), Martinique (Mus. Paris, under the name of *Trichaster leptocladia*).

This nice species, remarkable by its extremely small disk and arms, on the contrary, very long, slender and tubucular it is usually related to the Gorgonians and more particular to *Gorgonia verticillata*. We know another very close species that is distinguished by the form of the dorsal ribs of the disk that, instead of being long and joined together, are very short in the form of oblong tubercles and space apart so that at first gland we see only a simple crown or tubercles without perceive the corresponding pairs to each of the arms. The disk, in addition, is less pentagonal and larger so that the division of the arms is less or rather that in some way more merged with the disk. We propose to designate it under the name of *Asterochema affinis*. It comes from the same locality as the preceding and is found in the same conditions.

3rd GENUS. — **ASTEROPORPA**. *ASTEROPORPA*. — Lutken.

Disk pentagonal, gibbous, have five protruding more or less separated ribs. Buccal papillae simple and spiniform. Arms very long, simple, filiform, rounded, strongly ringed and covered with tubercular aspeities that, on the disk, have small hooks. Madreporite body simple.

Genus extremely interesting. Established by Lutken in his beautiful work regarding the family Ophiuridae. It is again one of these forms that serves as a kind of link between the Ophiuridae and Euryalidae. The arms, in fact, are simple, not branched, but covered with asperities arranged in rings that extend from the arms to the protruding ribs of the disk. We know until now only two species belong to this genus. All come from the seas of the Antilles. The extreme length of their arms, joined to their weakness leaves no doubt about the habits of these animals that probably should be referred to the Gorgonians. We think that we must refer to it as a very singular Ophiurid that we have confused sometimes with *Trichaster* and figured under the name of *T. dasycladia* in the collections of the Muséum de Paris.

1. RINGED ASTEROPORPA. *ASTEROPORPA ANNULATA*.—Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p.152, t. V, £. 4.

Disk pentagonal, more or less continuous with the arms that are long, slender, rounded and covered everywhere with protruding rings. These rings have asperities arranged in transverse series that, toward the base of the arms, i. e., on the part applied to the disk change to true spines whose last row constitutes the dental papillae. The entire surface of the body, in addition, is covered with a rough, villous skin.

Color yellowish.

Inhabits Central America, Saint Jean.

Charming species, extremely remarkable for the stellar shape of its disk on which the infrabrachial ribs, instead of being double as usual, are single or scarcely divided by a slight median groove. The simple arms, long and slender, are rounded and have a very singular ornamentation due to the presence of very protruding rings covered with asperities that are very regularly arranged by transverse zones.

2. RELATED ASTEROPORPA. *ASTEROPORPA AFFINIS*. — Lutken.

— Lutken, Addit, ad Hist. OphiurId., 1859, p. 154, t. V, f. 5.

Disk pentagonal, divided by five radiating ribs, divided by a median groove. These rounded and very protruding ribs give insertion to the arms that are very elongated, slender, rounded, ringed their entire length and on each ring transverse series of denticulations.

Color yellowish.

Dimension: total width: 40 cm.

Inhabits the Antilles.

Species very near the preceding but distinguished especially by the ribs divided on its disk, in the center of which they leave only a small free area.

3. DASICLADE-LIKE ASTEROPORPA. *ASTEROPORPA DASYCLADIA*. — Nobis.

— *Trichaster dasycladia*, Var. Coll. Mus.

Disk merges with the arms as in the Asteroids. Arms cylindrical, very elongated and tapered toward the end. They are convex and rounded above and below with a narrow groove that, leaving from the mouth, goes the entire length of the arms. Ventral surface of the disk with five stilliform slits on the border of which are inserted the dental papillae that change little by little into true spines. The dorsal surface has in its ornamentation a division into five lobes corresponding to the arms. It consists of ridges or very protruding ribs transforming into very protruding and rugose rings on the lateral parts of the ventral surface. These arms have a double series of small, nearly equal spines arranged like teeth of a comb, bifurcated at their base and separated by a median groove.

Color grayish white.

Dimension: total width: 25 cm.

This magnificent species was reported by Beauperthuis, who deposited it in the Musée de Paris. It is attached to a stem of black coral and comes from Guadeloupe.

B. SPECIES WITH DIVIDED ARMS.

4th GENUS. — **TRICHASTER**. *TRICHASTER*. — Agassiz.

(θρξι, τριχος, hair.)

Euryale, Lamarck, — *Astrophyton*, Bronm.

Five arms branched and regularly dichotomous only at the end. Disk above with brachial plates that are elongated, oblong, united in pairs. Mouth surrounded by cylindrical

papillae or spines but having in addition teeth inserted at the top of the protruding corners of the interbrachial sectors.

No madrepore tubercles. Ten genital slits. Arms rugose and ringed in part and having on their ventral surface ridges, papillae or spines on the lateral parts.

The genus *Trichaster* was established by Agassiz for a species known for a long time under the name of *Euryale palmiforme*, Lamarck. This singular species forms, in fact, a type very distinct from some points of view from the Ophiurids. It establishes directly the obvious passage between the preceding genera, which are in some ways only sketches of the Asterophydae and that. like *Astrophyton*, represent their extreme end. The characteristic that can be used to establish this connection is the bifurcation and dichotomy of the arms at their end.

We still know only two species belonging to this genus. One, *Trichaster palmiforme*, has been known for a long time and already figured in some works under the name of *Euryale.* The other still has not been described nor figured. It is *T. annulatum*, Val. (Mus. Paris).

PALM-LIKE TRICHASTER. *TRICHASTER PALMIFERUS*. — AGASSIZ.

— *Euryale palmiferus*, Lamarck, An. s. vert., 2^{e} édit., t. IIL, p. 217. — Encycl. méthod., pl. 126, f. 1–2. — *Trichaster palmiferus*, Agassiz, Prod. Echin. Mem. Neufchàtel, p. 193. — 14. *Id.*, Müller and Troschel., Syst. der Aster., p. 120. — *Astrophyton palmiferus*, Bronn, Syst. der Urwalt Pflanz., t. 109:

Disk bare, having only some sparse granules. Each side of the interbrachial area of the dorsal surface with two contiguous dentiform plates that extend into a protruding edge surrounding the marginal inter brachial area and is attached to the buccal plates. On the ventral surface of the disk, the interbrachial areas are entirely filled by the buccal plates that, separated by a shallow groove, are indented on the two sides and notched either in front or behind. The buccal papillae are cylindrical and the teeth that follow them are wide and blunt. The arms, simple for three quarters of their length, is dichotomized regularly toward the end, two or three times, and ends in some kind of very small cirri. The ventral surface of these arms is covered with a soft skin with extremely fine granules. The lateral parts have small plates and pavers 4 mm wide. At the edge of the bare part we see on each side a spine that is thick, blunt with a length of 2 to 4 mm and a width of approximately ¾ mm. This spine is on a conical base of the same length, forming a transverse rib and corresponding to each article of the arms.

Dimension: total width: 22 cm.

Inhabits the seas of India.

As we have said above, this species was confused by Lamarck with *Euryales* (*Astrophyton*, Linck). The dichotomies of its arms, only toward the end is in some way the first character that we are going to see so developed in the Euryales, where the divisions of the arms are not far from the disk and multiply to infinity.

5th GENUS. **ASTEROPHYTON**. *ASTEROPHYTON*.— Linck.

— *Euryale*, Lamarck. — *Gorgonocephalus*, Leach.— *Astrophyton*, Müller and Troschel. — *Asterophyton*, Lutken.

Disk thick, pentagonal or rounded, giving insertion to five bifurcated arms, first near the base, then divided again on each side into two or three branches with more or less small branches and sub-divided to infinity. The ends of the arms are very thin and appear cirrus. Mouth without true teeth but edged with spines that increase in length to the point of the re-entrant corners on the maxillary surface.

No buccal plates between the arms that are joined without intermediaries. In one of the interbrachial corners is the madrepore plate, not very protruding, and two genital slits in each interbrachial interval. The arms have on the ventral surface small ridges made of papillae or spines, some of which have hooks.

The genus *Asteropyton,* more generally known under the name *Euryale* given it by Lamarck, was figured a long time ago by Linck under the term that we accept with Agassiz, Müller and Troschel and most modern authors. Only the spelling had to be modified to be more correct and this is how Lutken in his beautiful work on Ophiurids writes *Asterophyton*.

The genus that concerns us contains animals very remarkable for the extreme development of their arms, several hundred slender and cirrus appendages whose use is probably basically locomotion. The number of species is very restricted, but their zone of habitation is very extensive and although more frequent and more numerous in the seas of the North, temperate seas have them and finally the equatorial seas also have them.

1. WARTY ASTEROPHYTON. *ASTEROPHYTON VERRUCOSUM*. — Lamarck.

— *Euryale verrucosum*, Lamarck, An. s. vert., 2e édit. t. III, p. (exclus. synon. Linckiae). — *Id. Id.*, Cuvier, Règ. an. Zooph., p. 5. — *Astrophyton scutatum*, Agassiz, Note sur les Euryales, 1839, Mem. Neufchâtel, t. III, pl. 2, f. 3. — (As *Gorgonocephalus verrucosus*, pro errore) *Astrophyton verrucosum*, Müller and Troschel. Syst. der Aster., 1842, p. 121.

Disk pentagonal, thick, having above ten radiating ribs that are protruding, rounded, truncated toward their end and with tubercles surrounded by a brown ring. Dorsal surface of arms with very scattered blunt tubercles. The opposite face broadly flattened and covered, like the disk, with dense granules whose largest ones are in the middle. The lateral parts have ridges each with three or four short papillae of very small spines.

Color yellowish, arms with a brown line on their ventral surface.

Dimensions: disc ……. 10 cm.

Arms …….. 40

Inhabits the sea of India.

2. BRISTLY ASTEROPHYTON. *ASTEROPHYTON MURICATUM*. — Müller and Troschel,

— *Astrophyton costosum,* Linck, t. XVIIL, n° 29, 30, 31. — *Euryale muricatum*, Lamarck, An. s. vert., 2e édit., t. IL, p. 217. — *Astrophyton muricatum*, Müller and Troschel. Syst. der Aster., 1842, p. 122.

Disk having above ten ribs and covered in addition with fine granules, as well as conical points that are truncated at their end. The ventral surface of this disk is distinguished in addition by the extreme width of the base of the arms that because especially of a kind of lateral border on each side, is as wide and even wider than the interambulacral areas. These edges of the base of the arms are joined in an arc on the ventral sides of the disk where the granules are still not very pronounced.

The madrepore plate is located between one of these arcs and the rest of the bare portion of the disk. The granules of the arms are very fine and dense everywhere and as, in general, they are flat and blunt, the arms appear smooth at first glance. The first part of the arms, as well as the first divisions, have no papillae or spines, but the sub-divisions further away have two or three papillae on each lateral ridge.

Color yellowish.

Dimension: width of the disk: 25 mm.

Inhabits ? Musée de Paris.

3. LINCK'S ASTEROPHYTON. *ASTEROPHYTON LINCKII*. — Müller and Troschel.

— F. Martins, Spitzberg Reis., 1679, t. P, f. e. —A*strophyton scutatum* (pars), Linck, t. XXIX, n° 48. — *Asterias caput medusae*, Fabricius, Faun. Groenl., p. 327.— *Astrophyton scutatum*, Forbes, Brit. Starfish., p.67.— *Astrophyton linckii*, Müller and Troschel., Syst. der Aster., p. 122.

Entire dorsal surface of the disk with numerous scattered conical or cylindrical tubercles between which are very visible granules. The arms. without tubercles, do not have at their base the wide edges characteristic of the preceding species. This ventral surface is granular and has a band of more or less large and flat granules. The spines are arranged in four rows on transverse ridges from the base of the arms.

Inhabits the seas of the North, White Sea.

4. EUCNEMID-LIKE ASTEROPHYTON. *ASTEROPHYTON EUCNEMIS*. — Müller and Troschel.

— Müller and Troschel., Syst. der Aster., p. 123.

Disk having above ten granular ribs but without spines nor tubercles. The depressed and blunt granules are abruptly limited to the edge of the ribs. The skin of the disk between the ribs is entirely bare. On the middle are some granules. The skin of the ventral surface of the disk is bare everywhere. The interbrachial areas are large and the stems or roots of the arms are narrow and without borders. The arms are uniformly covered with granules

that are not very protruding, hemispherical on the back and the sides, the ventral surface completely bare, with the exception of the lateral parts where there are transverse rows of four or five papillae.

Inhabits the seas of the North. Musée de Berlin.

5. LAMARCK'S ASTEROPHYTON. ASTEROPHYTON LAMARCKII.— Müller and Troschel.

— *Astrophyton lamarckii*, Müller and Troschel., Syst. der Aster., p. 129.

Disk covered with conical granules on the dorsal surface, on the sides and in their intervals but without tubercles. Ribs protruding and strongly truncated at their exterior end. Ventral surface of the disk finely granulated. Arms entirely bare on the ventral surface and without lateral borders. Their base at the level of the disk has transverse rows of four to six very large spines. Their dorsal surface is, in addition, covered with conical granules but without tubercles.

Color reddish brown.

Dimension: disk: 6 cm.

Inhabits the glacial sea (musée Berlin) where it is generally attached to the large *Alcyonium arboreum* and also gorgonians.

6. ARBORESCENT ASTEROPHYTON. *ASTEROPHYTON ARBORESCENS*. — Müller and Troschel.

— *Stella arborescens*, Rondelet, p. 120. — *Asterias caput-medusae*, Retzius, Dissert. Aster., 1805, p.35.—*Euryale mediterraneus*, Risso, Hist. nat. Eur. MérId., 1826, t. V, p. 274. — *Euryale costosum*, de Blainville, Män. Actin., 1834, p. 244, pl. 25.— *Gorgonocephalus arborescens*, Agassiz, Mem. sur les Euryales, in Mem. Soc. Neufchâtel, 1. II, f, 4. — *Gorgonocephalus verrucosus*, Grube, Actin., 1840, p. 19. — *Astrophyton arborescens*, Müller and Troschel., Syst. der Aster., 1842, p. 124. — *Id., Id.*, Sars, Middelh. littor. France, 1837.

Disk width 3 cm with six dorsal black spots, one located in the middle and the other five between the arms. The contour of the disk is equally dark as well as the interbrachial areas of the ventral surface which are the origin of two dark lines that extend onto the arms and follow the papillary ridges. The mouth is surrounded by a pale ring. The surface of the buccal corners is darker. The rest of the surface is gray. The disk is uniformly granular without tubercles nor spines. But each granule has at the top an extremely fine point. The dorsal ribs are not very protruding. The granules of the ventral surface are similar to those of the back, but those of the edge are a little finer. On the arms, above and below, the granules of the granules that are very close together are flat, rounded and without points. The dorsal, ventral and lateral surfaces of the disk are clearly separated from each other by a sharp contour. The base or stem of the arms on the ventral surface of the disk has a border that, from one arm to the other, is curved and occupies all the interbrachial interval. As a result, the madrepore plate is not located as usual in the corner formed by two arms but in the middle of the arced junction of these arms.

The papillae and spines on the ventral surface of the arms are arranged in rows of two or three. Smooth at first, they developed spinelets at the end in going toward the middle of the arms, then finally on the slenderest branches. Each spine has a small, curved hook.

The arms, 11 cm long, are bifurcated after the sixth article. The dorsal ribs, arranged in pairs, go to each of the primary branches that, seen by the back, appear double. Each primary branch, after dividing, has approximately eight to twelve small lateral branches, sub-divided into branches and smaller branchlets.

Inhabits the Mediterranean, the coasts of Sicily.

7. ROUGH ASTEROPHYTON. *ASTEROPHYTON ASPERU*— Müller and Troschel.

— *Asterophyton scutatum* (pars), Linck, t. XX, f. 32.— Sepa, Thesaur., t IL, tab. 9, f. 2.— Copiée Encycl. méthod., t. CXXVIL, p. 216.— *Euryale asperum*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 216. — *Astrophyton asperum*, Müller and Troschel. Syst. der Aster., p. 127.

Dorsal surface of the disk with five pairs of radiating ribs, very finely granulated and each with one or several spines at the end that are cylindrical, tubercular above and correspondingly at the base of the arms. The ventral surface is irregularly granular and covered with plates. The arms, quadrangular and less finely divided than in the other species, have on the dorsal surface two rows of spines, having above, like those of the ribs, a small spiny button. On each side of the ventral surface of the arms are two spines arranged transversely that are also spiny and forming a kind of ridge on each article.

Dimension: total width: 16 cm.

Inhabits the sea of India. Musée de Paris.

8. SMALL ASTEROPHYTON. *ASTEROPHYTON EXIGUUM*. — Müller and Troschel.

— *Euryale exiguum*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 217.— *Astrophyton exiquum*, Müller and Troschoel. Syst, der Aster., p.

Disk without dorsal ribs but divided by five grooves into five sectors, each with a bifurcated arm. All the dorsal surface on the disk and the arms is convex and covered with irregular granules among which are some larger and flattened ones, The ventral surface of the arms is wide, flat and uniformly granular. After the first bifurcation of the arms on the ventral surface are transverse ridges composed of four or five extremely small spines ending in a curved hook.

Total length: 65 mm.

Inhabits the sea of the South.

9. ASTEROPHYTON FROM CHILI. *ASTEROPRHYTON CHILENSE*. — Philippi.

— Philippi, Archiv fur Naturg., 1858, p. 268.

Disk with ten protruding ribs on the back. Arms elongate ed and only divided five times, the last rameau forming a kind of rosette. The bifurcation begins at approximately 9 mm from their base. Then each principal branch divides again, but the branches that result

are not equal. The first external branch is in fact only branched twice and the first internal one only once, while the principal branch bifurcates three times. The madrepore plate is small, scarcely visible.

Color brown with yellowish arms.

Dimension: total width …….. 80 mm.

Disk …… 7.

Inhabits the coasts of Chili.

10. CECILIA'S ASTEROPHYTON. *ASTEROPHYTON COECILIA*. — Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 157, tab. 5, fig. 6.

Disk with ringed ribs, as well as the base of the arms, and covered with unequal granules. The arms have in addition ambulacral spines.

11. KREBS' ASTEROPHYTON. *ASTEROPHYTON KREBSII*.— Lutken.

— Lutken, Addit. ad Hist. OphiurId., 1859, p. 158.

Disk with ribs on which continue the rings of the arms that are in addition covered with equal granules and lateral spines the entire length to the base but only extend onto the disk itself.

Madrepore tubercle formed of five small tubercles.

Inhabits Central America, Saint Jean.

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FOURTH BOOK.

ASTEROIDS.

DEFINITION.

Animals with body more or less depressed, discoidal, polygonal, but most often pentagonal with more or less pronounced corners, simply lobed or extended in brachial appendages, most often five in number, sometimes a larger number and can go in some cases up to thirty and even more.

This body, supported by a kind of internal skeleton formed of juxtaposed calcareous pieces united by a coriaceous integument, often very complex, with scattered spines or calcareous tubercles extremely varied in their form and disposition. Mouth located in the center of the ventral surface and from which go as many gutters or grooves as there are arms. These gutters or ambulacral slits give passage to the organs of respiration or locomotion. An anus in the larger number.

REVIEW

We can say that from the oldest times Asteroids or Sea Stars have attracted the attention of everyone and most particularly naturalists by the singularity of their form. We find already in Rondelet (1555) representations of these animals. — In the following century, Fabius Columna (1616), Gesner (1620), Aldrovande (1638), and Fr. Martens (1675), have also given figures. Then Luidius (1703) took care of them in a way that still has traces of his conclusions today. Rumphius (1705), Petiver (1711), and especially J. H. Linck, in his *Traité de Stellis marinis*, made a special study of them and gave representations that we are still happy to cite because of their correctness. Unfortunately, the attempts on classification of these animals, based principally on the number of arms, necessarily lack accuracy because the number of these appendages varies, not only from one species to another, but also in individuals belonging to the same species. Linck divided the animals in question first into three classes, the first containing genera and species having less than five rays or arm, from which came the names of *Trisactis, Tetrastis*. Let

us say immediately that the different species in this class are only monsters or mutilated individuals belonging to species that normally always have five arms at least. His second class, Quinquefidurum, is scarcely more correct for the reasons we gave above. namely, the variability of arms. As the general rule refers to the normal number is five, some generic sections have been able to be preserved in the present nomenclature. Such as the genera *Pentagonaster, Astropecten, Palmipes*, etc. His third class containing all species that had more than five arms is, as one could expect, even more indigestible than its elders and has left no trace in present methods. It contains the genera *Hexactis, Heptactis, Octactis, Ennactis, Decactis, Dodecactis, Triacodecactis*, etc.

After having reported Janus Plancus (1753), Knorr (1766), O.F.Müller (1776), Pennant (1777), Fabricius (1780), Retzius (1783), Pallas (1788), we arrive at the immortal author of *Systema naturæ*. Linné (1788) summarizes the works of his predecessors and gives a nomenclature of the numerous species already studied. It is thus that Brugnière (1792) did from a graphic point of view, what Linné had done from the nomenclatural. He reproduced, in the *Encyclopédie méthodique*, a large number of figures taken from different authors, most particularly of Linck, Müller as well as others. In the XIXth Century, a larger number of works have been made on Asteroids.

Mentagu (1804), Retzius (1805), Savigny (1809), Leach (1815) and finally Lamarck (1816), the French Linné in his *Hist. nat. des anim. sans vert*., made known a larger number of species preserved in the collections of the Muséum de Paris. Until now, we scarcely see naturalists concern themselves with these animals except in the dry state and give very little on their anatomy. It is from the date of Tiedmann (1816) that this new way was opened.

We return to the zoological point of view and cite Fleming, Otto and Delle Chiaje (1823). Say (1825) made known to us species from North America. Then Risso (1826), those of the Mediterranea. Eudes Deslongchamps, the same year, took care of the common Asteroid (*Asteracanthion rubens*). de Blainville, in his *Manuel d'Actinologie*, published in 1834, introduced into the classification of Asteroids, principles already important: the general form as well as the number of arms being taken into consideration. He separated the species known until then, as well as some new ones, into six groups or sections for which he proposed particular names, such are: Sect. A. *Oreillers*, for discoidal species as *Ast. disceidea*, Lk. Sect. B. *Palmasterias*. Ex.: *Ast. membranacea*. Sect. C. *Scutasterias*. Sect. D. *Platasterias*, for pentagonal species. Ex.: *Ast. tessellata, Ast. equestris*, Lk. Sect. E. *Pentasterias*, for those that a strongly divided into five rays. Ex.: *A. aurantiaca*, Lin.; *A. rubens*; *A. ophidiana*; etc. Sect. F. *Solasterias*, whose number of arms exceeds five or six. Nardo (1834) began to divide the Asteroids into several distinct genera. He brings the number to six: 1. STELLARIA. Ex.: *A. aurantiaca*. 2. STELLONIA. Ex.: *A. rubens*. 3. ASTERINA. Ex.: *A. exiqua*. 4. ANSEROPODA. Ex.: *A. membanacea*, Lk. 5. LINCKIA. Ex.: *A. laevigata,* Lk.

This same year 1834, Brandt (*Prod. descript. anim. ab. H. Mertensio observat*.) made known some species of the seas of the North and the year after, 1835, Agassiz, in his *Prodromus de la classe des Échinodermes*, raised to nine the number of genera of Asteroids 1° G. *Asterias* (= *Stellaria*, Nardo, *Pentasterias*, Bv.); 2° G. *Caelaster*, for fossil species; 3° G. *Goniaster* (= *Scutasterias*, Bv.); 4º G. Ophidiaster; 5° G. *Linckia*, Nardo; 6° G *Stellonia*, Nardo (= *Pentasterias* and *Solasterias*, Bv.); 7° G. *Asterina* (= *Platasterias*, Bv.); 8º G. *Palmipes*, Linck (= *Palmasterias*, Bv., *Anseropoda*, Nardo); and 9° G. *Culcita*, Ag. (= *Oreillers*, Bv.). We now cite briefly the works of Johnston (in *Lond. Mag. hist*. 1835);

those of (1836), Philippi (1837), and especially those very interesting ones of Forbes (*Mem. soc. Wern*., t. VII, 1839), as well as those of Thompson (1840), that open, in a way, a new fertile era in works on Asteroids. It is in fact from this moment that date the first observations of Müller and Troschel, making the subject of several memoirs inserted successively (*Weigmann, Arch*., 1840) and that have had so happy an influence on the natural history of the animals that concern us. The history of development in particular has been the subject of very important work and that serves as the basis for all that we know most positively on this part of their organization.

Grube (1840) made known to us the species of the Adriatic Sea and Gray gave his synopsis of the genera and species of Asteroids (in *Ann. and Mag. of nat. Hist*., t. VI, 1840), in which he made first an order under the name Asteroidea that he divided into four families: the 1st, Asteriadae, containing 2 genera: *Asterias* and *Tonia* (— *Asteracanthion*, M. T.); the 2nd, *Astropectinidæ*, containing the genera: 1. *Nauricia*, 2. *Astropecten* (= *Astropecten*, M.T., *Archaster*, M. T., *Ctenodiscus*, M. T.), 3. *Luidia*, Forbes, 4. *Petalaster*, Gray, 5. *Solaster*, Forbes, 6. *Henricia*, Gray (= *Cribella*, Ag.); the 3rd fam. Is that of Pentacerotidae, Gray. It contains these genera: 1. *Culcita,* Ag., 2. *Pentaceros*, Gray (= *Oreaster*, M. T.), 3. *Stellaster*, Gray, 4. *Comptonia*, Gray (fossil species), 5. *Gymnasteria*, Gray (= *Asteropsis*, M. T.), 6. *Paulia*, Gray (— *Goniodiscus*, M.T.), 7. *Randasia*, Gray (= *Goniodiscus*, M.T.), 8. *Anthenea*, Gray (= *Goniodiscus,* M. T.), 9. *Hosia*, Gray (= *Goniodiscus*, M. T.), 10. *Hippasteria*, Gr. (= *Astrogonium*, M. T.), 11. *Calliaster*, Gray (genus whose value is still doubtful), 12. *Goniaster*, Gray (= *Goniodiscus*, M. T. and *Astrogonium*, M. T.), 13. *Pentagonaster*, Gray (= *Astrogonium*, M. T.), 14. *Tosia*, Gray (= *Astrogonium,* M. T.), 15. *Echinaster*, Gray, 16. *Othilia*, Gray (= *Echinaster*, M.T.),17. *Metrodira*, Gray (— *Scytaster* (pars), M.T.), 18. *Rhopia*, Gray (= *Echinaster*, M. T., *Cribella*, Agassiz), 19. *Ferdina*, Gray (= *Echinaster*, M. T.?), 20. *Dactylosaster,* Gray (= *Ophidiaster*, Ag. T.), 21. *Tamaria*, Gray (= *Ophidiaster*, Ag. T.), 22. *Cistina*, Gray (= *Ophidiaster*, Ag.), 23. *Ophidiaster*, Ag., 24. *Linckia*, Nardo (= *Ophidiaster*, Ag.), 25. *Fromia*, Gray (=*Scytaster*, M.T.), 26. *Gomophia*, Gray (still doubtful), 27. *Nardoa*, Gray (= *Scytaster*, M. T.), 28. *Narcissa*, Gray (= *Scytaster*, M. T.), 29. *Nectria*, Gray (= *Goniodiseus*, M. T.?), 30. *Nepanthia*, Gray (— *Chaetaster*, M. T.?), 31. *Mithrodia*, Gray (= *Asteracanthion*, M. T.), 32. *Uniophora*, Gray (= *Asteracanthion*, M. T.). The 4th family contains the genera: 1. *Palmipes*, Linck (= *Asteriseus*, M. T. and *Asteropsis*, M. T.), 2. *Porania*, Gray (= *Asteropsis*, M. T.), 3. *Asterina,* Nardo (— *Asteriscus*, M. T.), 4. *Patiria*, Gray (= *Asteriscus*, M. T.), 5. *Socomia*, Gray (still doubtful).

In summary, the work is composed of 45 genera, 1 of Linné, 3 of Linck, 2 of Nardo, 3 of Agassiz, 2 of Forbes, and 34 new ones. As we shall see, these genera are much too many and most should return to those already previously established or are still too poorly defined to be accepted.

It was also in 1840 that Müller and Troschel (*Archiv für naturg*., 1840, p. 318) published on the classification of Asteroids, a first work in which, distinguishing first these animals according to the presence or absence of a posterior opening to the intestinal canal, then, afterwards, taking into account the number of ambulacral tentacle, they formed three families containing 14 genera, namely, one family characterized by the presence of an anus and four rows of tentacles in each ambulacral groove, G. *Asteracanthion*, M.T., and *Stichaster*, M. T.; a second family having two rows of tentacles containing the genera: *Echinaster, Crossaster, Chaetaster, Ophidiaster, Linckia, Goniaster, Asteropsis, Culcita*

Asteriscus and *Archaster*; a third family having for distinctive characters the absence of an anus and two rows of ambulacral tentacles containing the genera *Asterias*, Agassiz (*Stellaria*, Nardo), and *Hemicnemis*, M. T., (*Luidia*, Forbes). A little later, in another memoir, these authors proposed a new genus formed from *Asteracanthion*, and a genus *Platyaster* from *Goniasater.* But, afterwards, as we shall see, they did not preserve them. Forbes (*Brit. hist. starfish*, 1841) made known some new species and Erdt gave a very interesting work on prehensile organs (pedicellariae) of asteroids (*Weigm., Archiv*, 1842, p. 18).

In 1843 Müller and Troschel (*Weïgm. Archiv*, p. 113) made known some new species of Asteroids. Then, soon after, presented observations on the geographic distribution of these animals. Finally, in 1844, the same authors published their great general work (*Syst. der Asteriden*) in which they established and definitively fixed the genera and at the same time gave a detailed description of all the species. They separated them into 3 families based on the above characters. Then, after having rejected some genera they had previously established and established by others, they definitively accepted 18.

We shall see that their method has been generally adopted and that it still rules today without important modifications. But if the classification strictly speaking has been little modified, it is not the same with progress that concerns knowledge of the basic organization, the anatomy and physiology of this class of animals. We shall cite first the very interesting observations of Sars on the development of *Asterias* (*Cribella*) *sanguinolenta* (*Wiegm. Archiv*., 1844, p. 169). Then, from the zoological point of view, the work of Duben and Koren ono the Echinoderms of Scandinavia (*Vetensk akad. Handlingar*, 1844); that of Michelin (*Revue zoo*. 1844, and Mag. of zoolog. 1845), on the species constituting the fauna of Mauritius that mentions 20 species, 2 new (*Ophidiaster marmoratus* and *Oreaster desjardinsi*), then a particular genus under the name of *Heresaster* (*H. papillosus*).

Stimpson (*Proc. of the Boston*, 1851-54) made known some new species of Asteroids, and more particularly four species from California. Then Steenstrup (1854), Forbes (1856), each did the same for their coast.

Philippi (*Weigm. Archiv* 1857) gave a list of the Echinoderms of Chili and described a new species of *Goniodiscus* (*verrucosus*). The same year and in the same collection, Grube made known seven new species of Asteroids. Lutken (*Oversigt over Gronlands Echirodermata*) and Sars, already cited, studied the species of Asteroids of the Mediterranean and completed the descriptions of some species previously known at the same time that he described new ones. Finally, Leuckart (*Weigm. Archiv*, 1858, p. 150) described some species of Echinoderms of which two were Asteroids.

DESCRIPTION, FORMS OF ASTEROIDS.

Although very variable in their details, the Asteroids are scarcely separated from a common and general type, i. e., from a kind of star (αστηρ, star), from which the name of Sea Star has been applied to them for a long time and that they preserve today in the usual language. What is striking first of all in these animals is especially their star form, a disposition that we have already seen exist Crinoids as well as in Ophiuroids, but less well defined, less exact in some way, notably in the ensemble because in the Ophiuroids, for example, the arms, measurably longer, are not connected to the disk in a way to recall the

form of a star but seem so to speak added to the disk without being in perfect continuity with it. This character appears at first completely superficial and reveals a major difference between the two groups because while in Asteroids the body cavity. and consequently, the disk is prolonged into the arms, in Ophiuroids, on the contrary, the latter organs are complete and in no way communicate with this cavity. By the arrangement of the central mouth, around which are arranged different organs, Asteroids show us the radial type par excellence. However, we are quick to add that this disposition is more apparent than real because we know today, especially since the ingenious comparisons made by Agassiz, that these animals can, to some degree, be bilateral or binary. This scholar has demonstrated, in fact, that taking into account the position of the madreporite plate on the surface of the body or disk, in relation to other parts, the animal can be easily divided by a median line leaving on each side similar parts. In placing, for example, in placing before you an Asteroid with five arms so that the madrepore plates is located posteriorly, one has on the opposite side to it, i.e., in front, an unpaired arm that we can conceived formed of two similar parts joined. Then, on each side, two entire arms perfectly similar in form and arrangement. This symmetry has, in addition, been demonstrated according to the same principle for other animals that seem little disposed to be brought together. We speak of Echinoids, especially the Urchins strictly speaking. But if, instead of taking for example a regular Echinoid, i. e., in which the mouth and anus are on opposite pole, we take an irregular Echinoid, one sees then that the mouth remains located in the center, but the anus ceases to be opposite it. We have then the possibility of considering the necessarily posterior position of the anus to determine with certainty the anterior and posterior parts of the animal, then, consequently, it right and left sides.

Let us return now to an appreciation of the general form in Asteroids. We see it, in most cases, constitutes a depressed body composed of two more or less distinct parts: the disk and the arms, the disk always being in continuity with the second by a more or less wide base and offering, in a large number of cases, a kind of star with five branches or arms. But this number is far from being constant for all species of Asteroids. Not only does it vary from one genus to another, but this variation is seen in species belonging to the same genus, and is moreover, in individuals of the same species.

Independent of their number, the arms have very great differences in their form. It is precisely in the relation that exists between these arms and the disk that modifications have the most variation. We can say, in fact, that in this relation Asteroids show, between two extreme ends, all intermediary degrees. The first end is especially shown in the genus *Culcita*, Ag., in which the disk is so developed that it alone constitutes the entire animal. The arms scarcely reveal their presence by a slight protrusion on the periphery of the disk. The second end is offered by the genus *Luidia*, Forbes, in which, on the contrary, they are extremely elongated, very slender while the disk itself is reduced to the minimum.

Whatever the length of the arms, moreover, we always see them take a more or less elongated form, most often pointed toward the end, but sometimes blunt. They are nearly always depressed, rarely cylindrical and with two surfaces, one upper or dorsal, the other Lower or ventral, which is always hollowed out on the median line by a deep, longitudinal groove, leaving from the center of the disk and extending to the end of the arms and communicating with the general body cavity. This groove serves, moreover, for the outlet of organs of respiration and locomotion, organs that consist of kinds of hollow tubes or cylindrical tentacles, more or less extendable, most often ended in a small sucker, that has

received the name of feet. These organs vary, in addition, in number and are always arranged in rows along the slits of the grooves that are called *ambulacral grooves*. These ambulacral grooves are very important and play a large role either in the characteristic of the genus or in that of the species according to whether they are accompanied by spines or papillae or plates taking this or that disposition.

As for the disk, we have already seen that it varies in regard to its dimensions. It is the same with its form according to whether the arms are detached more or less deeply, i. e., according to whether the base of the latter is more or less wide and merges to different degrees with it. The Lower or ventral surface of the disk has, in its center, an opening that is the mouth, to which we shall soon return in speaking of the organs of digestion. The Upper or dorsal surface of the disk, independent of the different protruding parts, consists of very variable plates, spines or tubercles belonging to the dermal covering, always has at a point intermediary between the center of the disk and the arms, an irregular protrusion that has received the name of madrepore tubercle of madreporiform, whose role is still not well determined but it appears with the organs of reproduction. It is the same on the dorsal surface of the disk where the anus opens in species with a second opening of the intestinal canal. It does not open by a single hole but rather a kind of cribellated lamella more or less apparent, generally hidden and lost in the middle of tubular plates whose skin covers it. Such is, seen in a general way, the form of Asteroids. We add now that it is determined by an ensemble of extremely complicated solid parts that has received the name of skeleton, which in its turn is supported or covered by another ensemble no less complicated of equally solid dermal parts that is going to occupy us now.

SKELETON, INTEGUMENTS OF ASTEROIDS.

We saw in the preceding chapter that the form in Asteroids is always determined by an ensemble of very variable calcareous pieces and constitutes a kind of skeleton that, already for a long time, has been the subject of numerous works and more or less satisfactory theories from the comparative point of view, either with related animals or even with higher animals in which a true skeleton exists. Aristotle compared the covering of Sea Stars to a test and Pliny to a hardened skin. Davis Kade has made a study of the pieces composing Asteroids. He used, in this regard, names borrowed from the osteology of vertebrate animals, such is notably that of vertebra. Tiedmann, then Delle Chiaje are occupied with the integuments and skeleton of Asteroids and the same qualitative expressions are used. Meckel (*Traité d'anatomie comparée*, 1828) has studied with much care the pieces of Asteroids and has distinguished: 1° principal pieces or elongated pieces that occur the center of the rays and leave between them intervals for the passage of the ambulacral tubes; 2° ventral lateral pieces; 3° dorsal lateral pieces (— marginal pieces); 4° transverse or intermediary pieces; 5° ventral pieces. de Blainville, in his *Manuel d'Actinologie*, necessarily occupied himself with the same subject and was the first to indicate the relations that exist between the pieces of Asteroids and the covering or test of Echinoids. Agassiz (*Prodrome*, 1834) has taken his study still further and modified the ideas of de Blainville in the comparison of Asteroids and Echinoids. He established the bilateral symmetry of these animals, reviews and analyzes the different solid pieces, their mode of articulation and their number that he evaluates in an individual of the genus

Euryale to be more than one hundred thousand. Duvernoy (1848) opposed the opinions of Agassiz regarding the skeleton and sought to demonstrate that bilateral symmetry is found in each segment and not in the ensemble of the segments. The same author denies that the pieces of Asteroids can be considered a test but as a skeleton and then in particular to the skeleton of Chelonians. However, in this hypothesis, the ambulacral plates correspond to the vertebrae while the interambulacral plates correspond to the ribs. We do not need to add that these ideas did not prevail. Still, it is that Asteroids have an ensemble of calcareous pieces constituting a kind of interior skeleton that, developed to a high degree in Crinoids, can it constitute so to say the entire body of these animals, already becoming less important in Ophiuroids and finally having a special disposition in Asteroids. Here, in fact, the central portion of the skeleton appears less developed while the dermal portion acquires, on the contrary, a greater development. It is this that made some authors say that Asteroids, as opposed to Ophiuroids, lack a central system. We think that there is here an error in interpretation and that the solid parts in these two animals are completely identical and, in fact, the Ophiuroids having complete arms, i.e., not hollowed on the ventral surface with an ambulacral groove, differs from Asteroids only by an inverse arrangement that results from the presence of an ambulacral groove and skeletal pieces modified by this particularity. The pieces of Asteroids that belong to the internal skeletal system or to the dermal system are no less numerous and varied. They were estimated to be more than 11,000 in an individual *Asterias rubens* (*Asteracanthion*) by Gaudry, who treated with much talent the question that concerns us. In this very extensive work, this author sought to reduce them to three divisions or systems: 1° internal system; 2° intermediary system; 3° superficial system.

The internal system, according to Gaudry, would not exist or scarcely indicated in Asteroids while it would be very developed in Ophiuroids. We have expressed above our way of seeing this. We accept the most perfect identity in this regard between the two groups. For us, the internal system contains the ensemble of calcareous pieces juxtaposed one after the other from the mouth to the end of the arms, both above and below. All these pieces are united by a fibrous membrane forming a kind of bony cage containing the various organs. It is there, in some way, the outline of what we shall see so developed in Echinoids. Whatever it is, the pieces of Asteroids, so different both in their form and their position, can however be reduced to four principal series: 1° ambulacral series that are the most developed and leave between them intervales for the passage of the tubercles; 2° the interambulacral pieces, juxtaposed to the preceding and completing the ring canal; 3° the genital pieces; 4° the anal or tergal pieces that are divided into upper and lower ones. They are generally smaller and form either irregular networks of innumerable series, while, on the contrary, they are pressed against either other without leaving any interval or are juxtaposed irregularly and produce on the back large swellings (*Oreaster*), sometimes very large and cylindrical (*Astrogonium*), while, on the contrary, very small and having the form of palettes (*Asteriscus*).

The superficial or dermal system contains all the integumentary pieces designated under the names of spines, granules, tubercles, paxillae and finally pedicellariae, these singular organs whose role is still ill defined and to which we shall soon return. The spines are of several kinds. — the most important are the ambulacral spines, i. e., those accompanying the ambulacral groove. The form, number, as well the disposition of these spines are always taken in great consideration to characterize genera and species. In some

cases (*Asterias rubens, glacialis*), they are surrounded at their base by a kind of fleshy sheath, either on the lateral parts of the arms or bordering the ambulacral grooves. Other spines are found in other regions of the body, notably on marginal, dorsal, or ventral plates. Scales are only very small spines that often accompany granules. Granules are sometimes widespread on all the surface of the Asteroid body. Othes are limited to some regions and cover all or part of the plates. Tubercles are in the same case and differ from the preceding only by their larger size. Paxillae are kinds of plates to which we have given the name *paving plates* because of their disposition and arrangement. They are distinguished by this particularity, independent moreover of their proportions, that they are surmounted by a group of protrusions joined in the manner of a brush or rosette. We usually see them on the dorsal surface of Asteroids such as *Astropecten* where they occupy the area between the marginal plates. These latter also have a great importance for characteristics and, as well as indicating their name, they are located on the sides of the arms that they edge on the circumference.

The pedicellariae are organs that are hard, calcareous, taking the form of small pinchers, bivalve or trivalve, whose role in Asteroids is still not sufficiently determined although their form indicates they are probably involved in prehension. Their number as well as their position on the surface of the animal varies greatly. In *Asterius rubens*, for example, we see them surrounding the base of the spines that border the ambulacral gutters. They then appear like kinds of tentacles with pincers, ending in three small calcareous pieces capable of separating and then coming together like the petals of a flower. They often surround the mouth. Other times they are scattered on the dorsal surface and ae inserted between the plates of this region.

Finally, we mention again, as making part of the epidermal system, another very singular organ, called the madrepore plate or madreporiform, exists in all Asteroids without exception and located eccentrically on the dorsal surface of the disk in an interbrachial space. This plate opens into a calcareous column in relation to the sand canal whose appearance was described by Siébold and to which we shall return later. In some species of Asteroids, there are several madrepore plates and probably also, consequently, several of the small columns.

MUSCULAR SYSTEM, LOCOMOTION.

The lacunae that exist between the articulations of the internal skeleton are filled with muscles as demonstrated by the observations of Meckel. The cutaneous covering of these animals seems to contribute to movements of the arms by its elasticity. It thus has a purely passive role. But it is not the same in this regard either for the spines or especially the feet or tentacles with suckers that leave the ambulacral grooves. The latter, to which we give the name ambulacra, are placed in double or quadruple rows in these same grooves that extend from the mouth to the end of the arms. They consist of a fleshy cylinder, hollowed interiorly and ending in a large number of cases in a small sucker at the end. These organs are very extendable and serve the animal by attaching to foreign bodies and operating in true locomotion. They adhere there in two ways, either by suction or by very particular mode of adherence because we note, when they are attached to a container, they are held by some points where they seem to have a kind of adhesion. As we shall see later, the

tentacles serve not only for locomotion but lay a very important role in respiration. When we observe these organs in the living state, we see them crossed in the interior by currents of molecules determined probably by the elongation of the tentacle in one direction or another, i. e., by the centrifugal convex side and centripetal side. These currents are probably produced by interior cilia. The tentacles with suckers do not show cilia. Seen with sunlight, these tentacles are nacreous that indicates well their fibrous nature. On the exterior, the nacreous reflection has no effect on the longitudinal and transverse fibers.

SYSTEMS OF NUTITION (DIGESTION, RESPIRATION, CIRCULATION, ETC.) OF ASTEROIDS.

Asteroids do not have special organs of prehension to move food toward the mouth. We need to say only that their arms can in no way provide for this. The pedicellariae have been considered by some authors as filling this role, as well as the ambulacral tentacles. The first in some cases can in fact effect this function, but we can, however, conceive it only for those close to the mouth opening. As for the second, i.e., the tentacles, we can scarcely doubt that they cannot have this role. But we know that it is especially with the aid of the membranes that surround the mouth that the Sea Stars or Asteroids exert such a strong suction on the animals on which they feed that they can quickly consume animals much larger than themselves. Asteroids are in general very voracious and feed especially on animal material. They readily attack mollusks, even those with a shell. The mouth, in Asteroids, is always located in the center of the disk. There, all the pieces that constitute the skeleton of these animals, are arranged in a way to leave a circular space covered with a fibrous membrane resistant, with a rounded opening in the center that is sometimes armed with papillae having the function of teeth.

This mouth opens nearly directly into the stomach, or at least by only an extremely short esophagus. The stomach forms a very large sac occupying the middle of the disk and sending into the rays (arms) long extensions called radial caeca.

In species with an anus, i.e., in most, the digestive system is divided into three regions or distinct parts: 1° the stomach strictly speaking; 2° the region with the caeca of the arms that is separated by a circular peritoneal fold; 3° the rectal region formed by a distinct cavity from which leaves a short tube going to the anal pore. The stomach forms a globular sac. It is incompletely divided in the interior by a kind of fold of the internal membrane that results in a first chamber having the function of transforming food into chyme, which then passes into the upper chamber. From there leave the cylindrical extensions contained in the arms, dividing in their turn into two elongated tubes with a double series of hollow appendages, ramified and ending in culs-de-sac. These organs go into the rays or arms and are joined by peritoneal fold. The caeca vary, moreover, greatly in the relation of their number and disposition. We cite *Archaster typicus* as being one of the species that has the most. There are only two in *Astrogonium, Solaster* and *Asteracanthion.* Finally, it is missing in *Luidia*. The rectal portion of this intestine also has particular caeca that are in relation with the dorsal side of the disk. We call them interradial caeca because of their position in the disk itself and between the arms. The function of the interradial caeca in regard to the rectum has not yet been determined with certainty. They contain a brownish liquid in which we have vainly tried to discover uric acId. The anus, when it exists, opens

on the dorsal surface and is hidden between the spines, calluses or plates of the cutaneous cover.

Respiration in Asteroids is extremely complex and is by organs either internal or external, very different from each other.

First, with cilia on a part at least of their exterior surface, on the spines and on the different appendages of this surface, Asteroids should have an external respiration. But they have in addition, as special organs, numerous tentacles leaving from the holds of the coriaceous integument or by the interstices of the skeletal framework that supports them. These tentacles are localized, in general, in the intervals of the dorsal plates. They are very evident in special organs of respiration because we find them with cilia on the interior, observed for the first time by Ehrenberg (*Archiv Müllers*, 1834, p. 562) in *Asterias violacea* (*Asteracanthion*). This author recognized that they were responsible for a gyratory movement that is communicated to the liquid contained in their interior, in which liquid is evidently in indirect relation with the ambient or oxygenated environment. This fact is indisputable. But it is not the same in regard to the opinion of some authors, notably Tiedmann, Meckel and Siébold, who think that these tentacles are at the same time pierced at their end to give access to the environmental medium into the body cavity. However. there is also an internal respiration operating in a similar fashion by the effect of circulation of water that enters or leaves by openings surrounding the mouth, the water being put in motion in the interior by cilia that cover all the body cavity as well as the different viscera. According to some authors, the portion of the circulatory system that they call aquifer, should also have a respiratory function. We can also consider as a special mode of respiration the numerous branches of the capillaries of the vascular holes of each ambulacrum and on the surface of ambulacral vesicles in relation to the tube feet with suckers. Finally, we have also attributed the function that concerns us here, the secretions of yellowish glandular tufts located at the base of each row of ossicles constituting the framework of the arms. We ordinarily find two for each arm.

The circulatory system of Asteroids was studied first by Tiedmann, then by Meckel and has been the object of a special work by Wolkmann.

It is composed of three rings occupying the disk. The first or most superficial is the origin for each arm of a principal vessel that goes under the skin to the tentacular feet. The second sends vessels to the stomach, caeca and reproductive organs. It communicates by a narrow conduit with an elongated canal with muscular walls, which is the heart, then, from this heart leaves a third circular vessel, veinous of less capacity and placed immediately under the skin of the back. The latter receives twenty-five vessels, namely: 1° one for each of the intestinal appendages of which they occupy the upper surface (i. e., 10); 2° five coming from the stomach and joining in two trunks before opening into the canal of which we just spoke; 3° a branch for each ovary (i. e., 10).

Wolkmann supposes that the nourishing fluid from the heart in the first vascular ring and from there into the vessels sent by the circle to each ray. Then, by the branches reaching each foot or tentacle, in the interior of which it penetrates, these feet.by their contractability would act like so many veinous hears to make the blood return to the second vascular circle, from which leave large trunks of communication that go to the third circle. The latter, ending on either side of the heart, would thus complete the circuit.

The blood, in describing this circuit, would already be sufficiently oxygenated by contact with the water that fills the body cavity, but it is even more so by the vascular

system of the skin and the tentacular feet that consists first of a circular canal of tendinous structure that goes to the second circle. It is in fact into this canal that open the bulbs or vesicles, each with a long pedicel and that are united in groups of five in each interradial corner. It is also into this circle that discharges the sand canal that starts from the plate, discharges, accompanies the heart and arrives at this mouth. It is thus probable that Asteroids that have several of these plates also have canals and multiple hearts.

NERVOUS SYSTEM AND SENSE ORGANS OF ASTEROIDS

The nervous system of Asteroids has been shown in a certain manner, first by Tiedmann (*loc. cit.*., p.62), then by Meckel (*Deutsch. archiv*, 1, 1815, p. 69) and finally by Kroha (*Müller's archiv*, 1841, p. 8). It is composed of a central part forming a kind of ring, ordinarily pentagonal, surrounding the esophagous. From this ring leave nerve trunks that extend into each of the ambulacral grooves of the arms on the ventral surface. Wagner (*Vergleich act*., 1834, p. 372), on the same subject, has seen positively ganglia in the esophageal ring that had not been shown by his predecessors. As for the same parts, ganglia or nerve trunks, reported either by Spix (*Ann. du Mus. d'Hist. nat*., t. XII, p. 439, 1809), or by Konrad (*de Asterias, dissert. Fabr*., p. 13, 1814) are found on the dorsal surface of the arms, for example, in *Asteracanthion rubens* and *Ast. glacialis.* It is probable they are only simple tendinous fibers.

Among the sense organs, those of touch are the only ones to exist without question in Asteroids. It evidently has its seat either in the ambulacral tentacles or in those scattered on the dorsal surface of the disk, or finally in the pedicellariae.

It is not the same for the organ of vision that was observed for the first time by Ehrenberg (*Müllers Archiv*, p. 577, 1834, and Mém. Acad. Berlin, 1835) on *Asteracanthion violaceus* M. T., has since encountered contradictors. This author found that the eyes are points of bright red located on the ventral surface of the end of the arms and to which, he said, ended a nerve net running the length of the arms and swollen at the end. The eye or red point thus placed below would not be very useful if the animal did not have the possibility of raising the end of is arms to bring the eyes above. According to Tiedmann, it appears certain that Asteroids can distinguish very well dark from light, but he observes correctly that that this proof not in the least convincing because we know that in some lower animals that lack vision and even in plants, this sensation can be perceived by the surface of the skin or across their tissue, the light acts as the only stimulus that is necessary for them. Valentin searched in vain in the ocular points of Asteroids for a body similar to a crystalline lens and we do not know of any anatomist who has found it since. On the other hand, Forbes (in *Hist. Brit. Starfishes*, p. 131, and *Frorieps Mem. notizen*, n° 420, 1841) recounts with much wit of a *Luidia fragilissima* that, after having escaped him by sacrificing its arm looked at him with a mocking eye!

REPRODUCTION, REGENERATION, DEVELOPMENT AND METAMORPHOSIS IN ASTEROIDS.

Reproduction in Asteroids by way of development *ab ovo,* takes place following an extremely varied metamorphosis. Rathke showed, from 1840, that these animals have distinct sexes separated in different individuals, i. e., that they are dioecious. As for the sexual organs, either male or females, they have such a very similar appearance that, outside the spawning season, it is nearly impossible to distinguish them. These organs consist of varicose utricles forming more or less numerous tufts fixed in an intervisceral cavity in the re-entrant angles of the rays. Moreover, the form of the caeca that constitutes them, especially their number and extent, varies greatly according to genus and species. Thus, for example, in *Asteracanthion rubens*, the genital organs consist of two arborescent branches formed of caeca limited to the interradial spaces while in several other genera they lengthen and extend greatly into the arms and have, in this case, multiple insertions. It is thus that in *Ophidiaster miliaris*, we find two rows of clusters of caeca. It is the same in *Archaster typicus*. In *Chaertaster longispinus* (*subulatus*), the two rows of clusters are near each other. Their number is very large. They extend to the end of the arms, while in *Astropecten* they occupy only the disk without extending into the arms.

These genital organs open to the exterior by openings that Müller and Troschel have perfectly observed. According to these authors, there is a true oviducal canal, only the opening is never simple. It has the form of a cribellated lamella.

Thus, in *Asteracanthion rubens*, we find two genital openings in relation to the oviducts. They are located in each interradial space on the dorsal part of the disk near the origin of the arms. Each opening consists of a joining of small pores forming a kind of sieve.

In *Solaster papposus*, they occupy nearly the same position, but the two cribellated plates are near the ambulacral groove in the re-entrant angle of the arms although on the disk. In some species, the cribellated openings are placed obliquely one behind the other. Finally, in other they are merged.

There are some Asteroids in which we do not find exterior openings. It is very probable that in this case the genital organs open directly into the body cavity and that the productions of development leave by several genital pores but that are merged and serve at the same time as respiratory organs. Such would be, for example, the ambulacral tentacles. Tiedmann thought that the eggs in *Asteropecten aurantiacus* go to some openings located in the corners of the mouth that have the form of tentacular papillae. This opinion can be considered doubtful because Müller and Troschel have clearly established in a general way that species lacking an anus never have particular openings. Such is the precise case in *Astropecten.* It is the same for the genus *Luidia* that not only has no exterior openings but even has nothing that resembles that Tiedmann had announced. Thus, as we said above, these authors accept that the products of gametogenesis leave by respiratory pores. As Asteroids without special genital openings are precisely those that have no anus, it is very probable that with an anus all have, without exception, exterior genital openings. However, observations until now concern only some species, it is impossible to confirm this fact. This difference in ways of life in regard to the presence or absence of genital openings allows us to accept that, in some cases, the seminal liquid as well as the eggs pass into the general cavity of the body and probably leave by the respiratory tubes. Sars adds that the ventral surface of the disk and arms in *Echinaster sangquinolentus*, as well as in female *Asteracanthion Mülleri* as hollowed out at certain times into an incubatory cavity in which the eggs are preserved during their development.

There is no, in Asteroids, mating strictly speaking but we have observed frequently two individuals brought together one to the other by the ventral surface and keeping this position for a more or less long time. The ambulacral tubes of the two being placed in this relation, it is easy to conceive that fertilization would be favored.

The seminal liquid in Asteroids has been observed by different authors, in particular Wagner, in *Asteracanthion violaceus.* It is a milky color and cont ains spermatozoids with the form of Cercaria. Koollicker has also studied it in species of the same genus as well as in *Solaster papposus*.

As for the products of female organs, they consist of eggs usually rounded, covered by a thin chorion and containing a small amount of albumen as well as a vitellus with a germinal spot.

At the moment they begin development, the yolk fractures and is soon transformed into an elongated cylindrical embryo covered with cilia. After a few days, four small mamelons form little by little in part of the body that the animal always directs forward when it swims. Then, with their help, it settles into the incubatory cavity. — In another phase, it its soon flattens laterally and on one of the surfaces develops tentacles in the form of rays while the edges of the body form five corns that are the rudiments of the arms and on which we already see the presence of pigmented red spots, or eyes. At this period.the animal loses the mamelons that are probably resorbed. Then it moves with the aid of the ambulacra. Development of Asteroids has been studied by different authors. From 1835, Sars called attention to a very singular marine animal that he called *Bipinnaria*. A little later (1837), the same author made known some very curious particularities in the development of *Ast. sanguinea* that shows first in the different form from that it should have later. These newly hatched Asteroids have a depressed body, rounded, with four very short club-shaped appendages at their anterior end. When they are a little more developed, we can distinguish on the dorsal surface some papillae arranged in five radiating rows. These young Asteroid move slowly, but uniformly, in a straight line with their four arms directed in front. At the end of twelve days, the five rays of the body, that until then were rounded, begin to grow. After eight days, the two rows of feet or tentacles are developed on each ray and can serve for movement of the animal by elongating and contracting in turn and operating like suction cups. Swimming has ceased completely. Finally, in the space of a month, the four original arms have completely disappeared and the animal, at first symmetrical or bilateral, has become radial.

Koren and Danielson (*Fauna littoralis Norwegia*, part. II, p. 55, 1846) having resumed the study of the Bipinnaria of Sars, sought to demonst rate that it must relate to an Asteroid in some phase of its development, an opinion that Koren had already made in 1842 with some reserve, however.

The authors we just cited encountered in the month of October a large number of Bipinnaria composed of a small reddish Sea Star, width of 5 mm and length of 30 mm, of cylindrical form, a little depressed, ended posteriorly by a kind of heart-shaped fin. A little before this fin there was another, lamellar, at the anterior end of the apparatus and with a dozen compressed tentacles in two rows, one of eight, the other with four, covering a part of the back of the star. All these tentacles have a continual agitation when the animal swims. The apparatus has, in addition, in the middle of the anterior end, an opening that leads to the cavity of the body. The two anterior and posterior surfaces are covered with a skin that ceases to exist on the sides where it forms two freely protruding borders between which is

a non-cutaneous space. After having covered the two upper tentacles in front, the skin curves in the form of an arc, below which is another of the same form produced by the posterior part of the skin after it has covered the ten other tentacles. There are cilia on the sides of the swimming apparatus as well as on the tentacles.

The skin, seen with the microscope, appears composed of delicate granules between which are irregular calcareous particles, some of which are needle-shaped.

All this swimming apparatus preserves vitality for some time after the little star has detached at a given time.

This star, width of 4 to 5 mm, is convex above, flat below. In the skin that covers the back and sides is a calcareous net that produces a group of spines. These are flat and end in three protruding points, of which the median is a little longer.

In general, four or five of these spines come from a small calcareous tubercle. Each of these is surrounded by a membrane in a way to resemble a heart-shaped leaf. On the sides of the arms is a row of long spines. The feet, or tentacles, are rather long and arranged in two rows. The angular lamellae of the mouth are long and triangular. Each has two pairs of spines in front. The intestinal canal is curved in an arc, without appendages and everywhere of equal thickness. It has a muscular layer and is lined interiorly with an epithelium with cilia. Near the end of the intestinal canal leaves from the dorsal side, a cylindrical tube 3 mm long, light red in color, that continues in part into the star itself. It is only by means of this tube that the star remains tied to the swimming apparatus to which it is fixed by its anterior part.

The same authors have continued their studies with other types of Asteroids. They have seen, for example, that the eggs of *Pteraster militaris* develop like those of *Echinaster (Cribella) sanguinolentus* and *Asteracanthion Mülleri* in a cavity located under the skin. The young of *Pteraster* have three stages, namely: the embryonic stage, that of the larva and that of the perfect Echinoderm before leaving the maternal cavity. They have preserved their mode of development. They have seen that their mode of development differs in a notable way, 1° from that of Asteroids whose larvae have claviform prehensile organs while being in terms of the development of the internal organs still in the embryonic state; 2° from that of Asteroids that have in their young age, larval organs that will disappear later; 3° in *Pteraster*, the larva has an oval form. It lacks prehensile arms and has a mouth and a long and narrow intestinal canal ended by an anus. Then, both the mouth and the intestinal canal disappear later by resorption, but only after the perfect Echinoderm has appeared. We find already in the larva the rudiment of the stomach of the future Asteroid. Sometimes, this organ attains its perfect development only when the radial form appears. We see then the mouth of the larva, its intestinal canal and its anal opening subsist still for some time because it is only at a rather late period of development that all these organs disappear, namely, after the formation of the definitive mouth in the center of the ventral surface and that of the definitive anus on the back. In *Pteraster militaris*, the mouth is located, at the most advanced larval period, on the dorsal surface, then at the edge of two arms, and the anal orifice is located eccentrically as in the Bipinnaria, but the entire larva passes into the Asteroid, although the latter is enriched with a new mouth, a new intestinal tube and a new anus. On the contrary, in *Bipinnaria asterigera* of Sars, that Koren et Danielson, as well as J. S. Müller, considered the larva of *Solaster furcifer*, the Asteroid communicates with the larva only by the esophagus and the skin that passes from the larva to the Asteroid. Then

the larva detaches by means of a constriction of the esophagus accompanied by strong contractions that finish by tearing. Finally, the larva dies at the end of six to eight days.

In summary, development in Asteroids has phases that are very diverse and very complex. The beings have been described in turn under the names of *Pluteus, Bipinnaria, Auricularia, Tornaria* and *Brachiolaria*.

The vital phenomenon of regeneration is seen to a great degree of development in Asteroids. These animals reproduce with a extreme facility the parts that have been removed, either accidentally or, so to say, naturally because we see it often in individuals that lose spontaneously one or several of their arms and reproduce them later without the animal appearing to suffer in the least, at least without dying.

We have, moreover, the proof of the activity of this regeneration in observing some Asteroids in collections. There is perhaps no species that does not have individuals whose arms, in part regenerated, witness previous mutilations. At the same time, these reproductions show bizarre forms, either in the disposition or number of parts so regenerated. We can cite as a remarkable example to this point of view, a species of *Ophidiaster (miliaris*) that often has individuals in which four out of five arms are much smaller than the fifth and give it the appearance of a comet. This is the name that previously has been given, wrongly we believe, to a kind of monstrosity of the species *miliaris*, and that we find in identical conditions for other species.

Finally, we cite as an interesting example of regeneration, those Asteroids whose arms are bifurcated at their end.

We shall not dwell further on the numerous reproductions of the parts of these animals. We have too little to add to the behaviors and habits to open a special chapter. All Asteroids are marine. They inhabit especially sandy beaches and are tied most often to rather shallow depths.

It has been said that the spawn of Asteroids, ordinarily produced in the spring, are a rather violent poison and can even cause the death of mammals, like dogs, after it has eaten some quantity. The venomous properties of mussels have also been attributed to the absorption of spawn of these edible mollusks. Finally, Asteroids appear to have some parasites. Thus, we find in the intestinal cavity of *Culcita discoidea*, a small fish, *Oxybates branderi* Blecker. We know that the different species of mollusks of the genus *Stylifer* are often found in the dermal tissues of some large Asteroids, *Asteracanthion helianthus* (*Heliaster*, Gray), for example

GEOGRAPHICAL AND PALEONTOLOGICAL DISTRIBUTION OF ASTEROIDS.

Asteroids are found in nearly all seas and at all latitudes. The boreal seas are very rich in them. However, tropical seas nourish them in greater number at the same time that they have more varied forms. Of approximately 140 species, the seas of the North have 140; the Mediterranean, 12; the nearby islands and the west coast of Africa, 6. In the Indian Ocean, there are some species that are common at different points while others are specific to them. Thus, the Red Sea has 8, Mauritius, 6, more than 8 common; Mollucas and nearby islands, 15; Australia and the Society Islands, 22; then the seas of China and Japan, 12; Kamtschatka, 10, North America and Central America,21. We cite as widespread at many

points and even in all the seas, *Asteracanthion rubens, A. tenuispina, Echinaster oculatus,* and *Asteriscus verruculatus.* But the origins are too few to permit acceptance of this sort of cosmopolitism.

From a paleontological perspective, Asteroids present some interesting observations. We count approximately 70 species described by different authors, belonging to different genera. Among the latter, 10 are extinct, of which 4 are restricted to the Silurian terrain: 1 to the T. carbonifera, 4 to the T. conchylian, 4 to the T. oxfordian, and 3 to the upper T. cretacean.. Finally, the distribution of species is approximately this: T. palaeozoic, 18; T. jurassic, 20; T. cretacean, 4; and T. tertiary, 7. In summary, Asteroids belong to the Silurian period and are seen there with special forms such as the genera *Bdellacoma, Palasterina, Palaeaster, Lepidaster* and *Coelaster*, then decreasing. In the Muschelkalk, where the genus *Pleuraster* is found, they increased greatly in the T. jurassic, where the generic forms are continous until the present period. The T. cretacean is completely in the same case, but with a notable increase in the number of species (approximately 40). The T. tertiary, on the contrary, contains only a small number (7) while in the present seas they acquire their maximum of development.

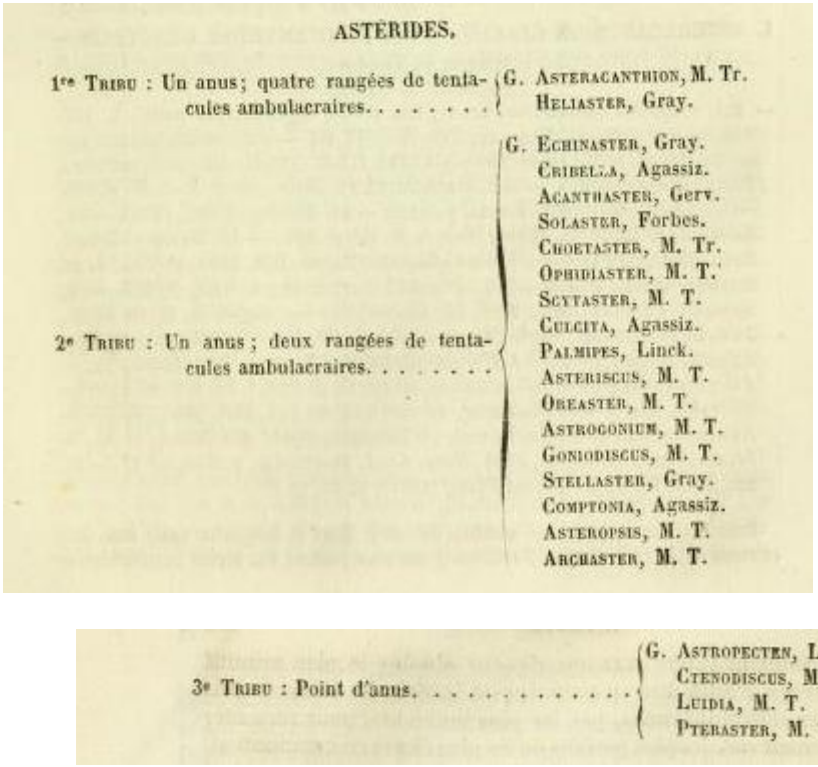
CLASSIFICATION OF ASTEROIDS.

The order Asteroidea has already received a large number of names: Lamarck, from 1812 (*Extrait du Cours*, p. 25), used *Stellérides* ; Eichwald (1829), *Zool. à. sp*., p. 224, that of *Stellata*; Maclay (1825, *Horæ ent*., II, p. 116) and Gray, *Ann. Phil*., t. X, that of *Stetlarida*; de Blainville (1834), *Dict. Sc. nat. et Man. d'Actin*., *Stelleridea*; Agassiz, *Prodr*., 1838, *Id.*; Müller and Troschel (1842), *Asteride*; Gray (1840), *Astroide*; Forbes (1841), Brit. Starf., p. 14, that of *Cirrigrada*; finally, Austin (1842), *Ann. and Mag*., that of *Lobistella*.

The authors who preceded Lamarck had attempted to distinguish Asteroids into several genera. But these classifications, as we have already said, depending on purely external characters, such as the number of arms, their form, and finally their dermal ornamentation were generally wrong. Presently, it is only after the works of Müller and Troschel that characters taken from the interior organization of these animals are given to their classification and great value and have had the happiest influence on the studies that have been done since. According to these principles, the scholarly authors from Berlin form three tribes or families in the order of Asteroidea: the 1st contains species that, with the presence of a visible anus, has four rows of ambulacral tentacle. It has only two genera.; the 2nd, also with an anus, has only two rows of these tentacles and contains most of the genera; finally, the 3rd has no anus and contains only four genera. The attached table has all the generally accepted species.

If we want to follow with absolute rigor the original plan of this work, i. e., beginning the series of beings included under the name of Echinoderms from the lowest to climb successively toward the most perfect of the highest in organization, we must modify this classification, inverting it, so to speak, completely. It is necessary to place at the head the tribe that contains the species lacking an anus and end, on the contrary, with those that have this second opening or intestinal canal. — This method would have at the same time the advantage of approaching the Echinoids, the Asteroids whose discoidal form recalls best

that of Urchins. The genus *Culcita* being that which has this disposition in the greatest development should thus end the series of Asteroids. Unfortunately, there is another character that is an obstacle to this way of doing things: we want to speak of the consideration taken from the number of rows of ambulacral tentacles. If, in fact, we give to this character all the importance it deserves, we see that in this relation *Culcita* and close related genera by their discoidal form are less happily endowed than *Asteracanthion*, for example, in which we observe four rows of ambulacral tentacles instead of two. Consequently, these should necessarily end the ascending series and, from then on, consideration of the form that would have allowed us in some way to tie the Asteroids to the Echinoids would become impossible. These are the reasons we have decided to adopt the generally accepted classification while having our reservations about the apparent disagreement with our framework.



1st Genus. **Asteracanthion**. *ASTERACANTHION*. — Müller and Troschel.

(αστηρ, star; αχανθ, spine)

Syn. *Stellonia*, Nardo, Agassiz (pars).— *Asterias*, Lamarck, Gray.— *Uraster*, Agass., Forbes.

Animals usually having five arms, but sometimes six to eight. These arms, more or less elongated, have several rows of spines along the ventral groove. All the rest of the surface of the body has blunt or pointed spines, scattered or regularly distributed tubercles. The bare skin, in the intervals, also covers the base of the spines and is pierced by a large number of tentacular pores. The pedicellariae in the form of pincers, on soft peduncles, are

arranged in a circle around the base of the spines or scatter between them. Some are also found on the edges of the ventral groove. The anus is sub-central. One or several madreporiform plates.

1. GLACIAL ASTERACANTHION. *ASTERACANTHION GLACIALIS*.— Müller and Troschel,

— *Sol. echinatus cancellatus*, Linck, tab. 38–39, copied Encyc. méth. t. 117–118. — *Ast. spinosa*, Pennant , Brit. Zool. IV, 62. — *Pentadactylosaster spinasus*, Linck, t. 35, copied Encyc., t. 119, p. 2–3.—*Stella hibernica echinata*, Periv.-Gaz, t. 16, f. 5. — *Ast. glacialis*, 0. Fr. Mull., Prod. Zool. D. p. 234. — *Id.* Linné, Syst. nat. Gmel., p. 3162.— *Id.* Retzius, Diss., p. 23. —*Id.*, Lamarck, n° 26.— *Id.* Risso, Hist. n. E. M., p. 268. — *Id.* Koren and Duben, Zool. Bidr., p. 240. — *Stellonia glacialis*, Nardo, Isis, 1834, p. 716. — *Id.* Agassiz, Prod., p. 25. —*Id.*, Forbes, Wer. Mém., t. VIII, p. 123. — *A. spinosa*, Pennant, Brit. Zool. IV, 62. — *Asterias angulosa*, 0. F. Mul, Zool. Dana II, p. 41, copied Encyc. méth., pl. 99, f. 1. — *Stellonia angulosa*, Agassiz, Prod., p. 25. — *Uraster glacialis*, Forbes, Brit. Starf., 78. — *Asterias echinophora*, Delle Chiaje, Mém., Il, p. 356, t. 18, f. 5.— *Asterias glacialis*, Gray, Ann. and Mag. of nat Hist. and Cat. Brit. Mus., p. 17. — *Asteracanthion glacialis*, Müller and Troschel, Syst. der Aster., p. 14. — *Id. Id.*, Duben and Koren, 1844, Mém. Acad, Stockholm, p. 240, n° 17.— *Id. Id.*, Sars, Middelh. litteral Fauna (1857), p. 51, n° 26.

Arms most often five in number, of which the length equals approximately eight times the small radius of the disk. These arms have longitudinal series of spines attached to kinds of keels that makes them slightly angular. The dorsal surface has three rows of these spines, of which the median one is more developed than the two lateral ones. Sometimes the spines are scattered irregularly, without apparent order. On the disk, they are usually disposed in a pentagon around one or several spines occupying the center. All these spines are conical, rounded at the end. Their base is surrounded by a circle of pedicellariae. On the ventral surface is, on each side of the groove of the arms, a double row of spines that are very elongated and sharper.

Color rather pale reddish brown but sometimes orange.

Dimension: total width, from 30 to 40 centimeters.

2. GELATINOUS ASTERACANTHION. *ASTERACANTHION GELATINOSA*. — Müller and Troschel.

— *Asterias gelatinosa*, Meyen, Reise I, p.222, and Archiv Weigm., 1835, p. 307. — *Asterias rustica*, Gray, Ann. and Mag. nat. Hist., VI, p. 179, — *Asteracanthion gelatinosus*, Müller and Troscohel., Syst. der Aster., p. 15.

Rather similar to the preceding species but with six arms of which the length from the center is six times the diameter of the disk. These arms have three rows of spines on the ventral surface and also have three more or less regular on the dorsal surface. The spines are cylindrical and cut transversely at their end. On the disk, the spines are sparse, without

apparent order and are surrounded by pedicellariae. Other interposed pedicellariae are scarcely two times as long as wide.

Color milky with orange spines.

Width: 580 millimeters.

Inhabits the coasts of Chili at Valparaiso.

3. REDDISH ASTERACANTHION. *ASTERACANTHION RUBENS*. — Müller and Troschel.

— *Tetractis petaloides*, Linck, pl. 30, n° 30. — *Stella coriacea vulgaris luidii*, Linck, pl. 36, n° 61. — *Asterias rubens*, Retzius, Vetenk. Acad. hand, IV, p. 236. — *Asterias rubens*, 0. F. Müller., Faun. Groënl., p. 369, Lin. Gmel,, Syst. nat. 1099, Muzz. Prodr. 2831.—Encyclep. méthod., pl. 113, f. 1–2. — *Asterias rubens*, Lamarck, An. s. vertèb., 2e édit., t. III, p. 160. — *Id.*, Risso, Hist. nat. Eur. mérId., V, p. 269. — *Id.*, de Blainv. Man. Act., pl. 22, f. ab.— *Id.*, Gray, Ann. Hist. nat., p. 179. — *Stellonia rubens*, Agass., Prodr. — *Id.*, Forses, Wern. Mem., VII, p. 121. — *Uraster rubens*, Forbes, Brit. Starf., f, 83. — *A. clathrata*, Pennant , Brit. Zool. IV, 61. n° 55, *junior*. — *Asteracanthion polaris*, Müller and Troschel, Syst. der Aster., p. 17. — *Asteracanthion rubens*, Müller and Troschel, Syst. der Aster.,p. 15, pl. .— *1d*., Duben and Koren, Zoo!. Bidr., p. 241, no 19. — *Uraster rubens* (fossil), Forbes, Pal. Soc., pl. 2, f. 7.

Species usually having five arms, rarely six, whose length is four to five times the diameter of the disk. They are flattened, a little widened at the base, pointed at the top and three times as long as wide. Two rows of spines in the ventral grooves. The other spines of the ventral surface are close together and form three rows on each side of the groove. The arms have in addition a regular row of spines on each side and numerous small, conical spines with a blunt tip irregularly scattered on the back except on the dorsal line where they form a rather regular row. Around each of these spines are small pedicellariae arranged in a not very distinct circle. Other larger pedicellariae, two times as long as wide, are scattered among the spines.

Color bright red in adults but yellowish, brownish or blackish violet in young.

Dimension: up to 200 mm.

Inhabits the seas of Europe.

This species frequently has variations in the number of its arms. Thus, we see that they have 4, others 6, and finally 7 of them.

Because of mutilations, we often see regenerating individuals and have the most singular anomalies in the irregular development of different arms in relation to each other.

Fossil from the crag of England.

4. VIOLET ASTERACANTHION. *ASTERACANTHION VIOLACEUS*. — Lin. Syst.

— *Sol, coriaceus planus*, Linck, 33, t. II, f. 5. — *Asterias rubens violacea*, Müller, Zool. Dan., t. 46. — Copied Encyclop. méth., p. 116, p. 4–5. — *Asterias violacea*, Limné, Syst. nat.,

p. 3163, no 24. — *Id.*, Blainville, Man. Act., 239. — *Id.*, Lamarck, 2e édit.,p . 256. — *Id.*, Enrenb, Berlin, Trans., 22, p. 209, t. 8, f. 9. — *Uraster violaceus*, Forbes, Brit. Starf. p. 91. — *Asterias holsatica*, Retzius, Dissert. 24, *junior* ? — *Asteracanthion violaceus*, Müller and Troschel. Syst. Aster., p. 16. — *Asterias minuta*, Retzius, Disc. 24, *jun*.? — *Asteracanthion rubens*, var. Müller and Troschel. Syst. der Aster., p.126. — *Asterias violaceus*, Gray, Brit. Mus., p. 17, n°2?

Species very near the preceding but is distinguished by its stockier form and at the same time by its generally finer ornamentation.

Inhabits the seas of the North.

5. PINK ASTERACANTHION. *ASTERACANTHION ROSEUS*. — Müller and Troschel.

—, O.F. Müller, Zool. Dan., pl. 67, copied in Encyclop. méthod., pl. 116, p. 2–3.— *Asterias rosea*, Linné, GmeL., Syst. nat., p. 3165. — *Id.*, Retzius, Dissert. de Stell., p. 20. — *Cribella rosea*, Forbes, Brit. Starfish., 1841. — *Asteracanthion rosea*, Müller and Troscohel., Syst. der Aster., p. 17.— *Id.*, Duben et Koren, Zool. Bidrag., p. 241.— *Henricia rosea*, Gray, Brit. radiat., p. 20, n° 2.

Species with five arms, rarely six, rounded, thin, pointed at the end, approximately six times as long as half the diameter of the disk from the center. On each piece at the edge of the groove are two spines arranged transversely and more outside we see three other similar spines so that the ventral surface has a ridge of five spines. On the back, there are rows of plates, each with a group of numerous small spines that in the young age end in several small very sharp points but that in the adult are truncated. The areas with tentacular pores are in rows and contain very few pores. The pedicellariae are in the ventral groove between the spines of the dorsal and ventral surfaces.

Inhabits the seas of the North.

6. AFRICAN ASTERACANTHION. *ASTERACANTHION AFRICANUS*. — Müller and Troschel.

— Muller and Troschel., Syst. der Aster., p. 15.

Species also very near the two preceding having five arms whose length is approximately six times the diameter of the disk. The ventral surface has two or three rows of spines flattened at their end and strongly grooved or rugose. The upper ones are long, having approximately 4 ½ mm. The spines that border the ventral groove are n a single row or the same form as the preceding. On the dorsal surface of the arms are up to nine longitudinal rows of spines, of which the two exterior are always more regular, but the intermediaries often lose their regularity. All these spines of the dorsal surface of the arms are cylindrical, truncated and longitudinally grooved to the top. On the disk, the species are irregularly scattered and surrounded by innumerable small pedicellariae. Between them are also large pedicellariae, two times as long as wide.

Color pale brown, with deep reddish brown and blue spots in the ventral groove of the arms.

Dimension: Width, 270 mm.
Inhabits the coasts of Africa.

7. ASTERACANTHION WITH FINE SPINES. ASTERACANTHION TENUISPINUS. — Müller and Troschel.

— *Stella marina echinata*, Cozumna, Aquatil, VI. — *Asterias tenuispina*, Lamarck, Anim. s. vertèb., 2e édit, t. III, p. 250. — *Id.*, Risso, Hist. nat. Eur. mérId., V, p. 269. — *Asterias savaresii*, Delle Chiaje, Mém. d. aus. vertèb., pl. 18, f. 6. — *Asterias glacialis*, Grube, Actin., p. 21. — *Id.*, Gray, Ann. and Mag. nat. Hist., VI, p. 179. — *Asteracanthion tenuispinus*, Müller and Troschel. Syst. der Aster., p. 16, pl. 1, f. 1. — *Id., Id.*, Sars, Middelh. littoral Fauna, 1857, p. 52, n° 27.

Species with five or eight usually unequal angular arms whose length from the center is four and a half times the demi-diameter of the disk. Spines of the ventral groove arranged in a single row. The arms have below near the groove, two or three other rows of nearly equal spines on the sides and back. The spines of the disk are irregularly scattered. They are all conical and rounded at their end. Pedicellariae surround the base of the spines in a circle. Other larger ones, three times as long as wide, are isolated among them. The upper part of the disk has, in addition two or three madreporiform plates.

Color, blood red.
Dimension: total width, 135 mm.
Inhabits the Mediterranean.

8. BOUVIER'S ASTERACANTHION. *ASTERACANTHION BOOTES*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 17.

Species with five arms whose length from the center is approximately five times the demi-diameter of the disk. These arms are thin, rounded, a little pointed, and more than four times as long as wide. The spines of the ventral groove are in two rows, those of the ventral surface are very near each other, forming three rows. The spines of the back have a tendency to form seven to nine rows. They are two times as long as wide, cylindrical and blunt at their end. The pedicellariae are isolated between the spines and have a triangular form.

Color pale pink.
Dimension: 200 mm.
Inhabits the sea of the North, the coasts of Greenland.

9. LINCK'S ASTERACANTHION. *ASTERACANTHION LINCKII*. — Müller and Troschel.

— *Pentadactylodaster reticulatus*, Linck, pl. 9 and 10, n° 16. — Copied in Encycl. méthod., pl. 112, f. 1–2. — *Mithrodia spinulosa*, Gray, Ann. and Mag. nat. Hist., VI, p. 288. — *Asteracanthion linckii*, Müller and Troschel, Syst. der Aster., p. 18.

Species with five arms that are very long, pointed and rather slender, whose length equals nine times the demi-diameter of the disk. Spines of the ventral groove conical, isolated on each plate and forming a single row on each side, outside of which is another incomplete row form of smaller spines. Nearer the edge, the ventral surface has a row of conical, much thicker spines, five times fewer than those of the ventral groove. On the dorsal surface are isolated spines arranged without order, much smaller and conical. Very large pedicellariae are in the area of the groove. Then other pedicellariae, having much thinner arms, are arranged in two dense groups near the large marginal spines. All the back has scattered large pedicellariae similar to those of the ventral groove.

Color reddish brown.

Dimension: 40 to 50 cm.

Inhabits ? (collection of Linck, at Leipzig),

10, STRIATED ASTERACANTHION. *ASTERACANTHION STRIATUS*. — Müller and Troschel.

— *Asterias striata*, Lamarck, Anim. s. vertèb., 2^{e} édit., t. III, p. 253.— *Asteracanthion striatus*, Müller and Troschel, Syst. der Aster., p. 18.

Five arms whose length from the disk is triple the demi-diameter of the disk. The spines of the ventral groove, four on each marginal plate, form a single row. But the same plate, more outside, also has a spine that is thicker, blunt, completely similar to those of the rest of the ventral surface. It is in addition accompanied by two smaller spines. On this same ventral surface, there are also many large and small spines, among which we can distinguish three rows of larger one, a little flattened and blunt. On the lateral parts, we also see a row of groups of spines each formed of three large and four to six small ones. Above this row and near the edge, there is another formed of kinds of small tufts composed of a circle of small spines in the middle of which is a pedicellaria with two branches, approximately 2 mm in length and placed obliquely. The dorsal surface is covered with small sharp spines that, on the arms, form eleven rows of which very few reach the end of the arms. The pedicellariae of the ventral surface, located between the spines and isolated, are tufted in the form of blunt pincers and nearly two times as long as wide.

Color reddish.

Dimension: 190 mm.

Inhabits the coast of Mauritius. (Mus. Paris).

11. POLYPLAX-LIKE ASTERACANTHION. ASTERACANTHION *POLYPLAX*. Müller and Troschel.

— Müller and Troschel, Weigm. Archiv, 1844, p. 178.

Species with seven arms whose length from the center is three times the diameter of the disk. Ventral groove with spines in two rows. Outside is a band of spines arranged in transverse rows of which several are on the same plate.

Color red.

Diameter: 54 mm.
Inhabits the coasts of Tasmania.

12. STAR ASTERACANTHION. *ASTERACANTHION ASTER*. — Müller and Troschel.

— *Asterias aster*, Gray, Ann. and Mag. of nat. Hist. VI, p. 178. — *Asteracanthion aster*, Müller and Troschel, Syst. der Aster., p. 18.

Species with twelve to thirteen arms, three times as long as the diameter of the disk. The arms are thin and conical. Their dorsal surface has seven rows of spines. On the ventral surface, in the corners of the buccal opening are very long labial spines.
Inhabits ? (Mus. Londres).

13. GRAINY ASTERACANTHION. *ASTERACANTHION GRANIFERUS*.— Müller and Troschel.

— *Asterias serrulata*, Encyel. méthod., pl. 104. — *Asterias granifera*, Lamarck, Anim. s. vertèb., 2^{e} édit., t. III, p. 248.

Species with five arms a little convex and slightly narrowed at the end. Their length from the center is four and a half times the radius of the disk. They are approximately three times as long as wide. The spines of the ventral groove are in two rows. They are small, cylindrical and are continuous immediately with the tubercles that cover the body. They have no order, are very dense, very depressed and have the form of a globe on a very short peduncle. They are of diverse sizes. The largest have a width of approximately two millimeters and are sometimes arranged in three rows. The pedicellariae, scattered among the tubercles, are small in the form of pincers and a little longer than wide. The madreporite plate is located in the middle of the distance between the center and the edge or a little nearer the latter.
Color red-brown above, with pearl white, or at least paler, granules. The ventral part is yellowish brown.
Dimension: 155 mm.
Inhabits the seas of the South.

14. BLUISH ASTERACANTHION. *ASTERACANTHION JANTHINA*.

— *Asterias janthina*, Brandt, Rec. Act. Acad. St.-Pétersb., 1834, p. 269, n° 3.

Species near the preceding.
Inhabits the island of Sitka.

15. PEARL ASTERACANTHION. ASTERACANTHION *MARGARITIFER*. Müller and Troschel.

— Müller and Troschel, Syst. des Aster., p. 20.

Five arms whose length from the center is triple the radius of the disk and scarcely two times longer than wide and end in a blunt point. Spines of the ambulacral groove forming a single row. The other spines of the ventral surface are very close together, cylindrical and blunt. They form five rows that merge insensibly with the spines of the groove and that are missing here and there. On the sides of the arms is a regular row of less numerous spines that are very short and end in a button. On the dorsal surface, instead of spines, are groups of capitate tubercles that are very short whose head, very distinct from the base, is isolated in a kind of pearl. On the disk, these tubercles are arranged according to the contour of a pentagon whose corners send a row toward the middle of the arms that soon stops. In the middle of the pentagon is a small group of the same tubercles. Pedicellariae that are all equal, very short, as long or one and half time as long as wide are around groups of tubercles and between them. The spines of the ventral surface are also surrounded by pedicellariae, particularly on the external side.

Color ochre yellow.

Inhabits the seas of the North (Mus. Berlin).

16. OCHER ASTERACANTHION. *ASTERACANTHION OCHRACEUS*.

— *Asterias ochracea ,* Brandt, Rec. Act. Acad. St.-Pétersb., 1834, p. 296, n° 2.

Species have the greatest affinity with the preceding and that Müller Troschel have even united with doubt.

Inhabits the island of Sitka

17. ORANGE ASTERACANTHION. *ASTERACANTHION AURANTIACUS*. Müller and Troschel.

— *Asterias aurantiaca*, Meyer, Reise I, p. 222. — *Stichaster striatus*, Müller and Trooscohel., Weigm. Archiv., 1840, p. 321. — *Tonia atlantica*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 180. — *Asteracanthion aurantiacus*, Müller and Troschel, Syst. der Aster., p. 21, pl. 1, f. 3.

Species with five conical arms, strongly convex above, thinning little by little with length from the enter, equal to four and a half time the radius of the disk and that are three and a half times as long as wide. All the ventral surface is covered with very dense spine that on one hand pass insensibly to the spines of the ambulacral groove and on the other hand pass little by little to the form of pedicellate tubercles. On the back and sides, we see nine longitudinal rows of plates whose intermediaries and externals are wider than the others and decrease less toward the end of the arms. These plates, all wider than long, are covered with a bare skin and become more distinct after drying. They are covered with pedicellate tubercles that are very close together and forming two to three transverse rows. In the middle of the disk, they are more grouped. The bare skin between these plates and groups of tubercles is occupied by small porous areas containing sometimes more, sometimes less tentacular pores. Small pedicellariae are in the ambulacral groove and other

pedicellariae, still small and very difficult to see, are here and there between the pedicellate tubercles.

Color generally orange.

Dimension: up to 325 mm.

Inhabits the coasts of Chile (Mus. Paris).

Müller and Troschel (Syst. der Aster., p. 21) think *Uniophora globifera* Gray (Ann. and Mag. nat. Hist., p. 288) must enter the genus *Asteracanthion*.

18. GLOBIFEROUS ASTERACANTHION. *ASTERACANTHION GLOBIFERUS*. — Gray.

— (Gray), *loc. cit.*

Body depressed, with five arms that are short, wide and blunt, with two or three rows of filiform spines on the ambulacral grooves. It is also covered with transverse plates each with a large spine and sub-globular at the end. These spines form longitudinal rows.

Inhabits the coasts of Tasmania.

19. GERMAN ASTERACANTHION. *ASTERACANTHION GERMANII*. — Phil.

— Phil, Archiv fur Naturg., 1858, p. 266.

Species with five unequal arms whose ratio is approximately 5 is to 4 between the largest and smallest. The plates that border the ambulacral grooves have three to four spines that are thin, long, cylindrical. Then, more outside, is on each side a double row of spines of the same length but two times thicker. The dorsal part of the arms is, on the contrary, covered with scattered very short and very numerous spines. The madrepore plate is surrounded by papillae. Its lamellae are not very protruding.

Color deep red (after drying).

Inhabits the coasts of Chile.

20. MOUSE ASTERACANTHION. ASTERACANTHION *LURIDUM*. — Philippi.

—Philippi., Archiv für Naturg., 1838, p. 265.

Species with five cylindrical arms that are five times as long as the diameter of the disk. Ambulacral grooves are edged with plates on each of which are two nearly cylindrical spines forming two rows. In addition, there are on each side four others as large, but two times as wide. On the dorsal part of the arms are five rows of spines that are more cylindrical and a little shorter. These rows are more separated and a little irregular. At the center are spines that are rather close together but arranged without order. The madrepore plate is surrounded by a circle of twelve spines. The pedicellariae are in the form of pincers and not very numerous.

Color is deep green in life but taking a red color after drying.

Dimension: 150 mm.

Inhabits the coasts of Chile.

21. SPINY ASTERACANTHION, *ASTERACANTHION ECHINATA*. — Müller and Troschel.

— *Asterins echinuta*, Gray, Ann, and Mag. of nat. Hist., VL, p. 179.—Müller and Troschel. Syst. der Aster., p.

Species with eight arms two times as long as the diameter. Ambulacral grooves with two rows of spines.

Inhabits the coasts of Chile, Valparaiso.

22.. KATHERINE'S ASTERACANTHION, *ASTERACANTHION KATERINAE*. — Müller and Troschel.

— *Asterias katherinae,* Gray, Ann. and Mag. of nat. Hist, VI, p. 179.

Species with six arms, rarely five, conical, nearly three times as long as the diameter of the disk. Spines of the ambulacral groove very close together and forming two or three rows. Dorsal surface with numerous spines without apparent order, blunt and coarse at the end. Back with a keel of two or three rows of spines.

Inhabits the northern coasts of America at the mouth of the Columbian River.

23. WILKINSON'S ASTERACANTHION. *ASTERACANTHION WILKINSONII*. — Müller and Troscohel.

— *Asterias wilkinsonü*, Gray, Ann. and Mag. of nat. Hist., VI, p. 179. — *Asteracanthion wilkinsonii*, Müller and Troschel. Syst. der Aster., p.

Five arms nearly three times as long as the diameter of the disk, with seven irregular and interrupted rows of spines that are blunt and coarse.

Inhabits the northern coasts of Africa.

24. FEATHERY ASTERACANTHION. *ASTERACANTHION CALAMARIA*. — Müller and Troschel.

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— *Asterias calamaria*, Gray, Ann. and Mag. nat. Hist., VI, p. 179.— Müller and Troschel. Syst. der Aster., p. 21.

Species with six or eight cylindrical arms, four times as long as the diameter of the disk, with seven rows of spines, of which three rows are dorsal.

Inhabits Mauritius and Australia.

25. WEBB'S ASTERACANTHION. *ASTERACANTHION WEBBIANUS*. — Nobis.

— *Stellonia webbiana*, D'Orbigny, Voy. Canaries (Webb and Bertuelot), Echinide, p. 148, pl. 2, f. 8–13.

Species with five narrow arms, elongated, with five rows of spines above. These spines are long and tubular at their base.

Color reddish.

Dimension: total width, 450 mm.

Inhabits the Canaries.

To complete the list of species of *Asteracanthion*, it remains to mention the following that are still little known.

26. ASTERACANTHION FROM GREENLAND. *ASTERACANTHION GROENLANDICUS*. — STEENST.

— Steenstrup i Vinenskag. Medde:., 1834, p. 240. — *Asteracanthion groenlandicus*, Sre., Lure, Over sigt over Gronl. Echin., 1837, p. 29, n° 14.

Inhabits the coasts of Greenland.

27. MÜLLER'S ASTERACANTHION. *ASTERACANTHION MÜLLERI*. — SARS.

— Sans, Weigm. Arcbiv, t. X, p. 169. — *1d., Id.*, Duben and Koren, 1844, Mém. Acad. Stockholm, p.240, n° 18.

Inhabits the seas of the North.

28. POLAR ASTERACANTHION. *ASTERACANTHION POLARIS*. — Müller and Troschel.

— *Asterias rubens*, Fabric., Faun. Groenland. — *Asteracanthion polaris*, Müller and Troschel., Syst. der Aster., p. — *Id., Id.*, Lutken, Overs. over Gronl. Echinod:, 1897, p. 28, n° 13.

Inhabits the seas of the North.

29. PROBLEM ASTERACANTHION. *ASTERACANTHION PROBLEMA*. — STEENSTRUP.

— Steenstrup i Vinexsxas. Middel., 1854, p.241. — *Id., Id.*, Lurken, Overs. over Gronl. Echin., 1857, p. 30, n° 15. — *Asteracanthion albuius*, Stimps.

Inhabits the seas of the North.

30. GREEN ASTERACANTHION. *ASTERACANTHION EPICHLORA*.

— *Asterias epichlora*, Brandt, Rec. Act. Acad. St.-Pétersb., 1834, p. 270, n° 4.

Inhabits Sitka Island.

31. SUNFLOWER ASTERACANTHION. *ASTERACANTHION HELIANTHOIDES*. — (Sp.) Brandt.

— *Asterias helianthoides*, Brandt, Rec. Act, Acad. St.-Pétersb., 1834, p. 269,

Inhabits Sitka Island.

32. ASTERACANTHION FROM . OKHOTSK. *ASTERACANTHION OCHOTENSE*.— (Sp.) Brandt.

— *Asterias ochotense*, Brandt, Rec, Act. Acad, St.-Pétersb., 1834, p. 269.

Species very near *A. polaris* M. T,
Inhabits Kamtschatka.

33. ASTERACANTHION FROM KAMTSCHATKA. — ASTERACANTHION CAMSCHATICUM. — (Sp.)

— *Asterias Camschatica*, Brandt, Rec. Act, Acad. St.-Pétersb., 1834, p. 271.

Species near *Asteracanthion violaceus*, Mull. Troschel.
Inhabits Kamtschatka.

34. COMB-LIKE ASTERACANTHION. *ASTERACNTHION PECTINATUM*. — Brandt (Sp.).

— *Asterias pectinata*, Brandt, Rec. Acad, St.-Pétersb., p. 270.

Inhabits Kamtschatka,

35. FORBES' ASTERACANTHION. *ASTERACANTHION FORBESI*. — Desor.

— Proc. Bost. Soc. IL, and Agassiz, Proc. of Amer, Acad. 1851.

Inhabits North America.

36. HAIRY ASTERACANTION. *ASTERACANTHION HISPIDUM*. — Nobis.

— *Stella coriacea acutangula hispida*, Linck, 31, t. 9, f. 19, t. 35, f. 39, — *Asterias hispida*, Pennant, Brit, Zool., vol. IV, f. 62, t. 30, f. 58, — *Asterrias distichum,* Brandt, Rec. Act. Acad. St.-Pétersb., 1834, p. 270.— *Stellonia hispida*, Forbes, Wern. Trans., t. VII, p. 123, and Brit. starf, p. 95, p. 95-99. — *Asterias hispida*, Gray, Brit., cat. Mus., p. 17, n° 4.

Inhabits the coasts of England.

37. RED ASTERACANTHION. *ASTERACANTHION MINIATUM*. — (Br.).

— Asterias miniata, Brant, Rec. Act. Acad. St.-Pétersh., 1834, p. 269.

Inhabits Sitka Island.

FOSSIL SPECIES

1. *ASTERACANTHION TENUIRADIATUS.* — Hall.

— *Asterias tenuiradiatus*, Hall, 1847, Palaeont. of New York, t. I, p. 18, pl. 4, p. 11. — *Coelaster tenuiradiatus*, D'Orbigny, Prodr., 1847, Et., 1, n° 38.

Fossil of the Silurian terrain of New York (United States)

2. *ASTERACANTHION MATUTINA*. — Hall.

— *Asterias matutina*, Hall, Paleont. of New York, 1847, t. I, p. 91, pl. 29, f. 5. — *Coelaster matutina*, D'Orbigny, 1847, Prodr. Et. 1er, n° 380.

Fossil of the Silurian terrain of New York (United States).

3. *ASTERACANTHION AMERICANUS*. — Graham.

— *Asterias americanus*, Graham, 1846, Ann. jour., 2^{e} série, t. I, p. 441. — *Coelaster americanus*, D'Orbigny, Prodr. Et. 1, n° 379.

Fossil of the Silurian terrain of Cincinnati (United States).

4. *ASTERACANTHION CONSTELLATUS*. — THOREST.

— *Asterias constellata*, Thorest, 1839, Mém. Soc. géol. fr., t. III, p. 259, pl. 22, f. 7. — *Coelaster consteliata*, D'Orbigny, Prodr. Et. 3, n° 900.

Fossil of the Carboniferan state of Mondrepuis (Aisne).

5. *ASTERACANTHION GAVEYI*. — Forbes.

— *Uraster gaveyi,* Forbes, Mém. géol. Surv. Du 3, pl. 2.

Fossil of England,

6. *ASTERACANTHION LUMBRICALIS*. —- Schl.

— *Asterias lumbricalis*, Schloth., Goldfouss, 1833, Petref., t. I, p. 208, pl. 63, f. 1, — *1d. Id.*, D'Orbigny, Prodr. Et. 8, no 242.

Fossil of the Lias of Germany.

7. *ASTERACANTHION LANCEOLATA*. — Goldf.

— *Asterias lanceolata*, Goldfuss, 1833, Petref. I, p.208, pl. 63, f, 2. — *Id*, *Id.*, D'Orbigny, Prodr. Et. 8, n° 243.

Fossil of the Lias of Germany.

8. *ASTERACANTHION YVARYANA*. — d'Orb.

— *Asterias Yvaryana*, d'Orb., Prodr. Manuscr.

Fossil of the Upper Lias (Toarcian) of Yvary.

9. *ASTERACANTHION DESMOULINSII*. — d'Arch.

— *Asterias desmoulinsii*, D'Arcniah, 1850, Mém, Soc. géol., t. III, 2e série, p. 418, pl. 10, f. 1.

Fossil of the Tertiary terrain, Parisian stage (London-clay of Hampstead).

Asteracanthion rubens M. T. (Forbes, Pal. Soc. pl. 2) was also found in the fossil state in the corallian crag of England.

2nd GENUS. **HELIASTER**. *HELIASTER*. — Gray.

— *Asterias*, Aucf. — *Asteracanthion*. — Müller and Troschel.

Although this genus does not differ in a notable way by its important characters from those of *Asteracanthion*, we have decided to accept it. The species, or rather the species that contains it, if we should unit it with two others distinguished by Gray, are remarkable for the extreme multiplicity of their arms, that can reach 40. Gray has, in fact, described

two species that appear to us still doubtful. These are: 1° *Heliaster cumingii*, Gray, whose arms number 30 or 31, are very large, conical, with blunt spines. Inhabits Hood Islands. — 2° *Heliaster multiradiatus*, Gray that has 22 or 24 arms whose length is approximately a third of the smallest radius of the disk and that have very long and compressed spines on their doral region. Inhabits Hood Islands.

1. SUNFLOWER HELIANTHUS. *HELIASTER HELIANTHUS*.— Lam. (Sp.)

— Encycl. méthod., pl. 108 and 109. — *Asterias helianthus*, Lamarck, Anim. s, vertèb., 2e édit., t. IV, p. 245.—*Asterias helianthus*, de Blainville, Man. act., pl. 23, f. 5. — *Stellonia helianthus*, Agassiz, Prodr. p. 25.-- *Asterias helianthus, A. cumingii* and *À. mulliradiata*, Gray, Ann. and Mag. of nat. hist., VI, p. 179–180. — *Asteracanthion helianthus*, Müller and Troscher. Syst. der Aster., p. 18.

Species with numerous arms, varying from 20 to 40, whose length is approximately one and a third the radius of the disk. The arms are slender and conical, pointed at their end, and very close to each other. The ventral groove has, on each side, spines alternatively smaller and larger, arranged in a single row. All the ventral surface and the sides of the arms are covered with regular rows of spines, but those that occupy the ventral surface are longer and compressed. On the dorsal surface, the spines are arranged in three more or less regular rows, those of the median row being particularly arranged in groups. In the middle of the disk, they form a kind of network. All the spines of the back are cylindrical. The pedicellariae are irregularly scattered and are one and a half or two times as long as wide. The madrepore plate is included in a group of small distinct pieces.

Color varies white and black, like a tiger.

Dimension: 20 to 30 cm.

This beautiful species, now rather common in collections, is especially remarkable for the large number of its arms. Up to now, it is also the species that has the most of the entire group of Stellérides. It also seems to be preferred by some mollusks like *Stylifer* that live as parasites on the membranes around the mouth.

Inhabits the coasts of Chile.

SECOND SECTION. — ASTEROIDS HAVING ONLY TWO ROWS OF TENTACLES IN THE AMBULACRUM; AN ANUS.

3rd GENUS. **ECHINASTER**. *ECHINASTER*.— Müller and Troschel.. Syst. der Aster.

(εχινοσ-αστηρ)

— *Asterias* Lamarck. — *Rhopia, Othilia, Henricia*, Gray.

Five and sometimes six arms that are elongated, conical or cylindrical. Skin supported by a fixed network of elongated ossicles on which spines are isolated or grouped. In the intervals of the network, this skin is bare and contains isolated or multiple tentacular pores. In the ambulacral groove, each plate always has a small, curved spine that starts from the lateral surface. At the edge of the groove is also, on each plate, a single spine. No pedicellariae. Anus sub-central. Ovaries limited to the intervals of the arms.

The name *Echinaster*, as we have already said, was originally assigned by Gray to a genus containing *Asterias solaris* Austin, to which Müller and Troschel gave that of *Echinites*. These latter authors have already returned to their point of view and have not believed it necessary, in their beautiful work on Asteroids, to preserve this generic division. And then, returning to the name proposed by Gray, that applied it to a genus with many more species and the concerns us now. This genus *Echinaster*, not as Gray composed it, but as constituted by Müller and Troschel, contains, we repeat, a rather large number of species that are far from having in their general aspect a satisfactory homogeneity. It is this that has led Gray to separate these species into several genera.

Thus, he calls *Othilia* the group that has as its principal representative *Asterias spinosa.* Then he unites under the name of *Rhopia* that which contains *Asterias seposita*, for which Agassiz had previously proposed the name *Cribella.* Finally, the genus *Henricia*. — As we shall see in the method followed by the scholarly authors from Berlin, these different genera are united into one under the name *Echinaster.* We believe there is place to sub-divide this genera, in accepting the genus *Cribella*, Agassiz, which would be preserved with advantage, as the naturalists of the north of Europe have done in their various works on these animals. It contains *E. sanguinolatus, E. sarsii, sepositus, brasiliensis*, etc.

1. SPINY ECHINASTER. *ECHINASTER SPINOSUS*. — Müller and Troschel.

— *Echinaster seu stella coriacea, Pentadactyla echinata*, Petiver, pl. 16, n° 6.— *Pentadoctylosaster spinosus*, Linck, pl. 4, n° 7. Copied in Encycl. méthod. p. 119, f, 2–3, — *Asterias echinophora*, Lamarck, Anim. s. vertèb,, 2ne édit., t. III, p. 248, — *Stellonia spinosa*, Narvo, de Aster. in Okens. Isis, 1834, p. 716.— *Id.*, Agassiz, Prodr, — *Othilia spinosa* and *O. aculeata*, Gray, Ann. and Mag. nat. Hist., VI, p. 281. — *Echinaster spinosus*, Müller and Troschel, Syst. der Aster, p. 22.

Species with five cylindrical arms, a little thinner at the end whose length from the center is five times the radius of the disk and four and a half times as long as wide. Spine very large and pointed, one time longer than those of the ambulacral groove, forming on the body even irregular longitudinal rows that, from the middle of the disk to the end of the arm contains only ten to twelve spines. The network on which the spines are found is here and there covered with small granules. The porous area contains many tentacular pores.

Color brownish.

Dimensions: width, 108 mm; spines approximately 4 mm.

Inhabits the coasts of North America. (Mus. de Paris).

2. THICK ECHINASTER. *ECHINASTER CRASSUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 23.

Species with five thick arms that are short and blunt, whose length from the center four times the radius of the disk. Spines of the ambulacral grooves forming a very dense row so that these spines overlap and are alternatively close or far from the groove and if they belong to two rows. All the surface is covered with conical and blunt spines, irregularly isolated scattered or grouped by two or three. In the vicinity of the ambulacral groove, the spines are very close together and are ten in number, forming a short row that, however, does not pass the disk. The spines of the dorsal surface are generally a little larger than those of the ventral surface.

Color deep purple.

Dimension: width: 135 mm.

Inhabits the sea of India. (Mus. Paris).

3. SLENDER ECHINASTER. *ECHINASTER GRACILIS*. — Müller and Troschel

— Müller and Troschel. Syst. der Aster., p. 23.

Species with five cylindrical arms, a little thinner toward their end, six times the length of the radius of the disk and approximately five times longer than wide. Spines of the ambulacral groove forming a single row. Spines of the back forming six to seven longitudinal rows on each arm. They are shorter than the preceding and resemble more small tubercles because they are scarcely longer than wide. There are about twelve in each row from the center of the disk to the end of the arm. The porous area contains approximately twelve tentacular pores.

Color deep brown.

Dimension: width from 50 to 80 mm.

Inhabits the sea of India (Mus. Paris).

4. ERIDANELLA-LIKE ECHINASTER. *ECHINASTER ERIDANELLA*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 24,

Species with five or six cylindrical arms scarcely thinned at their end and whose length is six or seven times the radius of the disk. Ambulacral grooves with a single row of very separated spines. After them is another row of smaller spines. Finally, all the other spines are irregularly scattered and isolated on the reticulated framework of the external surface. The intermediary porous areas contain only one to six tentacular pores. Madrepore plates are two in number.

Color brownish.

Dimension: width, up to 108 mm.

Inhabits the coasts of New Ireland (Mus. Paris).

5, SERPENT ECHINASTER. *ECHINASTER SERPENTARIUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 24 — *Id.* Valenciennes, Col. du Mus. de Paris.

Species with five arms, conical, acuminate, whose length from the center is approximately five times the radius of the disk. The spines of the ambulacral grooves, all equal, form three rows, each with two smaller spines at its base, one a little larger than the other. Outside these rows is another formed of nearly granular plates, each of which with three small spines located on the edge toward the end of the arms. The dorsal network is also nearly granular and consists of a joining of plates that, on the arms, are arranged in nine longitudinal rows. Some small spines are fixed to the edge of these plates and form small rows or small groups. They are in addition cylindrical and blunt.

Color reddish brown.

Dimension: 108 mm.

Inhabits Vera Cruz (Mexico). Mus. Paris.

6. SEA-URCHN LIKE ECHINASTER. *ECHINASTER DEPLANATUS*. — Grube.

— Grube, Weigm. Archiv, 1857, p. 341.

Species with five arms whose length is more than two and a half times that of the disk. They are slightly rounded, wide at their base and very narrow toward their end and angular on the sides. Spines of the ambulacral groove are thick, arranged in two rows, three on each plate. All the dorsal surface is covered with a kind of slightly granular network raised with short, smooth and pointed spines forming on the upper part of the arms three longitudinal winding rows.

Color pale red, the granules being paler.

Dimension: total width, 80 mm.

Inhabits ?

7. ROIDE ECHINASTER. *ECHINASTER RIGIDUS*, — Grube.

— Grube, Weigm. Archiv, 1857, p. 341.

Five cylindrical arms, bluntly heptagonal and tapered toward their end. Their length is five times that of the disk. The spines of the ambulacral groove are arranged in two rows. On the external row, they form two or three series and are slightly compressed. On the internal row, they form a double series fixed very near the groove. The dorsal surface of the disk, as well as the arms, is covered with a very pronounced network, more or less rectangular, on which are a large number of small vertical spines that are blunt, arranged in three rows in all of the dorsal surface strictly speaking but are sharper and in a single row on the lateral parts.

Color reddish brown, paler on the lateral parts.

Dimension: total width, 80 mm.

Inhabits ?

8. ECHINASTER WITH LACUNAE. *ECHINASTER LACUNOSUS*. — Grube.

— GRUBE, Weigm. Archiv, 1857, p. 342.

Species with five flattened arms, narrow at their base and tapered toward the end. They are approximately five times longer than wide. The spines of the ambulacral groove are very developed and in a double series. The external ones are very fine and silky and in a double series. The internal ones have many more smaller, blunt ones. The dorsal surface is covered with a network with spines arranged in single series, in the intervals of which we see four or five pores. On the dorsal part of the arms, there is sometimes a single, sometimes longitudinal series. The ventral series is, on the contrary, bare. The spines of the back are generally blunt and the small are approximately 1 mm in length.

Color reddish with a large number of small whitish smudges corresponding to the pores of the intervals of the network.

Dimension: 90 to 100 mm.

Inhabits ?

The following two species that Gray made a particular species under the name *Ferdina* should probably still belong to *Echinaster.* 1º *Ferdinia flavescens* Gray (Ann. and Mag. of nat. Hist., p.160, n° 49); from Mauritius. 2° *Ferdinia cumingii* Gray (*loc. cit*., p. 160, n° 20); from the coasts of Colombia.

4th GENUS. **CRIBELLA**. *CRIBELLA*.— Agassiz.

— *Othilia*, Gray. — *Echinaster* (pars), Müller. Troschel.

We have already said that this genus, established first by Agassiz, was confused or joined by Müller and Troschel, with *Echinaster.* The species that it contains are remarkable for their slender forms, by their surface covered with fine and numerous asperities. The best known is an old species, *Asterias sanguinolenta*, Müller, which has received a large number of names and whose synonymy is very complicated. The species that should be part of it are the following: 1° *C. sanguinolenta*; 2º *C. eschrichtii, C. fallax, C. brasiliensis.*

1. BLOODY CRIBELLA. *CRIBELLA SANGUINOLENTA*. — Sars.

— *Pentadactylosaster oculatus*, Linck, de Stell. marinis, p. 31, t. 26, f. 62.— *Asterias sanguinolenta*, Müller, Zool. Dan. Prodr, n° 234, (non Farriorus, nec Retzius). — *Asterias pertusa*, Müller, Zool. Dan. Prodr. no 235. — *Asterias oculata*, Pennant, Brit. Zool.— *Asterias spongiosa*, Farricius, Faun, Groenl., n° 363.—*Asterias seposita*, Retzius, Dissert., p.21. — *Asterias pertusa*, Fabricius, Kongel Dan Vidensk selskab. skift., II, p.41, t. IV, f. 2.—*Asterias oculata*, Fleming, Brit. Anim.—*Linckia oculata*, Forbes, Wern.Mem.— *Asterias spongiosa*, Gould, Superteb. of Massach.—*Cribella oculata*, Forbes, Hist. of Brit. starf., p. 100.— *Echinaster oculatus*, Müller Troschel, Syst, der Aster., p. 24.—*Echinaster eschrichtii*, Brandt, M. Tr. p. 25. — *Echinaster sanguinolentus*, Sars, Weigm. Archiv für

nat., X, p. 169 — *Echinaster sarsii*, M. Tr., *loc. cit*., p. 179. — *Echinaster oculatus*, Dub. and Kor., Vetensk. akab. Handl., 1844, p. 241. — *Echinaster eschrichtü,* Brandt, Midd. Ruz. Nord. II, p. 32. — *Linckia oculata*, Stimpson, Invert. of Grand-Mana, p. 14. — *Linckia pertusa*, Srimpson, *loc. cit*.

Species having five conical arms, having on the ventral surface transverse series of small bunches of cylindrical and blunt spines. The end of each group in the ambulacral groove is formed of a single spine that in some way makes a kind of transition from the papillae of the groove to the spines of the ventral surface. This latter also has outside, two rows of bunches of spines. On the back are numerous similar bunches only lower and very separated in the interval of which are isolated tentacular pores, not grouped as in other *Echinaster.*

Color a red brown above and a reddish yellow below.

Dimension: 33 mm.

Inhabits the coasts of Norway.

It is on this species that Sars made his observations on the development of young Asteroids.

2. ESCHRICHT'S CRIBELLE, *CRIBELLA ESCHRICHTII*, — Müller and Troschel. (Sp)

— *Echinaster eschrichtii*, Müller and Troschel., Syst. der Aster., p, 23 (non Brandt).

Species with five arms, very narrow and sharp at their end, having from the center of the disk four times the length of the radius of the disk. Each ambulacral groove contains, at a certain depth, a row of very short spines. The contiguous plates of the groove each have a transverse group of longer, club-shaped spines among which we often distinguish two series that converge in the shape of a wedge toward the groove and end in a larger and thicker spine. The ventral surface has three rows of plates covered with very fine, brush-like spines. The sides of the dorsal surface of the arms are as in the preceding species. The porous areas contain also a small number of tentacular pores that are found to near the ambulacral groove. The madrepore plate is also covered with spines.

Color reddish.

Dimension: up to 108 mm.

Inhabits the coasts of Greenland.

3. DECEITFUL CRIBELLA. *CRIBELLA FALLAX.* — Müller and Troschel (Spec.)

— *Asterias*, Savigny, Descript. de l'Egypte, Echinod., pl. 4, AS — *Othilia purpurea* and *O. luzonica*, Grau, Ann. and Mag. of nat. Hist., t. VI, p. 282. — *Echinaster fallax*, Müller and Troschel. Syst. der Aster., p. 23.

Species near the preceding, with which it is often confused. But, in addition to its always being smaller, the spines that cover it are also smaller and more numerous. The proportions are also generally slenderer.

Color red purple in the fresh state as well in the dried state and in alcohol. This persistence of color gives a distinct character with the preceding species.

Dimenson: never exceeds 155 mm.

Inhabits the sea of the Indies, the Red Sea where it was collected by Savigny who gave a very good figure in his great work on the description of Egypt.

4. BRAZILIAN CRIBELLA. *CRIBELLA BRASILIENSIS*. — Nob.

— *Echinaster brasilian, Echinaster brasiliensis*, Müller and Troschel. — Seba thesaurus, pl. 7, f. 4. — *Othilia multispina*, Gray, Ann. and Mag. nat. Hist., VI, p. 282. — *Echinaster brasiliensis*, Müller and Troschel. Syst. der Aster., p. 22, pl. 1, f. 4.

Species near the preceding having the arms nearly similar but distinguished by the number and length of the spines, much shorter, not exceeding those of the ambulacral groove and forming on the arms nine to eleven rows, each containing 39 to 40 spines from the center to the end.

Color deep purple, nearly black.

Dimension: 155 mm.

Inhabits the coasts of Brazil.

4. CRIBELLA WITH A COARSE NETWORK. *CRIBELLA SEPOSITA*. — Nobis.

— *Asterias seposita*, Retzius, Vetensk. Acad., IV, p. 337. — *Id.*, Linné, Gmel. Syst. nat., p. 3162. —*Asterias sanguinolenta* (pars), 0. F. Müller, Zool. Dan. Prodr., p. — *Asterias seposita*, Lamarck, Anim. s. vertèb., 2^{e} édit, t, III, p. 251. -— *Id. Id.*, Risso, Hist. nat. Eur. mérId., V, p. 270. — *Asterias sanguinolenta* and *A. Sagena*, Retzius, Dissert. de Stell., p. 21–22. — *Stellonia seposita*, Nardo, de Aster. in Okens, Isis, 1834, p. 716. — *Id. id*, Agassiz, Prodr, in Mém. Soc. sc. nat. Neufchatel, 1835. — *Rhopia seposita* and *R. mediterranea*, Gray, Ann. and Mag. of nat. Hist. VI, p. 282.— *Echinaster sepositus*, Müller and Troschel. Syst. der Aster., p. 23. — Sars, Litt. Fauna in nyt. Mus. fur naturv., 1857, p. 51, n° 25.

Species with five cylindrical arms, a little thinner toward their ends, six times as long as wide, whose length from the center is seven to eight times the demi-diameter of the disk. The ambulacral grooves have a row of spines on each side. The back is covered with a large number of other spines that are small, coarse and blunt, two or three times as long as wide, isolated from each other, and with any other disposition to form regular rows. On the contrary, the spines of the ventral surface form two or three longitudinal rows.

Color a red purple in the fresh state but becoming yellowish with drying or preserved in alcohol.

Dimension: width: up to 270 mm.

Inhabits the seas of Europe.

It is *Cribella seposita* that probably must be placed the species of Asteroid incompletely described by Lamarck under the name *Asterias acuminata*, Lamarck (Anim. s. vert., 2^{e} édit., p. 252). It is the size of *Asteracanthion rubens*, but differs greatly by the convex form of the body above, very concave below and by the conical rays, pointed and

finely papillose above with longitudinal striations pierced by holes. The ambulacral gutters are deep. Lamarck added, with doubt, that this could be *Asterias violacea* of O. F. Müller (Zool. Dan., t. II, pl. 46, and Encycl. méthod., p. 116, f. 4–5). We have seen this latter species was considered by Müller and Troschel as identical with the common Asteroid (*Asteracanthion rubens*).

5th GENUS. **ACANTHASTER**. *ACANTHASTER*.— Gervais.

—Dict. sc. nat., Supp. I, p. 474.—*Echinaster*, Gray (non Müller and Troschel. — *Echinites*, Müller and Troschel. (non Agassiz).

Body depressed, surrounded by numerous arms, covered with very tall, vertical spines interspersed with pedicellariae.

Each plate of the ambulacral groove also has several spines.

Several madrepore plates.

This genus was established by Gray under the name of *Echinaster*, then under that of *Echinites* by Müller and Troschel (Archiv, Wiegm., 4844, p. 180) who, later, united it to their genus *Echinaster* that. as we have already said, does not correspond at all to that of Gray. As a result, this latter name given by Müller and Troschel must be rejected as being later than that given by the English naturalist. As for the name of *Echinites*, it is inadmissible in its turn because, a long time before, it had been used already by Agassiz to designate a whole family of Echinoids. These reasons have determined us to accept the name proposed by Gervais, that of *Acanthaster* (Dict. Sc. nat.) as resolving this difficulty without leaving any ambiguity in the nomenclature. In this way, the genus *Echinaster*, Müller and Troschel remains a group of Asteroids of which *A. spinosa* is the most common type.

Acanthaster is an Asteroid particularly remarkable for the large number of its arms, but also because these organs, as well as the body itself, are surmounted by a large number of very strong, vertical spines. We still know only a single species belonging to the genus.

Gray has believed it necessary to distinguish a second that has been united with the first by Müller and Troschel.

1. SOLAR ACANTHASTER. *ACANTHASTER SOLARIS*. — Nob.

— *Stella pentekai de kactis*, Cozumna, Phytobasanus, pl. 38. — *Asterias echinus*, Solander and Elus, tab. 60, 61, 62. — Copied in Encyclop. méthod., pl. 107, A, B, C.— *Asterias solaris*, Naturforscher, p. 27, pl. 1–2.— *Asterias echinites*, Lamarck, Anim. s. vertèb., 2e édit., t, III, p.246. — *Stellonia echinites*, Agassiz, Prodr. p. 29. — *Echinaster ellisii* and *E. solaris*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 281. — *Acanthaster echinus* , Gervais, Supp. au Dict. Se. nat., 1841, 1, p. 474.— *Echinites solaris*, Müller and Troschel, Weigm. Archiv, 1844, p. 180.— *Echinaster solaris*, Müller and Troschel, Syst. der Aster., p. 25.

Arms whose length after the disk is double the radius of the disk. Ambulacral groove with plates each with three very long spines of which the intermediary is much larger (one of the laterals is however sometimes also large). Outside the ambulacral groove, the ventral surface has three rows of cylindrical spines between which is, here and there, a smaller spine. The sides of the dorsal part of the arms are covered with irregular spines that are sparse, conical, sharp, and much larger on an equally conical base. The largest are approximately equal to the width of the arms. Between these spines are many sessile pedicellariae that are elongated and pincers, attached to the skin of the back that is, in addition, crossed by tentacular pores. Similar pedicellariae also are round on the ventral surface, particularly next to the ambulacral groove. The skin of this surface also has scattered granules that are also found on the spines of the ventral surface except toward the end. The skin of the back is without granules. The madrepore plates are numerous, hemispherical, and form on the disk a large circle around the center, nearer the latter than the edge. The space between the plates is ordinarily the width of two arms.

Color brownish.

Dimension: total width 525 mm.

Inhabits the coasts of South America and Sumatra.

6th GENUS. **SOLASTER.** *SOLASTER*.— Forbes.

Syn. (*Solasterias*, Blainv.—*Stellonia*, (pars) Nardo, Agass.—*Solaster*, Forbes, Gray, Mull., Trosch. — *Crossaster*, Mull. Trosc. (olim.) s. g. — *Polyaster*, Gray).

Body surrounded by more or less numerous arms, varying between eight and fourteen, and covered everywhere by brush like appendages between which the skin is bare and with numerous tentacular pores. The ambulacral grooves do not have spines in the interior, but each plate bordering these grooves has a ridge formed by spines. No pedicellariae. Anus central.

The genus *Solaster,* established by Forbes, has also been designated by Müller and Troschel under the name *Crossaster*. Finally, it corresponds to the *Polyaster* of Gray but as a sub-genus only. This genus includes a very small number of living species. One only in the fossil state was attributed to it by Forbes himself. What is remarkable is that it came from the Great Oolite.

1. SOLASTER WITH PLUMES. *SOLASTER PAPPOSUS*. — Forbes.

— *Stella rubra coriacea*, 12 *radis luidiis*, Linck, p. 80, and Linck, pl. 17 n° 28, and pl. 34, n° 54. (CopiedCopiés Encycl. méthod., pl. 107, f. 3–7).— *Asterias stellata*, Retzius? — *Asterias papposa*, Fabricius, Faun. groënl., p. 369. — *1d. Id.*, 0. F. Müller, Prodr. Zool. Dan., p. 234. — *Id. Id.*, Linné, Gmel., Syst. nat., p. 3160. — *Id. Id.*, Lamarck, Anim. s. vertèb., 2e édit., t. III, p.246. — *Id. Id.*, Atlas du Règne animal de Cuvier, illustré, Echin., pl. 1, f. 1. — *Stellonia papposa*, Agassiz, Prodr., p. 25. — *Asterias papposa*, Johnston, Mag. of nat. Hist., 1836, p. 475, f. 69. — *Asterias helianthosus*, Pennant, Brit. Zool., t. IV,

66, f. 72. — *Solaster papposus*, Forbes, Wern. Mérm., VII, p. 121. — *Solaster papposus*, Müller and Troschel., Syst. der Aster., p. 26, pl. 111, f. 1.

Species with eleven to fourteen flattened arms pointed at their end, whose length from the center is two and a quarter to three times the diameter of the disk. Spines of the ambulacral groove very long, joined in a comb. At some distance from this groove, the ventral surface has on each side another series of transverse combs formed of spines similar to the preceding. Finally, on the edges of the arms is a row of tubercles prolonged in the form of large spreading brushes. Tubercles with similar brushes, but smaller, are scattered on the dorsal surface, particularly at the nodes of the dorsal network. The brushes are formed of numerous and very dense bristles. The areas of the tentacular pores are large.

Color very bright bloody red above, the middle darker being surrounded by a paler circular band and the edge also darker. The arms are a little paler toward their base than at the end.

Dimension: total width 325 mm.

Inhabits Northern seas of Europe.

2. SOLASTER WITH FINGERS. *SOLASTER ENDECA*. — Forbes.

— *Asterias endeca*, Linck, t. XV, f. 16, n° 26, and t. XVII, no 27. (Copied inEncyel. méthod., pl. 113, f. 3, pl. 114, 115, 116, f. 1.) — *Asterias endeca*, Retzius, Vetensk Acad., t. IV, p. 237. — *Id. Id.*, Linné, Gmel., Syst. nat., p. 2162. — *Asterias aspera*, Müller, Prodr. n° 2833. — *Solasterias endeca*, de Blainville, Man. d'Actinoi., p. 242. — *Stellonia endeca*, Agassi, Prodr., p. 25.— *Asterias endeca,* Johnston, Mag. of nat. Hist., 1836, p. 299, f. 44, — *Solaster endeca*, Forbes, Wern. Mém., t. VIII, p. 121. — *Id. Id.*, Müller and Troschel, Syst. der Aster., p. 26. — *Id. Id.*, Gray, Ann. nat. Hist., 1840, p. 183. — *Id. Id.*, (sub-genus *Endeca*) Gray, Brit. Mus., p. 19, 1848.

Species with eight to ten arms, but usually nine, flattened and pointed, whose length from the center is two and a half times the radius of the disk and that are approximately three times as long as wide. The spines of the ambulacral groove are very small and joined by two or even more, one after the other. After them is a series of transverse combs of small spines as in *Solaster papposus*. Not far is also found on the ventral surface, a similar series that curves to pass from the disk onto the arms. The combs of this series are less protruding than those that accompany the spines of the ambulacral groove. All the back and the rest of the ventral surface are covered with very numerous small brushes that are much closer together than in the preceding species and are formed of only a small number of bristles. The porous areas are small and have a few tentacular pores.

Color reddish.

Dimension: width 490 mm.

Inhabits the coasts of England.

3. DECAN SOLASTER. *SOLASTER DECANUS*. — Müller and Troschel.

— *Echinaster decanus,* Müller land Troschel. Archiv Weigm., 1843, p. 114.

Species with five arms whose length from the center is four times the smallest radius of the disk. The spines of the ambulacral grow, four on each plate, form a row and are equal in length. Immediately beside them are groups of similar small bristly spines that form very dense longitudinal rows on the ventral surface. Toward the sides of the arms, these groups become less numerous and instead of being arranged in longitudinal rows have a reticulated disposition. This network becomes even more distinct on the back where the bristles are very short and in its mesh are very large bare porous areas containing a considerable number of tentacular pores, sometimes more than twenty. The network itself is formed by round, isolated tufts each of forty to fifty bristles. The mesh become narrower toward the end of the arms.

Color dark violet.

Dimension: width 108 mm.

Inhabits the southwest coast of Australia. (Mus. Berlin).

4. FORKED SOLASTER. *SOLASTER FURCIFER*. — Duben, Koren.

— Duben, Koren, Mém. Acad. Stockhol., 1844, p. 234, no 24, t, VI, £. 7–10.

Species with five arms whose length is two times longer than the smallest diameter of the disk. These arms are wide, slightly depressed. The dorsal surface is covered with paxillae arranged longitudinal series, the two marginals being larger than the others. The paxillae have spines that are flattened, triquetate, and ending at their top by two or three kinds of forks.

Tentacular pores united by a group of up to four. Spines of the ambulacral groove arranged in threes on each plate and in transverse combs.

Color pink on the lateral parts, the middle being white.

5. RELATED SOLASTER. *SOLASTER AFFINIS*.

— *Asterias affinis*, Brandt, Rec. Act. Acad. St-Pétersbourg, 1834, p, 272, n° 8.

Species very near *S,* papposus that has only 10 rays.

Inhabits the Behring Strait.

6. SOLASTER WITH WHITE WARTS. *SOLASTER ALBOVERRUCOSA*.

— *Asterias alboverrucosa*, Brandt, Act. Acad. St.-Pétersb. 5 1834, p. 272, n° 9.

Species near *S. papposus*. (An eadem ?)

Inhabits the Behring Strait.

FOSSIL SPECIES.

MORETON'S SOLASTER. *SOLASTER MORETONIS.*

— Forbes. — Mém. Géol. Surv., déc. 5, p. 1. Fossil of the Grande Oolith Fossile de la Great Oolite (Et. Bathonian) from the quarry of Windrust (England).

7th GENUS. **CHAETASTER**. *Chaetaster.* Müller and Troschel.

(αστερ, χαιτος)

Syn. *Asterias* authors.

Body with five elongated spines, covered everywhere with plates that have very dense bristle at their top. Tentacular pores isolated between the plates. Anus sub-central. Ovaries prolonged into the entire length of the arms.

1. CHAETASTER WITH LONG FEET. *CHAETASTER LONGIPES*. — Retzius (Sp.).

— *Asterias longipes*, Retzius, Dissert. de stell., p. 20. — *Asterias subulata*, Lamarck, An. s. vert., 2nd édit., t. III, p. 256. — *Asterias subulata*, Delle Chiaje, Mém. d. an. s. vert., pl. 21, f. 5–6. — *Id. Id.*, Grube, Actin., etc., p. 22. — *Chaetaster subulata*, Müller and Troschel. Syst. der Aster., p. 27, pl. II, f. 1.— *Chaetaster longipes*, Sars, Midd. Litt. Faun, in nyt. Mag. of naturv., 1897, p. 51, n° 24.

Species with five arms that are elongated, subulate, whose length is seven to ten times the diameter of the disk and are seven times as long as wide. The spines of the ambulacral groove are conical and form a single row. There are four on each plate. A fifth of the same form is found, not near the groove in the same row as the four others, but on the side of the plate toward the mouth. More outside, on the same plate, is also a group of very small spines. On the ventral surface are three or four longitudinal rows of plates, only two of which continue up to the end of the arms and are arranged so that they form at the same time transverse rows perpendicular to the groove. Outside are also two longitudinal rows of plates a little larger and arranged the same. On the dorsal surface of the arms is, according to the age of the individuals, seven to eleven longitudinal rows of plates of which the median alone reaches the end of the arms. These rows also form at the same time transversely oblique rows. These plates are larger in the middle, decreasing toward the edges. Those of the disk are scattered without determined order. Each of these plates has an extension wider than long, covered with numerous short bristles on its truncated top. The bristles are in addition shorter on the large plates of the sides of the arms.

Color greenish brown. Dimension: width approximately 190 mm.

Inhabits the Mediterranean.

2. HERMANN'S CHAETASTER. *CHAETASTER HERMANNII*. — Müller and Troschel.

— Müller and TroscheL, Syst. der Aster., p. 27.

Species near the preceding and having the ensemble of characters but with the spines of the ambulacral groove long and in three rows. All the body is covered with regular plates having small spines that are frequently replaced by kinds of short pedicellariae. There are up to twenty of these small spines that are swollen into clubs toward the end. We count in addition about twenty of these plates on each arm. These plates, a little raised, form at the same time a network with isolated tentacular pores between them. The pedicellariae are short, rounded at the top and as wide as tall.

Color reddish. Dimension: width 216 mm.

Inhabits ? (Mus. de Strasbourg).

3, TROSCHEL'S CHAETASTER. *CHAETASTER TROSCHELII*.— Va.

— Valenciennes, Coll. du Mus.—*Id.*, Müller and Troschel. Syst. der Aster., p. 28.

Species having five conical arms, not very pointed, three times as long as wide and whose length from the center is approximately four times the radius of the disk. The corners between the arms and their base are nearly rounded. No spines strictly speaking in the ambulacral groove but the plates that accompany this groove have a bundle of bristly spines of which five, forming the internal row, are grouped into a kind of ambulacral spine. The plates of this ventral surface of the disk as well as one or two rows of other plates located near the groove are covered with numerous, very short bristles extending in longitudinal rows of which only three reach the end of the arms. In the middle of the disk and the arms, the plates form more longitudinal rows but have only oblique transverse rows. They are also covered with bristles.

Color reddish brown. Dimension: width 162 mm.

Inhabits the seas of the Antilles. (Mus. de Paris).

3. CHAETASTER WITH PARQUETS. *CHAETASTER TESSELLATUS*. — Müller and Troschel.

— *Nepanthia tessellata*, Gray, Ann. and Mag. nat. Hist. t. VI, p. 287. — *Chaetaster tessellata*, Müller and Troschel, Syst. der Aster, p.

Species having five long arms, regularly tapered toward their end, with rows of quadrangular tubercles covered with small spines.

Color brownish.

Inhabits the seas of India.

4. SPOTTED CHAETASTER. *CHAETASTER MACULATUS*. – Müller and Troschel.

— *Nepanthia maculata*, Gray, Ann, and Mag. nat. Hist., VI, p. 287.

Species with five arms that are depressed, blunt, covered with plates covered with small spines. These plates being transversely oblong in the middle of the back and quadrangular on the sides.

Color grayish spotted with black.
Inhabits the seas of India.

Müller and Troschel, in the previously cited work, reported a red Asteroid from the coasts of Norway that they had seen dried in the Musée de Stockholm and that, according to them, should belong to either the genus *Solaster* or *Chaetaster*. It has five elongated arms, thin and pointed. On the ambulacral grooves are wedge-shaped groups of spines forming transverse rows. Somes rows of brushes of small spines are outside the ambulacral groove. All the dorsal surface is covered with numerous similar brushes.

Diameter: total width 162 mm.

8th GENUS. **OPHIDIASTER**. *OPHIDIASTER*. — Agassiz.

(οφις, serpent; αστηρ.)

Linckia (pars), Nardo, Gray.

Five arms (rarely four or six) that are cylindrical or conical. — Body covered everywhere with granular plates, with porous areas between them that contain many pores and that are not bare but covered with granules. No pedicellaria. Anus central.

This genus, established by Agassiz and accepted by Müller and Troschel, corresponds in part to the genus *Linckia*, Nardo and Gray. It has for type *Asterias ophidiana*, Lamarck, and contains still other species of Asteroids of the same author such as *A. cylindrica, A. laegivata,* and *A. multifora*.

Müller and Troschel referred to this genus *Asterias coriacea* of Grube, *A. attenuata* and *A. pyramidata* of Gray, then *Linckia pacifica, columbia* and *guildingi* of the latter author, and finally, *Asterias ornithopus*, Val. (*Ophidiaster*).

They have made known seven unpublished species and referred with doubt to the genus *Ophidiaster*, the three genera *Dactylosaster, Tamaria* and *Cistina* of Gray. It is very probable that *Asterias bicolor* and *A. arenata* of Lamarck are also part. This brings to twenty-two the number of species presently known.

Ophidiaster is remarkable for the narrowness of its arms. This arrangement allows the suggestion that the caeca of the stomach do not penetrate it, as occurs also in *Scytaster*. Their integument, more coriaceous than in other Asteroids, seems to give them a very greater fragility because we frequently encounter individuals of different species of this genus whose arms are mutilated and regenerating. The numerous species of this genus can be separated into two groups: 1° Species having plates of the back in regular series. 2° Species having these plates irregularly scattered on the back.

* *Species having the plates of the back in regular series.*

1. SERPENT OPHIDIASTER. *OPHIDIASTER OPHIDIANUS*. — Agassiz.

— *Asterias ophidiana*, Lamarck, An. s. vert., 2e édit., t. III, p. 255. — *Ophidiaster ophidianus*, Agassiz, Prodr., p. 24. — ? *Ophidiaster aurantius*, Gray, Ann. and Mag. nat. Hist., t. VI, p. 264. — *Ophidiaster ophidianus*, Müller and Troschel. Syst. der Aster., p. 28. — *Id. Id.*, Sars, Middelh. littoral Fauna in pyt. Mag. fur Naturv., 1857, p. 50, no 23.

Species with five arms that are cylindrical, rounded at their end, nine times as long as wide, and whose length from the center is ten times the radius of the disk. The spine of the ambulacral groove form a double row, those of the external row being thicker and less numerous. Very close to this groove is a series of finely granular plates. Still more outside on the side as well as all of the back are seven regular longitudinal rows of other plates that are very finely and uniformly granular. The porous areas between the longitudinal rows of plates each contain twenty to thirty tentacular pores in the middle of the disk. These plates have no order.

Color grayish (in the dry state). Dimension: width up to 50 centimeters.

Inhabits the coasts of Sicily.

2. HEMPRICH'S OPHIDIASTER. *OPHIDIASTER HEMPRICHII*, — Müller and Troschel.

— Müller and Troschel. Syst. der Aster.

Species very near the preceding but distinguished by the granulation of the plates as well as by the tentacular pores that are only ten to fifteen in each area or interval of the plates. Among the fine granules of the plates are some larger or hemispherical grains.

Color orangish or yellowish. Dimension: total width 135 to 162 mm.

Inhabits the Red Sea. (Mus. de Berlin).

3. CYLINDRICAL OPHIDIASTER. *OPHIDIASTER CYLINDRICUS*. — Müller and Troschel.

— *Asterias cylindrica* , Lamarck, An. s, vert., 2e édit., t. III, p.255. — *Ophidiaster leachii*, Gray, Ann. and Mag. nat. Hist., t. VI, p. 284. — *Ophidiaster cylindricus*, Müller and Troschel., Syst. der Astcr., p. 29.

Species also resembling the two preceding, but the plate of the surface have, in addition to their fine granules, some small tubercles that are blunt and cylindrical. On those of the groove are many of these small tubercles a little longer than wide forming a longitudinal row. The number of the tentacular pores is less than in *O. hemprichii.* It is only three to seven.

Color red. Dimension: width 155 mm.

Inhabits the coasts of Mauritius. (Mus. Paris, Coll. Michelin).

4. OPHIDIASTER WITH NARROW ARMS. *OPHIDIASTER ATTENUATUS*. — Müller and Troschel.

— *Asterias coriacea*, Grube, Actinies, etc. p. 22.— *A. attenuata*, Gray, Ann. and Mag. nat. Hist., t. VI, p. 284. — *Ophidiaster attenuatus*, Müller and Troschel. Syst. der Aster., p. 29.

Species with five arms that are conical, thin at the end, and five and half times as long as the radius of the disk. The spines of the ambulacral groove are very large and form three rows. Those of the internal row are flattened, those of the external row are nearly cylindrical, thick and blunt. The plates in longitudinal series on the back and sides of the arms are equal. Those of the ventral surface, smaller, form seven rows. The tentacular pores are approximately twenty in each porous area. The granulation is everywhere uniform.

Color red passing to orange and sometimes marked with four darker transverse bands on the arms. Dimension: width 162 mm.

Inhabits the coasts of Sicily. (Mus. Paris).

5. DWARF OPHIDIASTER. *OPHIDIASTER PUSILLUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., 1844, p. 180.

Species with five arms whose length from the center is five and a half times the radius of the disk. The spines of the ambulacral grooves form a single row. There are ten on each plate. Among the fine granules that cover the ventral surface, we see protruding on each side of the arms two rows of larger granules that correspond to the number of rows of plates. These granules continue toward the edge of the arms by rather regular rows of still larger granules. The granulation of the back is uniform. The porous area has a small number of pores. The madrepore plate is single.

Color reddish. Dimension: width 27 mm.

Inhabits the Philippines (Mus. Berlin).

* *Species having irregular plates scattered on the back.*

6. SPOTTED OPHIDIASTER. *OPHIDIASTER MILIARIS*. — Müller and Troschel.

— *Dactylosaster miliaris*, Linck, pl. 28, n° 47 (copied Ercyel. méthod., pl. 120). — Seba, Thesaur., pl. 6, f. 13–14, — *Asterias laevigata*, Linné, Gmel., Syst. nat., p. 3164. — *Id. Id.*, Lamarck, An. s. vert., 2e édit., t. III, p. 254. — *Linckia typus*, Nardo, Isis, 1834, p.717.— *Linckia typus* and *L. brownii,* Gray, Ann. and Mag. nat. Hist., t. VI, p. 284. — *Ophidiaster miliaris*, Müller and Troschel., Syst. der Aster., p. 30, pl, 2, f. 2. Commonly: Comet.

Species with five arms that are cylindrical, rounded and blunt at the end, five times as long as wide and whose length from the center is six times the radius of the disk. The spines of the ambulacral groove are small, cylindrical and from two rows. Those of the external row are less numerous but no larger than the internal ones. On the ventral surface, near the ambulacral grooves, are three to five rows of small plates half as large as those of the back. Outside, on the sides of the arms, are two longitudinal arrows of larger plates. On the back, these parts are irregularly scattered. The granulation is fine and uniform everywhere. The porous areas are as large as the plates themselves and each contains approximately twelve tentacular pores.

Color yellowish or bluish is the dry state. Dimension: width 525 mm.

Inhabits Indian Ocean (Mus. Paris).

7. SUTURAL OPHIDIASTER. *OPHIDIASTER SUTURALIS*. — Müller and Troschel.

—? *Linckia unifacialis* and *L. bifacialis*, Gray, Ann. and Mag. of nat. Hist., t. VI, p.285.— *Ophidiaster suturalis*, Müller and Troschel. Syst. der Aster., p. 30.

Species very similar to *O. miliaris* but with arms that are conical, attenuated and pointed. The spines of the ambulacral groove in two rows are nearly the same size but those of the internal have between them on each side and very small cylindrical spine. On the ventral side are four or five rows of small plates and on the sides and row of plates two times as large. In the middle of the dorsal surface of the arms is an irregular band of plates not separated by porous areas that form, here and there, an interrupted rows between the middle and the side of the arms. No intermediary plates nor isolated porous areas. In the middle of the disk, the tentacular pores are completely missing. The granulation is finer on the porous bands and larger, on the contrary, in the middle of the disk.

Color reddish. Dimension: 216 mm.

Inhabits ? (Mus. de Vienna).

8. DIPLAX-LIKE OPHIDIASTER. *OPHIDIASTER DIPLAX*. — Müller and Troschel.

— Müller and Troschel Syst. der Aster., p. 30.

Species with five arms that are cylindrical, twelve times as long as wide and whose length from the center is thirteen times the radius of the disk. Spines of the ambulacral groove are flattened, all equally large and in two rows. Those of the external row are less numerous. Those of the internal row alternate with the smaller spines. The plates of the ventral surface of ordinarily small and regular. On the sides of the arms are three rows of larger plates. On the back, the plates are arranged in a kind of network. The porous areas on the back are larger than the plates and each has 25 to 50 tentacular pores. The granulation is uniform except on the ventral surface near the groove where the granules increase in size. Two madrepore plates.

Color reddish. Dimension: total width: 250 mm.

Inhabits ? (Mus. Berlin).

9. BIRD'S FOOT OPHIDIASTER. *OPHIDIASTER ORNITHOPUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 31. — Valenciennes, Coll. du Mus.

Species with five arms that are cylindrical, twelve times as long as wide, and whose length from the center is thirteen times the radius of the disk. Spines of the ambulacral groove forming three rows. Those of the internal rows alternatively larger and smaller.

Those of the two other rows, equaling the largest of the preceding, are opposite each of the small internal spines. On the ventral surface, near the groove, we see the dense granulation that covers two rows of plates. On the sides of the arms are three rows of larger plates. Finally, on the back, the plates are completely unequal and located irregularly with intermediary porous areas of the same size. These plates, like the porous areas, have larger granules. Two madrepore plates.

Color red becoming bluish in the dry state. Dimension: total width: 155 mm.

Inhabits Vera Cruz. (Mus. Paris).

10. MULTIFORMED OPHIDIASTER . *OPHIDIASTER MULTIFORIS*. — Müller and Troschel.

— *Asterias multifora*, Lamarck, An. s. vert., 2^{e} édit., t. III, p, 254.— Müller and Troschel. Syst. der Aster., p. 31.

Species with four, five or six arms that are cylindrical, attenuated toward their end, nine times as long as wide, and whose length equals ten to twelve times the radius of the disk. Spines of the ambulacral groove forming two rows. Those of the external row are less numerous those of the internal row are a little small and uniform. On the ventral surface are three rows of smaller plates and on the sides of the arms two rows of larger ones. The plates of the back are without order, with the porous areas as large as themselves and containing six to twelve tentacular pores. The granulation is generally fine and uniform but Inhabits becomes a little larger on the ventral surface. The madrepore plate is double in individuals with four and five arms. It is triple in those that have six.

Color yellowish in the dry state. Dimension: width up to 210 mm.

the Red Sea (Mus. Paris).

11. EHRENBERG'S OPHIDIASTER. *OPHIDIASTER EHRENBERGII*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 32.

Species having five that are cylindrical to their end that is blunt. They are seven times as long as wide and their length from the center is seven and a half times the radius of the disk. The spines of the ambulacral groove form two rows. Those of the internal row are alternatively smaller and larger and flat while those of the external row are nearly cylindrical, less numerous and a little larger than those of the internal row. The plates of the ventral surface are, like those of the back, covered with granules in not very distinct rows. On the sides of the arms are three longitudinal rows of plates of the same size as those of the back. The latter are without apparent order with small porous areas as large or smaller than they and containing tentacular pores that are not very numerous. Two madrepore plates.

Color pale background with four brown spots after drying. Dimension: width 155 mm.

Inhabits the Red Sea (Mus. Berlin).

12.TUBUCULAR OPHIDIASTER. *OPHIDIASTER TUBERCULATUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 32.

Species with five arms that are cylindrical at the base and conical at the end, seven times as long as the radius of the disk from the center. The ambulacral spines are long and form three dense rows. One row of small plates is on the ventral surface and two other rows of plates twice as large are further outside. The dorsal surface has plates irregularly placed with the porous areas as large as the plates themselves. The granules of the ventral surface are larger than on the back or it is more uniform. Some of the plates of the back are raised like short, blunt tubercles that are scattered and covered with granules. These tubercles are as wide as the plates that have them and a little shorter than the width.

Color pale brown, with four transverse bands, darker on the arms. Dimension: width 216 mm.

Inhabits sea of the Indies.

13. SPINY OPHIDIASTER. *OPHIDIASTER ECHINULATUS*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 32.

Species with five arms that are cylindrical, acuminate toward the end, and nine times as long as the radius of the disk from the center. The spines of the ambulacral groove form two rays. There are seven to nine on each plate of the internal row and arranged in a fan. Those of the middle are much longer than those of the ends. The external row has a single spine that is thick, cylindrical, longer than 2 millimeters, opposite each of these fans. The dorsal surface of the arms is covered with a network of oblong plates with large porous areas between them, ordinarily triangular and covered with granules like the plates themselves. The porous areas contain numerous tentacular pores. The nodes of this dorsal network are raised here and there with large spines that are thick and blunt that, like the small intermediary tubercles and the large external spines of the ambulacra are covered on all their surface with whitish granules, scaly, smallest to the largest. Beside these spines of the ambulacral groove are two, three or a large number of other spines that are white, hair-like and grouped together.

Color grayish (after drying). Dimension: width of 200 to 270 mm.

Inhibits the sea of the South (Mus. Paris).

14. PYRAMIDAL OPHIDIASTER. OPHIDIASTER PYRAMIDATUS.

— Gray, Ann. and Mag. nat. Hist., t. VI, p. 284.— *Id. Id.*, Müller and Troschel. Syst. der Aster., p. 33.

Species with five arms that are elongated, attenuated toward the end and slightly angular. They are four times as long as the diameter of the disk and have three rows of pores on each side, with seven rows of tentacles on their dorsal surface. The median row

is much larger than the others. The spines of the ambulacral groove are large, ovoid and pointed at their end.

Inhabits the bay of Carracca, the west side of Colombia.

15. OPHIDIASTER FROM COLOMBIA. *OPHIDIASTER COLOMBIAE*. — Müller and Troschel.

— *Linckia columbiae*, Gray, Ann. and Mag. nat. Hist., t. VI, p. 285. — Müller and Troschel. Syst. der Aster., p. 33.

Inhabits the coasts of Colombia. Species near the preceding.

16. OPHIDIASTER FROM THE PACIFIC. *OPHIDIASTER PACIFICA*. — Müller and Troschel.

— *Linckia pacifica*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 285. — Müller and Troschel. Syst. der Aster., p. 33.

Inhabits Tahiti.

47. GUILDING'S OPHIDIASTER. *OPHIDIASTER GUILDINGII*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 33. — *Linckia guildingii*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 285.

Species having arms that are cylindrical, thin, nearly equal, grossly granular. Spines of the ambulacral grooves with two equal rows. The porous areas of the back are spare. Each contains three or four pores.

Color brown, spotted with olive.

Two species mut be added to the preceding. These are:

18. BICOLORED OPHIDIASTER. *OPHIDIASTER BICOLOR*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 33. — *Asterias bicolor*, Lamarck, An. s. vert., 2^{e} édit., t. III p. 234.

Species with five rays or arms that are cylindrical, reddish, scattered everywhere with small papillae that are white and truncated.

19. SANDY OPHIDIASTER. *OPHIDIASTER ARENATUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 34. — *Ophiura arenata*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 255.

Species with eight arms arranged in two opposite groups of four each. These arms are cylindrical, conical, with scattered small papillae or tubercles ending in a head or capitulum. Ambulacral grooves wide and deep.

There is reason to think that this singular arrangement of the arms, divided into two groups, is only accidental and due simply to drying.

Müller and Troschel placed in *Ophidiaster* three species that Gray had made distinct genera. These are:

Dactylosaster cylindricus. — Gray. — Encycl, metrop,

Inhabits Mauritius.

Dactylosaster gracilis. — Gray. — *Loc. cit*., Müller and Troschel. Syst. der Aster,, p. 33.

Inhabits Columbia.

Tamaria fusca. — Gray. — *Loc. cit*., Müller and Troschel. Syst. der Aster, p. 33.

Inhabits Migupour.

Cistina colombiae. — Gray. — *Loc. cit*. Müller and Troschel. *loc. cit*., p. 33.

Inhabits Colombia.

These different species are still too imperfectly known to give satisfactory descriptions and also to decide if they should certainly be in the genus *Ophidiaster*.

Perhaps it is also necessary to refer to *Ophidiaster* the two following species:

Linckia crassa, Gray (Ann. and Mag. of nat. Hist., 1840, p. 161) and *Linckia leachii*, Gray (*loc. cit*., p. 161), Seba, t. 8, f. T7, *a b*.

Inhabits Mauritius.

Finally, it is probably also to *Ophidiaster* that it is necessary to refer the genus *Mediaster*, Simpson. *Mediaster aequaris*, Simpson, Weigm. archiv, 1858.

9th GENUS. **SCYTASTER**. *SCYTASTER*. — Müller and Troschel.

Syn. *Linckia* (pars), Nardo, Agassiz, Gray. *Metrodira*, Gray. *Fromia*, Gray. *Nardoa*, Gray. *Gomophia*, Gray? *Methrodia*, Gray? *Narcissia*, Gray ?

Disk small, with five elongated arms (sometimes six). Dorsal surface covered everywhere with granular plates that on the edges form a double row. Intervals of plates also granular and only having isolated tentacular pores. Anus subcentral.

Although some species of this genus were already designated previously as *Linckia*, either by Nardo or by Agassiz, it is correct that Müller and Troschel have substituted that of *Scytaster* because the first had become the receptable, so to speak, of species belong to very different genera. Nardo himself included both *Ophidiaster* and the true *Scytaster*.

Finally, the synonymy of the genus shows how it had been the subject of multiple and certainly useless generic distinctions.

We think it is appropriate to join to the same name the genus *Heresaster*, Michelin. This author, in a work on on the Echinoderms of Mauritius (Revue Zool., 1844) established and described a species under the name of *Heresaster papillosus*, Mich., that perhaps should be referred to simply as *Scytaster subulatus*.

1. VARIOLE SCYTASTER. *SCYTASTER VARIOLATUS*. — Müller and Troschel.

— *Pentadactylosaster variolatus*, Linck, pl. 1, f. 1, et pl. 8, f. 10, pl. 14, n° 24. (Copied in Encycl. méthod., pl. 119, f. 4-5.)—*Asterias variolata*, Retzius, Dissert. de Stell., p. 19.— *Id. Id.*, Lamarck, An. s. vert., 2e édit., t. III, p. 253. — *Linckia variolata*, Nardo, Isis, 1834, p. 717, — *Id. Id.*, Agassiz. Prodr., p. 24. — *Nardoa* and *Nardoa agassizii*, Gray, Ann. and Mag. nat. Hist., t. VL, p. 286-287.—*Scytaster variolata*, Müller and Troschel. Syst. der Aster., p. 34.

Species usually with five arms but sometimes four or six and even sever that are four and a half times as long as the diameter of the disk. They are flat below, convex above and four times as long as wide. The spines of the ventral or ambulacral groove form several rows very close together and passing little by little with the granules of the ventral surface. A row of small plates is located outside these spines, then two other rows nearly as large as those of the back are also found on the sides. The external row is wider than long. The dorsal plates are transversely oval and have a tendency to be in alternate rows. The resulting obliquely transverse rows are often very distinct. The granules near the ambulacral grooves are larger and so dense that they appear polygonal.

Color reddish brown after drying. Dimension: total width 155 mm.

Inhabits Mauritius (Mus. Paris).

2. MILLEPORE SCYTASTER. *SCYTASTER MILLEPORELLUS*. — Müller and Troschel.

— *Asterias milleporella*, Lamarck, An. s. vert., 2e édit., t. III, p. 253. — *Scytaster milleporellus*, Müller and Troschel, Syst. der Aster, p. 35.

Species with five arms, four and a half times as long as the radius of the disk. These arms are flat above and below. Spines of the ambulacral groove forming two rows. Those of the eternal row are thicker, longer and more spaced so that each of them corresponds to two spines of the internal row. Between these spines and the marginal lates are only two rows of ventral small plates, of which the internal reaches two thirds and the external only a fifth of the arm. The lateral plates are all of equal size. Between the dorsal plates are intercalated other, smaller plates so that the edge is tubercular. The lateral plates, as well as the ventral plates have some granules larger in the middle, mainly toward the end of the arm. The dorsal plates are smaller than the laterals and finely granular.

Color dark orange. Dimension: total width 67 mm.

Inhabits the Red Sea (Mus. Paris).

3. ZODIACAL SCYTASTER: *SCYTASTER ZODIACALIS*. Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 35.

Species with five arms, four and a half times as long as the smallest radius of the disk. Spines of the ambulacral groove in two rows. Those of the external row are less numerous. The ventral plates near the groove are not more numerous than the lateral plates and these

are near as large as the dorsal plates that are irregular but not wider than long. The granules are equal everywhere and not very dense.

Color more or less dark purple. Diameter: total width 67 mm.

Inhabits ? (Mus, Paris).

4. PATISSIER'S SCYTASTER. *SCYTASTER PISTORIUS*. — Müller and Troschel.

— Seba, Thesaurus, pl. 8, n° 10, a-b. — *Fromia milleporella*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 486. — *Scytaster pistorius*, Müller and Troschel Syst. der Aster., p. 35.

Species with five arms whose length from the center is three times the radius of the disk and that are two times as long as wide. Their form is flat and then toward the end. The spines of the ambulacral groove form two rows. Those of the external row are more separated here and there. Next to the groove are two rows of plates, of which the external does not reach the end of the arms. Outside it and on the side of the arms are two other rows of larger plates. Those of the upper row are as long or even longer than wide. The dorsal plates, irregularly arranged, are smaller than the lateral plates.

Color reddish brown. Dimension: total width 54 mm.

Inhabits ? (Mus. Berlin).

5. SEMI-REGULAR SCYTASTER. *SCYTASTER SEMIREGULARIS*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p.36.

Species with five arms whose length is seven and half times the smallest disk radius. They are thinned into an awl, a little flattened above and five times as long as wide at the base. The spines of the ambulacral groove are tall and thicker than the granules of the plates. They are very dense and pass little by little to granules. However, we distinguish at least two rows, in each of which each plate has four spines and thus form a small, slightly oblique row whose external spine is a little in front of the adjacent plate.

A row of small plates on the ventral surface, near the groove, is made a little distinct by the granules that cover it. More outside are two longitudinal rows of plates larger than those of the back and scarcely wider than long. The dorsal plates are regularly arranged at the base of the plates into nine longitudinal rows and transverse rows. But from the middle to the end of the arm, the plates are arranged without any order.

Color pale brown after drying. Dimension: total width 162 mm.

Inhabits the coasts of Java (Mus. de Leyden).

6. KUHL'S SCYTASTER. *SCYTASTER KUHLII*. — Müller and Troschel.

— Müller and Troschel. Syst, der Aster., p. 36.

Species having five arms whose length is approximately give times the small radius of the disk. They are flat above and below and pointed.

The spines of the ambulacral groove, in the form of thick granules, form only one row beside which begins a fine granulation that uniformly covers the rows of ventral plates.

The plates near the border are large. All the back is covered with small irregular plates arranged without order. Some are larger, a little protruding and granular only at their base.

Color brown above, pale below. Dimension: total width 135 mm.

Inhabits the coasts of Java (Mus. Leyden).

7. SUBULATE SCYTASTER. *SCYTASTER SUBULATUS*. — Müller and Troschel.

— *Metrodira subulata*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 282. — Moller and Troschel. Syst. der Aster., p. 36.

Species with five slender arms, nearly linear, whose length is eight times the smallest radius of the disk. On each marginal plate of the ventral groove is a row of four small spines arranged transversely. Beside it is a row of nearly granular plates. The upper part of the disk and the arms is covered with plates that are imbricated, smaller than the lateral plats and each of which has one and sometimes two small spines.

Color yellowish. Dimension: total width 108 mm. Diameter of the arms from 3 to 4 mm.

Inhabits Migupour (Mus. Paris).

8. SCYTASTER FROM THE CANARIES. *SCYTASTER CANARIENSIS*. — Nobis.

— *Asterias canariensis*, D'Orbigny, 1839. Voy. Canaries, Echin., p. 148, n° 2, pl. 1, f. 8-15.

Species with five arms that are conical, elongated, keeled on their middle and dorsal part, which makes them triangular. All the surface is covered with extremely small and dense granules. Ambulacral grooves very narrow with equally fine granules on each side. The ventral plates are equally covered, but they are even finer.

Color whitish. Dimension: total width 15 cm.

Inhabits the Canaries. (Coll. D'Orbigny.)

9. LATTICED SCYTASTER. *SCYTASTER CANCELLATUS*. — Grube.

— Grube, Weigm. archiv, 1857, p. 340.

Body depressed, with five arms that are elongated, with on the dorsal surface six transverse rows of tubercles that are flattened, orbicular and granular at their base. On the

sides of the arms are rounded plates, alternatively larger and smaller and slight granular only at their base. The ventral plates are equal and entirely covered with granules. The ambulacral grooves are narrow with rectangular edges and are accompanied by a double row of plates having tubercles forming a pentagon like that of the upper part.

Dimension: 60 mm.

Inhabits ?

It is very probable that after *Scytaster*, if they should not be part of it, should be placed the following species that are still doubtful, established by Gray and whose characteristics we reproduce.

10th GENUS. **MITHRODIA**. *MITHRODIA*.— Gray.

Body with five arms that are cylindrical, elongated, scattered with small spines and having in addition a series of claviform spines that are enlarged and regularly articulated on a large base. Ambulacral grooves with long spines that are fine, bristly, grouped in rosettes with another series of long spines next to them.

Gray includes in his genus *Mithrodia*, under the specific name of *Spinulosa*, the *Pentadactylosaster reticulatus* of Linck that Müller and Troschel have recognized, according to the author's own specimen, for *Asteracanthion* (*A. linckii*, M. T.).

The similarity indicated by Lamarck concerning his *Asterias clavigera*, could make one believe that all the *Mithrodia* belong to the same genus, but we think there are some that should return to *Scytaster*.

CLUB-BEARING MITHRODIA. *MITHRODIA CLAVIGERA*. — Gray.

— Gray, Ann. and Mag. of nat. Hist., VI, p. 286. — *Asterias clavigera*, Lamarck, 2e édit., t. III, p. 250. — *Asterias reticulata*, Blainville, Man. Act., p. 240 ?—*Asterias clavigera*, Lamarck, Blainville, Man. Act., p. 24

Species with five rays that are long, semi-cylindrical, with scattered very small papillae that are smooth and having a row of large, club-shaped spines that are finely granular.

Lamarck adds that it resembles, in its appearance, *Pentadactylosaster reticulatus*, Linck, t. 9 and 10, n° 16; copied Encycl. méthod., p. 419, f. 1–2, but that it differs by the presence of the large club-shaped spines. We have seen above that the species cited comparatively by Lamarck was nothing other than an *Asteracanthion* (l*inckii*, M. Tr.).

We give these details only to call attention to *Asterias clavigera*, Lamarck that still remains a doubtful species and to show the little value of the genus *Mithrodia*, Gray.

11th GENUS. **GOMOPHIA**. GOMOPHIA.— Gray.

— Gray, Ann. and Mag. of nat. Hist., VI, p. 286.

Gray has instituted under this name a genus of Asteroid containing a single species a

(*Gomophia aegyptiaca*). Müller and Troschel considered it as near *Scytaster*. The tentacular pores are isolated between the plates and the surface is granular. On the back are large, round pores and on the arms are rows of large conical spines like tubercles. Small, blunt spines are grouped on the sides of the ambulacral groove. The arms taper little by little to their end. They are four times as long as the diameter of the disk with five irregular, longitudinal rows of conical, pointed tubercles.

12th GENUS. **LINCKIA**. *LINCKIA*.— Gray.

As we have seen previously, the genus *Linckia* of Gray contains not only several species of *Ophidiaster,* but still others having depressed arms with a simple pore between the dorsal plates and a line of not very numerous pores on the sides of the arms. These species still seem to fit into the genus *Scytaster*. These are:

1° *Linckia pulchella*, Gray.

Having flattened arms, nearly three times as long as the diameter of the disk and who spine accompanying the ambulacral groove are long, compressed and notched. The color is brown.

2º *Linckia intermedia*, Gray.

Whose cylindrical arms are long and acuminate toward their end and covered with plates that are convex and oblong with isolated pores on the back and grouped by 3 or 4 on the sides. The rows of spines that border the ambulacral groove are both elongated.

3° *Linckia erythraea*, Gray.

Arms long, cylindrical. Ambulacral grooves edged with small spines forming double rows here and there

Inhabits the Red Sea.

4° *Narcissia teneriffae*, Gray. *Loc. cit*. from Teneriffe.

13th GENUS. **CULCITA**. *CULCITA*.— Agassiz.

— *Asterias*, Lin., Lamarck, etc. — *Les Oreillers*, Blainville.

Body pentagonal, thick, discoidal, scarcely lobed, lateral surfaces very elevated, rounded edges, without plates. — Each ventral groove is raised to some extent onto the back. — All the body is covered with plates and granules.

Valvular and pincer pedicellariae. Anus subcentral.

Genus established by Agassiz in 1836 for species that until then were merged with *Asterias.* Blainville made a particular section for them under the name of *Oreillers*. These are, of all the Asteroids, those whose disk is the largest because if constitutes, so to say, all the animal, the arms being scarcely indicated and forming only a slight protrusion on the circumference of the disk.

1. DISCOID CULCITA. *CULCITA DISCOIDEA*. — Agassiz.

— Schmidel. Naturforscher Stell., pl. 1.—Encycl. méthod., pl. 98, f. 3, pl. 99, f. 1 — *Asterias discoidea*, Lamarck, An. s. vert., 2e édit., t. III, p. 240. — *Id. Id.*, Blainville., Man. Act., pl.

23, f. 1. — *Id. Id.*, Atlas, Règne anim. de Cuvier, pl. 1, f. 3. — *Culcita discoidea*, Agassiz, Prodr., p. 25. — *Id. Id.*, Müller and Troschel, Syst. der Aster., p. 37,— *Culcita cmideliana,* Gray, Ann. and Mag. of nat. Hist., t. VI, p. 276.

Body discoidal, thick above, pentagonal, corners surpassing by a quarter the small radius of the disk. Spines of the ventral surface compressed cylinders forming a row of four or five on each plate. The ventral surface has granules that are thicker than those on the back. This granulation is raised into short pearly tubercles that are grouped in the forms of rows and are longer and conical near the ambulacral grooves. On the dorsal surface are, among the finer granules, some isolated granules that are a little larger. There are also isolated tubercles on a reticulated framework that the skin covers entirely. The pedicellariae of the ventral surface are valvular, two or three times longer than wide, but much smaller than the tubercles.

Color pale yellowish brown. Dimension: width 190.

Inhabits the seas of India.

2. CORIACEOUS CULCITA. *CULCITA CORIACEA*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster. … p: 38. — *Asterias coriacen*, Encyc. méthed., pl. 97, f. 3.

Species of the same form as the preceding but having on each plate bordering the ambulacral groove five to seven spines, of which those in the middle are longer. More outside is a row of thick tubercles that pass insensibly to small tubercles on the ventral surface that, instead of forming clusters like those of the preceding species, are scattered or having a tendency to form a row that leaves obliquely from the groove. On the sides and on the back, the tubercles are much smaller and pointed at the same time that the granules are smaller and elongated and scattered on the back. The large tubercles of the preceding species are missing in this one and the pedicellariae of the ventral surface have flattened arms but not very enlarged. They are intermediary between the valvular pedicellariae and those that are in the form of pincers. The pedicellariae of the back and sides are pincers.

Color yellowish. Dimension: 450 mm wide.— Thickness near the edge, 27 to 928.

Inhabits the Red Sea.

This species is generally confused with the preceding, which it has, moreover, the ensemble of characters and especially the general aspect. But the arrangement and number of plates that border the ambulacral groove, as well as some details of ornamentation of the skin, have permitted Müller and Troschel to specifically distinguish it.

3. CULCITA FROM NEW GUINEA. *CULCITA NOVAEGUINAE*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 38.

Body pentagonal, rarely hexagonal, of the same form as the preceding. Spines of the ambulacral groove large, protruding, five on each plate and forming a slightly oblique row.

Nearby, more outside, is another row of spines that are shorter and thicker. There are two on each plate. On the ventral surface there are, between the fine granules, large, depressed tubercles, becoming rare and longer on the sides of the body. In the middle of the abruptly limited lateral surfaces, the tentacular pores occupy large areas with numerous pores and small, spiny tubercles. The intervals of these areas have some granules that are larger, spiny and scattered.

Color dark yellow. Dimension: total width 200 to 270 mm.

Inhabits the coasts of New Guinea.

4. HYBRID CULCITA. CULCITA GREX. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 39.

Body regularly pentagonal, the longest radius of the disk is more than a quarter the smallest. Spines of the ambulacral groove in a row of six or seven on each plate. They are dense, flat and do not reach the height of adjacent plates. The ventral surface appears covered with granules and more or less large tubercles, but not in groups. The back appears smooth and black. The tentacular pores occupy very large areas that are round or oval, length of five to seven millimeters, protruding onto the coriaceous skin of the back and forming small mounds covered with numerous white granules. The madrepore plate is very protruding and located a third of the distance from the center to the edge. Pedicellariae valvular, as large as the granules of the ventral surface.

Color blackish, on which are whitish granules.

Inhabits (Mus. Paris).

14th GENUS. **PALMIPES**. *PALMIPES*. — Linck,

— Agassiz — Gray — Forbes. — *Asteriscus* (spec.), Müller and Troschel.

Body extremely flat, scarcely swollen above. Arms merged with the disk, very short, with a thin, sharp and short edge, membranous on all the circumference as well as the disk itself.

Anus subcentral.

This genus, mentioned for the first time by Linck under the term *Palmipes*, was accepted successively by Agassiz, Forbes, Gray, etc. Müller and Troschel have, on the contrary, united it with their genus *Asteriscus*. We believe it is correct to return to the old name, that of *Palmipes*, at least for the two species *P. membranaceus* and *P. rosaceus*, which, for all their characters, certainly merit a distinct generic section. This method, moreover, has the advantage of thus preserving the genus *Asteriscus* of Müller and Troschel.

The genus *Palmipes* understood in this way contains to the present only the two living species. As for the fossil species described by Forbes under the name of *Palmipes antiqua*, we believe it is better to place it among the *Asteriscus*.

1. GOOSE FOOT PALMIPES. *PALMIPES MEMBRANACEUS*.— Agassiz.

— *Palmipes*, Linck, pl. 1, n° 2 (Copied in Encyel. méthod., pl. 99, f. 2-3).— *Asterias placenta,* Pennant, Brit. Zoot., IV, p. 62, pl. 31, f. 59. — *Asterias membranacea*, Linné, Gmel. Syst. nat., p. 3164. — *Id. Id.*, Lamarck, An. s. vert., 2e édit., t. III, p. 244. — *Id. Id.*, Risso, Hist. nat. Eur. mérId., t. V, p. 268. — *Id. Id.*, de Blainville, Man. Actin., pl. 25, f. 2. — *Palmipes membranaceus*, Agassiz, Prodr., p. 25. — *Id. Id.*, Forbes, Wern. Mém., t. VIII, p. 119, pl. 3, f. 3.—*1d. Id.*, Gray, Ann. and Mag. nat. Hist., t. VI, p. 288. — *Asteriscus palmipes*, Müller and Troschel. Syst. der Aster., p. 39.

Species with five arms, two times as long as the smallest radius of the disk and scarcely longer than wide and more or less blunt. Body flattened, membranous at the edge. The spines of the ambulacral groove are grouped by five on each plate. The small plates of the ventral surface have numerous small and bristly spines arranged in kind of crest. The small plates, above and below, form rows that are regular, longitudinal and oblique that become more distinct near the edge. On the median and dorsal part of the arms are two rows of tentacular pores that extend toward the end. These pores are less numerous than the intervals of the plates and all the rest of the surface lacks them. No pedicellariae.

Color reddish. Dimension: width 162 mm.

Inhabits the seas of Europe, the Ocean and the Mediterranean.

2. ROSETTE PALMIPES. *PALM/IPES ROSACEUS*. — Noris.

— *Asterias rosacea*, Lamarck, An. s. vert., 2e édit. t. III, p. 245. — *Palmipes stokesii*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 288. — *Asteriscus rosaceus*, Müller and Troschel, Syst. der Aster., p. 40.

Species with fifteen arms, of which the length exceeds by a seventh the smallest radius of the disk. The spines of the ambulacral groove are seven on each plate. Right next to them is a band formed of two spines longer on each plate. The body is flat and membranous, like in the preceding species. The ornamentation of the back is equally similar, only the dorsal plates are covered with small spines that are more numerous and extremely fine. The ventral plates have only three to five spines of which the intermediaries are longer.

Color gray above with the points and edge dark brown. Below and the edge is paler with many white points and some red-brown spots. Dimension: 190 mm.

15th GENUS. **ASTERISCUS**. *ASTÉRISCUS*.— Müller and Troschel.

— *Asterina* and *Anseropoda*, Nardo, Agassiz. — *Asterina*, Gray.

Body flat below, more or less swollen above, or even completely flat, with arms so short that it becomes pentagonal. Edges of the disk and arms thin, sharp.— The small plates

of the ventral surface have small sharp or blunt spines or form small cylinders that are isolated on each plate or even united in rows in the form of ridges. The small plates of the back have similar appendages, united in crests or in groups. Tentacular pores isolated between the small plates of the back and go more or less toward the edge.

Sometimes pedicellariae. Anus sub-central.

1. ASTERISCUS WITH SPINES. *ASTERISCUS PECTINIFER*. – Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 40.

Body nearly pentagonal with rounded edges, flat below, slightly convex above. Arms short, equaling one and a half the smallest radius of the disk. Spines of the ambulacral groove are four or five on each plate and form a single row. Beside them is a row of plates each with three or four small spines that are flattened and wide. Those that are nearest the end of the arm being large and the others gradually decreasing. The rest of the ventral surface is covered with plates that, near the center, are very large and become very small toward the edge. Each of them has a crest of four to seven spines that are short, blunt and flattened that are separate only toward the point. The back is entirely covered with small, granular spines, between which rise transverse, oval groups of twelve to fifteen larger granules that form on the dorsal part of the arms and, paralleling the axis, very regular rows. These groups are equally arranged with regularity around the center on the back.

Color pale reddish. Dimension: total width 155 mm.

Inhabits the coasts of Japan (Mus. Leyden).

2. WARTY ASTERISCUS. *ASTERISCUS VERRUCULATUS*. — Müller and Troschel. (Sp.)

— *Asterias verruculata*, Retzius, Dissert. de Stell., p. 12.—*A. gibbosa*, Pennant, Brit, Zool., IV. — *A. exigua*, Delle Chiaje, Mém. sur l'Anat., pl. 18, f. 1. — *A. membranacea*, Grube, Actinies, p. 26. — *Asterina gibhosa* and *A. burtoni,* Gray, Ann. and Mag. of nat. Hist., t. VI, p. 289. — *Asterias*, Savigny, Descript. de l'Egypte, Échinod., pl. 4, f. 2. — *Asterias pulchella*, Bv., Man. Act., pl. 22, f. 3.— *Asteriscus verruculatus*, Müller and Troschel. Syst. der Aster., p. 41.

Species with five, rarely six arms whose width is more than double the smallest radius of the disk. The intervals between the arms are notched and the end of these latter is pointed. The ventral surface is flat. The dorsal surface, more raised in the middle, lowers abruptly toward the edges that are thin.

The spines of the ambulacral groove are three on each plate. The small plates of the surface are arranged like those of the Goosefoot Asteriscus. Each plate of these from the ventral surface has two, rarely three spines that are long and pointed. Those of the back have eight to ten short spines, grouped transversely. The tentacular pores form several rows corresponding to the intervals of the rows of plates. The pedicellariae are numerous, bristly, placed between the plates.

Color reddishi. Dimension: total width 108 mm.

Inhabits the seas of Europe.

Gray (Cat. Brit. Mus., p. 23) reproduces an *Asterina gibbosa*, Pennant (sp.) that he considers different from *verruculatus*, M. T. He refers there *Asterias puichella*, Blainv. as well as *A. minuta* of the same author.

3. DWARF ASTERISCUS. *ASTERISCUS MINUTUS*. — Müller and Troschel. (Sp.).

— *Asterina minuta*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 289. — *Asteriscus minutus*, Müller and Troschel. Syst. der Aster., p.41. — *Asterias exiqua*, Lamarck? An. s. vert., t. III, p. 554.

Species very similar to the preceding, with five very pointed arms. Spines of the ambulacral grooves are three or four on each plate. The ventral plates have spines of the same number. The small spines of the back are short, thick and grouped on the arms by fives and sometimes more.

Color dark gray-brown after drying. The point of the arms and the thin edge appears to have been paler. Dimension: total width 54 to 80 mm.

Inhabits the coasts of Brazil (Mus. Paris).

4. CEPHEUS'S ASTERISCUS. *ASTERISCUS CEPHEUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 41.

Species having the form of *A. verruculatus*, with five blunt arms, of which the length equals two and a half times the small radius of the disk and whose edge is flat and prominent. Spines of the ambulacral groove in a single row, six to seven on each plate and forming very regular groups, palmate of in fans, the lateral spines being very short and those of the middle much longer. On each plate of the ventral surface are two groups with five small spines that are short and pointed. The small plates of the back are raise in the forms of scaless of the kind that their edge protruding toward the center has a band of small spines that are short and pointed. The tentacular pores, forming eleven to thirteen rows, nearly reach the edge.

Dimension: total width 40 mm.

Inhabits the coasts of Batavia (Mus. Paris).

4. KRAUSS' ASTÉRISQUE. *ASTERISCUS KRAUSS*— Müller and Troschel (Sp.).

— Encycl.méthod, pl. 100, f. 4–5. — *Asterina kraussii*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 289. — *Asteriscus kraussii*, Müller and Troschel. Syst. der Aster., p. 42.

Body very convex above, with five arms whose width from the center is twice the smallest radius of the disk. Spines of the ambulacral groove are very short, in a single row, three on each plate. Outside is another row of small, conical spines, one on each plate. The small spines of the ventral surface are short, conical, isolated. They disappear toward the corners of the buccal opening where the skin remains bare. The dorsal plates, the same as

the ventrals, are not very distinctly separated and the back is uniformly covered with small dense spines, extremely fine and tubercular.

Color yellowish. Dimension: total width 34 mm.

Inhabits the sea of the Indies, the Cape of Good Hope.

5. PENTAGONAL ASTRODISCUS. *ASTERISCUS PENTAGONUS*. — Müller and Troschel (Sp.).

— Seba, Thesaur. p. 5 f. 19 (Copied in Encycl. méthod., pl. 100, f. 3).

Body pentagonal with five arms slightly or not protruding from the disk whose edge is sharp and folded on the ventral surface that is concave. The spines of the ambulacral groove form a single row and are two on each plate. Each plate of the ventral surface has a single small spine, but on the side of the row of the ambulacral groove is another row of larger spines. The dorsal plates have numerous spines.

Color reddish and dotted above, bluish below. Dimension: width 27 mm.

Inhabits the Red Sea and the sea of the Indies.

7. BRISTLY ASTERISCUS. *ASTERISCUS PENICILLARIS*. — Müller and Troschel (Sp.).

— *Asterias penicillaris*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. . — *Asteriscus penicillaris*, Müller and Troschel Syst. der Aster., p. 42, pl V, f. 1.

Species with five arms having two and a third the length of the smallest radius of the disk, the interval that separates them is angular. The spines of the ambulacral groove form a bundle on each plate, and three of them are inserted on the very edge of the groove. Each ventral plate has a dense tuft of eight to fifteen cylindrical spines. The dorsal plates hare from thirty to sixty much shorter and denser spines forming a kind of brush. The tentacular pores form numerous rows approaching the edge much more than in the other species. Often, they are also grouped in a way to have the appearance of a tentacular area. However, more usually there are small tufts of spines between them.

Color bluish above with blue spines. Dimension: width 67 mm.

Inhabits the Red Sea and the sea of the Indies (Mus. Berlin).

5. SOUTHERN ASTERISCUS. *ASTERISCUS AUSTRALIS*. — Müller and Troschel.

— *Asterina calcar*, and *A. gunnii*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 289–290. — *Asteriscus australis*, Müller and Troschel Syst. der Aster., p. 43.

Species having ordinarily eight or rarely nine arms pointed at their end whose length from the center is twice the smallest radius of the disk. The ventral surface is flat, the opposite surface, convex, lowering little by little toward the edges that are sharp. The spines of the ambulacral groove are two or four on each plate. A cylindrical spine is found on each plate of the ventral surface and the dorsal plates have numerous spines that are short and cylindrical, in transverse groups.

Color varied patches of green, yellow, red and blue above, these patches having the form of small circular arcs. The ventral is blue. Dimension: width 40 mm.

Inhabits Australia, Tasmania (Mus. Paris).

9. SPUR ASTERISCUS. *ASTERISCUS CALCAR*. — Lamarck (Sp.).

— *Asterias calcar*, Lamarck.

Lamarck, in establishing his *Asterias calcar*, had confused under this name several species that have been distinguished, correctly, by Müller and Troschel, but it should remain as the type of the Lamarckian species, variety B reported by this author.

10. DIESING'S ASTERISCUS. *ASTERISCUS DIESINGII*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 43.

Pentagonal species with six or seven arms scarcely protruding from the disk. The plates of the ventral surface have two small spines, but toward the central plates there are three. On the dorsal plates are small tufts of eleven to twelve species, and sometimes even more.

Color is yellowish in the dry state. Dimension: width 54 mm.

Inhabits ? (Mus, de Vienna).

11. SCARLET ASTERISCUS. *ASTERISCUS COCCINUS*. — Müller and Troschel.

— *Asteriscus coccinus*, Müller and Troschel Syst. der Aster., p. 43.

Species with pyramidal body, membranous, with five thin arms blunt at the end. The ventral plates have radiating groups of small plates. The dorsal plates are of two kinds: Some have one semi-lunar row of small bundles of spines, the others have irregularly rounded bundles between these.

Color scarlet red. Dimension: 64 mm.

Inhabits the Cape of Good Hope.

12. BRISTLY ASTERISCUS. *ASTERISCUS SETACEUS*. — Va.

— *Asteriscus setaceus*, Valenciennes, Coll. du Mus. Paris. — Müller and Troschel. Syst. der Aster., p. 43.

Species with five arms whose length from the center equals two and a half times the shortest radius of the disk. The spines, five on each plate, form a single row near the ambulacral groove. The two surfaces that are separated as usual by a sharp edge are covered with bundles of very small spines that are very numerous, extremely fine and silky, but do not form a row.

Color yellowish, paler below after drying. Dimension: width 121 mm.

Inhabits ? (Mus. de Paris).

13. LOZENGE ASTERISCUS. *ASTERISCUS TROCHISCUS*. — Müller and Troschel.

— *Asteriscus trochiscus*, Retzius, Dissert. de Stell., p. 10.— Müller and Troschel, Syst. der Aster. p. 10.

Body pentagonal. Spines of the ambulacral groove are three or four on each plate. The ventral plates are granular and have, in addition, two small spines. Those of the back are covered with dense granules without spines. Pincer pedicellariae between the dorsal plates/

Color yellowish. Dimension: 15 mm.

Inhabits the seas of the Indies

14. OLD ASTERISCUS. *ASTERISCUS ANTIQUUS*. — Forbes.

— *Asterias antiqua*, Hisinger, Lethæa suecica, p. 88, pl. 26, f. 6. — *Palmipes antiquus*, Forbes, Mém. géol. Surv.,t. II, p. 477. — *Id. Id.*, Pictet, Traité de Paléont., pl. 98, f. 4.

Fossil of the Green Sandstone of Gothland, Sweden.

16th GENUS. **OREASTER.** *OREASTER*.— Müller and Troschel.

(οροσ, mountain; αστηρ, star.)

— *Pentaceros*, Linck, Gray. — *Goniaster* (pars), Agassiz. — *Nidorellia*, Gray.

Body thick, divided into five branches. Ventral surface flat, dorsal surface of the disk and the arms more of less raised in the form of a mountain. The arms equally raised in the middle in the form of a keel, more or less triangular or very convex. Two rows of granular plates accompany the edge that, however, is formed by a single upper row so that the lower row is entirely located on the ventral surface. The rest pf the body is covered with larger or smaller plates that, as well as the lateral plates, are simply granular or have, at the same time, tubercles more or less similar to spines but are very robust. The areas with tentacular pores, between the plates of the back, are granular with numerous pores.

The pedicellariae are sessile, valvular or pincer. The anus is sub-central.

1. RETICULATED OREASTER. *OREASTER RETICULATUS*. — Müller and Troschel.

— *Stella reticulata sive cancellata*, Rondelet, Aquat. p. 122. — *Pentaceros gibbus*, *reticulatus* and *lentiginosus*, Linck, pl. 23 and 24, no 33, and pl. 41 and 42, n° 72. — Seba, Thesaurus, pl. 7, n° 1 and pl. 8, n° 1. — *Asterias reticulata*, Linné, Gmel. Syst. nat., p. 3163. — *Asterias pentascyphus* and *A. reticulata*, Retzius, Dissert. de Stell., p. 24 and p. 14.— *A. reticulata*, Lamarck, An. s. vert., t. III, p. 243. — Encycl. méthod., p. 100, f. 6-7-8. — *A. sebae,* de Blainville, Mém. d'Act., p.238. — *Pentaceros grandis, P. reticulatus* and *P. gibbus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 277. — *Oreaster reticulatus*, Müller and Troschel, Syst. der Aster., p. 45, pl. III, 112.

Body with five arms whose length equals two and a third times the smallest radius of the disk. Dorsal surface very convex. Spines of the ambulacral groove in a single row, six on each plate, of which the two intermediaries are the largest. There are, in addition, at the edge of the groove, a double row of larger spines, each corresponding to six of the spines of the first row. Granulation of the ventral surface is much greater than that of the back. On the granular plates are raised isolated tubercles that are short and in the form of spines that can be more or less thick and arranged in oblique rows going from the groove to the edge. This border is sharp and formed by the dorsal marginal plates. Each arm has sixteen to twenty of these plates that are a little larger than the others and whose uppers have large tubercles that are conical, pointed or blunt and of various sizes according to individual. On the back is an irregular network with triangular meshes formed by a framework of calcareous pieces whose nodes have tubercles similar to those of the edge. These tubercles do not contribute to the granulation of the back that stops abruptly at their base or goes up to half their height. All the meshes have numerous tentacular pores. On the ventral surface are small valvular pedicellariae nearly the same size as the granules. With the aide of a magnifying glass, we also distinguish some smaller and narrower ones on the dorsal surface between the tentacular pores.

Color brownish after drying. Dimension: total width up to 325 mm.

Inhabits the east coasts of America.

2. RELATED OREASTER. *OREASTER AFFINIS*.— Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 46.

Species very similar to the preceding from which it differs by the following characters: the internal spines of the ambulacral groove are nine to twelve on each plate and form by their union a kind of pointed lamella. Those of the second row are thick, flat, not very protruding, two or three on each plate. Sometimes also another row of similar spines is found outside. On the ventral surface are only small groups of large granules without spines. The ventral marginal plates are part, like the dorsals, of the edge. Both have short tubercles whose base is covered with granules. We count seventeen on each arm. The dorsal surface is similar to that of the preceding species but the tubercles of the network, toward the middle of the disk, form some elevated cones of which five, arranged in a circle, surround smaller tubercles. The large cones are in large part covered with granules, but their blunt end is bare or sometimes replaced by several blunt points on the same cone.

Color yellowish. Dimension: total width 325 mm.

Inhabits the seas of India (Mus. Vienna).

3. CHINESE OREASTER. *OREASTER CHINENSIS.* — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 46.

Species with five arms whose length from the center equals two and two-thirds times the smallest radius of the disk. Spines of the ambulacral groove number six on each plate and are very small and hidden in the groove. Outside them is a second row of spines that number three on each plate and correspond to the large spines in *Oreaster reticulatus.* Further outside is a third row that merges sometimes with the granulation of the ventral surface. The plates of this same surface are so close together that we see with difficulty the limits between them. They are, in addition, finely and uniformly granular. The marginal plates are larger than all the others. It is not the dorsal ones, as in *O. reticulatus*, but the ventrals that have the large conical tubercles. On the dorsal marginal plates, we see only some, particularly in the interval of the arms. In general, all the tubercles are proportionally small, and it is only at the top of the back that we see five large tubercles in a circle around a central tubercle, of which each corresponds to one of the arms.

The granulation of the dorsal surface is a little finer than that of the opposite surface and the granules that we see in the triangular areas with tentacular pores are a little larger than those on the protrusion of the network.

The valvular pedicellariae of the ventral surface are as large as the granules but we do not see them on the back.

Color whitish in the dry state. Dimension: total width 162 mm.

Inhabits the seas of China (Mus. Levden).

4. WARTY OREASTER. *OREASTER TUBERCULATUS.* — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 46.

Species with five triangular arms whose length from the center equals two and a half times the smallest radius of the disk.

Spines of the ambulacral grow in one row, five to six on each plate, those of the middle being larger. Outside these is a row of flattened spines, several on the same plate and that greatly exceed the preceding. The granules on the ventral surface are much larger than on the back, without larger spines nor tubercles. The marginal plates are seventeen in number on each arm and are distinguished by their size. Only the ventral ones have conical tubercles that, however, are missing sometimes. On the dorsal surface is a network of granular protrusions forming a kind of irregular mesh. On only some nodes of this network are raised irregularly large conical tubercles on the keel of the arms. These tubercles ordinarily form a very apparent row, The conical base of the tubercles is granular up to a height equal to the blunt or pointed tubercle that rests on it. On the ventral surface are valvular pedicellariae of the same size as the granules.

The marginal plates also have similar pedicellariae. Only, exceptionally, one of these plates is extended into a tubercle, pedicellariae are lacking. On the dorsal surface, the nodes of the network that do not have tubercles have one or several of these pedicellariae that are more valvular than pincer.

Color yellowish brown. Dimension: total width 216mm.
Inhabits the Red Sea.

5. OREASTER WITH TURRETS. *OREASTER TURRITUS*. — Müller and Troschel.

— *Rumphius*, pl. 15, f. A. — Petiver, Gazoph., I, pl.2, f. 6. — *Pentaceros turritus*, Linck, pl. 2, 3, no 3. — Copied Encycl. méthod., pl. 105.— *Asterias nodosa* , Linné , Gmel., Syst. nat., p. 3163. — *Asterias nodosa*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 243. — *Pentaceros turritus* and *P. franklinü*, Gray, Ann, and Mag. of nat. Hist., t. VI, p. 276. — *Oreaster turritus*, Müller and Troschel. Syst. der Aster., p. 47,

Species very similar to the preceding by all its characters but differs by some points. The spines of the ambulacral grooves are eight or nine on each plate, those of the middle being larger. Those of the external row are flat and three or four on each plate. The ventral surface is covered with granules of notable size, pentagonal and unequal that we see again on the marginal plates. On the back, the granules are flat where they cover the large tubercles, but all the rest of the back has granules that are protruding conical, more or less large. The marginal plates, twenty on each arm, are simply granular without tubercles nor pedicellariae. The large tubercles form on the arms a single row, but on the rest of the back the are irregularly scatter and sometimes contiguous at their base. The nodes of the dorsal network are surrounded by granules up to their top, from which a small, smooth point sometimes rises. The granules are plates, pentagonal, more or less small toward the base and elongated above. On the ventral surface we see with the aid of a magnifying glass some small valvular pedicellariae that are more distinct and more numerous near the ambulacral groove. The areas with tentacular pores have small and rather long pincer pedicellaria. Between each pair of lamellae of the pincers of the ambulacral groove is a pincer pedicellariae.

Color red, with black tubercles, as well as the point of the arms. Dimension: total width 270 mm.

Inhabits the sea of the Indies (Mus. Paris).

SPINY OREASTER. *OREASTER MURICATUS*. — Nobis.

— *Pentaceros muricatus,* Linck, t. 7, no 8. — *Asterias linckii*, Blainville, Man. Act., p. 238. — *Pentaceros muricatus*, Gray, Ann. and Mag. of nat. Hist., 1842, p.

Inhabits the seas of India.

6. YAWNING OREASTER. *OREASTER HIULCUS*. — Müller and Troschel.

— *Pentaceros hiulcus* and *P. gibbus*, Linck, pl. 26, f. 41. — Copied Encycl. méthod., pl. 106, f. 2. — *Pentaceros hiulcus*, Gray, Ann. and Mag. of nat. Hist., t. VI p. 276. — *Oreaster hiulcus*, Müller and Troschel, Syst der Aster., p. 48, pl. IL, f. 3.

Species of the same general form as the preceding but having six internal spines on the plates in the ambulacral groove, of which the intermediary is longest. More outside, on each plate, are two or three spines that are thicker and of equals size. There are 17 to 18 marginal plates on each arm. The dorsal side of the arms is raised into a tall keel with four to five very large and thick tubercles. The largest of these tubercles form a kind of pentagon on the disk, itself nor having anything. The areas with tentacular pores are very large. The granules of the ventral surface are as in the preceding species but those of the back are very different. The granules that cover the tubercles up to very near the terminal point are pentagonal, flat, large, but not elongated. Here and there in their midst are some that are larger, rounded, surrounded by a circle of smaller ones. The plates of the back and the areas with tentacular pores are covered with flat granules, between which are some others that are much smaller. Bivalve pedicellariae that are smaller than the large granules are on the ventral surface near the groove. Those of the dorsal surface, visible with a magnifying glass, in the areas with tentacular pores are rarer and pincers. Finally, the cross beams of the network are still fewer.

Color uniform brown. Dimension: total width 162 mm.

Inhabits the sea of the Indies. (Mus. Paris).

7. MAMELONATED OREASTER. *OREASTER MAMILLATUS*. — Müller and Troschel.

— *Asterias mamillata*, Audouin, Expl. des planches de l'ouvrage d'Egypte, p. 209, Savigny, Échinod., pl. 5. — *Oreaster mamillatus*, Müller and Troschel. Syst. der Aster., p. 48.

Species of the same form as *Oreaster reticulatus*, having two rows of spines in the ambulacral groove. Those of the internal row are six in number on each plate and form a kind of lamella in which those of the middle are longest. The external row is form of two to four thick spines on each plate. The ventral plates are not very distinct, grossly granular with some larger granules as we also find on the lower marginal plates. The dorsal marginal plates have granular, conical tubercles at the base. There are 48 to 49 plates on each arm. On the nodes of the dorsal network are numerous, isolated conical tubercles that are not very large that distinguish this species from *O. turritus*. The granular part of the base of these tubercles exceeds that of the end that is smooth, conical and usually sharp. On the dorsal keep of the arms, the spines are a little larger, fifteen forming a row. In the middle of the disk are five tubercles in a circle.

Color reddish brown. Dimension: total width 325 mm.

Inhabits the Red Sea.

8. WARTY OREASTER. *OREASTER VERRUCOSUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 49.

Species very similar to *O. turritus* except for the marginal plates and pedicellariae. The dorsal and ventral marginal plates each have a short tubercle and lack pedicellariae.

The protuberances of the dorsal network are raised here and the with similar small tubercles. These tubercles are larger on the keel of the arms as well as the five in the idle of the disk. The tubercles of the keel of the arms also have a conical, granular base that fills two-thirds or three-fourths of their height. The end alone is bare and blunt. Bivalve pedicellariae are found here and there on the parts of the dorsal network that lack tubercles as well las between the keel and the edge of the arms.

Color red above. Dimension: width 108mm.

Inhabits the sea of the Indies (Mus. de Vienna).

9. CLUB-BEARING OREASTER. *OREASTER CLAVATUS*. — Müller and Troschel.

— Crowned star-fish, Grew. Mus., pl. 8, f. 1. — Seba, Thesaurus, pl. 6, f. 1–2, pl. 5, f. 7–8. — *Oreaster clavatus*, Müller and Troschel. Syst. der Aster, p. 49.

Species with five arms, having three spines on each internal plate of the ambulacral groove, those of the middle being a little longer. The external spines are very thick, blunt, longer than the internals and isolated on each plate. The granular plates of the ventral surface are raised into a short, very thick tubercle as long as wide and appearing truncated at the top. The dorsal marginal plates, eleven on each arm, are much wider and have two to three tubercles one above the other in going from the ventral surface to the dorsal. The plates of the back also have similar tubercles that are short, think that appear to emerge bare from the granulation. On the keel of the arms are regularly disposed wider plates equally the marginals and having three to six tubercles in the form of pearls that, without conical bases, emerge directly from the surface of the convex plates. The fine granules of the back and belly are equal. There are no bivalve pedicellaria.

Color yellowish, browning above. Dimension: total width 408 mm.

Inhabits ? (Mus. de Vienna).

10. KEELED OREASTER, *OREASTER CARINATUS*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 49.

Species with five arms, have plates each with five to six spines in the ambulacral groove. Those of the second row being isolated, thick and shorter than the others.

Short and thick tubercles rise in the middle of the granules that cover the ventral surface. There is one on each plate. The marginal plates are not very distinct. Each has a tubercle that is short and blunt. The dorsal surface has similar tubercles whose pyramidal base alone is covered with granules. The short, rounded end is bare. The plates of the keel of the arms ar wider and ordinarily have two or three tubercles that are close together.

Color yellowish. Dimension: width 60 to 100 mm.

Inhabits the Adriatic sea ?

12, POINTED OREASTER. *OREASTER ACULE*ATUS.— Müller and Trosche.

— Seba, Thesaurus, IL, pl. V, f. 5–6. — *Pentaceros aculeatus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 277.

Species with five arms whose length is twice the radius of the disk. Spines of the ambulacral groove in two rows. Those of the internal row, four or five on each plate, form by the union, a kind of lamella. Those of the external row, larger, a little flattened, pointed are isolated on each plate. The plates of the ventral surface are convex coarsely granular and have in the middle, one or several larger granules. The ventral marginal plates have nearly the same appearance but toward the end of the arms, the largest granules rise in the form of spines. Each plate thus has one or several. The dorsal marginal plates, thirteen on each arm, are uniformly granular. Most of them are raised into a conical spine that extends above the granules. The plates of the back, more finely granular than the ventrals, are raised into spines also for the most part. The areas with tentacular pores are also granular and contain only a small number of pores.

Color pale brown. Dimension: total width 81 mm.

Inhabits the seas of America.

13. BLUNT OREASTER. *OREASTER OBTUSATUS*. — Müller and Troschel.

— *Asterias obtusata*, Lamarck, Encycl. méthod., pl. 103. — *Oreaster obtusatus*, Müller and Troschel. Syst. der Aster., p. 50,

Species with five arms whose length is triple the smallest radius of the disk. The back is convex and the intervals that separate the arms are notched. The spines of the ambulacral groove form three rows. Those of the internal row are small, a little flattened, five to seven on each plate. Others, three or four, are shorter and thicker, equally flat. Those of the external row, three on each plate, are still shorter. The ventral plates are covered with granules that are polygonal, very depressed, enlarged, but decreasing toward the edge. The ventral marginal plates belong completely to the ventral surface, sometimes having at the edge small tubercles and at the same time coarsely granular although finer than the rest of the ventral surface. Between these plates, in pairs, is intercalated a row of four to five small plates. The dorsal marginal plates, eighteen on each arm, are obviously protruding in the terminal half of the arms. They are raised in the form of a cone and have smooth tubercles at their top. In the corners that separate the arms, other plates have tubercles that are raised between these plates so that they form a distinct row. They are only half as large as the ventral marginal plates. The plates of the back are smaller and in part raised in the form of small balls. All have, in addition, non-granular tubercles. The granules of the back are similar to that of the ventral marginal plates. Between the spine of the ambulacral groove and the paired plates is a large pincer pedicellariae approximately two times as long as wide. All the other pedicellariae are bivalve. There are several different sizes on each plate in the area of the ambulacral grooves. They are small on the back and nearly two times as large as the granules.

Color yellowish. Dimension: total width 216 mm.

Inhabits the coasts of Mauritius (Mus, Paris).

14. OREASTER WITH OBTUSE ANGLES. *OREASTER OBTUSANGULUS*. Müller and Troschel.

— *Asterias obtusangula*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 243. — *Oreaster obtusangulus*, Müller and Troschel. Syst. der Aster., p. 51.

Species with five arms whose length from the center is double the radius of the disk and that are a little longer than wide, blunt at the end and separated by blunt reentrant corners. Spines of the ambulacral groove in two rows. Those of the internal row small, five on each plate. Those of the external are thicker, two on each plate. The ventral surface has some granules that are thick, globular, between which are scattered many bivalve pedicellaria, nearly as long as wide.

The dorsal and ventral marginal plates, twelve on each arm, are covered with dense but very large granules. The first has bivalve pedicellaria. On the back are similar plates that are coarsely granular in the area of the marginal plates. The largest part of the back however, lacks these plates and only has rare smooth and globular tubercles that, in the middle of each arm, are arranged in rows.

Color reddish brown. Dimension: total width 162 mm.

Inhabits Mauritius.

15. ROYAL OREASTER. *OREASTER REGULUS*. — Müller and Troschel.

— *Oreaster regulus*, Müller and Troschoel. Syst. der Aster., p, 91.

Species with five arms whose length from the center equals two and a half times the smallest radius of the disk. Back convex. Spines of the ambulacral groove are nine on each plate and form a kind of triangle, those of the middle being much longer than the others. Outside is a row of spines that are a little larger and flattened. There are two or three on each plate. This row doubles sometimes, especially toward middle part of the arms. Among the irregular granules of the ventral surface are many tubercles that are globular or cylindrical.

The marginal plates, twenty-two on each arm, are large and have blunt tubercles that, on the dorsal row, are larger and isolated while on the ventral, they are often multiple and grouped.

The ventral plates in the intervals of the arms are smaller than those of the sides of the arms. The plates of the back form a network whose nodes are raised in regular rows following the direction of the arms and have tubercles like the marginal plates.

Between each group of spines of the ambulacral groove is a larger pincer pedicellaria. On the ventral surface, there is also many bivalve pedicellariae, small and large, these having approximately a millimeter and a half. On the ventral marginal plates, they are rather numerous and the size of the granules. On the contrary, they are rare on the dorsal marginal plates, on the protruding crossbeams of the back as well as in the areas with tentacular pores that contain very numerous pores.

Color yellowish brown in the dried state. Dimension: total width 270 mm.

Inhabits the coast of India, at Pondichéry (Mus. Paris).

16. OREASTER WITH NODES. *OREASTER NODOSUS.* — Müller and Troschel.

— *Pentaceros nodosus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 277. — Seba, Thesaurus, pl. V, f. 11–12.— *Oreaster nodosus*, Müller and Troschel. Syst. der Aster., p. 92.

Species near the preceding, having the back covered with protruding plates in irregular rows. Arms number five with a double row of hemispherical tubercles on the dorsal part. Marginal plates unequal, the ventral having a small tubercle that is conical and blunt.

Inhabits the coasts of Mauritius.

17. ARMED OREASTER. *OREASTER ARMATUS*. — Müller and Troschel.

— *Pentaceros armatus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 277. — *Oreaster armatus*, Müller and Troschel, Syst. der Aster., p. 92.

Species having the back covered with granular plates, each in middle has a blunt mobile spine. Arms short and wide. The ventral marginal plates, most particularly the last three, have at the top a short, blunt spine. The dorsal surface has groups of spines either in the center or on the sides, as well as a row on each arm.

Inhabits St. Helena.

18. ORIENTAL OREASTER, *OREASTER ORIENTALIS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster. Nachtr., p. 128.

Species have five arms that are robust and triangular. Spines of the ambulacral groove in three rows. The first, with nine on each plate, the intermediaries being longer and a pince pedicellaria between each of the groups. The spines of the second row are five and have the same disposition. Finally, those of the external row, two or three on each plate, are compressed. The ventral surface is coarsely granular and has many small bivalve pedicellariae.

The marginal plates are more finely granular. In the reentrant angles of the arms, the dorsal and ventral marginal plate has short and conical spines. The ventral marginal plates, toward the end of the arms, also have some similar spines, twenty on each arm, and in addition small bivalve pedicellariae. The dorsal surface is finely granular. The nodes of the network formed by the protrusion of the dorsal plates are raised in conical points covered with granules except at the top that is sharp. It is mainly on the disk itself that these points occur, among which we distinguish five forming large, conical tubercles arranged in a pentagon around the center. On the back are here and there small bivalve pedicellariae.

Color brownish. Dimension: 490 mm.

This species is very near *Oreaster reticulatus*.

Inhabits the seas of China.

19. VALVULAR OREASTER. *OREASTER VALVULATUS*, — Müller and Troschel.

Müller and Troschel, Weigm. archiv, 1844, f. 115.

Species with five arms whose length from the center equals two and a half times the smallest radius of the disk. Their intervals are deeply notched. The dorsal part is swollen. The spines of the ambulacral groove are in two rows. Those of the internal row, nearly equal, are nine on each plate. Those of the external row are thicker, three on each plate, and attached to large granules of the ventral surface. The plates of this surface are all coarsely granular and have large bivalve pedicellariae, length more than four millimeters. Similar pedicellariae also occur on all the marginal plates, fifteen for each arm, that are more finely granular and whose dorsal ones have each several short, blunt tubercles. The ventral marginal plates have only some traces of tubercles toward the end of the arms.

The granules of the back are finer than those of the ventral surface and on the dorsal plates raised into blunt tubercles whose base is surrounded by granules. At the limit of these granules are large granules that, here and there, develop into accessory tubercles so that each protrusion has several tubercles. On the middle part of the arms are about twenty tubercles forming a kind of row parallel to the other rows but the largest tubercles are on the disk where they form a circle around the center. The small bivalve pedicellariae, a little larger than the granules, are scattered on the dorsal surface.

Color a yellowish brown. Dimension: total width 216 mm.

Inhabits southwest coast of Australia (Mus. Berlin).

20. LAPIDARY OREASTER. *OREASTER LAPIDARIUS*. — Grube.

— Grube, Weigm. archiv, 1857, p. 342.

Species with five short arms, measuring approximately twice the smallest radius of the disk and slightly keeled on their dorsal part. Ambulacral spines in two rows on each side of the groove. The internal rows have on each plate three or four spines that are flattened, blunt, whose median is a little longer than the others. The internal row is composed of isolated spines.

The dorsal surface of the disk is covered with beams that are thick, very short, fusiform or cylindrical and slightly truncated, each with a raised spine. Among these spines we distinguish some larger and oval. The plates of the ventral surface are raised, six rows on each side of the ambulacral groove and toward the bae of the arms, while toward their end there are only three. These plates are, in addition, covered with a large number of very small granules, among which we distinguish two to five larger. Bivalve pedicellariae are in the intervals of the plates.

Color yellowish. Dimension: total width 160 mm.

Inhabits ?

21. DESJARDIN'S OREASTER. *OREASTER DESJARDINSII*. —

— Michelin, Revue zool., 1844, p. 173, and Mag. de Zool., 4845, p. 23, pl. 11.

Small species with five arms that are slender, cylindrical, elongated whose length is four or five times the smallest ray of the disk. Spines of the ambulacral groove very short and very numerous, flattened and like fascicules. The dorsal surface of the disk is covered with plates surmounted by an agglomeration of small, round tubercles in the middle of which rise some more elevated. These groups are separated from each other by holes or very deep depression in which the tentacular pores are located. The ventral surface is covered with plates that have very fine granules, bordering exteriorly five longitudinal grooves with numerous small papillae that are compressed and that seem to form small fascicules. The madrepore plate is rounded, granular and located very near the edge opposite the brachial interval.

Color whitish. Dimension: total width 5 cm.

Inhabits Mauritius.

This species is remarkable among all its congeners for its slender, elongated form, the elongation of its arms and the shortness of its disk, so that we would be tempted to refer it to another genus. But the form and arrangement of its plates and especially their ornamentation remove any doubt in this regard.

Gray (Ann. and Mag. of nat. Hist., 4840, p. 276) describes a species of this genus under the name of *Pentaceros cumingii*, Gray, of St. Helena. It is probably to this same genus that it is necessary to refer *Calliaster childreni*, Gray, (*loc. cit*., n° 414).

FOSSIL SPECIES.

1. *Oreaster coronatus*. — Forbes. — Mém. géol. Surv., t. 2, p. 467. — *Id.*, Forbes, in Dixon geol. of Sussex, p. 21-23-24. Upper Chalk (Senonian) of England.
2. *Oreaster boysii*. — Forbes. — Mém. géol. Surv., t. 2, p. 467, and Forbes, in Dixon, geol. of Sussex, p. 21. Upper Chalk (Senonian) of England.
3. *Oreaster bulbiferus*, — Forbes.—Mém. géol. Surv., t, 2, p. 467, and Forbes, in Dixon geol. of Sussex, p. 22. From the Upper Chalk (Senoniar) of England.
4. *Oreaster obtusus*. — Forbes. — Mém. géol. Surv., t. 2, p. 467, and Forbes, in Dixon geol. of Sussex, p. 22. From the Upper Chalk (Senonian) of England,
5. *Oreaster ocellatus*. —Forbes. — Mém. geol. Surv., t. 2, p. 467, and Forbes, in Dixon geol. of Sussex, p. 22. From the Upper Chalk (Senonian) of England.
6. *Oreaster pistilliformis*. — Forbes.— Mém. géol. Surv., t. 2, p. 467. — *Id.*, Forbes, in Dixon geol. of Sussex. From the Upper Chalk (Senonian) of England.
7. *Oreaster squamatus.* — Forbes. — Mém. géol. Surv., t. 2, p. 467. — *Id.*, Forbes, in Dixon geol. of Sussex, p. 23. From the Upper Chalk (Senonian) of England.

17th GENUS. **ASTROGONIA**,. *ASTROGONIUM*.— Müller and Troschel.

— *Goniaster* , Agassiz. — *Hippasterias, Goniaster, Pentagonaster* and *Tosia*, Gray.

Body pentagonal, flattened above and below, with two rows of marginal plate larger than all those of the back and belly and concurrent with the formation of the edge. These plates are surrounded by a crown of granules. Although their contour is granular, the rest of their surface is smooth. Sometimes they have in the middle a larger isolated tubercle. The ventral and dorsal surfaces are paved with plates irregularly arranged, between which are narrow, granular spaces with tentacular pores with or without pedicellariae. Anus subcentral.

1. PHRYGIAN ASTROGONIA. *ASTROGONIUM PHRYGIANUM*.— Müller and Troschel.

— *Pentaceros planus seu Oxyceros*, Linck, p. 21, t. 22, n° 21, and *Pentaceros macroceros,* Linck, t. 33, n° 53. — Copied Encycl. méthod., pl. 101 and 102.— *Asterias phrygiana*, O.F. Müller, Prodr. Zool. Dan., p.234. — *Id. Id.*, Linné, Syst. nat., édit. Gmelin, p. 3163. — *Asterias equestris*, Gmelin ? — *Id. Id.*, Lamarck, An. s. vert., 2e édit., t. III, p.242. — *Id. Id.*, Fleming, Brit. Anim., 485. — *1d. Id.*, Jameson, Wern. Mém.I, p. 559. — *Goniaster equestris*, Agassiz, Prodr. in Ans. sc. nat., f, p. 441.— *Id.Id.*, Forbes, Brit. Starf., f. 125-127. — *Hippasteria europaea*, Graay, Ann. and Mag. of nat. Hist., 1840, p. 279. — *Asterias johnstonii*, Gray, Johnst. Mag. nat. Hist., t. IV, p. 146, f. 21, (non Delle Chiaje). — *Hippasteria johnstonii*, Gray, Ann. and Mag. of nat. Hist., 1840, p. 279. — *Astrogonium phrygianum*, Müller and Troschel. Syst. der Aster., p. 52. — *Id. Id.*, Duben and Koren, Zoo!. Bidrag, p. 246, — *Id. Id.*, Duben and Koren, Mém. Acad. Stockholm, 1844, p. 246, no 26.—*Hippasteria equestris*, Gray, Cat. Brit. radiata, p. 24, n° 1.

Species with five pointed arms whose length from the center is more than double the smallest radius of the disk. Spines of the ambulacral groove large, thick, nearly cylindrical or a little flattened, forming three rows that in length outside. The spines of the external row are equally tall, two or three on each plate. Those of the two other rows are isolated. The plates that have these spines have on their extern and transverse edges, a band of granules that is missing on the internal edge. The ventral surface has two kinds of plates. Some have three tubercles that are short, cylindrical, a little longer than wide, rounded at the end, and all surrounded by a row of thick granules. The other plates that are larger have in the middle a very large bivalve pedicellaria whose valves, two times longer than wide, has two millimeters. The plates have at the same time two rows of tubercles similar to the preceding and ordinarily three on each row. The edges without tubercles have a row of irregular granules that are contiguous with the row of the adjacent plate, with an interval. The marginal plates, twenty on each arm, are a little larger than the dorsal and ventral plates and decrease toward the end of the arms where they are very small. They have on their smooth part. limited by a border of granules, one, two or three cylindrical tubercles similar to those of the ventral surface but a little larger and one and a half or two times as long as wide. The dorsal surface of the arms is uniformly covered with small plates bordered with

granules smaller than on the ventral surface and having in the middle of their smooth part a cylindrical tubercle elongated or truncated at the end, a little smaller than those of the marginal plates. Some of these plates, instead of having a central tubercle, have a bivalve pedicellaria half smaller than those of the ventral surface. The granules of the back, toward the middle of the disk, are generally larger than towards the circumference. The madreporite plate is nearly equal distance between the center and the edge.

Color pale red or scarlet. Dimension: total width 216 mm.

Inhabits Atlantic Ocean and the northern seas of Europe (Mus. Paris).

2. MAGNIFICANT ASTROGONIA. *ASTROGONIUM MAGNIFICUM*. — Müller and Troschel.

— Müller and Troschel. Syst, der Aster., p.53, pl. IV, f, 1.

Body pentagonal, with the sides strongly notched. The arms are five in number, whose length equals one and a half times the smallest radius of the disk. The spines of the ambulacral groove form a thick and compact band on each side, the most internal have two or three on each plate. The ventral plates are polygonal and only surrounded by granules toward the edge. Near the groove and toward the end of the arms are here and there granular plates. The marginal plates are wider than long. There are eight dorsals and nine ventrals. They decrease toward the end of the arms. Those of the ventral side are a little convex and are not more protruding than the other ventral plates. The dorsal marginal plates are generally more convex. The dorsal plates, being closer to each other, are bare and simply surrounded by a circle of fine granules. On the middle of the back is a plate surrounded by five others, corresponding to the arms and further on, in the middle of small irregular plates, are five larger and round ones that form a pentagon and correspond to the intervals of the arms.

Immediately outside is the madrepore plate, closer to the center than the edge. On the arms, the plates form longitudinal rows and become smaller near the edges. No pedicellariae.

Color brownish. Dimension: total width 54 mm.

Inhabits the coasts of Tasmania.

3. ASTROGONIA OF THE ASTROLOG. *ASTROGONIUM ASTROLOGORUM*. — Müller and Troschel.

— Müller and Troschel. Syst, der Aster., p. 54.

Body pentagonal with the sides a little notched. Spines of the ambulacral groove in two for each plate. Ventral plates small, bare, surrounded by a role of granules. Ventral marginal plates very large, five for each arm, penultimate being smaller and the last still smaller. Dorsal marginal plates, three in number, of which the very large last one corresponds to the three last ventrals. All are smooth in the middle and surrounded by a single border of granules. Dorsal plates flat or slightly convex, smooth in part and also surrounded by a border of granules. A row of these plates, larger than the others, is directed

toward each reentrant angle between the arms. It is in one of these rows, between the largest plate and the two that follow it the madrepore plate is located. No pedicellaria.

Color brownish. Dimension: 54 mm.

Inhabit the coasts of Australia. (Mus. de Paris).

4. GEOMETRICAL ASTROGONIA. *ASTROGONIUM GEOMETRICUM*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 54.

Body completely pentagonal with rectilinear sides. Ventral surface with very numerous granules. Adjacent plates of the ambulacral groove are complete granular and the others have only a single border of granules. Dorsal marginal plates number three, of which the last is a little larger. Only two ventral marginal plates. The plates of the back are similar to those of the preceding species but are generally less distinct.

Color brownish. Dimension: 27 mm.

This species, very near the preceding, is distinguished first by its completely pentagonal form, its sides being less notched, and also by the number of marginal plates.

Inhabits the Indian Ocean (Mus. de Paris).

5. PRETTY ASTROGONIA. *ASTROGONIUM PULCHELLUM*. — Müller and Troschel.

— *Pentagonaster pulchellus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 280. — *Steçhanaster elegans*, Ayres, Proc. Boston Soc., IV. — *Astrogonium pulchellum*, Müller and Troschel. Syst. der Aster. p. 55.

Body pentagonal, having five arms whose length equals five and a half times the smallest radius of the disk. Spines of the ambulacral groove equal, forming two rows that completely fill the groove. Ventral plates smooth, each surrounded by a border of thick granules and nearly all having a small arc that corresponds to the location of a pedicellaria and contains two or three calcareous pieces capable of moving and getting closer together. Marginal plates, either ventral or dorsal, are three on each arm. They are very large and surrounded on their periphery by a circle of granules. They increase in size toward the end of the arms so that the last is two times as long as those in the re-entrant angle between the arms. The dorsal surface is convex with plates that are smooth, convex, more or less large and surrounded by a border of granules on each arm. There is a longitudinal row of them that are a little larger. The madrepore plate is nearly as far from the center as from the edge.

Color brownish. Dimension: width 108 mm.

Inhabits the coast of New Zealand (Mus. de Paris).

6. SOUTHERN ASTROGONIA. *ASTROGONIUM AUSTRALE*.— Müller and Troschel.

— *Tosia australis*, Gray, Ann. and Mag. of nat. Hist., t, VI, p . 281.— *Astrogonium australe*, Müller and Troschel. Syst. der Aster., p. 55.

Body pentagonal, with five arms whose length equals one and a half the radius of the disk. Ambulacral grooves bordered with a compact band of spines. Ventral plates polygonal, entirely granular. Dorsal marginal plates, six on each arm. There are eight ventrals, wider than long, bare and surrounded only by a border of granules. These plates decrease gradually toward the end of the arms. The dorsal plates are also bare, with a border of granules and obviously flattened. Small bivalve pedicellariae of the same size as the granules are here and there on the back, very near the border of granules on the plates.

Color brownish. Dimension: width 108 mm.

Inhabits Australia (Mus. Paris).

7. ORNATE ASTROGONIA. *ASTROGONIUM ORNATUM*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 55.

Body pentagonal, slightly notched on the sides. Spines of the ambulacral groove in two rows, two on each plate for both. Near the groove is a row of small plates, but the other ventral plates are two times wider, and all covered with uniform granules. The marginal plates, five per arm, are very large, smooth, as long as wide, and surrounded by a single row of irregular granules. The dorsal plates become larger near the center and are, like those of the ventral surface, surrounded by a row of irregular granules. All these plates are very close together and leave only very small intervals for the tentacular pores. No pedicellariae.

Color brownish. Dimension: width 54 mm.

Inhabits ? (Mus. de Leyden).

8. LAMARCK'S ASTROGONIA. *ASTROGONIUM LAMARCKII*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 56.

Body pentagonal with deeply notched sides. Spines of the ambulacra are in two rows. Those of the internal row, small, five on each plate. Those of the external row, thicker, only two. The ventral plates are covered with dense and large granules. The marginal plates are strongly convex and smooth. The four most external have cylindrical tubercles approximately one and a half millimeters. The dorsal plates are uniformly granular, each surrounded by a row of larger granules, especially between the tubercles of the back. These tubercles form ten rows, two belonging to each arm. There are five per row. They are thick and rounded above. It is always the second of each row that is the most developed at the same time that toward the end of each double row is a larger tubercle. Toward the center

of the back are three tubercles. The madrepore plate is nearly triangular. It is located approximately a third of the distance from the center toward the edge.

Color yellow brown. Dimension: width 135 mm.

Inhabits the Indian Ocean (Mus. Paris).

9. ASTROGONIA WITH CUSPS. *ASTROGONIUM CUSPIDATUM.* — Müller and Troschel.

— *Pentagonaster semilunatus*, Linck, pl. 23, n° 37, and pl. 24, n° 39, Copied in Encycl. méthod., pl. 97, f. 1–2. — Seba, Thes., 3, pl. 6, f. 9–10. — *Asterias tessellata* (pars), Lamarck , An. s. vert., 2^{e} édit., t. III, p. 238. — *Id. Id.*, de Blainville, Man. Actin., pl. 23, f. 4. — *Goniaster cuspidatus*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 280. — *Astrogonium cuspidatum*, Müller and Troschel, Syst, der Aster., p. 56.

Body pentagonal, with five arms whose length is one and a half times the smallest radius of the disk. Spines of the ambulacral groove equal, forming several rows. Marginal plates all large, very convex, smooth, with a granular borer and a little wider than long. The last of the dorsals alone, five in number, are on the contrary longer than wide. The ventral marginal plates, nine on each arm, gradually decrease toward the end of the arms where they are very small. The ventral plates are polygonal and independent of the general granulation, sometimes have in the middle one or several much larger granules. The dorsal plates are strongly granular, leaving between them narrow intervals in which are the tentacular pores. Many of these plates rise not thick tubercles, nearly cylindrical, truncated at the top, forming regular rows in the direction of the arms. No pedicellariae.

Color brownish (in alcohol). Dimension: width 408 mm.

Inhabits the sea of the Indies (Mus. Berlin).

10. GRANULAR ASTROGONIA. *ASTROGONIUM GRANULARE*. — Müller and Troschel.

— *Asterias granularis*, O. F. Müller, Zoo. Dan., pl, 92. — *Asterias tessellata* (pars), Lamarck, An. s. vert., t. III, 2^{e} édit., p. 238.—*Astrogonium granulare*, Müller and Troschel. Syst. der Aster., p. 57. — *Id. Id.*, Duben and Koren , Mém. Acad. Stockholm, 1844, p. 246, n° 27.

Body pentagonal with notched sides, the largest radius equaling one and half times the smallest. Spines of the ambulacral groove forming two rows, three on each plate. Those of the internal row are more than two times as long as wide, those of the external are also nearly as long as wide. All the ventral plates have eight plates. They are equally granular but with a small bare space opposite the corresponding plate. The dorsal plates are very dense and uniformly granular. Some, rarer, have a smooth space in the middle. The madreporite plate is located a third of the distance from the center to the edge. No pedicellariae.

Color red brown. Dimension: width 40 mm.

Inhabits the northern seas of Europe.

11. NOBLE ASTROGONIA. *ASTROGONIUM NOBILE*, — Müller and Troschel.

— Weigm. Archiv, 1843, p.116.

Body hexagonal, strongly notched on the sides, the longest radius corresponding to the arms, equaling one and two-thirds the smallest. Spines of the ambulacral groove in three rows. The two internals have two and the third have two or three on each plate. More outside is a band of granules that established the passage of a third row. Ventral plates smooth, decreasing in size toward the edges and surrounded by a single border of granules except the most external at the end of the arms that are entirely covered with granules. Four dorsal marginal plates that are very convex, of which the penultimate, the largest, is longer than wide, the last being, on the contrary, the smallest. Seven ventral marginal plates on each side of the arms decrease in size, both surrounded by a border of granules that, some that sometimes make a double row. Dorsal plates smooth, surrounded by a single row of granules and ordinarily raised in the form of a seat. The largest of these plates is from the center in the direction of the re-entrant angles of the arms. A very large first one near the center is followed by two pairs of plates a little smaller. The other plates are arranged in rows on the arms, those in the middle being the most protruding. The madrepore plate is one of the largest unpaired plates of the disk and the one that follows

Color reddish brown. Dimension: width 81 mm.

Inhabits the southwest coast of Australia (Mus. de Berlin).

12. FONK'S ASTROGONIA. *ASTROGONIUM FONK*— Philippi.

— Archiv fur Naturg., 1858, p. 267.

Body pentagonal, convex above, having he largest radius one third larger than the smallest from the center. The interbrachial notches are very pronounced but their contour appears rounded because of the protrusion of the marginal plates in the middle. The number of these plates on each arm is approximately seventeen on each side. They are elongated, i.e., longer than wide in the direction of the arms. They each have one or rarely two short and wide papillae. The ventral surface has approximately six rows of plates similar to those of the edge and unarmed. They are arranged with such regularity that this surface seems paved. The spines of the ambulacral groove are in two rows. The back is covered with plates similar to the belly but they are not regularly arranged. The back has, in addition, not very numerous tubercles, namely: one at the center around whose tubercle are five to six others, sometimes doubles, then six to seven others in the median line of each are and nearly at their end on each side, a row of three to four rubercles. But this disposition is not always regular.

Color dark red. Dimension: width 85 mm.

Inhabits the coast of Chile.

13. SPINY ASTROGONIA. *ASTROGONIUM ACULEATUM.* — BARRETT.

— Barre, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 46, pl. IV, f. 4 to 6.

Body pentagonal with scarcely excavated interambulacral. Arms moderately elongated, circumscribed on each side by nine large marginal plates that are smooth in the middle and with granules on the side and on their external keel a spine that is short, blunt and tubercular. Dorsal surface covered with plates that are circular, small and numerous and arranged in a circle. Ambulacral grooves protected by two rows of large spines. Ventral surface covered with blunt plates, each with six granular globules. These plates form transverse rows.

Color yellowish. Dimension: total wide 30 mm.

Inhabits the seas of the North (Finmark).

14. BOREAL ASTROGONIA. *ASTROGONIUM BOREALE*. — Barrett.

— Barrett, Ann. and Mag, of nat. Hist., 1857, t. 20, p. 47, pl. IV, f.5 to 6.

Disk pentagonal bordered with marginal plates, eighteen on each arm, the top of which being formed by a single triangular plate. These marginal plates are longer than wide especially toward the end of the arms. They are smooth in the middle but covered with granules toward their external edge. Upper or dorsal surface formed of a large number of hexagonal plates, covered with depressed granules with the exception of those of the center that are raised into kinds of tubercles arranged in a circle in the middle from where leave five lines following the direction of the arms and occupying the middle. On the ventral surface, the marginal plates have a single row of very large granules. The ambulacral grooves are bordered with four rows of straight, pointed spines directed toward the groove. The rest of the ventral surface is covered with a large number of small, depressed spines.

Color reddish brown. Dimension: total width 32 mm.

Inhabits the seas of the North (Finmark).

This species resembles by the general form the preceding although the arms are a little more pronounced. It differs especially by the tubercles on the dorsal part of its disk.

15. SPOTTED ASTROGONIA. *ASTROGONIUM PUNCTATUM*. — Lamarck (Sp.)

— *Asterias punctata*, Lamarck, An. s. vert., 2e édit., t. III, p. 239, no 2.

Lamarck thus described a species that still remains doubtful: "*A. pentagona*, inermis, utrinque tessellata tessellis dorsi sinuato-angulis, punctatis; margine articulato." The author adds that it is very near the paved Asteroid, *Ast. tessellata*. We have seen that Lamarck also confused several perfectly distinct species. i. e., 1° *Ast. tessellata* (*Astrogonium cuspidatum* M. T.), 2º *Asterias granularis* (*Astr. granulare*, M. T.).

From Southern seas. Voyage of Pérou (Lesueur).

16. SOULEYET'S ASTROGONIA. ASTROGONIUM SOULEYETII. — Nobis.

PI, VIL, fig. 1.

Species whose length equals approximately three and a half times the smallest diameter of the disk. The arms are rather wide at their base and separated from each other by the re-entrant angles that are very regularly rounded. The marginal plates, 18 or 19 for each arm, are a little longer than wide and are joined closely on the median line in a way to cover entirely the diameter of the arms. The contour of these plates forms on the disk a regular pentagon figure in the center of which are flattened dorsal plates, rather wide and rounded. Other smaller plates nearly the same form are arranged in three slightly decreasing rows that go toward the protruding corner of the median part of each arm at the point of meeting with the marginal plates.

The ventral or lower surface has very narrow ambulacral grooves limited by small plates. On the internal edge of these are small, squamous papillae arranged om several nearly equal rows. Finally, more outside, are the ventral marginal plates that are generally less pronuned that the dorsal marginals but in the same number.

Color a reddish brown with five quadrangular spots on the two dorsal interbrachial marginals. The arms themselves have similar spots in several areas. The ventral surface is less brightly colored but it is in the same manner.

Diaameter: total length …… 65 mm.
Length of the arms from the center .. 32.

This nice species, by the length of its arms and their acuminate form, forms in the genus *Astrogonium*, a special section. We can say that it is in relation to this genus the equivalent of *Gonicdiscus cuspidatus*, is in relation to this latter genus.

It has been collected by the expedition of the *Bonite*, to whose success Eydoux and Souleyet have contributed so successfully. In dedicating to one of the intrepid and unfortunate voyagers, we make only a small tribute of our admiration for the beautiful work he has given to science.

Inhabits the Strait of Malacca (Mus. Paris).

17. ABB'S ASTROGONIA. *ASTROGONIUM ABBENSIS.*

— *Goniaster abbensis*, Forbes, Ann. and Mag. of nat. Hist., t. XI, p. 280, — *Hippasteria abbensis*, Gray, Cat, Brit. Radiat., p. 21, no 2.

Inhabits the coasts of England.

FOSSIL SPECIES.

A large number of species probably belonging to this genus has been mentioned or described by authors under the generic names of *Pentagonaster, Goniaster, Astrogonium,* etc. In the impossibility of determining with great rigor fragments of simple isolated pieces of Asteroids in the fossil state, it appears preferable to us to unite them under the name of

Astrogonium.

We count around forty species whose appearance in the layers of the earth have occurred from the Jurassic period. The species there are still few (5) but this increases in the Upper Cretaceous (Senonian), decreasing greatly in the Tertiary terrains and continues in the present time.

1. *Astrogonium jurense* — M. T. (Sp.).— *Asterias jurensis*, Munster, Goldf., 1833, Petref., I, p. 210, pl. 63, f. 6. — *Goniaster* ? *jurensis*, Agassiz, Mem. de Neufch. Soc., p. 191. — Lamarck, 2^{e} édit., t: III, p. 261. — *Pentetagonaster jurensis*, D'Orbigny, 1847, Prodr., t. 1, p. 381. Et. 13^{e}, no 536.
   Fossil of the Oxfordian stage of Nattheim {Wurtemberg).
2. *Astrogonium tabulatum*. — Gollsf.. (Sp.). — *Asterias tabulata*, Goldfuoss, Petref., 1833, L, p. 210, pl. 63, £. 7 — Lamarck, 2^{e} édit., t. III, p. 261. — *Pentetagonaster tabulatus*, D'Orbigny, Prod., t. I, p. 381. Et. 13^{e}, no 537,
   Fossil of the Oxfordian stage of Bayreuth.
3. *Astrogonium scutatum* — Goldf.. (Sp.).— *Asterias scutata*, Goldfuoss, 1833, Petref., t. 1, p.210, pl. 63, f. 8 — Knorr, Supp. t. IX, no 210. — Lamarck, 2^{e} édit, t. III, p. 262.— *Pentetagonaster scutatus*, D'Orbigny, Prodr., t. I, p. 381. Et. 13^{e}, no 538.
   Fossil of the Oxfordian stage of Bayreuth and Streitberg (Germanoy).
4. *Astrogonium stelliferum*. — Goldf. (Sp.). — *Asterias stellifera*, Goldfuss, Petref., 1833, t. I, p. 211, pl. 63, f. 9. — Lamarck, 2^{e} édit., t. III, p. 261. — *Pentetagonaster stellifera*, D'Orbigny, Prodr., 1847, t. I, p. 371. Et. 15°, n° 539.
   Fossil of the Oxfordian stage of Bayreuth and Streitberg (Germany).
5. *Astrogonium fleuriausum*. — d'Orb. (Sp.). — *Pentetagonaster fleuriausa*, D'Orbigny, 1847, 294, Prodr., t. I, p. 381. Et, 13^{e}, no 540.
   "Large species, near by its marginal pieces to *P. jurensis*, but with much smaller tubercles (D'Orb.)."
   Fossil of the Oxfordian stage: Enaudes, near Rochelle (Charente Inférieure).

CRETACEOUS FOSSILS.

6. *Astrogonium vuriabil*e. — KocH. (Sp.). — *Cidaris variabilis*, Koch and Dunker, Beitr. Ool., pl.6, f. 9. — *Asterias dunkeri*, Roemer, 1840, Nordd. kreId., p. 27, n° 1. — *Pentetagonaster variabilis*, D'Orbigny, Prodr., t. II, p. 90. Et. 17^{e}, no 505.
   Fossil of the Lower Neocomian stage of Hanover.
7. *Astrogonium malbosii*. — d'Orb. (Sp.).— *Pentetagonaster malbosii,* D'Orbigny, Prodr., t. 11, p. 90. Et. 17^{e}, no 504 (species still undescribed).
   Fossil of the Lower Neocomian terrain in the vicinity of Berrias (Ardèche).
8. *Astrogonium porosum*. — Agass. (Sp.). — *Goniaster porosus*, Agassiz, Mém. Soc. Neufchâtel, t, I, p. 143, pl. 14 — *Pentagonaster porosus*, Pictet, Traité Pal., t. IV, p. 269.
   Fossil of the Neocomian terrain of Neufchâtel.
9. *Astrogonium couloni*. — Acass. (Sp.). — *Goniaster couloni*, Agassiz, Mém. Soc. Neufe., t. 1, p. 143, pl. 14. — *Pentagonaster couloni*, Pictet, Traité Pal., t. IV, p. 269.
   Fossil of the Neocomian terrain of Neufchâtel.

16. *Astrogoniwm dutempleanum*. — d'Orb. (Sp.).— *Pentetagonaster dutempleanus*, D'Orbigny, Prodr., t. 1, p. 142, Et. 19^{e}, no 333 (not described.). — *Id. Id.*, Pictet, Traité Pal., t. IV, p. 269.

Fossil of Gault (Albion) of St. Marc (Ardennes).

SPECIES OF THE UPPER CHALK (SENONIAN) OF ENGLAND.

11. *Astrogonium parkinsoni*. — Forbes (Sp.). — *Asterias regularis*, Parkinson, Organ. Rem. t, III, pl. 1. — *Goniaster parkinsoni*, Forbes, in Dixon geol. of Sussex, pl. 21. — *Pentagonaster parkinsoni*, Pictet, Traité Pal., t. IV, p. 270.
12. *Astrogogium bowerbankii*. — Forbes (Sp.). — *Goniaster bowerbankii*, Forbes, in Dixon geol. of Sussex, pl. 21. — *Pentagonaster bowerbanki*i, Pictet, Traité Pal., t. IV, p. 271.
13. *Astrogonium compactum*.—Forbes (Sp.). *Goniaster compactus*, Forbes, in Dixon geol. of Sussex, pl. 21.— *Pentagonaster compactus*, Pictet, Traité Pal., t. IV, p. 270.
14. *Astrogonium mosaicum*. — Forbes. — Forbes, in Dixon geol. of Sussex, pl. 23. — *Id. Id.*, Pictet, Traité Pal., t. IV, p. 270.
15. *Astrogonium combii*.— Forbes.— Forbes, in Dixon geol. of Sussex, pl. 23, and in Mem. geol. Surv., t, 11, p. 473.—*1d. Id.*, Pictet, Traité Pal., t. IV, p. 270.
16. *Astrogonium latum*.—Forbes.—Forbes, in Dixon geol. of Sussex, pl. 24, and Mem. geo!. Surv., t. IL, p. 473. — *Id. Id.*, Pictet, Traité Pal., t. IV, p. 270.
17. *Astrogonium smithii*. —Forbes.— Forbes, in Dixon geol, of Sussex, pl. 24, and in Mem.geol. Surv., t. IL, p. 273.—*1d. Id.*, Pictet, Traité Pal., t. IV, p. 270.
18. *Astrogonium angustatum.* — Forbes. — Forbes, Mem. geol, Surv., t. II, p. 273, and in Dixon Mem geol. of Sussex, p. 24. — 1d., Pictet, Traité Pal., t. IV, p. 270:
19. *Astrogonium hunteri*. — Forbes (Sp.).— *Goniaster hunteri*, Forbes, in Dixon geol. of Sussex, pl. 21. — *Pentagonaster hunteri*, Pictet, Traité Pal., t. IV, p. 270.
20. *Astrogonium mantellii*. — Forbes (Sp.). — *Goniaster mantellii*, Forbes, in Dixon geol. of Sussex, pl. 14. — *Pentagonaster mantellii*, Pictet, Traité Pal t. IV, p. 270:
21. *Astrogonium rugatum.* — Forbes (Sp.), — *Goniaster rugatus*, Forbes, in Dixon geol. of Sussex, pl. 14. — *Pentagonaster rugatus*, Pictet, Traité Pal., t. IV, p. 270.
22. *Astrogonium sublunatum*.—Forbes (Sp.).—*Goniaster sublunatus*, Forbes, Mem. geol. Surv., t. II, p. 471. — *Pentagonaster sublunatus*, Pictet, Traité pal, t. IV. p. 270:
23. *Astrogonium uncatum*. — Forbes (Sp). — *Goniasler uncatus*, Forbes, in Dixon geol. of Sussex, pl. 14. — *Pentagonaster uncatus*, Pictet, Traité Pal., t. IV, p. 270, pl. 98, f, 7.
24. *Astrogonium lunatum*. — Forbes. — Forbes, in Dixon geol, of Sussex, pl. 24, and Mem. geol. Surv., t. 11, p.273.—*1d. Id.*, Pictet, Traité Pal, t. XV, p. 270,
25. *Astrogonium rectilineum*.—M'Coy.—*Goniaster rectilineus*, M'Coy. Pictet, Traité Pal., t. IV, p. 270.
26. *Astrogonium quinquelobum*.—Goldf. (Sp.).—Asterias quinqueloba, Goldfuss, 1833, Petref., pl. 63, f. 5. — *Id. Id.*, Roemer, 1840, Nordd. KreId., P. 27, pl. 6, f. 20. — *Pentetagonaster quinqueloba*, D'Orbigny, Prodr., t, 2, P.. Et. 22, no 2257.

Fossil of the Upper Cretaceous terrain (Senonian) of Meudon (near Paris), Ventes (S. Inférieure), Maestritcht, Rugen and Gehrden (Germany).
27. *Astrogonium chilopora*. — Des. (Sp.). — *Asterias chilopora*, Desmoulins, 1852, Act. Soc. Lin. de Bordeaux, t. 4, p. 19, pl. 2, f. 5. — *Pentetagonaster chilopora*, D'Orbigny, Prodr. t. IL, p. 274. Et. 22e, no 1261. — *Pentagonaster chilipora*, Pictet, Traité Pal.,t. IV, p. 270.

Fossils of the Upper Cretaceous terrain (Senonian) of Talmont (Gironde).

28. *Astrogonium stratiferum*. — Desm. (Sp.). — *Asterias stratifera*, Desmoulins, 1832, Act. Soc. Lin. Bord., t. 5, p. 17, pl. 2, f. 6. — *Pentetagonaster stratifera*, D'Orbigny, Prodr., t. II, p. 274. Et. 22e, no 1260. — *Pentagonaster stratifera*, Pictet , Traité Pal., t. IV, p. 270.
Fossil of the Upper Cretaceous terrain (Senonian) of Royan, Languais (Dordogne).
29. *Astrogonium costatum.* —d'Orb. (Sp.).— *Pentetagonaster costata*, d'Orabigny, Prodr. Et. 22^{e}, no 1259,
Fossil of the Upper Cretaceous terrain (Senonian) of Meudon.
30. *Astrogonium dutemplei*. — D'Orbigny. (Sp.). — *Pentetagonaster dutemplei*, d'Ongicny, Prodr., 1847. Et. 22^{e}, no 1259.
Fossil of the Upper Cretaceous terrain (Senonian) of Chavot (Marne), Sens, etc.
31. *Astrogonium moulinsii*. — d'Orb. (Sp.). — *Pentetagonaster moulinsii*, D'Orbigny, 1847, Prodr. Et. 22^{e}, no 1262.
Fossile of the Upper Cretaceous terrain (Senonian) of Lanquais (Dordogne).

SPECIES OF THE TERTIARY TERRAINS.

32. *Astrogonium marginatum*. — Forbes. — Forbes, Mem. geol. Surv.., t. II, p. 475, Dec. I, *Id.* Tert. Echin. in Pal. Soc., p. 4. — *Id. Id.*, Pictet, Traité Pal., t. IV, p. 208.
Fossil of the clay of Sheppy (England). Eocene terrain.
33. *Astrogonium stokesii*. — Forbes. — Forbes, Mem. geol. Surv., t. I, p. 475. Dec. I, and Tert. Echin. in Pal. Soc., pl. 4. — *Id. Id.*, Pictet, Traité Pal, t. IV, p. 208; pl. 98, f. 5:
Fossil of the clay of Sheppy (England). Eocene terrain.
34. *Astrogonium tuberculatum*.—Forbes — Forbes, Mem. geol. Surv., Dec. 1, t. II, p. 475, and Tert. Echin. in Pal. Soc., p. 4.—*1d. Id.*, Pictet, Traité Pal. t. IV, p. 208.
Fossil of the clay of Sheppy (England). Eocene terrain.

18th GENUS. **GONIODISCUS**.. GONIODISCUS.— Müller and Troschel.

— *Asterias*, Authors, *Paulia, Randasia, Anthenea, Hosia* and *Nectria*, Gray.

Body a pentagonal disk, flat above and below with two rows of large marginal plates entirely granular contributing equally to form a thick border of the disk and to circumscribe the pentagon of each surface. The two surfaces are equally paved with plates but with a different granulation. With or without pedicellariae.

Anus sub-central.

The genus *Goniodiscus* is still one of those lacking homogeneity, at least in exterior form. Among the different sections established by Gray and united by Müller and Troschel under the name of *Goniodiscus*, there is one that is very remarkable and perhaps merits to be preserved. This is the genus *Nectria*, Gray that contains *Asterias ocellifera* , Lamarck. It is evident that the singular form and especially the squamous plates that cover the dorsal surface seem to become distinguished from *Goniodiscus*.

1. PENTAGONAL GONIODISCUS. *GONIODISCUS* PENTAGONULUS. — Müller and Troschel.

— *Asterias pentagonula*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 241. — *Anthenea ehinensis*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 279. — *Goniodiscus pentagonulus,* Müller and Troschel, Syst. der Aster., p. 57, pl. IV, 12.

Disk pentagonal with very short corners, the largest radius of the disk, the arms compressed, equaling one and a half the smallest. Marginal plates, twelve or thirteen on each arm. The angles between the arms, not very notched, are nearly perfectly square. The spines of the ambulacral grooves form three rows. Those of the internal rose, five on each plate, equal in height. Those of the second row, have only three of which the intermediary is largest. Outside is still a row lower ad incomplete. The granules of the ventral surface are formed of small cylinders that are smaller and dense near the edge on which are other, larger granules. The granules of the dorsal surface are very small and not very dense. We still see small tubercles that are cylindrical, short, that toward the end of the arms form a band in which we distinguish three middle rows. The areas with tentacular pores are very irregular. Bivalve pedicellariae are on the ventral and dorsal surface on two rows of lateral plates. Those of the ventral surface are larger and occupy all the length of the plates that have them. Those of the ventral marginal plates are smaller but pass however those of the dorsal marginal plates or dorsal plates.

Color reddish above, paler below. Dimension: total width 162 mm.

Inhabits the seas of China (Mus. Paris).

2. SEBA'S GONIODISCUS. GONIODISCUS SEBAE. — Müller and Troschel.

— *Artoceras altera*, Seba, Thesaurus, pl. 6, f. 7–8. — *Goniaster sebae*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 28. — *Goniodiscus sebae*, Müller and Troschel, Syst. der Aster., p. 98.

Body pentagonal with sides not very notched and whose largest radius equals one and a quarter the smallest. Spines of the ambulacral groove long and equal, five or six on each plate of the internal row. There are only two or three for the others, but they are thicker and by not very obvious transitions pass to the granules of the ventral surface. Near these spines, more outside, is a row of vey small plates. The other plates of the ventral surface are two times wider, hexagonal and decrease toward the edge. The granulation of this ventral surface is compact but not uniform. Some thicker granules occupy the top of each plate. The marginal plates, six on each arm, are covered with dense granules and have, outside, three or four large, flattened granules that ordinarily form a vertical row. The plates of the dorsal surface are not contiguous but are connected by bars to form a kind of network whose meshes with tentacular pores surround each plate. All these parts are granular and each plate has, in addition, one or several large granules like the marginal and ventral plates. Each area contains 20 to 24 pores. The marginal plates lack pedicellaria but, with a magnifying glass, we distinguish on the ventral surface bivalve pedicellariae as large as the large granules, and on the dorsal surface we see very small ones that approach the pincer form. The madrepore plate is approximately a third of the distance between the center and the edge.

Color brown-yellow in the dry state. Dimension: width 50 to 80 mm.

Inhabits the Red Sea, the coasts of the Moluccas and New Guinea.

3. CAKE GONIODISCUS. *GONIODISCUS PLACENTA*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 99.

Body pentagonal form with the intervals of the arms angular. Arms compressed, pointed at their end. All the plates on the two surfaces and the edge completely granular and without tubercles. Marginal plates six to seven on each arm, longer than wide except the last three of the upper row that are much wider than the others. Granulation, especially uniform, is a little greater on the ventral surface. No pedicellariae.

Color reddish. Dimension: total width 162 mm.

Inhabits? (Mus. de Vienna).

4. REGULAR GONIODISCUS. *GONIODISCUS REGULARIS*. — Müller and Troschel.

— *Pentagonaster regularis*, Linck, pl. 13, f. 22. — Copied in Encycl. méthod., pl. 96, — *Asterias tessellata*, Lk., var. A (pars). — *Goniaster regularis*, Gray. Ann. and. Mag. of nat. Hist., t. VI, p. 280. — *Goniodiscus regularis*, Müller and Troschel. Syst. der Aster., p. 59.

Body pentagonal, sides scarcely notched. The arms have five marginal plates on the ventral surface and seven on the dorsal. Nearly all as long as wide, but the penultimate is a little smaller than the others and a little longer than wide. The last is much shorter and narrower.

No pedicellariae.

Color reddish brown. Dimension: total width 108 mm.

Inhabits ? Coll. of Linck at Leipzig.

5. PLEYADELLA GONIODISCUS. *GONIODISCUS PLEYADELLA*.— Müller and Troschel.

— Seba, Thesaurus, pl. 6, f. 5–6.—*Asterias pleyadella*, Lamarck, An. s, vert,, 2^{e} édit., t, III, p. 239. — *Goniodiscus pleyadella*, Müller and Troschel. Syst. der Aster., p. 99.

Body pentagonal or quinquelobed with the sides strongly notched, the largest radius equaling two and a half times the smallest. Arms nearly two times as long as wide with eleven large marginal plates. Spines of the ambulacral groove in two rows. Those of the internal row are two on each plate, smaller. The externals, two on each plate, are thicker, a little flattened and cover nearly entirely those of the other row. The ventral surface is covered with coarsely granular small plates and that, however, only reach half of the arms. The back is covered with small, rounded plates that form longitudinal rows on the arms, but whose median alone reaches the end of the arms. This median row is a little raised and forms a kind of keel. Around the center are five tubercles forming a pentagon. The madrepore plate is located between two of these tubercles. All the plates are universally covered with coarse granules. Between those of the back are some tentacular pores and

some of these plates, as well as those near the ambulacral groove, have isolated bivalve pedicellariae.

Color pale brown. Dimension: width 27 to 40 mm.

Inhabits the sea of the South (Mus. de Paris).

6. GONIODISCUS WITH CUSPS. *GONIODISCUS CUSPIDATUS*. — Müller and Troschel.

— *Asterias cuspidata*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 239. — *Goniodiscus cuspidatus*, Müller and Troschel. Syst. de Aster., p. 60.

Body pentagonal with five narrow and pointed arms, three times as long as the smallest radius from the center and separated by wide and deep notches.

The plates of the ambulacral groove curve into the interior and each of the rows with seven small spines whose intermediary is longest. Their ends are very small. Outside this row are two or three others with flattened spines in the form of scales, three on each plate. The ventral surface is covered with coarse granular plates.

The marginal plates, twenty-two for each arm, are on the dorsal surface large and uniformly granular. The ventral ones are a little more protruding than the dorsals in the angle between the arms. The back is covered with plates on which are some granules larger than the others. From the central part, a row of dorsal plates is directed toward the end of each arm. In the middle of each interval between the arms are two rows of large plates that decrease toward the edge. Large pincer pedicellariae, nearly three times as long as wide are between the groups of spines of the ambulacral pedicellariae.

Large spines in the form of scales as well as granules are frequently, themselves, replaced by pedicellariae of the same form and size. The same thing happens, although more rarely, on the marginal plates. Finally, on the back are also pincer pedicellariae, one and a half times longer than wide. They are especially numerous in the small porous areas that do not have many pores.

The madrepore plate is a little nearer the center than the edge.

Color brown orange. Dimension: width 135 mm.

Inhabits the sea of the South (Mus. de Paris).

7. GONIODISCUS WITH MAMELONS. *GONIODISCUS MAMILLATUS*. — Müller and Troschel.

— Syst. der Aster., p. 61.

Body pentagonal having the sides little notched between the five arms that are one and a half times as long as the smallest radius of the disk from the center. Spines of the ambulacral groove forming a single row of four on each plate that has them, in addition granules smaller than the spies but larger than the granules of the ventral surface. This is covered with large, flattened plates that are uniformly but coarsely granular and each surrounded by a row of large granules. The marginal plates, eight above and nine below, are very large and the last of the dorsal row divides sometimes into several irregular pieces.

The third dorsal plate from the end of the arm is very wide and gives the end a mamillary aspect. All the plates are granular.

Small, bivalve pedicellariae are very rarely seen on the ventral surface. The madreporite plate is located a third of the distance from the center to the edge.

Color brown with the end of the arms blackish. Dimension: 140 mm.

Inhabits the Indian Ocean (Mus. de Paris).

8. CHAPEL GONIODISCUS, *GONIODISCUS CAPELLA*, — Müller and Troschel.

— Syst. der Aster. p. 61.

Body pentagonal with notched arms and whose very narrow arms are two times longer than the smallest radius of the disk. Spines of the ambulacral row are all equal, six on each plate. Outside these spines are also on each plate two or three small, depressed tubercles.

The ventral plates are flattened, polygonal, slightly granular.

The marginal plates, particularly the ventrals, are wider than long in the corners between the arms but their width decreases toward the end of the arms until they are, on the contrary, longer than wide. The dorsal marginal plates, thirteen on each arm, are not longer than wide at the end of the arm. All the marginal plates are bare at the edge except toward the end of the arms that are covered with very sparse granules. The arms, in addition, are so pointed that the five last marginal points on each side are contiguous on the back. The dorsal plates are smooth, hexagonal and so close together that there are only isolated tentacular pores between them. Their granulation is a little denser than on the ventral surface and they form very regular rows toward the end of the arms.

The madrepore plate is equal distance between the center and the edge.

Color reddish. Dimension: total width 81 mm.

Inhabits the seas of China ?

9. SINGULAR GONIODISCUS. *GONIODISCUS SINGULARIS*. — Müller and Troschel.

— Müller and Troschel. Weigm. Archiv, 1843, p. 116.

Body pentagonal, armed with five arms two times as long as the smallest radius of the disk, separated by broadly notched corners and each have fifteen dorsal and ventral plates in addition to an unpaired interradial plate above and below. The spines of the ambulacral groove are cylindrical on three or four rows and isolated on each plate. The plates of the ventral surface are covered with nearly cylindrical granules or often appearing surrounded by granules in the middle of which is one larger. The marginal plates decrease in size. They are wider than long and arranged obliquely. The middle interbrachial plate is nearly triangular. The granulation of the marginal plates as well as that of the dorsal plates is more depressed and thicker. The porous areas are small and numerous. There are no pedicellariae.

Color red. Dimension: total width 81 mm.

Inhabits the coasts of Chili (Mus. Berlin).

10. SERIAL GONIODISCUS. *GONIODISCUS SERIATUS*. — Müller and Troschel.

— Müller and Troschel, Archiv Weigm., 1843, p. 117.

Species pentagonal with five pointed arms whose length equals two and quarter the smallest radius of the disk from the center and that are separated by notched corners.

Spines of the ambulacral groove, seven on each plate of the internal row and forming together an arced lamella because those of the middle are a little longer. Outside this row is a group of spines that are thicker, compressed, swollen and truncated at their end.

The ventral plates are coarsely granular and have pedicellariae the size of granules that are abundant, especially near the ambulacral groove. The granulation of the marginal plates is a little more compact than on the ventral plates.

The pedicellariae are as large as the granules are seen rather frequently on the ventral marginal lates. They are rarer or are completely missing on the dorsals. The dorsal plates form regular longitudinal rows on the arms and on the back two pairs of plates a little larger located in the intervals of the arms. All these plates are covered with granules, among which are some flat, much larger granules. These granules on the arms are often in transverse rows. Pedicellariae the size of the granules are rather rare on the back. The madreporite is large and located equal distance from the center and the edge.

Color a reddish brown in the dry state. Dimension: total width 135 mm.

Inhabits the southwest coast of Australia (Mus. Berlin).

10. WARTY GONIODISCUS. *GONIODISCUS VERRUCOSUS*. — Philippi.

— Philippi, Weigm. Archiv, 1857, p. 132.

Species pentagonal having the re-entrant interbrachial angles very obtuse and rounded. Dorsal and ventral marginal plates, 19 or 20 on each side of the arms. The plates of the dorsal surface are covered with depressed papillae that are extremely close together so that they touch in a kind of pavement. They have, in addition, warts that are granular and very dense. The spines of the ambulacral groove are arranged in three or four row. The plates of the ventral surface are covered with very dense cylindrical papillae. The madreporite plate is small and surrounded by six warts or which three are smaller and three larger.

Color reddish. Dimension: total width 90mm.

Inhabits the coast of Chile, near Valparaiso.

11. HORRIBLE GONIODISCUS. *GONIODISCUS HORRIDUS*. — Müller and Troschel.

Müller and Troschel indicated with doubt that *Paulia horrida*, Gray, Ann. and Mag. of Nat. Hist., t. VI, p. 278 should belong to the genus *Goniodiscus*. — An *Goniodiscus capella*, M. T.?

This species with a flattened body covered with plates that are granular, finer on the back and with spines but without pedicellariae.

Inhabits St. Helena.

The same authors also referred *Randasia luzonica*, Gray, *loc. cit.* to the genus *Goniodiscus,*

From the island of Luzon

19th GENUS. **NECTRIA**., *NECTRIA*.— Gray.

Asterias (Sp.), Lamarck. — *Goniodiscus* (pars), Müller and Troschel.

Body nearly pyramidal, having truncated warts, sparse, granular. Arms rounded, bordered with two rows of flattened warts on each surface. Below very granular.

OCELLIFER NECTRIA. *NECTRIA OCELLIFERA*. — Gray.

— *Asterias ocellifera*, Lamarck, An. s, vert., 2e édit., t. III, p.239, — *Nectria ocellifera*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 287. — *Goniodiscus ocelliferus*, Müller and Troschel. Syst, der Aster., p. 60.

Body pentagonal, have protruding arms, two and a half times as long as the smallest radius from the center and separated by profoundly notched corners.

The ventral surface is flat and the back is a little swollen. The sides are rounded without angular edges. The spines of the ambulacral groove form two rows. Those of the internal have three on each plate. Those of the external have two on each plate, a little shorter. The ventral surface is covered with very coarsely granular plates. The marginal plates, also granular but much larger, are seventeen on each arm and decrease toward the end of the latter. The dorsal plates near the edges and on the arms, are completely similar to the ventrals, but on the disk that are raised into cylinders that are wide, short and truncated at the top. They are, in addition, totally covered with large, flat granules and surrounded by a circle of round scales that give them an ocellar appearance. Between the plates of the back are rather large porous areas containing ten to twenty tentacular pores. The madrepore plate is at a third of the distance from the center to the edged.

Pedicellariae have not been seen.

Color yellow orange marked with whitish ocelli. Dimension: total width 108 mm.

Inhabits the sea of the South (Mus. de Paris).

This singular species certainly merits forming a distinct genus. It is thus that Gray thought that he made the genus *Nectria* that we believe should be accepted.

20th GENUS. **Stellaster**. *STELLASTER*.— Gray.

— Gray, Ann. and Mag. of nat. Hist. t. VI, p. 278.

Body nearly pentagonal, flat above and below, with two rows of granular marginal plates concurrent with each other at the beginning of the edge that is rather raised. Each ventral marginal plate has a spine. The two surfaces of the disk are covered with granular plates.

Pincer and bivalve pedicellariae. Anus sub-central.

This genus contains, up until now, only a single living species. Pictet has proposed to unite it with the genus that has been established by Gray under the name of *Comptonia*. As we still have some doubts in this regard, we prefer to preserve the latter until more information.

1. CHILDRENI'S STELLASTER. *STELLASTER CHILDRENI*. — Gray.

— Gray, Ann. and Mag. of nat. Hist., t. VJ, p.278.— *Id Id.* Müller and Troschel, Syst. der Aster., p. 62, pl. 4, f. 3 — *Stellaster equestris*, Müller and Troschel, Syst. der Aster., p. 62. — *Asterias equestris*, Retzius, Dissert.

Species with pentagonal body whose large radius equals two and a third the smallest. Arms very pointed, separated by a re-entrant rounded angle. Spines of the ventral or ambulacral groove forming two rows. Those of the internal row are arranged with six on each plate, those of the middle being longer. The external role has wide spines, flattened and isolated. Pincer pedicellariae occur between the latter spines. The ventral surface is covered with large plates that are uniformly granular. Marginal plates much larger than the dorsal and ventral plates, sixteen on each arm and also granular.

Each ventral marginal plate has a mobile and pendant spines of flattened form and three times as long as wide.

The dorsal plates are a little less granular than the ventral.

The tentacular pores, not very numerous, occupy small spaces along the ventral groove between the plates.

All the ventral, dorsal and marginal plates have more or less numerous small bivalve pedicaellariae.

Dimension: total width 108 mm.

Inhabits the coasts of Japan.

Müller and Troschel first accepted as a second species under the name of *Stellaster equestris*, according to Retzius, an Asteroid in the Musée de Lund, that later they recognized as identical with the preceding and differed on by the fall of pedicellariae. Müller and Troschel (Nacht. syst. der Aster.).

FOSSIL SPECIES.

1. STELLASTER COMPTON.. *Stellaster comptoni.*— Forbes.—Forbes, Mem. geol Surv., t. Il, p. 476.—*1d. Id.*, Picrer, Traité Pal. t. IV, p. 268, pl. 98, f. 6. — Id., Forbes, in Dixon geol. of Sussex, p. 335.

Fossil of the Green Sandstone of Blackdown.

2. SCHULTZ'S STELLASTER. *Slellaster schultzii*. — Pictet. — *Asterias schultzii colta*, in Roemer, Nordd. Kreïd., p. 28, pl. 6, f. 21. — *Pentetagonaster schultzii*, D'Orbigny, Prodr. Et. 20e, no 677, t. Il, p. 180.—*Stellaster schultzii*, Pictet, Pal., t. 1V, p. 269.

Fossil of the Green Chalk (Cenomanian) of Germany.

21th GENUS. **COMPTONIA**. *COMPTONIA*.— Gray.

This genus was established by Gray for a fossil AsteroId. It is very near the preceding and has spines on the marginal plates. Pictet proposed to unite it to *Stellaster* of the same author. The only species known until now comes from the Cenomanian stage (Green Chalk).

ELEGANT COMPTONIA. *COMPTONIE ELEGANS*. — Gray, Ann. and Mag. of nat. Hist., 1840, f. VI, p. 278. — *Id. Id.*, Morris, Cat. Brit. foss. p. 50. — *Id. Id.*, D'Orbigny, Prodr., t. IL, p. 180. Et. 20e, no 677. — *Stellaster elegans*, Pictet, Traité Pal., t. IV, p. 268,

Fossil from the Green Chalk of Blackdown (England).

22nd GENUS. **ASTEROPSIS**. *ASTEROPSIS*.— Müller and Troschel.

— *Gymnasteria* and *Porania*, Gray.

General form nearly pentagonal, Flat below, more or less convex above. Arms very short, often keeled. Contour with two rows of marginal plates, only one of which forms the edge that is sharp. The skin of the dorsal and ventral surfaces is covered with plates, but it is completely bare in the intervals of the plates and in the spaces occupied by the tentacular pores. The plates themselves are sometimes bare, with or without pedicellaria.

Anus sub-central.

1. KEELED ASTEROPSIS. *ASTEROPSIS CARINIFERA*. _— Müller and Troschel.

Species pentagonal, the largest radius equaling two and a half times the smallest. Arms one and a half as long as wide. Spines of the ambulacral groove in two rows. The internal row has five on each plate, the intermediary longest. Those of the external row are thicker and isolated on each plate. The plates of the ventral surface are fine granular and separated by a bare skin. Edge keeled, having a row of sixteen plates that are a little thicker, each prolonged into a spine that the bare skin covers in large part. Beside this keel, on the ventral surface, is a second row of larger plates, sometimes with small spines.

The plates of the dorsal surface form regular rows and are, like those of the ventral surface, fine granular and separated by bare places.

The dorsal surface of the arms is keeled and has in the idle a row of spines similar to those of the edge and in large part covered by the bare skin, but sometimes not very developed. Pincer pedicellariae very long, located only near the edge on the ventral surface.

Color brown, passing to reddish yellow. Dimension: total width 120 mm.

Inhabits the sea of the Indies, the Red Sea (Musée de Paris).

2. ASTEROPSIS WITH A COMB OF SPINES. *ASTEROPSIS CTENACANTHA*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 63.

Body pentagonal, length of radius from the center is double the smallest Re-entrant interbrachial angles regularly rounded. Arms one and a half as long as wide, convex above, flat below. Spines of the ambulacral groove in two rows at first, the in three toward the end of the arms, and isolated on each plate. Plates of the ventral surface smooth and with granules, appearing covered with bare skin. Peripheral edge keeled, with a row of large plates, twenty on each arm, and decreasing toward the end where they are very small. Each of these plates has on the edge, a row of five spines, between the arms, decreasing little by little to become single on the last plates. The dorsal surface is covered with small and numerous plates, cover by a skin and forming a kind of network. The madreporite plate is located nearer the edge than the center.

Color reddish brown. Dimension: total width 408 mm.

Inhabits the sea of the Indies (Mus. Paris).

3. CUSHION ASTEROPSIS. *ASTEROPSIS PULVILLUS*. — Müller and Troschel.

— *Asterias pulvillus*, O. F. Müller, Zool. Danic., pl. 19, Encycl. méthod., Pl. 107, f. 1–3.— *Asterias gibbosa*, Leach, Brit. Mus., 1817.— *Goniaster templetoni*, Forbes, Wern., Mem., t. VIII, p. 118, pl. 4, f. 1 2. — *Porania gibbosa*, Gray, Ann. and Mag. of nat. Hist., t. VI, p. 288. — *Asteropsis pulvillus*, Müller and Troschel, Syst. der Aster., p. 14 and 128. — *Id. Id.*, Duben and Koren, Mém. Acad. Stock., 1844, p. 246, no 28.

Bosy pentagonal, having the longest radius from the center one and a half as long as the shortest, convex above, flat below. Spines of the ambulacral groove in two rows at first, then three toward the end of the arms. These spines are thick, equally numerous in each row and totally embedded in the skin, each plate with two. Plates of the ventral surface entired covered by bare skin that is nearly divided to the edge by transverse groove corresponding to the intervals of the plates. Plates of the edge also covered by skin and each having three short spines that form a row on the sharp edge. Dorsal surface everywhere covered by a bare skin with spines nor pedicellariae except a small spine on each side of the madrepore plate and a circle of small papillae in the form of spines around the anus that is nearly central. Madreporite plate located a third of the distance between the center and the edge.

Color scarlet red. Dimension: total width 91 mm.

Inhabits the sea of the North.

0. F. Müller took for granular spines (granular cusps) the tentacles dried in place that are irregularly scattered on the back and form here and there small groups of tentacles right up to the edge.

4. GREENISH ASTEROPSIS. *ASTEROPSIS VERNICINA*. — Müller and Troschel.

— *Asterias vernicina*, Lamarck, An. s. vert., 2^{e} édit. t. III, p. 240. — *Asteropsis vernicina*, Müller and Troschel. Syst. der Aster., p.

Body pentagonal, whose length of the largest diametrical radius is double that of the smallest. Interbrachial re-entrant angles rounded. Spines of the ambulacral groove in two

rows. Those of the internal rows are united in threes on each plate and very nearby is a row of small tubercles or granules, one or two corresponding to three spines. Ventral surface with plates or parquets. Marginal plates a little larger than the preceding, completely unarmed, twelve on each arm making a blunt edge.

Dorsal surface irregularly covered with plates that, however, appear to form a longitudinal row in the middle of each arm. All the plates are barely granular and the skin in the intervals has no trace of granules.

In each corner between the grooves of the ventral surface is a large bivalve pedicellaria, length greater than two millimeters. Other similar pedicellariae cover the dorsal surface near the edge in the interbrachial corners.

Color cherry red. Dimension: total width 18 mm.

Inhabits the southwest coast of Australia (Mus, Paris).

5. IMBRICATED ASTEROPSIS. *ASTEROPSIS IMBRICATA*. — Grube.

— Grube, Weigm. Archiv, 1857, p. 340.

Species with five short arms, slightly keeled. Marginal plates imbricated, the ventrals passing or covering the edge of the dorsals. Ventral plates also imbricated and juxtaposed with dorsals. Ambulacral grooves with a double row of spines united at their base by skin. Those of the interior row are longer and free. There are 55 dorsal and ventral plates on each side.

Color reddish. Dimension 7 ½ mm.

Inhabits Sitka Island.

According to Müller and Troschel, it is necessary to unite to the genus *Asteropsis*, the following species::

Gymnasteria spinosa, Gray, Ann. and Mag. of nat. Hist., p.

Gymnasteria inermis, Gray, *loc. cit*., as well as

Porania gibbosa, Gray, *loc. cit*. — *Asterias gibbosa*, Leach, Brit. Mus., 4817.— *Asterias equestris*? Thompson, Mag. nat. Hist., t. IX, p. 257.— *Goniaster templetoni*, Forbes, Wern. Trans., 1839, p. 6.

23rd GENUS. **ARCHASTER**. *ARCHASTER*. — Müller and Troschel.

— *Asterias* (pars), AUTHORS.

Body flattened with five, rarely six, elongated arms with two rows of large marginal plates, the ventrals nearly reaching ambulacral groove. These plates are covered with scales that change into mobile spins toward the edge. Dorsal marginal plates covered with granules that, in some, elongate to take the appearance of bristles. Dorsal surface covered everywhere with numerous papillae whose end has small bristles. Isolated tentacular pores located between these papillae. Pincer pedicellariae. Anus central.

1. TYPICAL ARCHASTER. ARCHASTER TYPICUS. — Müller and Troschel..

— *Astropecten stellaris*, Gray, Ann. and Mag. of nat. Hist. — *Archaster typicus*, Müller and Troschel. Syst. der Aster., p. 65, pl. V, f. 2.

Species ordinarily with five arms, rarely four or six, approximately four times as long as wide and length from the center quintuple the smallest radius of the disk. The interbrachial re-entrant angles have straight sides. The ambulacral groove has two rows of spines. The internal row has on each plate three spines that are united like a wedge. The external row has only two spines that are flattened, larger, Sometimes, there is only one with a pedicellaria. The ventral marginal plates have small scales on the external edge, a row of flattened spines, one for each plate. The dorsal marginal plates, thirty-six on each arm, are much longer than wide and have only one row of granules. The papillae of the back are arranged so that they form in the middle of each arm a longitudinal row of larger plates with bristles from which originate on each side rows of smaller papillae directed toward the edge. The papillae of the dorsal surface of the disk and similar to those of the middle of thSe arms. Four or five larger than the others surround the anus that protrudes in the middle of them. The madrepore plate is near the middle of the distance from the center to the edge. Elongated pincer pedicellariae are between the spines of the ambulacral groove.

Color dark brown. Dimension: total width 120 mm.

Inhabits the sea of the Indies (Mus. Paris).

2. HESPERUS ARCHASTER. *ARCHASTER HESPERUS*. — Müller and Troschel.

— Müller and Troschel. Weigm. Archiv, 1840, p. 223, and Syst., der Aster., p. 66, 1842.

Species with five arms whose length from the center is three and a half times the smallest radius of the disk. The interbrachial re-entrant corners have straight or slightly rounded sides. The spines of the ambulacral groove are unequal. Five larger ones are on the internal edge of each plate. The others, smaller, are on the rest of this plate. Each arm has 25 to 50 marginal plates covered with scales as in the preceding species. The papillae of the back form only transverse rows on each arm and not in the median row. They are larger in the middle of the disk, around the anus. The papillae are very small and not very numerous. The madareporite plate is nearer the edge than the center.

Color whitish (after drying). Dimension: total width 81 mm.

Inhabits coasts of Japan (Mus. de Paris).

3. ANGULAR ARCHASTER *ARCHASTER ANGULOSUS*. — Müller and Troschel.

— *Astropecten mauritianus*? Gray, Ann. and Mag, of nat. Hist., t. VI, p. 182. — *Archaster angulosus*, Müller and Troschel. Syst, der Aster., p. 66. — *Id. Id.*, Michelin, Mag. Zool., 1845, p. 24.

Species having arms seven and a half times as long as the smallest radius of the disk. Spines of the ambulacral groove flat and forming wedge-shaped groups between which are

very long pincer pedicellariae equaling the length of the spines and approximately three times less wide than long. Marginal plates of the ventral surface do not pass the dorsals and are covered with uniform scales without spines but only a little larger and rounded near the edge. The latter, corresponding to the spines, are united in groups of two or three on each plate and are flat or rounded. The dorsal marginal plates are very narrow and very tall so that their edge shows on the dorsal surface. They do not have spines. There are seventy on each arm. The papillae of the back are equal. Pincer pedicellariae are between them. The madreporite plate is nearer the center than the edge.

Color brownish. Dimension: total width 525 mm.

Inhabits Java, Mauritius and Australia (Coll. Michelin).

THIRD SECTION. — ASTEROIDS HAVING TWO ROWS OF TENTACLES IN THE AMBULACRAL GROOVE. NO ANUS.

24th GENUS **ASTROPECTEN**. *ASTROPECTEN*. — Linck.

— *Asterias*, Lamarck, Agassiz. — *Crenaster*, LuId. — *Stellaria*, Nardo, Müller and Troschel.

Body flat and below with five elongated arms. Two rows of marginal plates, the ventrals with scales in the form of spines that, near the edge, become longer and mobile. These plates extend to those of the ambulacral groove of the arms. Dorsal marginal plates are covered with granules that often are elongated in the form of bristles and sometimes spines. Dorsal surface covered with numerous papillae whose top is crowned with bristles (paxillae) as in *Archaster*.

The genus *Astropecten* was established by Linck for Asteroids that had been designated by Luidius under the name of *Crenaster.* As a result, the latter would have priority over that of Linck and consequently should be substituted. Such has been, in fact, the opinion of several modern authors, most particularly D'Orbigny and Pictet. But, outside the inconvenience that always results from thus changing the names that have been used for a long time in science and have been accepted who are the guides in some way of everyone, we believe that in regard to this, it would be advantageous to be less strict in the application of the respectable principle of priority. The name *Crenaster,* it is true, was used by Luidius but in applying this term to a genus of Asteroid, the author did not intend in any way to establish a specific generic section, and consequently did not attach a general sense to this name as Linck did in applying his to a group of species, among which was that of Luidius. It is thus to Linck that it is necessary to attribute the creation of the genus under the name of *Astropecten*, a name that, moreover, we repeat again on purpose, has been accepted by the authors who are specialists of this group of animals and have made good and important works. We add that if something should be attributed to Luidius, it would rather be the specific name and from then on the species would take the name of *Astropecten crenaster, Luïd*. (sp.). This would avoid changing the name of a very large number of species and require only a modification of the name of the species of which Luidius spoke, i. e., *Astropecten aurantius*, that from then on would be *Astropecten crenaster*.

1. NOTCHED ASTROPECTEN. *ASTROPECTEN CRENASTER*. — Luidius (Spec.).

— *Crenaster luidius*, 1699. — *Astropecten echinatus major*, Linck, pl. 3, no 6, et pl. 6, n° 6. (Copied in Encycl. méthod., pl. 110, f. 2-3.) — Seba, Thesaur., t. IL, pl. 7, f. 2. — *Asterias aurantiaca* (pars), Lamarck, An, s. vêrt., 2e édit., t. III, p. 251. — *1d. Id.*, Tiedman, Anat., pt 5 and 6. — *Id. Id.*, Iconogr., R. A. Guérin, Zooph.. pl. 1, f. 1. — Savigny, Desc. Égypte, pl. 3 and 4. — *Id. Id.*, Philippi, Archiv Weigm., 1837, p. 193. — *Astropecten aurantiacu*s, Middet bav. Littoral-Fauna in Nyt. Mag. for NaturvId., 1837, p. 46, n° 15.

Species with five arms whose length from the center is five to six times longer than the radius of the disk. These arms have 40 to 50 marginal plates. The spines of the internal rows of the ambulacral groove are cylindrical, small, three on each plate, the intermediary the largest. The second row is formed of large spines that are flat and wide, two on each plate. Outside these rows are scattered groups of large and small spines. Among the very dense scales that cover the ventral plates, are three or four spines that are flat, lanceolate, much smaller than the others of the edge that are pointed and flat only in the middle of the interval of the arms. The dorsal marginal plates are scarcely wider than tall, coarsely granular. They each have one or two short spines. The dorsal marginal plates are scarcely wider than tall, coarsely granular and each with one or two short spines. The internal row of spines is especially developed in the re-entrant corner of the arms where the external row ceases on the contrary.

Color dark orange on the back between the paxillae.

For the reasons we have given above, we have changed the name of this species and restored to it the name under which it was first designated by Luidius. The species of concern here has been known for a long time already under the name of *Asterias auramtiaca*. It is in fact under this name that Lamarck designated it and after him different authors concerned with the study of Asteroids. We add, however, that the celebrated author of Histoire des animaux sans vertèbres, confused under the same name several species that have been separated by Philippi, such as *Asterias bispinosa, A. johnstoni, A. plathyacantha.*

2. IRREGULAR ASTROPECTEN. *ASTROPECTÈN IRREGULARIS*. — Linck.

— *Asterias aurantiaca*, Müller, Zool. Dan., t. 83, *Id.*, Prodr., n° 2831 (not ASTERIDES. Lin.). — *Id.* Fleming, Brit. anim, 486. — *Id. Id.*, Johnston, Mag. nat. hist. t. IX, p. 299, f. 44. — *1d. Id.* Forbes, Wen. Mëm., t. VIE p. 118, and Brit. Starfish., f. 130. — *Astropecten irregularis*, Linck, p. 27, t. 6, f. 13, À. 8, f. 11–12. Copied Encycl. méthod., t. 90, f. 1–5, t. 91, f. 1-6. — *Stélla marina minor*, Johnston, Hist. nat., t. 8, f. 11. — *Astropecten mülleri*, Müller and Troschel. Archiv Weigm., 1844, t. X, p. 181. — *Id. Id.*, Duben and Koren, Zool. Bidray, 247.—*Astropecten irregularis*, Gray, Cat. Brit. radiata, p. 18, n°1.

Species still doubtful and that perhaps should be united with the preceding as a simple variety?

Inhabits the seas of the North.

3. ASTROPECTEN FROM BRAZIL. *ASTROPECTEN BRASILIENSIS*. Müller and Troschel.

— *Astropecten duplicatus*, Gray? Ann. and Mag. of nat. Hist., t. VL, p. 185. — *Astropecten brasiliensis*, Müller and Troschel, Syst. der Aster., p.68.

Species with five arms whose length from the center equals five and a quarter times the smallest radius of the disk. The marginal plates are fourty-five on each arm. The spines of the internal rows of the ambulacral groove are three on each plate with the intermediary the largest. This row is continuous with the buccal side of the plates by two small spines. The external row is formed of larger plates that are single on each plate. The pointed spines of the ventral plates decrease successively from the edge. The dorsal marginal plates are taller than wide with two very large spines but of which the external is missing in the interradial corners. There, on the contrary, the internal becomes larger. These dorsal marginal plates have, in addition, cylindrical granules. The paxillae of the back form on the sides transverse rows but are irregularly arranged toward the middle. The interval between the marginal plates in the middle of the arms is two to three times as wide as those of the un-armed plates.

Color reddish yellow. Dimension: total width 155 mm.

Inhabits the coasts of Brazil (Mus. de Vienne).

4. VALENCIENNES' ASTROPECTEN. ASTROPECTEN VALENCIENNII. — Müller and Troschel.

— *Astropecten stellatus*, Gray? Ann. and Mag. of nat, Hist., t. VI. p. 181. *Astropecten valenciennii*, Müller and Troschel. Syst. des Aster., p. 68.

Species with five arms whose length from the center is quintuple the smallest radius of the disk. The spines of the ambulacral groove form three rows, of which the internals have a large spine that is wide and rounded and a small one that is flat and truncated, above which the large one advances toward the edge. The third row is formed of groups of three small spines that are truncated, equal to the smallest of the second row. The ventral plates have more or less large scales, not very dense, and three small spines that are flattened and arranged in rows toward the edge. The dorsal marginal plates, thirty on each arm, are wider than tall and uniformly convex. The granules that cover them are depressed and blunt. Near the internal edge of the plates, starting from the interbrachial corner is a row of very small spines that decrease and disappear in the middle of the arms or go to their end. Another row begins, on the contrary, further out at the end of the arms and only reaches their middle so that the plates in this area can lack spines or have only two very small ones. The interval between the dorsal plate, in the middle of the arms, is nearly two times as wide as these plates. The madreporite plate is near the dorsal marginal plates.

Color reddish yellow after drying. Dimension: total width 162 mm.

Inhabits Vera Cruz (Mus. de Paris).

5. TIEDMANN'S ASTROPECTEN. ASTROPECTEN TIEDMANNI. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 69,

Species with five arms whose length from the center is triple the smallest radius of the disk. Each arm has twenty-two marginal plates. The ambulacral groove has two rows of spines. The internal has three spines on each plate, of which the intermediary is longer and protruding. The external has large spines that are a little flattened, on each side of which is a smaller, thinner one. The marginal spines of the ventral plates are flattened and blunt. The dorsal marginal plates have two or three long spines, sometimes in larger numbers of smaller and thinner ones.

Color yellowisih. Dimension: total width 67 mm.

Inhabits ? (Mus. de Vienne).

6. BISPINOSUS ASTROPECTEN. *ASTROPECTEN BISPINOSUS*. — Müller and Troschel.

— *Astropecten echinatus minor*, Linck, pl. 8, n° 12. — *Asterias aurantiaca* (pars), Lamarck, An. s. vert., 2^{e} édit., t. III, p. p. 251 .—*Asterias bispinosa,* Otto, Nov. act. Acad. Leop. XI, p. 285, pl. 39. — *Id. Id.*, Gravenhorst. *Tergestina*, p . 96. — *Id. Id.*, Philippi, Weigm. Archiv, 1837, p. 193. — *Id. Id.*, Grube, Actiniers, etc., p. 24. — *Astropecten bispinosus*, Müller and Troschel. Syst. der Aster., p. 69. -— *Id. Id.*, Sars, Middelh. litt. Fauna in ayt. Mag. f. NaturvId., 1857, p. 46, n° 16.

Species with five, very narrow arms, approximately eight times longer than the smallest radius of the disk. Ambulacral grooves with spines in two rows. The internal row has three small spines on each plate. The external has spines that are rarer and larger. Beyond these are still some smaller spines. The ventral marginal plates have small, isolated that have the form of spines but without reaching the size of the flattened spines of the edge. The dorsal marginal plates, fifty to sixty on each side, are in large individuals much taller than wide and have a row of spines that are very large, round and sharp. The granules of these plates of small, thin cylinders. The ventral marginal plates also have a single row of spines. The dorsal part of the arms, compressed between the dorsal marginal plates, is much narrower than the plates themselves. The arms are, moreover, very narrow, perhaps more than in any other species, but their width varies from one individual to another.

Color greenish brown. Dimension: total width 490 mm.

Inhabits the Mediterranean.

This species is one of those that Lamarck had confused with his *Asterie frangée, Asterias aurantiaca*.

7. MANY-SPINED. ASTROPECTEN. *ASTROPECTEN POLYACANTHUS.* — Müller and Troschel.

— Müller and Troschel., Syst. der Asteri, p. 69, pl. V, f. 3.

Species with five rays or arms whose length from the center is six times the smallest radius of the disc. The internal row of the ambulacral groove has three spines forming an angle on each plate so hat the one in the middle is largest and most protruding. Behind it is a group of smaller spines. The spines of the ventral surface, or five on each plate, are all large and reach the length of the marginal spines. The dorsal marginal plates, thirty-three on each arm, are taller than wide and have long and conical spines that, in the interbrachial corners, are perpendicular and form a row on the edge. Spines are always lacking on the second and often alsoon the third plate from the base of the arms. We rarely see outside an indication of a second row. The granules of the dorsal marginal plates are conical. The areas between these latter plates are wider than in the preceding species.

Color deep yellowish. Dimension: total width 200 to 325 mm.

Inhabits the Red Sea (Mus. Paris).

8. ASTROPECTEN WITH WIDE SPINES. *ASTROPECTEN PLATYACANTHUS*. — Müller and Troschel.

— *Asterias platyacanthus*, Philippi, Weigm. Archiv, 1837, p, 193. — *Id. Id.*, Grube, Acktia., p. 25. — *Astropecten platyacanthus*, Müller and Troschel. Syst. der Aster., p.70. — *Id, Id.*, Sars, Midd, litt. Fauna in nyt. Mag. f. Naturv., 1857, p. 46, n° 17.

Species with five arms whose length from the center is five times the smallest radius of the disc. The internal row of the ambulacral groove has three thin spines and sometimes more on each plate, but ordinarily not in the same line. Outside these spines are two that are much longer and flatter near which are grouped several small ones. Among the small spines of the ventral plates, we can distinguish only the most external that are flat. The dorsal marginal plates, 20 to 24 on each arm, are taller than wide and have a spine that, near the interbrachial re-entrant corner, becomes larger and flat. The granules of these dorsal marginal plates are formed of small scales that are wide and flat that, toward the edges, become cylindrical. The ventral marginal plates are also armed with a single spine, but larger and lanceolate.

Color greenish brown. Dimension: total width 120 to 490 mm.

Inhabits the Mediterranean.

9. PORCUPINE ASTROPECTEN. *ASTROPECTEN HYSTRIX*. — Müller and Troshel.

— Müller and Troschel. Syst. der Aster., p.71, n° 8.

Species with thirty marginal plates on each arm. The spines of the ambulacral grooves, nine or ten on each plate, area arranged in two rows, the largest forms a point toward the groove. The ventral plates, finely scaled, have four or five spines that are a little flat and pointed that increase in length outside. The most external, approximately 7 mm in length, is proportionally thicker. The dorsal marginal plates are obliquely protruding on the arms, particularly in the middle, which makes them separated by a deep depression. They are taller than wide and have at their top a conical spine. The two plates of the interbrachial re-entrant corner are longer than all the others. The madreporite plates is far from the

marginal plate by a little less than its diameter. The dorsal areas of the arms between the marginal plates are a little more than three times as wide as thee plates.

Color brownish. Dimension: total width 60 mm.

Inhabits the coasts of Ceylon (Mus. de Paris).

10. ARMED ASTROPECTEN. *ASTROPECTEN ARMATUS*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 71 (non Gray).

Arms whose length from the center equals three and a quarter times the smallest radius of the disk. The spines of the ambulacaral groove are long, numerous, and do not form distinct rows. A row of small spines, sometimes double, is raised above the scale of the ventral plates. Near the ambulacral grooves, and on each plate, are two large spines, the ventral one a little less. The dorsal marginal plates, 20 to 22 on each arm, are taller than wide. Each has a spine that is round, perpendicular, shorter than the spines of the ventral edge. The spines decrease in size from the base of the arms. On the second, third and fourth plate, there is never a spine so that the two spines in each interbrachial re-entrant corner is separated on both sides from the other spines.

Color yellowish. Dimension: total width 408 mm.

Inhabits the coasts of Japan.

Gray has also established a species under the same name but we do not know if it is the same as this one.

11. ASTROPECTEN FROM BALAI. ASTROPECTEN SCOPARIUS. — Müller and Troschel.

—Valenciennes, Coll. du Mus. — Müller and Troschel. Syst. der Aster., p.71.

Species with five arms whose length from the center is four times the smallest radius of the disk. These arms are wide at their base and narrow at the top. The spines of the ambulacral groove form groups in the form of a wedge. Among the scales that cover the ventral plates, we distinguish many small spines that become more frequent toward the edge. The most exterior spine is very long, wide and a little curved into a laminar blade. The dorsal marginal plates, 25 to 30 in number, are uniformly granular. From the end of each arm leaves a row of small, conical spines. There is one on each plate on the exterior edge. The spines are missing on the plates of the interbrachial re-entrant corner. The dorsal area of the arms, between the marginal plates, is two to three times as wide as these plates. The madreporite plate is near the edge.

Color yellowish. Dimension: total width 190 mm.

Inhabits ? (Mus. Paris).

12. HEMPRICH'S ASTROPECTEN, *ASTROPECTEN HEMPRICHIL* — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 71.

Species with five arms whose length from the center equals four and a third the smallest radius of the disk. The spines of the ambulacral groove, in several rows, form on each plate a wedge-shaped group whose top is formed by only one of them. The small spines of the ventral plates are extremely fine, nearly capillaries. The nearest from the marginal spines are only half as long. These latter are flat and pointed with the exception of those in the interbrachial re-entrant corner. The dorsal plates, 33 on each arm, are much wider than tall. Those at the base of the arm and of the interbrachial corner are without spines. But a row of small spines goes toward the end of the arms.

Color yellowish. Dimension: total width 122 mm.

Inhabits the Red Sea (Mus. Berlin).

13. ARTICULATED ASTROPECTEN. *ASTROPECTEN ARTICULATUS*. — Müller and Troschel.

— *Asterias articulata*, Say, Journ. of Phil., t. V, p. 141. — *Astropecten articulatus*, Müller and Troschel, Syst. der Aster., p.72.

Species near the preceding and having the general aspect but having flat marginal plates. Those of the ventral side have a row of flat spines, a little truncated, equaling in length nearly two marginal plates and inserted two together on each plate. From the end of the arms to the middle is on the dorsal plates a row of small tubercles, one on each. The ventral side has numerous small spines.

Color yellowish. Dimension: total width 200 mm.

Inhabits the coasts of Florida and Georgia.

14. ASTROPECTEN WITH FINE SPINES. *ASTROPECTEN TENUISPINUS*. Duben and Koren.

— Duben and Koren, Mém. Acad. Stockholm, 1844, p. 251, n° 32, tab, VIII, f. 20–22.

Species with five rays, narrowed at their end, approximately four times as long as the smallest diameter of the disk. Marginal plates very protruding, founding forming a raised edge, 18 on each arm. These plates are armed with rare, bristly spines and a much larger, cylindrical one. The ambulacral groove is bordered with equally rounded plates, each with eight spines of which four in the middle of each plate are larger.

Color purple. Dimension: 120 mm.

This nice species is especially remarkable for its marginal plates that are protruding, globular and moniliform, with spines of which one or two larger ones protrude on the edge of the arms.

Inhabits the seas of the North, Norway.

15. ANDROMEDA'S ASTROPECTEN. *ASTROPECTEN ANDROMEDA*.— Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 129.— *Astropecten christi*, Duben and Koren, 1834, Oversigt of K. V. A. Forhazd, p. 113. — *Id. Id.*, Duben and Koren, Mém. Acad. Stockholm, 1844, p. 250, t. VIL f. 18–19.

Species whose arms have a length six times that of the smallest radius of the disk from the center. The spines of the ambulacral groove, eight to nine on each plate, form a single row. The rest of the plate is occupied by small very dense tufts. The marginal plates are 45 for each arm. The ventrals are bordered laterally by spines and in addition have scattered depressed granules that are not very numerous. The dorsals are without spines or have only a very small one. On most of the arms they are wider than tall. The plates that cover the ventral surface have four small spines that are equal and flattened, forming a transverse row. The madreporite plate is equal distance between the center and the edge. The area of the middle of the arms between the marginal plates is twice as large as the plates themselves.

Color reddish. Dimension: total width 190 mm.

Inhabits Kattegat (Mus. de Stockholm).

16. PARELIUS'S ASTROPECTEN. *ASTROPECTEN PARELII* — Duben and Koren.

— *Asterias aurantiaca*, var. *parelius*, Act. Nidros IV, p. 425, f. XIV, f. 3–4. —*Astropecten parelii*, Duben and Koren, Mém. Acad. Stockholm, 1844, p. 247, n° 30, pl. VIL, f. 14–16.

Species with five acuminate arms separated by rounded intervals that are not very deep, the arms having only one and a half times the smallest radius of the disk. Marginal plates, thirty on each arm, without spines but with simple granules. Paxillar area very wide. Lower or ventral surface is covered with a large number of granules and the marginal plates, on the side, make a protrusion that is compressed, sub-lamellar.

Color blood red. Dimension: 108 mm.

Inhabits seas of the North, Greenland.

This species with the general aspect of *Astrop. andromeda*, but, in addition to its less elongated arms, differs especially by the complete absence of spines on the edge of its marginal plates.

17. VAPPA'S ASTROPECTEN. *ASTROPECTEN VAPPA*. — Müller and Troschel.

— Müller and Troschel. Weigm. Archiv, 1843, p. 119.

Species having arms whose length from the center equals three and a half times the smallest radius of the disk. The spines of the ambulacral grooves form two rows each having three spines of the same form on each plate. There are 21 marginal plates on each arm, the ventrals having small isolated, protruding scales in the form of spines. whose most external is longer than the marginal spine that is also pointed and a little flattened. The

dorsal marginal plates, in the middle of the arms, are also as wide as tall. They have in addition a small, conical spine. The paxillar area between the marginal plates is very wide, equal to more than three times the width of these plates toward the middle of the arms. The madreporite plate is very near the edge.

Color yellowish. Dimension: total width 40 mm.

Inhabits the southwest coast of Australia (Mus. de Berlin).

18. BUSCH'S ASTROPECTEN. *ASTROPECTEN BUSCHII*. — Phil.

— Philippi, Weigm. Archiv, 1843, p. 113.

Species with five arms whose length equals approximately four and a half times the smallest radius of the disk. Spines of the ambulacral groove arranged in two rows. The internal row is composed of three spines on each plate, that of the middle passing the others. The external row is on plates a little larger with an equal number of spines but more developed and rounded at their end. The ventral plates located outside the preceding have spines arranged in transverse lines and that, toward the edge, become larger and form a row of straight and cylindrical spines that are very close to each other. The dorsal marginal plates, thirty-six on each arm, are covered with granules that are a little raised and one, two or three conical spines that are rather far apart, whose length equals that of a plate. On the middle of the arms, the marginal plates are wider than tall. The paxillar area is very narrow. It scarcely reaches half the width of the marginal plates. The paxillae of the disk is distinguished from that of the arms in that a small spine is raised in their middle. The madroporite is located very near the marginal plate.

Color yellowish orange. Dimension: total width 90 mm.

Inhabits ? (Mus. Berlin),

19. TRISERIAL ASTROPECTEN. *ASTROPECTEN TRISERIATUS*. — Philippi.

— Philippi, Weigm. Archiv, 1843, p. 113.

Species with five arms whose length equals four times that of the smallest radius of the disk. The spines of the ambulacral groove form a kind of wedge-shaped tufts. The ventral plates only have some small scales among which protrudes a rather long spine. There are thirty marginal plates on each arm, On the dorsal ones are three small, conical spines whose length decreases from the base of the arms up to their end. These spines are close very close together and, toward the middle of the rms, their length equals that of the marginal plates themselves. The paxillar area is wide. It is approximately triple the width of the marginal plates toward the middle part of the arms. The madroporite plate is very large and located very near the marginal plates.

Color yellowish. Dimension: total width 90 mm.

Inhabits the southwest coasts of Australia (Mus. Berlin).

20. SPINY ASTROPECTEN. *ASTROPECTEN ECHINULATUS*. — Müller and Troschel.

— Müller and Troschel. Weigm. Archiv, 1844, p. 181.

Species whose length of the arm equals three and a half times the smallest radius of the disk. The spines of the ambulacral groove form a kind of wedge at the top at which three of them meet followed by two others outside. All are thin and coarse. The ventral plates are covered with small, very finely bristled spines between which is a protruding row of large and equally coarse spines that increase in size to the edge. The dorsal marginal plates, twenty-five on each arm, are covered with fine bristles between is raised a short spine. These plates, in the middle of the arms, are as tall as wide and the area between the marginal plates has a width more than twice the plates themselves. The paxillae have a crown of bristles. The madrepore plate is near the marginal plates at a distance equal to its diameter.

Color yellowish. Dimension: total width 67 mm.

Inhabits the sea of the North, Fôhr Island (Mus. de Berlin).

21. JOHNSTON'S ASTROPECTEN. *ASTROPECTEN JOHNSTONI*. — Müller and Troschel.

— *Asterias aurantiaca*, var. (2), Lamarck, Anim. s. vertèb., 2^{e} édit., t. III, p. 251.—*Asterias johnstoni*, Delle Chiaje, Mém. des anim. s. vert., pl. 18, f. 4 — *Id. Id.*, Phhilippi, Weigm. Archiv, 1837, p. 193. — *Astropecten johnstoni*, Müller and Troschel. Syst. der Aster., p. 72.

Species with five arms whose length equals three and a half times the smallest radius of the disk. The spines of the ambulacral groove are arranged in several rows and form on each plate a group in the form of a wedge whose top is composed of a single spine. The ventral plates are covered with scales above which are raised three spines a little smaller than those on the edge. These become flat toward the interbrahial re-entrant corner. There are 25 or 30 arms on each arm. The dorsals are as tall as wide, and have one or several very small, pointed tubercles. The ventrals have a single spine and are in addition nearly smooth.

Color yellowish orange. Dimension: total width 81 mm.

Inhabits the Mediterranean.

This species is one of those that had been confused by Lamarck with *Asterias Astropecten aurantiaca.* It is a var. (2).

22. SERRATED ASTROPECTEN. *ASTROPECTEN* SERRATUS. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 72.

Species whose length of the arms if quadruple the smallest radius of the disk. These arms are rather pointed, regularly narrowing and each with thirty marginal plates. The spines of the ambulacral grooves are very long and arranged thus on each plate: three very

near the groove and the others near the scales that cover the ventral plate. Some of these same scales also have near the edge, four or five spines of which the third is the longest. The dorsal marginal plates, a little taller than wide, have in addition two, three or more conical tubercles that form transverse rows on the arms. The paxillar area, between the dorsal marginal plates toward the middle of the arm is approximately three times as wide as one of the plates. The madreporite plate is at a distance from the edge equal to it own diameter.

Color yellowish. Dimension: total width 135 mm.

Inhabits the Mediterranean.

23. SPINY ASTROPECTEN. *ASTROPECTEN SPINULOSUS*. — Müller and Troschel.

— *Asterias spinulosa*, Philippi, Archiv Weigmann, 1837, p. 193. — *Astropecten spinulosus*, Müller and Troschel. Syst. der Aster., p. 72. — *Id. Id.*, Sars, Midd. littoral Fauna in nyt. Mag. f. NaturvId., 1857, p. 47, n° 18, pl. 1, f, 16–17.

Species whose length of the arms equals four and a half times the smallest radius of the disk. Each of these arms has twenty-four marginal plates. The spines of the ambulacral grooves, five or six on each plate, form three rows: one of these spines, a little flatter is directed transversely toward the interior of the groove and two or three others, also flattened but wider and truncated at the top, are directed longitudinally. They are very near each other in the second and third row. Among the scales of the ventral plates, four are large and are larger and larger going from the groove to the edge. The dorsal marginal plates are very small. Two to four small scales attach them to the scales of the ventral plates. The marginal plates merge, so to say, with the paxillae of the back. The ventral marginals are armed with a single spine.

Color yellowish orange. Dimension: total width 108 mm.

Inhabits the coasts of Sicily (Mus, Paris).

24. ASTROPECTEN FROM JAPAN. *ASTROPECTEN JAPONICUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p.73.

Species whose length of the arms is quadruple that of the smallest radius of the disk. Each of them has thirty marginal plates. The spines of the ambulacral grooves, five on each plate, are grouped in a kind of wedge. The ventral plates are covered with very delicate scales. On each plate, at first, is a larger marginal spine below which are three small spines forming a row parallel to the edge and having nearly a third the length of the largest. The dorsal marginal plates are as wide as tall and have rarely on their external edge a small mobile tubercle. On the middle of the arms, their width is equal to that of the median area. The terminal article of the arms is very large and colored brown. The madreporite plate is located near the edge.

Color dark yellowish. Dimension: total width 67 mm.

Inhabits the coasts of Japan (Mus. Leyden).

25. HISPID ASTROPECTEN. *ASTROPECTEN HISPIDUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 73.

Species whose length of the arms is approximately triple the smallest radius of the disk, each with twenty-five marginal plates. The spines of the ambulacral grooves form two rows. In the one nearest the groove are three spines that are long and thin on each plate. In the external row, the spines are more numerous and merge, so to say, with the scales that cover the ventral plates. These latter are covered with numerous, more or less large scales, On their edge or three or four small spines, of which the second and third are larger than the more external. In the intervals or areas of the arms, the spines are flattened. The dorsal marginal plates are as tall as wide and have in addition to their granules, one or several larger granules instead of spines. The paxillae are very close together and from transverse rows on the arms that do not reach the middle. The madreporite plate is at a distance from the edge equal to its own diameter.

Color dark brown (after drying). Dimension: total width 67 mm.

Inhabits ? (Mus. Leyden).

26. ASTROPECTEN WITH LONG SPINES. *ASTROPECTEN LONGISPINUS*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 73.

Species whose length of the arms is quintuple that of the small radius of the disk from the center. Each has thirty-eight marginal plates. The spines of the ambulacral grooves form two rows and are near the groove. There are three on each plate, of which the intermediary is longer and directed inward. After the marginal plates there are three others, of which the intermediary is, on the contrary, smallest. The ventral plates are covered with very small, scaly spines that have at their end two spines of which the more external is two times as long as the other and rather long (6 or 7 mm) so that its end reaches the ambulacral groove. We distinguish also in the interbrachial re-entrant corner, spines that are isolated, flat, shorter than the preceding (2 mm) that is raised in the middle the ventral plates among the scales of the surface. The dorsal marginal plates are as tall as wide and have one and sometimes two very small points or pointed granules. The paxillar area of the back is wide and toward the middle of the arms is even double the width of the dorsal marginal plates.

Color dark yellow. Dimension: total length 216 mm.

Inhabits the coasts of Java (Mus. de Leyden.)

27. ASTROPECTEN WITH FIVE SPINES. *ASTROPECTEN PENTACANTHUS*. — Müller and Troschel.

— *Asterias pentacantha*, Delle Chiaje, Mém. des anim. s. vert., pl. 18, f.1–3.— *Asterias aranciaca*, Johndston, Mag. of nat. Hist., 1836, p. 298, f. 43. — *Asterias pentacantha*,

Philippi, Weigmann Archiv, 1837, p. 193. — *Id. Id.*, Grube, Actiniens, etc., p. 25.— *Astropecten pentacanthus*, Müller and Troschel, Syst. der Aster., p. 74. — *Id. Id.*, Sars, Midd. littoral Fauna in nyt. Mag. f. Naturv., 1857, p. 48, no 19.

Species with five arms whose length is four to six times larger than the smallest radius of the disk and each with 40 to 50 marginals. The spines of the ambulacral grooves form two rows, the internal with three thinner spines on each plate, the external with two that are little wider at the end. The scales, in the form of spines on the ventral surface increase in size toward the edge and, instead of large marginal species we see a ridge of five to six spines that become flat toward the interbrachial re-entrant corners. The dorsal marginal plates are uniformly granular and as tall as wide. Their granules are blunt in the form of small cylinders. The ventral marginal plates are armed with five spines that more particularly characterize this species and that gives it its name.

Color brick red or gray-red, with the dorsal marginal plates toward the end of the arms bluish as well as the madreporite plate. Dimension: total width 135 mm.

Inhabits the Mediterranean. It is all indicated as found on the coasts of England.

28. LESS ARMED ASTROPECTEN. *ASTROPECTEN SUBINERMIS*. — Müller and Troschel.

— *Asterias subinermis*, Philippi, Weigmann Archiv, 1838, p. 193. — *Astropecten subinermis*, Müller and Troschel, Syst. der Aster., p. 74. — *Id. Id.*, Sars, Midd. litt. Fauna in nyt. Mag. fur Naturv., 1857, p. 48, no 20.

Species whose length of the arms is quadruple that of the smallest radius of the disk, each with 70 to 80 marginal plates. The interbrachial re-entrant corners are completely rounded, which leaves a large interval between the marginal plates and the center on the ventral surface. At the same time, the dorsal area is equally wide. The spines of the ambulacral groove form a single row and are directed along the sides of an angle whose top would be in the axis of the ambulacral grooves. The ventral plates are simply covered with scales between which are raised only some very small scaly spines toward the edge, so that the large marginal spines are missing. The dorsal marginal plates are simply granular with any spines and instead of curving against the ventral plates they are separated only by a small groove so that the sides are rounded. The ventral marginal plates are armed with a single, very small spine.

Color yellowish. Dimension: total width 325 mm.

Inhabits the Mediterranean, the coasts of Sicily.

29. BORDERED ASTROPECTEN. *ASTROPECTEN MARGINATUS*. — Müller and Troschel.

— Müller and Troschel, Syst. der Aster., p. 79.

Species whose length of the arms from the center is quadruple the smallest radius of the disk. The spines of the ambulacral groove form several rows and are grouped in the form of a wedge on each plate. The end of this wedge is formed by a single spine that is directed toward the groove. The ventral plates have small, extremely fine spines, nearly capillaries that are cylindrical, a little flattened and truncated at the end. They are ordinarily united two or three together on each plate in the direction of their rows. The dorsal marginal plates, 44 on each arm, are flat, without spines and much wider than tall. They are covered with depressed granules. The marginal spines of the ventral plates are much more protruding laterally than in the other species so that the edge, seen from above, appears ciliated. The madreporite plate is far from the edge, a little less than its diameter. The dorsal marginal plates toward the middle of the arms have only a third of the width of the paxillar area that separates them.

Color yellowish. Dimension: total width 135 mm.

Inhabits ? (Mus. Paris).

30. SCHOENLEIN'S ASTROPECTEN. *ASTROPECTEN SCHOENLEINII*. — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 75.

Species with five arms, moderately elongated, having the spines of the ambulacral groove united in threes on each plate and forming a kind of triangle, the front longest, then larger outside and surrounded by some smaller spines. There are forty marginal plates on each arm. The dorsals are taller than wide and without spines. The madreporite plate is very near the marginal plates.

Color reddish. Dimension: total width 168 mm.

Inhabits Gorée (Mus. Bamberg).

31. GRANULOSE ASTROPECTEN. *ASTROPECTEN GRANULATUS*, — Müller and Troschel.

— Müller and Troschel. Syst. der Aster., p. 75.

Species whose arms from the center are quadruple the smallest radius of the disk. The spines of the ambulacral groove are flat and grouped in the form of a wedge. The scales that cover the ventral plates are large, flat and particularly lanceolate in the interbrachial re-entrant corners. On the edge of each of these plates is a spine that is flat, larger, often also accompanied by one or two spines that are a little smaller. There are 25 to 50 marginal plates. The dorsal marginal plates are taller than wide and very tall in the interbrachial corners. The arms are so narrow that the marginal plates equal the paxillar area they separate. The paxillae are small. The madreporite plate is located near the edge.

Color yellowish. Dimension: total width 67 mm.
Inhabiats ? (Mus. Leyden).

32. PREISS' ASTROPECTEN. ASTROPECTEN PRESSII. — Müller and Troschel.

— Müller and Troschel. Weigmann Archiv, 1843, p. 119.

Species whose length of the arms from the center equals five and a half times the smallest radius of the disk. The spines of the ambulacral grooves are grouped in the form of a wedge. The ventral plates have a row of small, thin spines that become very large near the edge without however merging with the marginal spines that are always thicker and longer. They are pointed and a little flattened but not enlarged in the re-entrant corner. Further on, they are cylindrical and truncated at their end. There are 60 marginal plates on each arm. The dorsals are granular without spines nor tubercles and their width, near the middle of the arms equals their height. The paxillar area, toward the middle of the arms, is double the width of the marginal plates. The madreporite plate is not visible.

Color yellowish. Dimension: 216 mm.
Inhabits southwest coast of Australia (Mus. de Berlin).

33. SCALY ASTROPECTEN. *ASTROPECTEN SQUAMATUS*. – Müller and Troschel

— Müller and Troschel. Weigm. Archiv, 1844, p. 182.

Species whose length of the arms from the center is triple the smallest radius of the disk. The spines of the ambulacral grooves form two rows. The first has on each plate three cylindrical spines whose median is longest and a little more protruding. The second row also has three spines whose intermediary is flat, much longer and wider. The laterals are more cylindrical. The ventral plates, with the exception of those of the disk and the end of the arms are without spines and only surrounded by a circle of delicate scales. At first are two marginal spines that are flat and located beside each other. There are 50 marginal plates. The dorsals are granular and without any spines. They are as tall as wide toward the middle of the arms. The paxillar area, seen in this region, is double the width of the marginal plates. The paxillae are crowned by numerous small spines. The madreporite plate is, at a distance from the marginal plates, equal to its own diameter.

Color yellowish. Dimension: total width 54 mm.
Inhabits the sea of the North, near Föhr Island (Mus. Berlin).

34. CILIATED ASTROPECTEN. *ASTROPECTEN CILIATUS*. — Grube,

— Grube, Weigm. Archiv, 1857, p. 340.

Species with five arms whose length equals four and a half times that of the radius of the disk. The spines of the ambulacral grooves are in two rows, one of them is much larger than the other. There are 45 dorsal marginal plates and 42 ventral marginal plates. The

marginal plates are covered with nearly equal granules and their border is surrounded by very small spines resembling cilia. The dorsal marginal plates have two spines that are equal, flattened. Then, below them, we distinguish three others much smaller.

Color yellowish. Dimension: 50 mm.

Inhabits Puerto Cabello.

35. ARCTIC ASTROPECTEN. *ASTROPECTEN ARCTICUS*.—Sars.

— Sars, Fauna littor. Norweg. Liv. II, p. 61. — *Id. Id.*, Barrett, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 319.

Species pentagonal with five arms whose length from the center is approximately one and a half times that of the smallest radius of the disk. There are 25 marginal plates on each arm. Dorsal surface covered everywhere by tubercles that are conical, very short. Paxillar area four or five times as wide as the plates at the base of the arms. Interbrachial spaces or re-entrant corners of the arms are rounded.

Color pale yellow orange. Dimension: 40 mm.

Inhabits the seas of the North.

36. LUTKEN'S ASTROPECTEN. *ASTROPECTEN LUTKENI*. — Barrett.

— Barrett, Ann. and Mag. of nat. Hist., 1857. t. 20, p. 45, pl. IV,f . 3, abc.

Disk pentagonal with five that are moderately elongated, enlarged at their base, acuminate toward their end, with on each side approximately twenty plates covered with spines and tubercles on the lateral parts. The ambulacral grooves are bordered by two rows of small spines. Then, outside, five or six other rows with smaller spines forming kinds of tufts. Finally. The rest of the ventral surface of the arms has transverse rows of very small spines with bristles, directed in the direction of the arms. The dorsal surface is covered with very small paxillae forming tubercles among which we distinguish a large number of spines similar to those of the marginal plates.

Color yellowish. Dimension: total width 50 to 60 mm.

Inhabits the seas of the North (Finmark).

37. CALTROP ASTROPECTEN. *ASTROPECTEN CALCITRAPA*,

— *Asterias calcitrapa*, Lamarck, Anim. s. vertèb., 2e édit, t. III, p. 252.

Species with small disk, with five arms that are linear, subulate, having the dorsal surface covered with truncated paxillae. Marginal plates unarmed.

Observation. Lamarck added to this unfortunately very insufficient description that this species coming from the voyage of Péron and Lesueur, probably from southern seas, closely resembles *Asterie frangée* (*A. aurantiaca*) from their reports but that the rays (arms)

are elongated, liner subulate and with a small should make it distinguished as a species. Lamarck also reported a variety with extremely narrow rays (*perangustis*).

38. HORNED ASTROPECTEN. *ASTROPECTEN CORNICULATUS*. — Linck.

— Linck, t. 36, n° 63, Sp. 4. — Copied Encycl. méthod., pl. III, f. 3–4. — *Id. Id.*, Gray, Ann. and Mag. of nat. Hist., 1840.

Species still doubtful that could even be quite simply the young age of *Astropecten aurantiacus*.

39. FRINGED ASTROPECTEN. *ASTROPECTEN FIMBRIATUS*. — Linck.

— Linck, t. 93 et 24, no 38. — Copied Encycl. méthod., pl. IL, f. 5–6. — *Asterias fimbriata*, Blainville, Man. Act., p. 239.

We know this species only by the figures cited above. If they are correct, the form of the arms as well as several other characters seem to indicate that this species should be preserved.

Gray has made known some species about which he still has doubts. These are: *Astropecten longipes*, Gray (Ann. and Mag. of nat. Hist., 4840,'p . 182), from Mauritius, *Astropecten dubius*, Gray, *loc. cit*., from the seas of India. *Astropecten gracilis*, Gray, *loc. cit*., n° 14, of unknown origin. *Astropecten mesodiscus*, Gray (*Astropecten mesodiscus minor*, Linck, t. 4, f. 16), of unknown origin. *Astropecten erinaceus*, Gray, *loc. cit*., no 42, from St. Helena. *Astropecten regularis*, Gray, *loc. cit*., n° 10, from San Blas. Finally, this author has established a generic section under the name of *Nauricia* (*N. pulchella*, Gray) that appears to us must enter into the *Astropecten*.

FOSSIL SPECIES

We know at present 19 species distributed in the following way: three in the Lias; five in the Lower or Upper Oolite; one in the Oxfordian stage; two in the Corallian; one in the Cretaceous terrains; one in the Nummulitic terrain; five in the Eocene beds (Parisian terrain); and one in the Miocene (Falunian).

1. *Astropecten priscus*. — Goldfus. — *Asterias prisca*, Goldfuss, 1833, Petref., p. 208, pl. 64, f. 1 — *Crenaster prisca*, D'Orbigny, 1847, Prodr., t. I, p. 240, and 8, no 241.
   Fossil of the Liasian stage of Wasseralfingen (Germany).
2. *Astropecten hastingiae*. — Forbes. — Mem. geol. Surv., Dec. 1, t. II, p.477, pl. 2. — *Crenaster hastingiae*, Pictet, Traité Pal., t. IV, p.27, pl. 98, f. 8.
   Fossil of the Lias of Yorkshire (England).
3. *Astropecten orion*. — Forbes. — Forbes, Mem. geol. Surv., t. III, p. 477. — *Crenaster orion*, Pictet, Traité Pal., t. IV, p. 27.
   Fossil of the Lias of Yorkshire (England).

4. *Astropecten mandelslohi*. — Munster. — *Asterias mandelslohi*, Munster, 1339, Beitr. 1, p. 98, pl. IL, f. 1, a b. — *Coelaster mandelslohi*, D'Orbigny, Prodr. and 10th, no 518. — *Crenaster mandelslohi*, Pictet, Traité Pal., t. IV, p. 271.
   Fossil of the Lowerr Oolite (Bajocian), Conlie (Sarthe), Port en Bessin (Calvados), Niort (Deux Sèvres), Aalen (Germany).
5. *Astropecten arenicolus*. — *Asterias arenicola*, Charlesworth, Lond. geol. Journ., t. I, p. 17 (non Goldfuss). — *Crenaster arenicolus* (Charl.), Pictet, Traité Pal, t. IV. p. 271.
   Fossil of the Lower Oolite (Bajocian) of England.
6. *Astropecten cotteswoldiae*. — Bucken. — Forbes, Geol. Surv., t. II, p. 479 — *Crenaster cotteswoldiae*, Pictet, Traité Pal., t. IV, p.271.
   Fossil of the Great Oolite (Bajocian) of Gloucestershire (England).
7. *Astropecten philippsii*. — Forbes. — Forbes, 1849, Mem. geol. Surv., Dec. I, pl. 2, f.2. — *Crenaster philipsi*, D'Orbigny, Prodr., t. I, p. 320, and 11, no 425. — *Id. Id.*, Pictet, Traité Pal., t. IV, p. 271.
   Fossil of the Great Oolite (Bathonian) of England.
8. *Astropecten cottaldinus*. — D'Orbigny (Sp.). — *Crenaster cottaldina*, D'Orbigny, 1847, Prodr., t. I, p. 320. and 11th, no 425. — *Id. Id.*, Pictet, Traité Pal., t, IV, p. 271.
   Fossil of the Great Oolite (Bathonian) of Châtel Censoir (Yonne), Luc (Calvados).
9. *Astropecten nodotianus*. — D'Orbigny (Sp.). — *Crenaster nodotiana*, D'Orbigny, 1847, Prodr., t. 1, p. 481. and 13th, no 54.
   Fossil of the Oxfordian terrain of the vicinity of Dijon (Côte d'Or).
10. *Astropecten rupellensis*. — D'Orbigny (Sp.). — *Crenaster rupellensis*, D'Orbigny, 1847, Prodr., t. II, p.28. and 14th, no 447.—*Id. Id.*, Pictet, Traité Pal; t. IV, p.271.
    Fossil of the Corallian stage (Coral rag) of the pointe du Ché near Rochelle.
11. *Astropecten rectus*. — M'Coy (Sp.). — *Asterias rectus*, MCoy, Ann. and Mag. of nat. Hist., 1848, p. 409. — *Crenaster rectus*, Pictet, Traité Pal., t. IV. p. 271.
    Fossil of the Coral rag (Corallian) of Yorkshire (England).
12. *Astropecten propinquus*.—Munster (Sp.).—*Asterias propinquus*, Munser, Paper, Tert. verst Nordw. Deutsch., p. 70. — *Crenaster propinquus*, Forbes, Mem. geol. Surv., t, III, p. 480. — *Id. Id.*, Pictet, Traité Pal., t. IV, p, 271.
    Fossil of the Cretaceou terrains of the North of Germany.
13. *Astropecten castellanensis*. — D'Orbigny (Sp.). — *Crenaster castellanensis*, D'Orbigny, 1847, Prodr., t. II. Et. 24th, no 638. — *Id. Id.*, Pictet, Traité Pal., t. 1V, p. 271.
    Fossil of the Nurmmulitic terrain (Suessonier) of Castellane (Basses Alpes).
14. *Astropecten armatus*.—Forbes.—Forbes, Mem, geol. Surv., t. II, p. 479, and Tert. Echin. in Pal. Soc., pl. 4. — *Crenaster armatus*, Pictet, Traité Pal., t. IV, p. 271.
    Fossil of the London Clay (Parisian) England.
15. *Astropecten colei*.—Forbes, Mem. geol. Surv., t. I, p. 479, and Tert. Echin. in Pal. Soc., p. 4.
    Fossil of the London Clay (Parisian stage) England.
16. *Astropecten crispatus*.—Forbes, Mem. geol. Surv , t. II, p. 479, and Tert. Echin. in Soc. Pal., p. 4,
    Fossil of the London Clay (Parisian) England.
17. *Astropecten poritoides*. — Desmourins (Sp.). — *Asterias poritoides*, Desmourins, 1832, Act. Soc. Lin. de Bord., 4th liv., 2, p. 44, pl. 2, f. 3. — *Crenaster poritoides*, D'Orbigny, Prodr. and 25th, no 1236,— *Id. Id.*, Pictet, Traité Pal., t. IV, p. 271.

Fossil pf the Parisian stage (Eocene terrain) of Parnes, Mouchy, Henouville and the vicinity of Crépy (Oise).

18. *Astropecien levis*. — Desmoulins (Sp.). — *Asterias laevis*, Demoulins 1832, Act. Soc. Lin. Bord., t. V, 4 Liv., p. 15, pl. 2, t. 4.—*Crenaster laeuis*, D'Orbigny, Prodr. and 25th A, no 1237.
Fossil of the Parisian stage (Eocene terrain) of the basin of Gironde.
19. *Astropecten adriaticus*. — Desmoulins (Sp.). — *Asterias adriatica*, Desmoulins, 1832, Act. Soc. Lin. Bord., t. V, 4th liv., p. 15, pl. 2, f. 2. — *Crenaster adriatica*, D'Orbigny, Prodr. and 23, n° 2686.
Fossil of the Falunian stage (Miocene) of Saucats (Gironde).

25th GENUS. **CTENOODISCUS**. *CTENODISCUS*. — Müller and Troschel

(χτενος, comb; διοχος, disque.)

— Syst. der Aster., p. 76.

Body flattened, nearly pentagonal, having on its edges two rows of plates that are completely bare above. The marginal plates extend onto the ventral surface by transverse bands formed of scales, the lateral edges of these bands, as well as those of the marginal plates, have small, thin spines, erect and arranged in parallel like a comb. It is the same for the free edge of the marginal plates of the dorsal surface. The dorsal plates, like the ventrals, have on their upper border a rows of fixed spine. The dorsal surface is covered with paxillae as in *Astropecten*.

1. FRILLED CTENODISQUE. *CTENODISCUS CRISPATUS*, — Lutken.

— *Asterias crispata*, Retzius, Diss. de stell., p. 17. — *Asterias polaris*, Sabine, Supp. to the Append. of Cap. Parry's voyage, 1824, p. 223, pl., f. 3. —*Asterias aurantiaca*, Dewurst, the nat. Hist., p. 283—*Astropecten polaris*, *Ctenodiscus pygmaeus*, Müller and Troschel, Syst. der Aster., p. 76, t. V, f. 5. — *Ctenodiscus crispatus*, Lutken, Oversig. over Groul. EchId., p. 45, n° 18.—*1d. Id.*, Duben and Koren, Mém. Acad. Stockholm, 1844, p. 253, n° 33.

Species with five arms whose length is double the smallest radius of the disk. These arms are triangular, a little wider at their base. The spines of the ambulacral groove, three or four for each plate, are conical, pointed, nearly equal and united. There is usually another spine outside on the same plate. The ventral bands consist of two smooth rows, 7 in the longest row. There are 12 marginal plates on each arm. The terminal plate at the top is nearly two times as long as wide. It has two spines at the end and a little protruding one behind. Finally, it is ciliated on its edge. The madreporite plate is located on the disk near the edge. It is covered with parallel grooves.

Color yellowish. Dimension: total width 40 mm.

Inhabits the coasts of Greenland.

It is possible that this species is the same as that figured in Linck under the name of *Astropecten corniculatus*, but as there is still doubt about this it is better, with the example of Lutken, to assimilate it with the species of Retzius (*A. crispata*). Müller and Troschel were the first to describe as a second species, under the name of *Ctenodiscus pygmaeus*, a small example with a width of 11 mm and having only six marginal plates on each arm. But later, in the appendix to their work (Syst. der Aster., p. 129), these authors thought it very probable that it is the young age of the first species (*Ct. polaris* = *Ctenod. crispatus*), Lutken.

26th GENUS. **LUIDIA**. *LUIDIA*.— Forbes.

— *Asterias*, Lamarck. — *Hemicnemis*, Müller and Troschel.

Seven to nine very elongated arms, having only one row of marginal plates armed with spines on the ventral surface. Dorsal surface entirely covered with paxillae as in *Astopecten* and *Ctenodiscus*.

This genus was established by Forbes, who dedicated it to Luidius, author well known for his works on Asteroids since 1703. Müller and Troschel had also named, for their part, *Hemicnemis*; but these authors subsequently accepted the name given previously by Forbes who, the also first to observe the singular property of the typical species (*L. savignii*) to destroy itself in some way by losing first its arms that break with extreme facility and decomposing itself completely into very small fragments, from which the specific name of *L. fragilissima*, proposed by this author.

1. SAVIGNY'S LUIDIA. *LUIDIA SAVIGNII*. — Aud. (Sp.)

— *Asterias savignii*, Aud Explic. Egynte Savreny, Echin., t. 3, f. 1— *Luidia savignii*, Gray, Ann. and Mag. et nat. Hist., 1840, p. 183. — *Id, Id.*, Müller and Troschel. Syst. der Aster., p. 77.

Species with seven arms that are elongated, depressed and a little blunt at their end. Their length equals approximately four times the smallest radius of the disk. All the dorsal surface, arms and disk, is covered with very numerous and very close together paxillae, each forming kind of rosette of papillae, in the middle of which is, most often, a larger, conical papilla. The lower or ventral surface is bristly with numerous spines. The ambulacral groove has first, on each side of a plate, three, the internal smaller and crowned. Then, further outside, are five other rows of conical, larger spines that protrude on the edge. Finally, other much smaller spines are at the base of these. The madreporite plate is small and near the edge of one of the interbrachial corners.

Color brownish with large whitish marbling. Dimension: total width 55 centimeters.

Inhabits the Red Sea.

2. CILIATED LUIDIA. *LUIDIA CILIARIS*.— Phil. (Sp.).

— *Asterias ciliaris*, Philippi, Weigm. Archiv, t. III, p. 193. — *Luidia fragilissima*, Forbes, Wern. Mem., t. VIII, p. 125, and Brit. Starf. p. 135.— Gray, Ann. and Mag. of nat. Hist., 1840, p

. 183. — *Luidia ciliaris*, Gray, *loc. cit*. — *Luidia savignii*, Müller and Troschel Syst. der Aster. — *Asterias N*., sp. Sars, Besk., p. 39. — *Luidia sarsii*, Duben and Koren, Ofver k. v. Acad, Stockh., 1844, p, 113, *Luidia savignii*, Gray, Brit., rad., p. 18, n° 2.

This species was united incorrectly with the preceding. It has, in fact, in its generally more slender proportions, differences that permit distinguishing them.

Inhabits the Mediterranean.

3. SPOTTED LUIDIA. L*UIDIA MACULATA*.— Müller and Troschel,

— Müller and Troschel., Syst. der Aster.,p. , sp. 2.

Inhabits the seas of Japan.

4. LUIDIA FROM SENEGAL. *LUIDIA SENEGALENSIS* — Müller and Troschel.

— *Asterias senegalensis*, Lamarck, Anim. s. vertèb., 2^{e} édit., t. III, p. Encycl. méthod., pl. 121, f. 1–2. — *Luidia senegalensis,* Müller and Troschel, Syst. der Aster., p. , n°3.

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5. WILLIAMSON'S LUIDIA. *LUIDIA WILLIAMSONI*. — Forbes. — Forbes, Mem. geol. Surv., t. III, p. 480. — *Asterias williamsoni*, Forbes, London Mag., 1836, t. IX, — *Luidia murchisoni*, Pictet, Traité Pal., t, IV, P 272.

Fossil of the Lias of Yorkshire,

Gray has described under the generic name of *Petalaster*, two still doubtful species of Asteroids. *Petalaster hardwickia*, Gray (Ann. and Mag. of nat, Hist., 1840, p, 185), from the Indian Ocean and *Petalaster columbia*, Gray (*loc. cit*.) from San Blas.

27th GENUS. **PTERASATER**.. PTERASTER.— Müller and Troschel.

(πτερον, wing; αστηρ, star.)

Body pentagonal, depressed, covered entirely above with a bare skin supported on by the bundles of small, thin spines between this skin and the reticulated framework. The periphery is formed by a row of long spines that are connected to each other to their end by bare skin. On the ventral surface are transverse rows of spines united to the end by the skin like fins. No pedicellariae. Anus central.

This genus, extremely remarkable by the extreme development of its dermis, has in the arrangement of the spines embedded there a very singular type of Asteroid. We know, up to now, only a single living species. We shall see, however, that some genera

(*Bdellacoma*) found in the fossil state in Palaeozoic terrains have the greatest affinity with it.

1. ARMED PTERASTER. *PTERASTER MILITARIS*. — Müller and Troschel.

— *Asteriscus militaris*, Müller and Troschel. Syst. der Aster., p. 44. — *Pteraster militaris*, Müller and Troschel. Syst. der Aster., p. 128, pl. VI, f. 1.— *Id. Id.*, Duben and Koren, Mem. Acad. Stockh., p. 246, n° 25, pl. VII, f. 11–13.

Body pentagonal, having the largest radius of the disk, the arms included, approximately double the small one. Ventral surface flat. Dorsal surface slightly convex and with bundles formed of two or here very long and very thin spines fixed under the skin by tendinous fibers. This skin is, in addition, soft and fleshy and has many wrinkles. All the ventral surface is occupied by transverse rows of six long spines in the skin that connects them in the manner of fins. The spines of the ambulacral grooves are completely missing. The madreporite plate is located very near the center

Color reddish. Dimension: total width 94 mm.

Inhabits Greenland, Spitzberg.

2. *Pteraster capensis*, Gray, Ann. and Mag. of nat. Hist., 1840, t. XX, from the Cape of Good Hope.

Species still doubtful.

With the impossibility of classifying with certainty the genera of Asteroids that we know only as fossils because the characters used for living species are completely missing, we have had to relegate them in the end under the label of extinct genera. The study of these genera showed us that most should probably be reported to the third tribe. There is one especially, restricted to Paleozoic terrains, that has the greatest similarity with the presently living genus *Pteraster.* This is the genus *Bdellacoma*, Salter.

GENERA IN THE FOSSIL STATE (EXTINCT)

1st Genus. **PALAEASTER**, — Hall.

— *Uraster* (sp.), Forbes.

Disk depressed with thin edges between the arms. Arms thick, convex, short or moderately elongated with several rows of spines and pierced with pores. Ambulacral grooves wide, bordered on both sides with a single row of large and flattened plates. Tuberculated madreporite in the re-entrant corner next to the base of the arms.

This genus was established by Hall (Pal. of New York, t. 2, p. 247 and 352), for Asteroids whose species had been described as *Uraster* (= *Asteracanthion*).

All the species referred there are from Silurian terrains, either of America or England.

1. *Palaeaster niagarensis*. — Hall. — Hall, Pal. of New York, t, 2, p. 247, — *Id. Id.* Pictet, Traité de Pal., t. IV, p. 265, pl. 98, f. 2.
   Fossil of the Middle Silurian terrain of Lockport (Niagara).
2. PALAESTER OPRUS. *Palaeaster obtusus*. — Salter. — *Uraster obtusus*, Forbes, 1849, Mem. geol. Surv., Dec. I, pl. 1, f. 3. — *Palaeaster obtusus*, Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 326.
   Fossil of the Lower Silurian terrain of Westmoreland (England).
3, PALAEASTER DE RUTHEN. *Palaeaster ruthveni*.—- Salter.— *Uraster ruthveni*, Forbes, Mem. of geol. Surv., t. 2, p. 462, pl. 1, f. 3. — *Id. Id.*, Pictet, Traité Pal, t. IV, p. pl. 98, f. 1.-- P*alaeaster ruthveni*, Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 326.
   Fossil of the Lower Silurian terrain of Westmoreland (England).
4. PALAEASTER SANGSUE. *Palaeaster hirudo*. — Salter. — *Uraster hirudo*, Forbes, Mem geol. Surv., 1849, Dec. I, p. 462, pl. 1, f. 4. — *Palaeaster hirudo*, Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 326, n° 5.
   Fossil of the Lower Silurian terrain of Westmoreland (England).
5. PALAEASTER COURONNETTE. *Palaeaster coronella*. — Salter, — Salter, Ann. and Mag. of nat, Hist., 1857, t. 20, p. 326.
   Fossil of the Silurian terrain of Greenwich (England).
6. PALAEASTER TRESRUDE. *Palaeaster asperrimus*.— Salter. — Salter, Ann. and Mag. of nat. Hist, 1857, t, 20, p. 325, pl. IX, f. 1.

Species with five arms that are short, nearly cylindrical, blunt at their end. The dorsal surface is covered with twelve longitudinal rows of sharp tubercles. Ambulacra wide, deep, edged with transverse plates that are strongly keeled.
Fossil of the Silurian terrain (sandstone of Caradoc) N. Wales.

2nd GENUS. **PALASTERINA**. *PALASTERINA*.— Mac'Coy.

Pentagonal disk depressed. Arms not very elongated. Dorsal surface has three or four principal rows of tubercles mixed with plates, especially in the interbrachial corners. Ambulacral grooves narrow, bordered with small plates that are quadrangular, narrow, and more outside, a single row of wide, square plates. Interambulacral spaces with wide plates that are triangular, protruding, spiny and pectinate.

This genus contains only one species that had been placed by Forbes among the *Uraster.*

PALASTERINE ANCIENNE. *Palasterina primaeva*. — Salter.—*Uraster primaeva*, Forbes, Mem geol. Surv., t. 2, Dec. 1, p. 462. — *Palasterina primæva*, Salter, Ann. and Mag. of nat. Hist., 1857, p. 324, tab. IX, f. 2,
Fossil of the Silurian terrain of Westnsoreland (England).

3rd GENUS. **TROPIDASTER**. *TROPIDASTER*.— Forbes.

Disk pentagonal, wide, flattened, extended into five arms that are very short, wide and blunt at the end and keeled on their dorsal surface. Keel composed of a double row of plates in the form of scales. The rest of the surface is covered with single tubercles, not spiny, arranged in transverse rows. Ambulacral grooves edged with transverse plates, armed with spiny crests, protruding into the internal edge.

This genus has the general form of *Asteriscus*, but it is distinguished especially by its keeled and very scaly arms. We know only one species coming from the lower beds of the Jurassic terrain.

TROPIDASTER PECTINÉ. *Tropidaster pectinatus*.— Forbes. — Mem. geol. Surv., Dec., 3, p. 3. — *1d. Id.*, Pictet, Traité Pal., t. IV, p.265, pl. 98; f.3.
Fossil of the Lias of Gloucestershire.

4th GENUS. **LEPIDASTER**. LEPIDASTER. — Forbes.

Body depressed with numerous short and blunt arms. The dorsal surface is covered with polygonal ossicles. The ventral surface has four rows of oblong ossicles or plates united in pairs on each side of the ambulacral grooves and a little like scales. The groove itself has in the interior small polygonal plates.

By its general form and especially the multiplicity of its arms, this genus completely recalls *Solaster*, but the nature of the plates that cover it distinguishes it perfectly.

We know only one species coming from the Paleozoic terrain.

LEPIDASTER OF GRAY. *Lepidaster grayi*. — Forbes. — Forbes, Mem. geol. Surv., Dec. 3, pl. 1.— *1d. Id.*, Pictet, Traité Pal., t. IV, p. 273, pl. 98, f. 9.
Fossil of the Upper Silurian terrain of Dudley (England).

5th GENUS. **COELASTER**. *COELASTER*.— Agassiz.

The author of this genus says that it differs from *Crenaster* in that the interior cavity is circumscribed by plates likes those of Urchins and that it, even toward the top, an ambulacral star.

According to these characters, the genus that concerns us here, would be very singular and relate on one hand to *Crinoids* and on the other to *Echinoids*. We know only one species.

CAELASTER OF COULON. *Caelaster couloni*. — Agassiz. — Agassiz, Mém. Soc Neufchâtel, t. 1, p. 191.
Fossil of the Cretaceous terrain.

D'Orbigny (Prodrome) has referred to this genus several species described under the name of *Aserias*, such as: *Asterias matutina*, Hall; *Asterias tenuiradiata*, Hall; *Asterias*

constellata, Thor.; *Asterias americana*, Graham, and *Asterias mandelslohi*, Munster. According to the judicious remarks of Pictet, it is appropriate to place these species in other genera, the first four would be *Asteracanthion*, and the fifth an *Astropecten.*

6th Genus. **Pleuraster**. *PLEURASTER*.— Agassiz.

This genus, still little known, approaches *Astropecten.* It is distinguished, according to D'Orbigny, by the existence of a single row of marginal pieces on the arms. We refer there the following two species.

1. Pleuraster obtus. Pleuraster obtusa. — Agassiz — *Asterias obtusa*, Goldfuss, Petref. 1, 1833, p. 208, pl. 63, f. 3. — *Pleuraster obtusa*, D'Orbigny, Prodr., t. I, p. 177. Et. 5e, no 98.—*Id. Id.*, Pictet, Traité Pal., t IV, p.272.
   Fossil of the Conthylian stage, found in the vicinity of Draguignan (Var) and in Wurtemberg.
2. Pleuraster arenicola. *Pleuraster arenicola*. — Agassiz. — *Asterias arenicola*, Goldfuss, Petref., pl. 63, f. 4. — *Pleuraster arenicola*, D'Orbigny, Prodr., t. I, p. 381. and 13e, no 535. — *Id. Id.*, Pictet, Traité Pal., t. IV, p.272
   Fossil Oxfordian stage of Westphalia.

7th Genus. **Arthraster**. *ARTHRASTER*.— Forbes.

Disk narrow. Six or seven arms, cylindrical, covered, as well as the disk, with small plates that are very close together. Each of these plates is ended by a sharp corner and surmounted on a crest. It appears that it is with *Ophidiaster* that this genus should be placed that differs especially by the considerable fewer pieces in the arcs of the arms. We know, until now, only a single species.

Dixon's Arthaster. *Arthraster dixoni*. — Forbes, — Forbes, Mem, geol. Surv., t. II, p. 465, and in Dixon, Geoi. of Sussex, p. 336, pl. 23, f. 1.
Fossil of the Upper Chalk (Senonian stage) of the county of Sussex (England).

8th Genus. **Bdellacoma**. *BDELLACOMA*.— Salter.

— *Palaeocoma*, Salter (non D'Or.).

Disk flattened, membranous in the center and covered with star-shaped spicules. Interbrachial corners also membranous. Arms flattened, covered with several rows of quadrangular, reticulated and fringed on their edges by a row of small spines. The ventral surface has very narrow ambulacral grooves, edged with quadrangular plates a little longer than wide and alternate. Then, outside, are two rows of marginal plates. Oon the external row the plates are keeled and without spines. The other row is formed of plates that are larger, oblique, with pectinate edge and with very long and erect spine.

This extremely curious species completely recalls by it general form as well as by its plates edged with spines in the form of a comb, the genus *Pteraster*.

This connection is all the more curious as the genus that concerns us at the moment is restricted to the Silurian stage.

In establishing this genus, Salter (Ann. 1857, p. 324) imposed on it the name of *Palaeocoma*, He divided it into two sub-genera: *Bdellacoma* and *Rhopalocoma.* As the name of *Palaeocoma* had already been used by D'Orbigny for a genus of the order of Ophiuroids, we believed in necessary to take as its generic name that given it as a sub-genus by Salter.

1. MARSTON'S BDELLACOMA. *Bdellacoma marstoni*. — Salter— *Palaeocoma marstoni*., Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 328, pl. IX, f. 3.

Arms lanceolate, four times longer than wide and blunt at their end, edged exteriorly with straight marginal spines, not very elongated. Mouth large. Ambulacral grooves narrow. Dimension: three inches.

Fossil of the Upper Silurian terrain at Leintwardire.

2. COLVIN'S BDELLACOMA. *Bdellacoma colvini.* — Salter.—*Palaeocoma colvini*, Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 328, no 2.

Species flattened, covered with very long spines, flexuous and bristly spines. Arms depressed in the form of a ribbon and spiny. Ambulacral grooves narrow. Mouth small. Dimension: 6 inches.

Fossil of the Upper terrain of Leintwardine.

3. SWAN'S FOOT BEDELLACOMA. *Bdellacoma cygnipus*. — Salter. — *Palaeocoma cygnipus,* Salter. Ann, and Mag. of nat. Hist., 1857, t. 20, p. 329, n° 3.

Species thin, having the form of a narrow disk and as membranous. Arms elongated, with short spines. Mouth very small. Dimension: 2 ½ inches.

Fossil of the Upper Silurian of Leintwardine.

4. VERMIFORM BDELLACOMA. *Bdellacoma vermiformis*. — Salter. — *Palaeocoma* (*Bellacoma*) *vermiformis*, Salter, Ann. and Mag. of nat. Hist., 1857, t. 20, p. 329, no 4.

Arms very long, linear with short spines and claviform tubercles. Ambulacral grooves wide and alternate.

Fossil of the Upper Silurian terrain of Leintwardine.

5. PYROTECHNIC BDELLACOMA. *Bdellacoma pyrotechnum*. — Salter. — *Palaeocoma* (*Rhopalocoma*) *pyrotechnium*, Salter, Aun. and Mag. of nat. Hist.,
1857, t. 20, p. 329, n° 5.

Species pentagonal, with very short arms, reticulated surfaced and edged with short spines, claviform, flattened. Dimension: 2 ½ inches.

Fossil of the Upper Silurian terrain of Leintwardine.

APPENDIX.

We mention another genus for which we for which we lack sufficient information to assign its place in the Series with certainty.

9th Genus. **BRISINGA ABSJORN**.

— *Absjornsen*, Fauna littoralis, liv. II, p. 95, and Ann. and Mag. of nat. Hist., t. XX, 1857, p. 320.

Disk small, sub-pentagonal, armed with spines, a madreporite plate located on the side. Arms cylindrical, elongated, with a large number of small transverse ribs. Ambulacral grooves with three rows of papillae in the form of spines on each side, similar to those that cover the different parts of the disk and that are themselves echinulate, their bae being invaginated in a kind of sheath formed by the skin. Two series of pores on the lateral and dorsal parts of the arms. Pedicellariae numerous.

This genus, still doubtful, appears intermediary between *Ophiuroids* and *Asteroids*. We know only one species.

Brisinga endecacnemos. Ans. loc. cit., t. IX, f 1–15.

It is very bright red vermillion and reaches a total width of approximately 10 to 12 centimeters.

Inhabits the seas of the North (Hardangerfjord).

FOURTH BOOK.

ECHINOIDS.

DEFINITION.

Echinoderms have bodies that are oval, globulose, regular, constituted of a solid calcareous envelope composed of polygonal plates that are juxtaposed and fused more or less intimately, forming regular rows and have mamelons or tubercles with spines or radioles, solid, calcareous, extremely varied in their form and serving either for locomotion or especially organs of protection.

Some constituted plates are pierced with holes or pores forming regular longitudinal rows, called ambulacra. These holes give issue to very extendable tubular tentacles that serve for location, but also and especially for respiration.

Mouth located most often on the ventral surface of the body, but in some cases occupying a variable position. It opens in an opening of the test and is often armed with extremely developed jaws. Anus always distinct, vary variable in position, while obviously approaching the dorsal surface that it occupies in the largest number of cases.

Sexes separated in distinct individuals. The openings of the organs of reproduction are always toward the dorsal top.

REVIEW.

The very singular form of urchins, the nature of their test ornamented exteriorly sith spiny extensions have caught the attention of naturalists for a long time. Aristotle applied the name of Echinus to them. During the XVth and XVIIth century, some authors occupied themselves with Echinoids. Rondelet in 1554, Gesner (1565), Aldrovande (1599) have spoken of them in their writings and, like their predecesors, placed them sometimes among the Crustaceans, sometimes among the Mollusks or Tetaceans in consideration especially of their tough and solid covering. Rumphius (1705) made known some new forms. Then Breynius (1732) considered them more specially because his studies resulted in the establishment of several genera that we find in the classifications today although these

genera were ignored for a long time by the authors who came after him. We can cite the genera *Echinobrissus, Echinanthus, Echinocorys, Echinodiscus, Echinometra*, etc. In 1734, Kiein also made a very remarkable work on the Echinoids in which he established 14 particular genera of which some had already mentioned by Breynius but attributed other names to them. Despite this, Klein still has the genera *Cidaris, Discoidea, Mellita, Laganum, Arachnoides, Spatangus* and *Brissus*, and as for the genera founded by Breynius, we see them abandoned by subsequent authors until recently when they have been used by Agassiz. Toward the year 1742, Gualtieri worked with Echinoids and separated the species into 4 genera whose names are borrowed from Breynius. These are: *Echinometra, Echinanthus, Echinospatagus* and *Echinodiscus.* We see that already confusion begins to increase again and reaches in some way its apogee in the *Systema naturæ* (1758): Linné in fact forms only one genus for all Echinoids under the term *Echinus*.

Davila (1767) accepts six genera that he borrowed from the classification of Klein. These are: *Cidaris, Spatangus, Brissus, Scuta, Placenta* and *Rotula.* Then comes Van Phelsum (1774) who accepted the genera of Breynius and added those of *Echinoneus* and *Echinocyamus*. F. Müller (from 1776 to 1789). Scopoli (1777) separated Urchins from Testaceans to unite them with Asteroids and Polvpiers.

In 1778, Leske accepted the genera established by Klein, to which he added 3 of Breynius and created the genus *Echinarachnius*. Blumenbach (1779) made the Echinoids separate under the name of Crustacea and added the Stars or Asteroids.

Molina (1782) described several species from the coast of Chile. Bruguière (1789) adopted the system of Blumenbach but changed the name to Vers Echinodermes. He gave in addition in the *Encyclopédie méthodique* a large number of representations of species taken from the works of his predecessors, most particularly of Klein and Linck. At the same time, he added some new ones. It is still there, it is necessary to say, that we find united most of the recent Echinoids. Faujas de Saint Fond, in his *Histoire de la montagne Saint-Pierre de Maestricht* (1799), made known some fossil species of the Upper Chalk. Then in 1801, Lamarck took up the classification of Echinoids and preserved or established the following genera: *Galerites, Echinus, Echinoneus, Cassidulus, Clypeaster.* In 1816, in his immortal work on *Animaux sans vertébres*, he completed his first attempt and founded new generic sections under the names of *Scutella, Fibularia, Ananchytes, Cassidulus*, etc. Already, at this time, the French Linné took great advantage of the relative position of the mouth and anus to establish divisions of a higher order among the Echinoids.

It is necessary to go to 1829 to find works of any importance on these animals. Cuvier first, in his *Régne animal*, concerned himself with both the organization and classification of Echinoids. We find already the separation of Echinoids into two principal groups, the E. regulars and the E. irregulars. In France, Marcel de Serres and Defrance, in England, Phillips made known some fossil species.

de Blainville (*Manuel d'Actinologie*, 1834) presented a new classification of Echinoids that he divided first into two families: E. excentrostomes and E. centrostomes, according to whether the mouth is not or on the contrary is central. This author accepted 17 genera taken from his predecessors and founded that of *Echinoglycus* (= *Clypeus*, Klein). Desmolins (1835) published his *Études sur les Échinides* and added to the 17 genera of Lamarck those of *Pyrina, Echinociduris, Heliocidaris* and *Coliyrites.* Then Gray, the same year established the genera *Echinolampus, Diadema, Arbacia, Salenia, Asteropyga.* Roemer described and figured a large number of fossil species. Agassiz (1836), whose

name will appear so often in speaking of Echinoids, gave a first classificaiono tht contained 29 genera, of which: 1 of Linné; 8 of Lamarck; 5 of Klein; 1 of Van Phelsum. Then he created 8 himself. These are: *Dysaster, Hemipneustes, Holaster, Micraster, Amphidetes, Schizaster, Catopygus* and *Pygaster*. It is toward this period that the knowledge of fosil species received a very marked increase from the works of Goldfuss, Hoennighaus, Munster, Grateloup, Koch and Dunker (1837), Hisinger, Dubois de Montperreux, Bronn, Leymerie, D'Archiac, etc., etc. Agassiz (1838) established new genera belonging to a family remarkable for the disposition of the apical system, to which he gave the name Salenias, containing the genera: *Goniopyqus, Salenia, Peltastes* and *Goniophorus.* Then, from 1839 to 1840 (*Échinides de la Suisse*), he created the genera *Pygorhynchus, Conoclypus, Pyqurus, Hyboclypus, Tetragramma, Acrocidaris, Pedina, Acrosalenia, Hemicidaris, Glypticus.* In 1840 (*Cat. syst. Ectyp. Echin. foss. Mus. Neoc*.), the same authormade known by the diagnosis the genera *Toxaster* (— *Echinospatagus*, Breyn.), *Brissopsis, Nucleopygus, Globator, Caratomus, Amblypygus, Amphiope, Eucope, Echinopsis, Cyphosoma* (= *Phymosoma), Acropeltis, Cœlopleurus, Codiopsis, Podophora, Acrocladia*.

In 1841, in the introduction to a *Monographie des Scutelles*, he established, at the expense of the genus *Echinus*, those of *Temnopleurus, Pleurechinus, Microcyphus, Tripneustes, Amblypneustes, Toxopneustes, Stomopneustes, Tetrapyqus, Agarites*, and in the group SCUTELLIDAE, the genera *Runa, Lobophora, Scutellina, Moulinsia*. It is also in 1841 that Valentin published his *Études sur l'anatomie du. genre Echinus*, in which he summarized all that knew on the organization of Urchins and at the same time published details of some points still doubtful until then. Everything relating to the detailed structure of the different parts of the external covering, as well as the principal viscera, was elucidated with wisdom and remarkable skill.

In 1842, Desor published successively the monographs: 1° of Clypeasterids that he separated into 11 genera, with a new genus *Holetypus*; 2° that of *Dysaster*.

de Koninck (1842–44) concerned himself with the fossil species of the Carboniferous terrains and Sismonda (*Mem. Geo-Zool. Echin. foss. di Nizza*, 1843) described some species of the Tertiary terrain of Italy. We also cite about the same time the works of Forbes (Ann. and of nat. hist., vol. XIV, p. 413), of Merian (*Cat. syst*.), of Duben and Koren (*Zool. Bird*), the species living in the seas of the North; Marcou (*Fossiles du Jura salinois*), two species; Morton (*Syn. foss. cret. des Etats-Unis*); Murchison and de Verneuil (*Geol. de la Russie d'Europe*), and then MCoy, that reported the genera *Palaechinus, Echinocrinus*, i. e., the first representatives of Echinoids in the layers of the earth (*T. palaeozoiques*). Klipstein (1846) made known Triasic species. Philippi established the genus *Tripylus*, and Forbes (*Trans. of the geol. soc., vol. VII*) gave the description of 8 species of fossils. In 1847, Duchassing, (*Bull. soc. geol. de France*), Deshayes (*Explor. scientifique de l'Algérie*), made known species of the Antilles and five species from Africa.

It was also the same year of the great work of Agassiz and Desor (*Cat. rais. des Echinides*), in which the authors presented a complete table (for this period) of all the Echinoids.. Forbes (1850, *Mem. geol. Survey 1 to V decade*), and Salter, in the same collection, published a large number of fossil species from England. In 1851, Wright gave the monograph of the Cassidulae of the Oolothe (*An. and Mag. of nat. hist*). Michelin, whose works on echinoderms are numerous, gave (*Revue et Mag. zool.,* janvier 1851) the description of some new species of Echinoids. In 1852, Forbes (*Monogr. of the Echinod.*

of the British Tertiar. Pal. Society) concerned himself with the Tertiary species of the same country. 1854, D'Archiac and J. Haïme made known the Nummulitic species of India and Herkolt those of de Java. In 1855, Wright, already cited, gave monographs of the Echinoids of the Oolite relating to the Cidaridae, Hemicidaridae and Diademidaes, then those of the island of Malta (*Ann, and Mag. of nat. hist.,* vol. XV). It is in this same year that the question of the perforation of the rocks was discussed. Robert, Lory and Caïllaud have each presented their observations on this subject and to which we shall soon return.

In 1856, Michelin (*Revue et Mag. de Zool*.) made known some species of fossil Echinoids. Leuckart (*Weigm. Archiv 1858*), Sars (*Nyt. Mag. for NaturvId.*) occupied themselves with the Echinoids of the Mediterranean. Lutken reported the presence of *Echinus drobachiensis* in Greenland.; Stimpson, *Echinus purpuratus* at San-Francisco. Philippi described *Echinus magellanicus* and made critical observations on *Echinocidaris spatuliger*. Barrett (*Ann. and Mag. nat. hist.,*t. XIX, p. 33) concerned himself with *Amphidetus gibbosus*, and Grube (*Weïgm. Archiv*) with *Brissus panis*. But the work on fossil Echinoids will henceforth dominate and it is necessary to cite in first place those of Cotteau, Desor and Michelin, who, successively and up to the present even, published a large number of memoirs on the Echinoids. Desor gave his nice work titled *Synopsis*, that was the most complete summary of our knowledge of fossil Echinoids. Michelin (*Revue et Mag. de Zool.* 1858) reviewed the species of the genus. This memoir is followed by a note relative to the principle that should guide the descriptions of Echinoids. Ebray (*Bull. soc. geol.,* t. XV, p. 482) proposed the establishment of a new genus under the name of *Centropygus* (= *Galeropygus*), then in his *Études paléontologiques du département de la Nièvre*, concerned himself with fossil Echinoderms. Finally, he gave a note (*Bull. soc. geol.,* t. XV, p. 523) on the classification of the Echinoconidae. In 1858, Cotteau studied the apical system of the genus *Goniopygus*.

In 1859, Michelin (*Bull. soc. geol. Pr.,* 2° série, t. XVII, p. 146) gave the description of some new Echinoids:: *Porocidaris tuberculosa, Cassidulus sorignesi, Hebertia parisiensi*s.. Then, in the *Revue Cuviérienne* (1859, n° 9), the diagnoses and descriptions of Laganids, 6 species of the genus *Echniarachnius*, of which 3 were new, *Echniarachnius asiaticus, Australae,undulatus* Mich.; the genus *Polyaster*, and finally *Echinocyamus australis* Desmoul. *Clypeaster gaimardi* A. Br. was the subject of a corrective noteest l'objet d'une note rectificative (Bull. soc. geol. Pr., t. XVI, p.767).

Cotteau (in the same collection, p. 289) gave a note on the genus *Galeropygus*, created by himself in 1856. Then, in 1860, he described the Echinoids of Spain collected by de Verneuil, Triger and Collomb (*Bullet. soc. geol. Pr*., t. XVII, p. 572) and then gave a note on the genus *Heterocidaris* (*H. trigeri*). Finally, the same author published, in collaboration with Triger, a grand work on the Echinoids of Sarthe that is not yet finished.

ECHINOIDS — DESCRIPTION.

Animals that are globular, ovoid or disciform with a rounded or sharp and diversely notched contour, have a test of exterior skeleton covered by an integument that is thin, membranous and with cilia and that is prolonged into diverse appendages and contributes continually to their growth.

The test of Echinoids is formed of plates that are polygonal, areolar, contiguous and adherent at their edges. These plates form twenty rows arranged by pairs. two larger called

interambulacrals with stronger spines and two narrower, called ambulacrals, are pierced by holes by which retractile tentacles pass. These rows of plates leave, radiating, from the top or middle of the dorsal surface and go to end at the edge of the mouth that, often, occupies the middle of the ventral surface. The number of these plates increases with age toward the top and, in addition, each plate grows on all its periphery, but more particularly in the direction of the width.

The pores for the passage of the retractile tentacles are arranged with great regularity in longitudinal bands and in very variable transverse or oblique rows. They form thus bare bands without any appendage and as if bare in the manner of a garden path, the source of the name ambulacra (*ambulacrum*) that has been given them. There are always five pairs of these ambulacra. In some Echinoids, the ten ambulacra extend more or less distinctly from the dorsal top to the mouth that is centro-ventral. But in others, they are less extended and joined in pairs before having reached the edge of the test and thus form a kind of rosette with five petals, more or less regular, around the dorsal top. Finally, in some genera, like Spatangoids, there are only four very evident petals, the fifth being hidden in a kind of depresion or dorsal gutter. The tentacles of the ambulacra are tubular, covered with longitudinal and transverse muscle fibers. They swell and become turgid by the influx of liquid that they contain. We see them then pass the length of the spines so that they attach to various solid bodies by means of the terminal sucker that is supported by a reticular calcareous disk (pl. 9). Other fleshy tentacles, little or not retractile, are noted around the mouth. They are palmate and appear to serve simply for touch like the palps of articulate animals.

The spines have a porous structure like those of the test. Those of Urchins and Cidarids are longitudinally grooved for form lamellae starting from their axis, all riddled with holes and united by transverse extensions so that we see from the outside only the edge of these lamella, covered with a ciliated membrane. The dimensions and form of these spines is extremely variable. Some Cidarids have spines three or four times longer than the diameter of the test while in Urchins strictly speaking they are four or five times shorter than this diameter and the spines of *Clypeasteroids* and *Spatangoids* are like short bristles lying on the surface. It is especially among the Cidarids, either living or fossil, that these spines take extremely varied form as well as considerable size. In some fossil species, we see kinds of funnels or swellings in the form of olives or become pyriform. It is in the latter, very common in Jurassic terrains, to which previously were given the name of Judaic stones. All these spines end at the base in a small, smooth head, separated by a constriction or collar that corresponds to the insertion of motor fibers. The ventral surface of this small head is hollowed with a small concave articular fact that fits onto a corresponding tubercle of the test.

The tubercle, sometimes very large and protruding, is perforated in *Diadema* that gives passage to a ligament has been suggested. But this is a mistake. It is simply an extension of the interior cavity because the spines are really held only by the fibers inserted on their collar.

ANATOMY. — SKELETON.

The dermal test or skeleton of Echinoids, compared to that of other Echinoderms, attains in some way here its peak of development.

It constitutes in fact a solid covering, composed of a very large number of pieces or testaceous plates, to which we have given different (plaquettes, assules). These plates are hexagonal or polygonal. In consideration either of their position on the surface of the body or of the organs they protect, can be divided into four groups: 1° genital plates; 2° ocular plates; 3° ambulacral plates; 4° interambulacal plates.

The arrangement of all these pieces in relation to each other shows that the test of an Echinoid can be divided into vertical zones leaving from a central point, the top (*apex*) and ending in at a point diametrically opposite the spheroid, i. e., at the buccal opening. These vertical zones have received the name of area and are distinguished as ambulacral areas or poriferous zones (*ambulacra*) and interambulacral areas. There are always five of each kind. They are unequal, the first being generally less wide than the second. Each area is composed of a double row of plates so that there are twenty zones, ten constituting the ambulacral zones and ten the interambulacral zones. Agassiz has taken these elements to more general proportions. This scholar considers the Echinoid is formed of five segments of a sphere of equal size: two paired segments and one unpaired. Each of them contains a poriferous zone placed between two interambulacral zones and thus perfectly compared to an arm of an AsteroId. The unpaired segment has been regarded as the anterior and its determination is always in the certain in the sense that it is constantly opposite the large genital plate that is as easy to recognize because it has the madrepore tubercle.

The mode of appearance of all these plates has this remarkable arrangement, that it is the genital or ocular plates, i. e., that appear first, their number being moreover invariable, then the other plates, either ambulacrals or interambulacrals develop. Their number increases with age. The apical plates (*apical system*) are of two kinds and form around the anal opening. When they are central, a double ring, one internal, the other external. The first is formed of anal plates whose number varies with size and that ordinarily take a triangular or pentagonal form at the same time their surface is either smooth or granular. We give the name periproct to this ring that consequently contains the anus.

The second ring is composed of ten plates, five genitals and five oculars. These genital plates are pentagonal, and each is pierced by a small opening called the genital pore that serves for the release of the reproductive products. When the anus is not located at the top, there plates still exist in this region. Only, there are only four instead of five. We see them then remain in contact or separated, two to the right, two to the left. The anterior right, always large, has moreover the madreporite tubercle. In some cases, as in the genus *Holectypus*, for example, there is a fifth genital plates, called the complementary plate that corresponds to the anal side. Finally, in some genera in the family Salenidae, there is a sixth plate to which we have given the name suranal.

The ocular or intergenital plates are always five in number. They are generally saller than the genital plates and located outside them. Their size is moreover variable, but each is always pierced by a small hole, or ocular pore, destined to lodge the organ of vision. Some genera, however, are exceptions to this, such as *Collyriles, Echinocorys, Holaster* and *Cardiaster*.

The ambulacral or branchial plates form five zones: an unpaired anterior and two bilateral pairs. Their number is invariable and is always greater than those of the interambulacral plates at the same time they are narrower. Each plate is pierced by two or more ambulacral pores. The union of these pores in two rows of plates forms two vertical zones call poriferous or ambulacral zones. These pores that give passage to the organs for respiration are usually elongated, oblong or tear-shaped. They are equal or unequal, transverse of oblique. Finally, we say they are conjugated when pairs are united by a transverse groove, unigeminate of by single parts, bigeminate, trigeminate, multigeminate.

These ambulacra play a very important role in the economy of the animal, furnishing very important characters for the classification of Echinoids. We call ambulacra simple when they extend in a straight line from the dorsal top to the edge of the mouth that is opposite it. It is called *petaloid* when the two poriferous zones are separate from each other and then approach each other and unite. It is, on the contrary, *sub-petaloid* when this union does not occur and there remains an interval toward the end. Then, it can be complete or incomplete according to whether it extends from the top to the mouth without interruption or it disappears at some distance from the top to reappear in the vicinity of the mouth. Finally, it is said to be *limited* if it disappears more or less far from the top without then reappearing.

The interambulacral plates form five double rows leaving from each genital plate and extending vertically to the mouth. Their number is unlimited, and their form is hexagonal. They have two small facets at the ends and two large facets, one above, the other below. They are always larger than the ambulacral plates and ordinarily have larger tubercles and consequently also spines or rods of a greater size.

All the plates, ambulacral or interambulacral, have extremely variable tubercles, either in number, size and their arrangement on the surface of the EchinoId. Some are large and arranged in regular rows. These are the principal tubercles that have in general large spines. Others, smaller, intermediate, are call miliary tubercles. The principal tubercles vary in number according to age, but especially according to species. The interambulacral areasa contain more than the ambulacral areas. To give an idea of the numerical importance of these tubercles, we recall that in *Echinus lividus*, for example, we count 90 rows divided as follows: 10 primary rows, 10 secondaries and 5 or 10 tertiaries; for the interambulacrals, there are 40 primary rows, 10 secondaries, 10 tertiaries and 10 quaternaries that, at 649 per zone, gives a total of 3,200. The arrangement of these tubercles on the surface of the Echinoid is generally very regular and it has been demonstrated that it forms a double spiral system, of which one is directed from left to right and the other in the inverse direction.

As for their structure, the tubercles have some notable peculiarities. In general, they are constituted by a kind of smooth mamelon, sometimes pieced with a hole at their top. We then call them simple, mamelonated, smooth or crenelated. Then, in their arrangement, they are scattered or in rows. Their base is surrounded by a raised, areolar region, sometime smooth, often radial called *scrobiculate* or scrobicular circle. All these tubercles are destined to support the organs to which we have given the name of spines and rods. The size of these organs varies greatly. It is naturally in proportion to the size of the tubercles on which they are attached. These spines or rods are composed of two essential and very distinct parts:1° a free part, generally conical but having various forms; 2° a non-free part, hidden in the articular membranes or by muscles that move them. It is divided into two regions that are the head, or condyloid portion, and the annular swelling (collar) that gives

insertion to the motor muscles. The internal structure of these spines shows that they are composed of radiating lamellae, divergent from the center to the periphery, whose substance is of two kinds, on simple, the other reticulated. The mode of formation of these spines takes place by superposed lamellae so that a transverse section shows numerous concentric striations covering each other. The means of adherence between the spines and the and the tubercles is a kind of joint and has for parts: 1° an external pigmented membrane; 2° muscles that are inserted on the edges of the articular facet of the spine and go to attach to the other part of the periphery of the mamelon; 3° the articular capsule that consists of a very solid fibrous or ligamentous membrane.

The external surface of Echinoids has still other solid organs called *pedicellariae*. These singular bodies that we have already seen in Asteroids were first reported by O. F. Müller who considered them parasites. This author even described the different kinds, designating them under the names of *Pedicellaria globifera, Pedicellaria triphylla* and *Pedicellaria tridens*. Since this early period, pedicellariae have been studied by several naturalists: Tiedemann, Delle Chiaje, Forbes and Sars, and finally Valentin. This last author accepts three kinds that he designates by particular names: 1° gemmiform pedicellariae; 2° tridactyl pedicellariae; 3° ophiocephalus pedicellariae. The pedicellariae do not differ only in their form but also in the regions of the body of the Echinoids where they are ordinarily encounter thus: gemmiform pedicellariae are located around the large tubercles either on the ambulacral areas or on the interambulacral areas and sometimes even on the poriferous zones. These pedicellariae have a long, slender stalk on which is fixed a swelling to which we give the name of button and that is colored brown red. This button is, in its turn, surmounted by three pieces in the form of pincers that can be opened or closed at the will of the animal. These pincers have in addition dentiform protrusions that permit seizing objects and retaining the with more certainty.

The tridactyle pedicellariae, already mentioned by Baster, Tiedemann and Delle Chiaje, also surround the tubercles, but especially the small ones. Their head or button is composed of 3 convergent pieces, and each of these pincers is formed of two strongly serrated pieces and a third more deeply cut.

Finally, the ophiocephalous pedicellariae more commonly surround the buccal appendages. All these pedicellariae have a similar structure and are constituted of a kind of calcareous skeleton surrounded by soft tissue and cover with an epithelium with cilia. The functions of the pedicellariae, as well as the role they play in the economy of the Echinoids are still poorly defined. Mouro was the first to assign them the role of prehension organs. This point of view has been generally adopted as being the most probable with, however, explaining in a satisfactory say how this occurs.

To terminate what concerns the test, it remains for us to say some words about the internal surface. The walls are generally smooth and show in a more or less obvious way, the sutures of the different external plates with their polygonal, pentagonal or hexagonal fors. The ambulacral pores, seen from the interior of the test, are in the form of small round holes, pierced obliquely from outside to inside and from top to bottom. In the middle of each poriferous area rises a parallel keel, on each side of which leave horizontal protruding lines. This small system supports the respiratory tubes.

Toward the edges of the buccal orifice of the internal cavity, we note, in most species, vertically raised calcareous pieces in the form of auricles that give support to the jaws in the numerous cases where they exist. Finally, the interior of the test often has pillars or

extremely variable solid partitions destined to lodge the different parts of the intestine and, especially, to protect them.

DIGESTION, — RESPIRATION. — CIRCULATION.

We have already said that the ventral opening of the test in which the dental apparatus is embedded has in the interior and at its periphery vertical or horizontal lamellae constituting a veritable bony armature or framework having some variation it their disposition, but reducing in most cases the solid calcareous arcs that serve for the inserion of the muscles of the jaws and give an extremely solid support to a very complicated buccal apparatus known for a long time as *Aristotle's lantern* (pl. 2).

This apparatus is composed of five distinct symmetrical parts: 1° the tooth, 2° the dental plume, 3° the pyramid, 4° the scythe, 5° compass. The five teeth are contained in a gutter formed by the pyramids, in which ten are joined in pairs, their base being consolidated by five pieces in the form of a scythe, then by an equal number of other pieces in an arc that contributes equal to increase the solidity of the apparatus that, in summary, is formed of thirty distinct pieces.

The teeth have the form of pieces that are long, strong, arced, extended at the base in an enlarged part called the plumule. These teeth vary a little, moreover, according to group. It is thus that in Cidararidae, they are in the form of a gutter, In Echinids, they are tri-keeled as in *Acrocladia*. Clypeastroids have their dental apparatus much simpler than in Echinids. The jaws, in fact, are composed of only ten pieces fused in pairs, in the middle of which are fixed the five teeth. These jaws themselves rest on ten supports raised on the internal surface of the test and on which they pivot with the help of a kind of intermediary rotula. We thus find in them neither paired accessory pieces nor intermediary pieces. All the apparatus is reduced to horizontal lamellae forming a kind of star or very depressed rosette in its ensemble.

The buccal apparatus or jaws is missing in a large number of Echinoids, notably in the Spatangoids. But in all, the buccal opening is surrounded by very resistant buccal membrane that has not only small, irregular calcareous pieces but also particular pedicellariae and finally soft, branched organs that are considered as external accessory gills because the principal organs of respiration are the ambulacra.

Immediately after the buccal orifice and the teeth, in which they exist, the digestive tube begins by a very short pharynx, in pentagonal form, protected by the buccal apparatus. Then, following, begins the vertical esophagus that is followed by an intestine that is applied to the internal wall of the test. This intestine describes two principal circuits directed obliquely from bottom to top, from back to front, and from left to right, the lower being smaller. Independently of its successive swellings and constriction, the esophagus is distinguished from the intestine by a special structure. Its surface has irregular, longitudinal striations to which are joined follicular tissues that we are tempted to consider glands, if we were able to find excretory canals. This esophagus is, moreover, formed of three distinct membranes: 1° a muscular membrane 2° an outer cellular; 3° a mesenteric or peritoneal membrane that serves as a general covering of all the viscera and whose surface has cilia. The intestine strictly speaking opens directly into the esophagus without have any particular valve. It is wide, its membranes extremely thin and folded, and, of the three

membranes that make it up, the mucosa is only remarkable for its thickness. The terminal portion of the intestine goes up, in regular Echinoids, toward the top that is central, by a short and straight rectum that opens by a small anus surrounded by particular plates of which we have already spoken. We give the name periproct to the ensemble of the external anal apparatus.

The food of Echinoids is still little known. The presence or absence of a dental apparatus already indicates it is varied. Inspection of the material contained in the intestine has shown the presence of a large amount of debris of hard bodies, such as shells, coral, crustaceans as well as fragments of Echinoderms that permits thinking that some species are very carnivorous. Finally, the presence of vegetable material, shown in the same condition, shows that in some cases the food is equally vegetable.

Respiration.

The organs that bring about this important function in Echinoids are of several kinds. As in other Echinoderms, they appear to respire by all their external surface what has cilia on the integument and various appendages so that the ambient liquid is constantly renewed. But there is in addition an internal respiration that has its basis in all the ciliated surface of the mesentery and of the different viscera. We can even regard as organs specialized for respiration, the branched tubercles that surround the mouth. These organs, ten in number, are connected to the ten notches that exist on the periphery of the buccal orifice of the test. Finally, it is especially necessary to consider as more essential respiratory organs, the internal gills that are located on the internal surface of the test and form thus five double rows of organs arranged in transverse layers that have numerus vessels. These branches are connected to the poriferous zones of the test, across which pass the ambulacral tubes that thus become mediators of respiration by introducing the ambient liquid and placing it in contact with the gills. These tubes or ambulacral tentacles are small hollow cylinders that are very extendable, formed of longitudinal and transverse fibers, containing in their interior a kind of skeleton or calcareous network that forms at the end a kind of disk having itself numerous radiating spicules (30 to 40) that probably serves to increase the attachment of the terminal tentacles as a king sucker at their end. Also, independently of the role they play in respiration, it is perfectly demonstrated that, with the help of their terminal sucker, they can also function in locomotion.

Perhaps it is even necessary to apply respiration to what we call fascioles, i. e., bands or variously curved bands surrounding certain parts of the test and most particularly the ambulacra or the anus. These fascioles are formed of an accumulatio of extremely small pores making kinds of bands distinguished from other parts of the test by their smoother appearance. However, independently of the pores, they also have on their surface extremely fine black tubercles.

Finally, we add that the portion of the vascular system that we call aquafer system has also been give the function of respiration by some authors who accept that water, entering from the exterior by the ambulacral feet thus arrive in the gill vesicles, passing from there into the vascular trunks of the aquifer system that follows the axis of the ambulacra and communicates outside by ten openings located near the buccal opening.

Circulation.

According to the investigations of Cuvier and Duvernoy, there are in Echinoids two distinct vascular systems, the intestinal and the cutaneous. The intestinal vascular system has for the central organ a true heart that is fusiform, narrowed above, swollen below, approximately 4 mm long, with brown walls composed of interlaced fibers. This heart pours into the arterial system the blood that it has received from its opposite end, from a kind of pulmonary vein. The aorta that arises immediately gives a branch that goes to the esophagus and into the muscles of the buccal mass. Another branch follows the internal edge of the intestinal canal and is divided into numerous and delicate branches. At the opposite or external edge of the intestine is a vessel that, like it, increases in diameter from the origina of this canal up to its middle part, then decreases little by little in going toward the anus. It receives from the walls of the intestine many branches and produces many on the opposite side that go to the internal membrane of the visceral cavity. This vessel, which contains a clearer liquid than the preceding, is both a mesenteric vein and a pulmonary artery, if we accept that the blood sent to the peritoneum must be oxygenated by the sea water that is constantly renewed in this cavity. The blood appears to return to the heart by the vascular gills that pass into a ring surrounding the end of the intestine. It is from this ring that leaves a venous trunk that goes to the heart and ends in the end opposite to that which produces the aorta.

NERVOUS SYSTEM. — SENSE ORGANS.

The nervous system of Echinoids is composed first of an esophageal ring in the form of a pentagon, located near the mouth. Then, this ring gives off five nerve trunks that each enters the pyramids of the buccal apparatus and gives to the buccal membrane some fibers. Then these trunks cross the auricle and continue on the median line of the internal gills to end at the ocular pores, i. e., at the organs considered as eyes by different authors (Forbes, Agassiz). The branchial nerve is divided into two branches that give branches to the branchial filaments while other fibers go to the ambulacral tubes and to the terminal suckers.

The sense of touch is very developed in Echinoids. There is, in the active state, branched tentacles that surround the mouth and in the pedicellariae, but especially in the ambulacral tentacles that are also the principal organs of locomotion. Forbes, who has studied with care and sagacity the organization of these animals, has shown that they move with the aid of these tubes with a truly remarkable ease and sureness. He has seen perfectly these animals climb vertical walls of a very smooth vessel like a glass jar for example.

The muscles responsible for these active movements are formed of contractile fibers that are single or in a network, curved or cylindrical. Their very energetic contraction during the life of the animal is preserved for some time after mutilation of the individuals.

The passive organs of movement are the rods and spines.

Another sense, that of vision, really appears to exist in Echinoids. It resides in four or five red spots in the center of the ocular plates that alternate with the genital plates and are located at the top of the dorsal surface. These ocular spots, reported for the first time by Forbes (1841) have been studied by several naturalists. Their determination as ocular spots was rejected for a long time principally because of the consideration that it was

impossible up to now, to demonstrate the presence of a lens. Direct observations made during the life of the animal in the goal of demonstrating the existence of an organ of vision are rather rare in science. Also, we believe it is necessary to report here that it is due to F. de Candé, captain of the ship that reported the following fact: “I examined”, he said, “ on the side of a pool of water, an Urchin with long rods (*Diadema*) that I attempted to grasp when I saw it direct in the direction of my hand, all the rods as if to defend itself. Surprised by this maneuver, it attempted to grasp it from another direction. Immediately its rods were directed to this new side. I thought form then on that the Urchin saw me and defended itself from my approach. But, however, to know if this movement did not come from the agitation of the water at my approach, I repeated the experiment slowly and even above the water with a stick. The Urchin always directed its rods to the side of the object that approached it, either in the water or outside. I became certain that these animals certainly see and that their rods serve as means of defense.”

REPRODUCTION.

For a long time, Echinoids were reputed to hermaphroditic. It was Peters (*Archiv für anat. de J. Müller*, 1840, p. 143) who was the first to establish the separation of the sexes in Urchins, whose males produce in five large glands a white seminal liquor filled with spermatazoids that are oval, elongated thin in the back while females have ovaries of the same form and even structure placed in the same conditions. These ovaries contain a mass of red eggs that are nearly microscopic with yolk and a germinal vesicle.

These observations were confirmed by Milne Edwards and Lallemand (*Ann. des Sc. nat*. 1840, t. XIII, p. 376) who recognized in addition that these spermatozoids with an oval body had a very delicate tail appendage that Peter had only suspected, without being able to see it distinctly. We have reported some exterior characters appropriate for distinguishing the sexes. It is thus in *Clypeaster*, for example, male individuals are distinguished by their more compact form and narrowness of the genital pores destined, in this case, to release spermatozoids and not relatively larger eggs. The male and female organs always open to the outside toward the top of the test by five distinct openings pierced in particular plates (genital plates), placed symmetrically around the anus.

We can also consult on this subject the observations of Derbès on the mechanism and formation of the embryo of the edible sea urchin. Dufossé has published (*Ann. des Sc. nat.,* janvier 1847) some extremely curious observations on the development of the edible sea urchin, *Echinus esculentus*, whose fertilization of the eggs had been obtained artificially. According to this naturalist, the mature eggs in the ovary are reddish or orange. They are globular and are approximately a ninth of a millimeter. They are composed: 1° of an external envelop that is then thin, flexible (testaceous membrane); 2° an albumen liquid of variable thickness; 3° a very thin vitelline and very diaphanous membrane; 4° a yolk of spherical form, granular, greasy grayish in appearance, but that appears to have a nice orange color when separated; 5° a germinal vesicle that we see in a clearer space in the yolk. These eggs, taken from the ovary, are likely to develop if one places a drop of seminal liquor and sufficient renewed sea water. Then begins embryonic life that lasts only 24 to 48 hours according to temperature. From 13 to 15 minutes after fertilization, the yolky sphere begins to shake, then to oscillate on its center and soon becomes alive with a

movement of rotation that takes 45 seconds for a complete rotation. Sometimes also, the yolky globe has slow, less durable oscillation or remains completely immobile without development itself being slowed down. From the fourth to the sixth hour, the yolk begins to break apart and the smaller the segments become, the more they lose their greasy appearance to become hyalin. At the end of 12 hours, there is a surface with a large number of small globules that rapidly surround the larger globules in the center and constitute the rudiment of an integument covering. The embryo then has acquired the form that that is specific to it and which it still has when it leaves the egg. Some hours after, its surface is covered with filiform appendages or cilia of such tenuity that we distinguish them only when they move, which takes place some time before hatching. Finally, after 24, 36 or 23 hours, depending on conditions, the embryos move with more force and speed, these filiform appendages become rather long and robust to serve as locomotory organs.

By shaking them, it begins to turn on itself in the liquid that contains the external testaceous membrane and soon breaks the latter by its greater agitation, it frees itself and swims freely in the water. The larva of the Urchin, when it frees itself, has the form of a small fish. It is a little concave on the ventral surface, at the center of which is the rudiment of the buccal opening. At the opposite pole is the anus already recognizable by the disposition of the integument. The skin is thick, with an unequal surface, with deep lines and transparent enough to see the large globules that still exist in the center of the body. In addition, it is so delicate that the least shock and slightest pressure is sufficient to start the disintegration of the globules that constitute it.

The filiform appendages that we see only with difficulty across the covering of the egg, then the embryo still has them and they are now very distinct. They are long, thin and on nearly all the integument. With the aid of these appendages, the larva moves with ease, but nearly always rolling on itself, most often in a completely irregular way. However, the body has a rotary oscillation movement as if it rolled around an axis passing through the mouth and anus, that being directed most usually above. At the sixteenth or eighteenth day, the form of the animal is sensibly modified at the same time that its movements become slower. Thus, the upper half of the body, that with the anus, is a little elongated. The globules of the integumentary covering have less distinct contours. They begin to form a tissue whose organic elements are better connected. Its transparency is greater and permits seeing that the large globules of the center have disappeared and to perceive the first rudiments of the intestinal canal showing a short esophagus, swollen in the middle, a stomach in the form of a large bulb and a very short intestine, also enlarged in its middle. The three swellings of the digestive tube are in a nearly straight line from the mouth to the anus. At the twelfth or fifteenth day, the configuration of the larva considerably changed, its body is completely pyriform. The anus occupying the center of the small end is surrounded by small disks that appear cut into the integument and form together a kind of small network. We note also in the rest of the integument the appearance of small pieces in the form of a shield.

The dimensions of the buccal pole have greatly increased, and the animal has lost nearly all its agility. From the sixteenth to the eighteenth day, a more remarkable change occurs. The larva loses all its locomotory capacity, remains attached by the anal pole to some solid environmental body. A rather large cylindrical stalk, with a length one and a half times the diameter of the body, develops very quickly at the point of attachment and the animal is thus fixed by a flexible stalk, floating with the movement of the water like an

aquatic plant. Only its position is inverse because the mouth is above and the anus below. The integument of adjacent parts of the mouth has small mamelons arranged in regular rows that also see toward the opposite pole, but less pronounced and less numerous. At the twentieth day, spines of a great length compared to the size of the animal are produced at the top of the mamelons of the integument and the calcareous material is already so abundant there that the slightest shock is sufficient to break them without their bending before breaking. Those around the mouth are longer and thicker. The anal pole has now a great extent. It contains all the anterior half of the body that is also wider. The integument of the middle region, i. e., that between the two poles, has no spines and its tissue is softer and thinner. But little by little this portion is complete and when the animal detaches from its stalk to live freely, the form of the body is already more rounded than at the twentieth day. From these facts, Dufossé concludes that all the parts of the body of the embryo are arranged nearly symmetrically around the buccal-anal axis and that it is principally from the two ends of this axis that development radiates and extends to the periphery. We have already seen, in speaking of the cutaneous skeleton of these animals, that it is always in conformity with these principles that growth occurs in Echinoids. The plates, in fact, of the two opposite poles, buccal and anal, are fixed and invariable in number while those that are intermediary are susceptible to increase in number with growth of the individual.

Kolliker has given some very interesting details about the Zoosperms. He has seen that their elongated body ends in a very fine tail, capillary so to say, that has very rapid movements. In *Echinus saxatilis*, the testicles are a deep brown and the eggs a pale brown. The spermatic liqueur is white and animalcules that it contains are pyriform, depressed at a point of their surface. They move snake-wise by jerky contractions of the tail.

NATURAL HISTORY STRICTLY SPEAKING OF ECHINOIDS.

In regard to the usefulness that these animals can offer the human species, we can cite some examples as edible. *Echinus esculentus* and some related species are in this case. It is only in the season when the ovaries are very developed that the Urchins are sought for food. They are then eaten in the manner of eggs, with a whisk.

We know little about the customs and behavior of Echinoids. All, without exception, live in sea water and are encountered at nearly all latitudes, from polar regions down to the equator. We ordinarily encounter them on rocky bottoms, but a large number of species, and especially those of Spatangoids, appear to prefer sandy bottoms.

Some species have the singular property of digging holes in rocks, even the hardest to live there and find shelter. The granitic rocks of the coasts of Britanny and particularly the sandstones of the Silurian stage of the Bay of Douarnenez offer numerous examples. For some years, very followed and very interesting observations have been made on this subject by several naturalists. Caïllaud, curator of the Museum of Natural History or Nantes has studied with much care the phenomenon of the perforation both by individuals of *Echinus miliaris* found on the Plateau du Four in the Bay of Croisic, or on the specimens of *Echinus lividus* at the place named Grabinek, two kilometers east of Douarnenez in the Silurian sandstones. He has perfectly seen young individuals although they are as small as peas attack the rock and dig the holes according to their size. His results indicate that the Urchins, after attaching to the rock by the ambulacral tentacles corrode the latter by means of their teeth. Then their spines contribute also by expelling the detached detritus. Robert,

as well as Lory, professor in the faculty at à Grenoble, has observed the same fact that there remains no doubt on the perforation ability of the Echinoids.

Some Echinoids have the ability to case a burning pain when touched. *Diadema savignyi* has been cited in this case. We do not think a large number of species has this property because, despite the extreme abundance of Urchins, this fact is mentioned a very small number of times.

We know no case of true parasitism in Echinoids. In truth, some small acephalous mollusks have been found frequently on urchins, established on the test and protected by the rods, but we do not believe this can be considered as parasitism. We could say the same regarding the observation made by one of us[1] on an Echinoid from Australia, *Cidaris* (*Leiocidaris*) *imperialis*, Lamarck. We have, in fact, found a small gastropod mollusk of the genus that lives enclosed in a spine (rod) that had undergone a profound modification in form and structure under the unusual presence of this mollusk.

In observing this fact, we have expressed the opinion that some spines found in the fossil state and that have extremely bizarre forms could have been deformed by similar causes, but we do not think that this fact can be generalized and we do not accept in any way that most of the spines with bizarre, swollen or flared forms were produced uonder this accidental influence. If we have cited in this circumstance an example, *Cidaris cyathifera*, which has its spines in the form of a funnel, it is because we have had the opportunity to see several times the presence of foreign bodies, small oysters that had thus established themselves in the terminal cavity of the spines. Truthfully, nothing proves that their installation had preceding the development of the spine and had determined its formation.

From the paleontological point of view, Echinoids merit attention. Their extreme abundance in the fossil state in the different geological stages has permitted some scholars, in particular Agassiz, to deduce very curious facts. They show in fact this very remarkable peculiarity, that their order of appearance in the layers of the earth is in perfect concordance with their organic development. Thus, we see that the spherical type, or that of Cidarids, that is the least elevated in organization, appears first in ancient terrains, then successively, in passing to the 2° family, that of Clypeastroids, we reach by some intermediary forms the 3° family, the Spatangoids, whose organization is highest.

Echinoids are rare during the Paleozoic period. One only, the genus *Palaechinus*, dates from the Silurian period. Another, the genus *Archaocidaris*, characterizes the Devonian period. Then, some species, also belonging to the Cidarids, begin in the Triassic and continue under the same generic forms to the present period. In the Jurassic and Tertiary terrains, the Echinoids reach in some way their maximum development and the number of fossil genera exceeds even that of living genera because the proportion is approximately 50 for the first and 45 for the latter.

CLASSIFICATION OF ECHINOIDS.

Considered in a general way from the point of view of their classification, Echinoids offer a very obvious organic gradation, consisting principally in a kind of successive transformation from the regular spherical type of the true Urchins into a more or less elongated form as we see in Spatangoids that are the opposite term. All the classifications

[1] Hupé, Revue et Mag. de Zoologie.

that have been attempted more or less successfully meet this fundamental arrangement. Without wanting to enumerate here the different works that have for their goal the classification of Echinoids, we shall recall at least in a few words the principal ones. Klein (1734) divided the Echinoids into three classes (or divisions, because the word class is taken in a much narrow sense than presently: 1° the Anocystes (anus located at the top), 2° the Catocystes (anus on the ventral surface), 3° the Pleurocystes (anus on the side). The secondary divisions, or sections, are taken from the general form of the body as well as the respective position of the two preceding openings. As we shall soon see, the classifications adopted today do not differ in a notable way from that of Klein.

de Blainville separated the Echinoids into four families. He takes into consideration both the position of the moth and anus, he introduces a new consideration, i.e., the absence or presence of a dental apparatus. His first family contains the species with the mouth located eccentrically and without a dental apparatus. These are the EXCENTROSTOMES (genera *Spatangus, Ananchytes*). The 2° family, PARACENTROSTOMES, is characterized by a sub-central mouth more marginal than median and without teeth (Ex. G. *Nucleolites, Echinoclypus, Echinolampas, Cassidulus, Fibularia, Echinoneus*). The 3° family, PARACENTROSTOMES DENTÉS, contains the genera *Echinocyamus, Laganum, Clypeaster, Echinodiscus* and *Scutella*. Finally, the 4° family, the CENTROSTOMES, contains the Echinoids whose mouth is located in the center of the ventral surface and the anus in a diametrically opposite position, i. e., the genera *Galeries, Echinometra, Echinus* and *Cidaris*.

Desmoulins distributed the Echinoids in nearly the same fashion. It is also formed of four groups. Only, to the characters already used, he adds consideration of the number of genital pores.

Agassiz, in his Prodrome (1830), divided the Echinoids into three families: the Spatangoids, the Clypeasters and the Cidarids. Then, later, the same author in a work made in collaboration with Desor, modified his classification and increased it with a new family in also changing the names. Thus: 1° Cidarides, 2° Clypeastroides, 3° Cassidulides, 4° Spatangoides. The first two are characterized by the presence of a dental apparatus; the two others lack this apparatus.

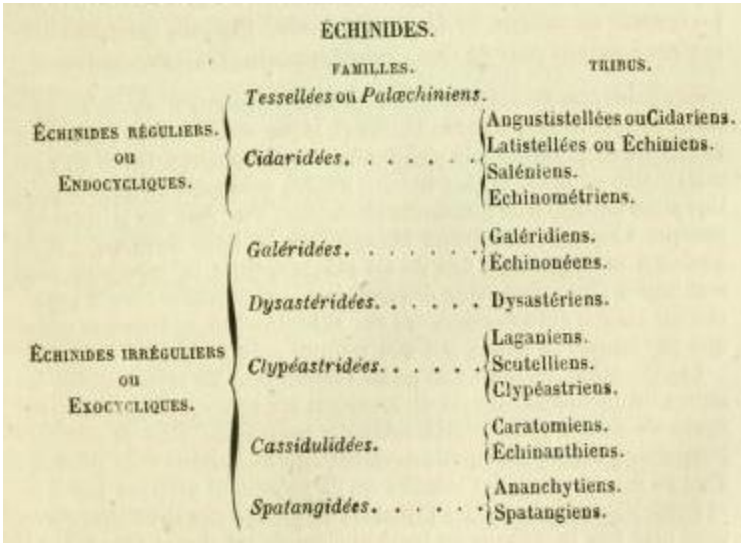
In recent times, classification has made a very great step, due principally to Albin Gras. This consisted of a first division of Echinoids into two primary groups: 1° the *E. réguliers*, 2° the *E. irreguliers*. To the first relate the species whose form is regularly spheroidal and have the mouth located in the ventral center and the anus in the opposite position. To the second belong the non-regularly spheroid species, but especially whose two openings do not occupy opposite poles.

D'Orbigny, who also accepted this first division made three families among the regular Echinoids: 1° Cidaritides, 2 Salenides, 3° Echinides; then six in the Échinides irréguliers: 4° Clypeastroides, 5° Galeritides, 6° Nucleolitides or Echniobrissides, 7° Spatangides, 8° Ananchytides, 9° Echinometrides.

Wright, in England, has also proposed a classification that differs from the preceding only that this author accepts a greater number of families: 5 in the 1° group or Endocycla, and 8 in the 2° or Exocycla.

Finally, Desor, in his great work on the Echinoids titled Synopsis, took as base the general dispositions of the preceding classifications and added very welcome

modifications. Thus, it is precisely that he gave that we propose to follow in our work. Here is the general table:



ECHINIDES.

	FAMILLES.	TRIBUS.
ÉCHINIDES RÉGULIERS. OU ENDOCYCLIQUES.	*Tessellées* ou *Palæchiniens.*	
	Cidaridées.	Angustistellées ou Cidariens.
		Latistellées ou Échiniens.
		Saléniens.
		Echinométriens.
ÉCHINIDES IRRÉGULIERS OU EXOCYCLIQUES.	*Galéridées.*	Galéridiens.
		Échinonéens.
	Dysastéridées.	Dysastériens.
	Clypéastridées.	Laganiens.
		Scutelliens.
		Clypéastriens.
	Cassidulidées.	Caratomiens.
		Échinanthiens.
	Spatangidées.	Ananchytiens.
		Spatangiens.

FIRST SUB-ORDER.

REGULAR ECHINOIDS OR ENDOCYCLIQUES.

Regular spherical form with openings of the intestinal canal located at each of the poles. The various radiating organs from one of these poles to the other are the dominant characters of this sub-order. It is necessary to add the presence of a very developed dental apparatus.

This large group is divided into two families. One, the Tessellae or Palaechinidae, for Echinoids that have at least three longitudinal rows of interambulacral plates. The other contains only Echinoids whose rows of plates never passes two.

1st SUB-ORDER: Normal regular Echinoids or Endocyclics.

Families

TESSELLIDAE OR PALAECHINIDAE.

CIDARIDAE.

FIRST FAMILY TESSELLIDAE

Body globular, spheroidal, regular. — Buccal opening or peristome at the center of the ventral surface. Anal opening or periproct in the middle of the dorsal surface. Interambulacral plates forming more than two rows of plates that are always hexagonal.

The Echinoids of this family are completely distinct from all the others by this fundamental character that consists in the existence of more than two rows of interambulacral plates. It is never less than three and is raised sometimes up to eight. Another no less essential is that the plates nearly always have a hexagonal form so that it is sufficient to have one of these plates to refer it with certainty to one of the genera of this family. We shall soon appreciate this advantage because these Echinoids are hardly ever found except as isolated fragments such as plates or spines.

The Tessellidae form a small family whose relations with the other Echinoderms has been variously appreciated. Agassiz, having considered the large number of rows of interambulacral plates though they should be compared to Crinoids. While recognizing the similarities they have with the latter and particularly with the group of Cystidae of Crinoids, we cannot deny that the sum of their differences is still greater while the ensemble of their characters unites them to the Echinoids. Thus, their spheroidal form, the mouth diametrically opposite the anus, the presence of ambulacra extending to these points, all in the organization of Tessellidae, indicate their close relation with the Echinoids.

All representing them known to the present have been found as fossils only in Paleozoic terrains. They are thus the first Echinoids whose existence we can show, and they are all those whose organization appears least complete, less developed. We know only five genera belonging to this family. As for the species, they are not very numerous and, in addition, the isolated parts that we encounter in each of them, does not always permit characterizing them and establishing them with great certainty. Here is the table of the genera:

1st FAMILY: Tessellidae.
- G. PALAECHINUS.
- MELONITES.
- ARCHAEOCIDARIS.
- EOCIDARIS
- PERISCHODOMUS.

1st GENUS. **PALAECHINUS**. *PALAECHINUS*.

Body spheroidal having two rows of plates in the ambulacral areas and at least five rows in the interambulacral areas. Poriferous zones pentagonal. All others being on the contrary hexagonal. Spiniform and imperforated tubercles on each plate. Pores of the ambulacral zones arranged in single series.

The genus *Palaechinus* still contains only a small number of species that all come from Paleozoic terrains, two from the Silurian stage and six from the Carboniferous stage.

1. ELEGANT PALAECHINUS. *PALAECHINUS ELEGANS*. — M'Coy.

— MCoy, Foss. of Ireland. — Pictet, Pal., pl. 97, f. 22,

Fossil of the Silurian stage of Malvers (North America).

2. PHILLIPS' PALAECHINUS. *PALAECHINUS PHILLIPSIAE*. — Forbes.

— Forbes, Mem. geol. Surv., Dec. II, p . 384. — *Id.*, Desor, Syn., p. 159,

Fossil of the Silurian stage of Ireland.

3. GIANT PALAECHINUS. *PALAECHINUS GIGAS*. — MCoy.

— M'Coy, Foss. Ireland, p. 172, t. 24, f. 4:— *1d*., Bronn, Letha geog. t. IV, f. 1. —., Desor, Syn. p. 158.

Species nearly spherical, slightly acuminate near the top. Ambulacra proportionally wide and protruding. Interambulacral plates arranged in six rows, a little longer than wide. Ambulacral plates very narrow, seven of these plates correspond to one interambulacral plate. All these plates are covered with small tubercles arranged in a staggered pattern.

Fossil of the Carboniferous stage of Ireland.

4. ELLIPTICAL PALAECHINUS. *PALAECHINUS ELLIPTICUS*.— M'Coy.

— M'Coy, Foss. Ireland, p. 172, t. 24, f. 3, — *Echinocrinus ellipticus*, D'Orbigny, Cours de Pol., vol. 2, p. 126, f. 278. — *Id.* Desor, Syn., p. 158.

Fossil of the Carboniferous stage of Ireland.

5. SPHERICAL PALAECHINUS. *PALAECHINUS SPHAERICUS*.—Scouler.

— Scouler in MCov, Foss. Ireland, XXIV, f. 5.

Species having six or seven rows of interambulacral plates, one of them disappears before reaching the top.

Fossil of the Carboniferous stage of Ireland.

6. KONINCK'S PALAECHINUS. PALAECHINUS KONINCKII. —MCoy.

— M'Coy, Foss. of Ireland, p. 472, t. XXIV, f. 1. — *Id.*, Desor, Syn., p. 159.

Fossil of Carboniferous limestone of Ireland.

7. UNEQUAL PALAECHINUS. PALAECHINUS DISPAR. — Fischer.

— Fischer, Bull, Soc. Imp. des nat. de Moscou, 1848, t. 21, p. 243, pl. 3, f. 4.

Fossil of the Carboniferous stage of Russia.

2nd GENUS. **MELONITES.** *MELONITES*. — Owen.

Body spherical. Ambulacral areas with narrow plates each pierced with two pores. Interambulacral areas numerous, forming eight or ten rows, all the plates are smooth.

This genus is that of all those of the same family in which the number of rows of interambulacral plates is the greatest. We know only one species.

MULTIPORA MELONITE. *MELONITES MULTIPORA*. — Owen.

— D. Owen, Amer. Journ., 2nd series, t. II, p. 225, tab. 1, f. 1–2. — Bronn, Leth., p. 288.

Fossil of the Carboniferous Chalk of St. Louis (Missouri). Mus. Paris.

3rd GENUS. **ARCHAEOCIDARIS.** *ARCHAEOCIDARIS*. — M'Coy.

Echinocrinus, Agassiz — Palaeocidaris, Deson.

Form spheroidal. Interambulacral plates each with a large mamelonate tubercle, perforate and surrounded by a protruding row of secondary tubercles surrounding the preceding. Spines in the form of cylinders, more or less lanceolate.

The species that we have referred to this genus are known only by isolated plates or spines so that their determination leaves much to be desired. Their number is approximately twelve. Two only belong to the Devonian stage, the others are Carboniferous with the exception of one that is found in the Permian stage.

1. NEREI'S ARCHAEOCIDARIS *ARCHAEOCIDARIS NEREI*. — Desor.

— *Cidaris nerei*, Munster, Beitr. zur Petref. I, p. 40, tab. III, f. 6.—*Palaeocidaris nerei*, Desor, Cat. rais., p.48. — *Cidaris protei*, Munster, Beitr. zur Petref., t. I, p. 40. — *Id.* De Konnex, An. foss. carb., p. 34, tab. E, f. 1.— *Archaeocidaris nerei*, Desor, Syn., p. 154, t. 1, f. 6. — *Id.*, Pictet, Pal., t.97; f. 19:

This species is known only by isolated plates and spines. The hexagonal plates have on their middle a rather large tubercle, mamelonated and perforated, surrounded first by two concentric circles then by a third marked by rugose radiated striations. The spines, in the form of rods, are long and lanceolate toward their free end. Their surface is dotted with small asperites.

Fossil of the Carboniferos stage of Tournay (Belgium), in the clay of Illinois (North Amerique).

2. URI'S ARCHAEOCIDARIS. *ARCHAEOCIDARIS URII*. — Desor.

— *Cidaris urii*, Fleming, Brit. an., p. 478. — *Echinocrinus urii*, MCov, Foss. of Ireland, p. 174, tab. 27, f. 1.—*Id.* Brown, Leth. geog., 1. IV, pl. 1, f. 2.— *Cidaris benburbiensis*, Porlock, Geol. Rep. — *Archaeocidaris urii*, Desor, Syn., p. 194, tab. 21, f. 11–12.

Plates hexagonal, each with, at their center, a tubercle surrounded at its base by a very distinct and smooth ring. The edge of the plates is marked by radiating ridges, more pronounced on one side than on the other. Spines finely striated toward the base, their upper part with five or six rows of bristles.

Fossil of the Carboniferous limestone of Ireland.

3. ANCIENT ARCHAEOCIDARIS. *ARCHAEOCIDARIS PRISCA*. — Desor.

— *Cidaris prisca*, Munster, Beitr. zur Petref,, p. 41. — *Palaeocidaris prisca*, Cat. rais., p. 36. — *Archaeocidaris prisca*, Desor, Syn., p. 155.

Fossil of the Carboniferous stage of Regnitzlosan.

4. DEKONINCK'S ARCHAEOCIPARIS. *ARCHAEOCIDARIS KONINCKII*. — Desor.

— Desor, Syn., p. 155, tab. 21, f. 7–10.

Fossil of the Carboniferous clay of Tournay.

5. TRISERIAL ARCHAEOCIDARIS. ARCHAEOCIDARIS TRISERIALIS. — Desor.

— *Echinocrinus triserialis*, MCoy, Foss. of Ireland, p. 173, t. 26, f. 1.— *Archaeocidaris triserialis*, Desor, Syn., p. 155.

Species known only by its spine that is tri-keeled, each keel with a row of large spines.

Fossil of Carboniferous limestone of Ireland

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6. ARCHAEOCIDARIS WITH GLABROUS SPINES. *ARCHAEOCIDARIS GLABRISPINA*. — Desor.

— *Cidaris glabrispina*, Phil.., Geol. Yorksh.

Fossil of the Carboniferous stage of England.

7. ANCIENT ARCHAEOCIDARIS. *ARCHAEOCIDARIS VETUSTA*,— Desor.

— *Cidaris velusta*, Phil., Geol. Yorksh,

Fossil of the Carboniferous stage of England.

4rh GENUS. **PERISCHODOME**. *PERISCHODOM*—.

Body sub-spherical, sub-pentagonal, slightly depressed. Interambulacral areas formed of five rows of unequal, hexagonal plates. Each of those that border the poriferous zones have a large, perforated tubercle. The other plates have only miliary tubercles.

This genus, established by M'Coy in 1849, contains only one species of the Carboniferous stage.

BISERIAL PERISCHODOME. PERISCHODOMUS BISERIALIS. — M'Coy.

— M'Coy, Ann. and Mag. of nat. Hist., 2nd series, 1849, t. III, p. 253. — *Id.*, Desor, Syn., p. 197. — Pictet, Traité Pal., t. 97, f. 21.

5th GENUS. **EOCIDARIS**., *EOCIDARIS*.—- Deson.

Plates hexagonal, each has a large, perforated tubercle whose base is smooth, without a double ring at the periphery. Spines slender, with small, sparse bristles.

This genus, known only by some isolated plates and spines, is distinguished from the genus *Archaeocidaris* by the absence of a second ring at the base of the tubercles. We still know only six species. They have been found in the Devonian, Carboniferian and Permian stages.

1. KAYSERING'S EOCIDARIS. *EOCIDARIS KAISERLINGI*, — GEINITZ.

— Genitz, Verstein der Deutsch. Zechst., p. 16, tab. VIL, f, 1-2. — Desor, Syn. Echin., p.155, tab. XXI, f.15 and 16.

Tubercules very small, perforated, without crenellations, surrounded by a complete scrobicular circle. Spines in the form of rods that are small, cylindrical subulate, with a collar at their base, and covered with very fine asperities.

Fossil of the Lower Zeichstein of Carbusen (duchy of Altenburg).

2. EOCIDARIS WITH SMOOTH SPINES. *EOCIDARIS LAEVISPINA*.—Desor.

— *Cidaris laevispina*, Sandb., Verst. des Rhein Schich. Syst., tab, XXXV, f. 2. — *Eocidaris laevispina*, Desor, Syn. Echin., p. 156, tab. XXI, f. 18–21.

This species, known only by its plates, should be of large size. The scrobicular circle is composed of very large granules that appear mamelonated and even perforated. Spines in the form of cylindrical and thin rods.

Fossil of the Devonian stage of Willmar, Duchy of Nassau.

3. SCROBICULATE EOCIDARIS. *EOCIDARIS SCROBICULATA*. — Desor.

— *Cidaris scrobiculata*, Sandb, Verst. des Schicht. Syst. — *Eociduris scrobiculata*, Desor, Syn. Echin. p. 157, tab. XX, F. 17.

Species characterized by its very pronounced scrobiculae surrounded by a circle composed of dense granules.

Fossil of the Devonian stage of Willmar, Duchy of Nassau.

4. VERNEUIL'S EOCIDARIS. *EOCIDARIS VERNEUILEANA*. — Desor.

— *Palaechinus verneuillanus*, King. — *Archaeocidaris verneuillana*, King, Monogr. of Permian Foss., 1850, p. 53, t. VI, f. 22–24. — *Eocidaris verneuillana*, Desor, Syn. Echir., p.156, tab. XXI, f. 13–14.

Near the preceding, this species differs, according to Desor, by it more granular miliary zones. Tubercles whose mamelon base is surrounded by radiating folds.

Fossil of the Carboniferous sandstone of Turnstall Hill and Humbletor.

5. EOCIDARIS FROM RUSSIA. *EOCIDARIS ROSSICA*. — Desor.

— *Cidaris rossica*, De Buch, in Kurst. Archiv, 1842, p. 523. — *Palaeocideris rossica*, Desor, Cat. rais., p. 36. — *Id.*, Murchison and De Verneull, Géol. de la Russie, tome 2, p. 17, tab. I, f. 2, — *Eocidaris rossica*, Desor, Syn. Echin., p. 196, tab. 21, f. 3–5–6.

We know only a single plate of this species, whose scrobiculae are very large. The spines, in the form of large rods, are covered with non-serial, fine granules.

Fossil of the Carboniferous sandstone of Vitegra, on the edge of Moscow and Paskra, Ivanof, etc.

6. EOCIDARIS FROM MUNSTER. *EOCIDARIS MUNSTERIANUS.*—Desor.

— *Echinocrinus*, De Koninck, An. foss. carb. — *Id.*, M'Coy, Foss. of Ireland, p. 173. t. XXVII, f. 2. — *Eocidaris munsterianus*, Desor, Syn. Echin., p.156.

Fossil of the Carboniferous sandstone of Ireland.

SECOND FAMILY. **CIDARIDAE.**

Test globular, circular, sometime oval. Peristome central on the ventral surface. Periproct opens in the middle of the top, in the middle of the apical system. — Five genital plates. — Five ocular plates, sometimes a suranal plate. Ambulacra formed of poriferous zones extending from the mouth to the anus. A very developed masticatory apparatus.

The family of Cidaridae is assuredly one of the most numerous of Echinoids, and despite an homogeneity that is more apparent than real in regard to form, the variations are very multiplied. The external ornamentation of the test acquires, in this family, a great development, principally in regard to the appendages called spines that have modifications and the most extraordinary forms, both in living species and in fossil species.

From the Paleontological point of the view, the Cidaridae come immediately after the Tessellidae, by rank of seniority. Their appearance dates to the Triassic period. They cross all the stages to the present period where we find species, but they follow a constantly decreasing path.

The Cidaridae can be divided into several tribes. Two are based on the relative proportions of the ambulacral and interambulacral areas, the other on the particular structure of the apical system, and finally a last on the general form of the test that instead of being circular is more or less oblong.

Ambulacral areas	*Tribes*
narrow …….	ANGUSTISTELLIDAE or CIDARIANS.
wide ……	LATISTELLIDAE or ECHINIANS.
A suranal plate ……...	SALENIANS.
Oblong test …….	ECHINOMETRIANS.

1st TRIBE. ANGUSTISTELLIDAE or CIDARIANS.

Ambulacral areas narrow, formed of a very large number of small plates covered only with granules. Interambulacral areas very large, formed of larger plates each with a large tubercle that is always perforated at the top, a scrobicula generally circular, surrounded itself by a circle of granules.

Poriferous zones (ambulacra) extend without interruption from the top to the periphery of the mouth. — Pores variable, sometimes contiguous, sometimes separated and connected by a groove (conjugated). — Periproct (anus) formed by small, angular plates. Peristome generally rather large, without notches on the edges. Buccal membrane with imbricated scales and onto which extend the ambulacral pores. Masticatory apparatus very developed. Teeth cut into a hollow bevel.

The fundamental character of this division does not at first seem very important and not sufficient to justify this separation. But if we consider that it is linked to a particular arrangement of the organs of respiration, we soon have the conviction that it must have a real value.

The Angustistellidae, in addition, have on their buccal membrane, imbricated scales on which are continued the ambulacral pores, while in the Latistellidae, this portion lacks

scales and the pores do not extend in rows. They are, on the contrary, limited to two plates or calcareous shields each pierced by a pore giving passage to two simple tubes. These are the buccal ambulacra of Valentin. Then, there are on the edge of the peristome, at the corners of the ambulacra, ten fleshy appendages called buccal gills that we do not find in the Angustistellidae. This particularity is always indicated on the test by ten more or less deep notches on the peristome. These notches give passage to these buccal gills. It is, in fact, following this principle that Desor has been able to place in the group of Latistellidae the genera *Hemicidaris, Hemidiadema* and *Hypodiadema,* genera that had been classed among the Angustistellidae by some authors, in particular by Albin Gras. Finally, the noumber of ambulacral pores is also very different in the two groups because while in the Angustistellidae there is only one pair for each plate, in the Latistellidae, on the contrary, there are never less than three and can be more.

1st TRIBE: Angustistellidae or Cidarians.
G. CIDARIS, Lamarck.
LEIOCIDARIS, Desor.
GONIOCIDARIS, Desor.
RHABDOCIDARIS, Desor.
DIPLOCIDARIS, Desor.
POROCIDARIS, Desor.
HERTEROCIDARIS, Cotteau.

1st GENUS. **CIDARIS**. *CIDARIS*. — Lamarck.

Test thick, circular form, a little depressed above and below. Ambulacral areas narrow, curving, lacking large tubercles. — Interambulacral areas very wide, with two rows of large tubercles perforated at the top, with smooth or crenelated base. Scrobiculae large, sometime circular, sometimes elliptical. Poriferous zones narrow, formed of contiguous or non-contiguous pores. Spines very robust, cylindrical, fusiform, prismatic or in the form of a club, most often with spines or granules.

The current genus *Cidaris* is no longer completely understood in the same way as constituted by its founder. Several genera have been removed and the entire tribe of Angustistellidae nearly corresponds to the old genus *Cidaris.* Despite these reforms, it is still extremely numerous in species. More than one hundred distributed in the different stages from the Triassic period up to the present period. Among the general established at the expense of *Cidaris*, there are two that are living: *Letocidaris* and *Goniocidaris*. The first, characterized by it geminate pores, contains species so well-known under the name of *Cidaris*, that it appeared to us urgent to first mention them here. They are: *C. histriae, C. papillala, C. affinis (stokesi), C. imperialis, C. thouarsii, C. danae.* The second genus has for representative *C. geraprioides, C. quoyi*. These species will naturally rank after *Cidaris* strictly speaking.

1. CIDARIS WITH A KEEL., *CIDARIS METULARIA*. — Lamarck.

— *Echinometra muscosa amboinensis*, Sera, Mus., t. III, pl. 13, f. 10 and 11 (*varietas*). —Klein, apud Leske, t . XX VI, f. 3. *Echinus saxitilis* var. B., Lin., Gmel.., p. 3171. — *Cidarites metularia*, Lamarck, 2e édit., t. III, p. 381, no 7. — Encyclop. méthod., pl. 134, f. 8. — *Id.*, Deslongchams, Encycl. méthod., t. 2, p. 195.—*Id.*, de Blainville, Man. Act ., p. 232.—*Id.*, Agassiz, Prodr., p. 159. — *Id.*, Desmoulins. Das Etud. Syn., p. 324. — *Id.*, Michelin, Mag. zool., 1845, p. 17. — Agassiz and Desor, Cat. rais., p. 326.

Species with narrow ambulacra, the interporiferous space very protruding and with two rows of granules. Spines in the form of rods that are cylindrical, blunt at the end, covered with extremely fine granules and rings of white and brown.

2. CIDARIS LIKE A CALTROP. CIDARIS TRIBULOIDES. — Lamarck.

— *Echinus tribulus*, Van Phils, p. 127, n°0 34. — *Echinometra*; Rumphius, Mus., t. XIII, f. 3–4, — *Echinometra circinata*, Gault., p. 108, f. e. — Knorr, Delie., t. D, f, 5. Encyc. méth., tab. 136, f. 4–5. — *Cidarites trbuloides*, Lamarck, Anim. s. vertèb., t. 14, p. 380, n° 6, — *Id.*, Deslongsch., Encyc. méth., t. 2, p. 195.—14., de Blainville, Dict. sc. nat., t. 9, p. 200. — *Id.*, Agassiz, Prodr., p. 189. *Id*: Desmoulins, Echin. Syst, p. 322.— *Id.* Agassiz and Deson, Cat. rais., p. 326.

Species having its ambulacral areas composed of six rows of granules, the internals very small and very dense. Tubercles small, with a narrow smooth zone. Spines in the form of subulate rods, covered with fine striations and granular, but without asperities.

Inhabits the Indian Ocean.

3. CIDAROID WITH ROUGH RODS. *CIDARIS BACULOSA*.— Lamarck.

— Lamarck, Anim. s. vertèb., 2e édit., &. III, p. 386, no 4. — Savigny, Egypte Zoo!. Echin., t. 7, f. 1. — *Id.*, Deslongch., Encyc. méth., t. 2, p.195. — *Id.*, Agassiz, Prod p. 189. *Id.* Desmoulins, Echin. Syn., p . 322.—*Id.*, Michelin, Mag. zool., 1845, p. 18, t.IV, f. 1–8.—*Id.*, Agassiz and Desor, Cat. rais., p. 327.

Large species with ambulacra with two external rows of granules and four very small internals that are very small, scarcely visible and spaced. Scrobicula elliptical, transverse. Intermediary spaces very wide, covered with very dense granules. Spines in the form of small spines.

Inhabits Reunion Island, Mauritius, the Red Sea.

4. PISTILLATE CIDARIS.. *CIDARIS PISTILLARIS*.— Lamarck.

—Lamarck, An. s. vertèb., 2e édit., t. III, p. 379, no 2.—Encyc. méth., pl . 137. — *Id.*, Deslongchamps, Encyc. méth., t. 2, p. 194, — *Id.*, Agassiz, Prodr. — *Id.*, Desmoulis, Echin., p. 322. — *Id.* Agassiz and Desor, Cat. rais., p. 326.

Large species with subulate and acuminate spines toward the end, with granules in rows.

Inhabits Mauritius, Seychelles.

5. CIDARIS WITH RINGS. *CIDARIS ANNULIFERA*.— Lamarck.

— Lamarck, An. s. vert, 2e édit,, t. III, p. 382, n° 11. — *Id.*, Deslongchamps, Encyc. méth., t. 2, p. 195. — *Id.*, Agassiz, Prodr. Echin., p. 189. — *Id.*, Desmoulins, Echin. syn., p. 322. — *Id.*, Agassiz and Desor, Cat. rais., p.327.

Large species with elongated, compressed spines. Those of the dorsal surface are pointed but those of the ventral surface are cupulate. They have, in addition, rings of white and pink.

Inhabits Australia.

6. TUBULAR CIDARIS. *CIDARIS TUBARIA*.— Lamarck,

— Lamarck, An. s. vert., 2e édit, t. III,p . 382, n° 9. — 7d., Deslongchamps, Encyc. méthod., t. 2, p. 196. — *Id.* Agassiz, Prodr., p. 189. — *Id.* Desmoulins, Echin., p. 322. — *Id.* Agassiz and Deson, Cat. rais., p. 327.

Species whose spines have small spines disposed laterally. They are ringed in with, pink or violet spots.

Inhabits Australia.

7. KROHN'S CIDARIS. *CIDARIS KROHNII*. — Agassiz.

— Agssiz, Cat. rais., p. 327.

Species having spines similar to those of *C. baculosa* but compessed and more spinose.

Inhabits Seychelles.

8. WHORLED CIDARIS. *CIDARIS VERTICILLATA*. — Lamarck.

— Favanne, pl. 80, f. 1. — Lamarck, An. s. vert., 2e édit., t. III, p. 381, n° 8. — *Id.*, Encycl. méth., pl. 136, f. 2 3. —*Id.*, Deslongchamps, Encycl., méth., t. 2, p. 195. — *Id.*, de Blainville, Dict. sc. nat., t. 9, p. 200. —: Agssiz, Prodr.- , P. 189. — *Id.*, Desmoulins, Echin, 5 *Id.*: 324. — *Id.* , Agassiz and Desor, Cat. rais., p. 237.

Species whose scrobicular circles are small, with dense granules. There are no granules between the tubercular rows. Spines with whorled small spines. Those near the mouth are simply subulate.

Inhabits Southern seas.

9. CIDARIS LIMA. *CIDARIS LIMA*, — Val.

— Agassiz and Desor, Cat. rais., p, 327.

Species small, having its ambulacra composed of sic rows of granules. Spines in the form of rods, very long, swollen and the base, narrowed toward their end and spotted with pink toward the base near the collar.

Inhabits Reunion Island (Mus. Paris).

FOSSIL SPECIES.

The Triassic stage (St-Cassian) contains 40 species among which we cite the ost characteristic: *C. subsimilis*, Munster. — *C. vetusta*, Munster. — *C. klipsteinii*, Munster.

— *C. bronnii*, Klipt, etc., etc.

LIASIC SPECIES.

41. *Cidaris amalthei*. Quenst. — Petref., p. 974, t. 48, f. 28–30. — *Id.*, Wright, Pal. Soc., p. 59, vol. 1, 1855. — Goldfuss, Petref., t. 39, f. 3 5, (spines). — *Id.*, Desor, Syn., p. 10.

This species is known only by its plates and spines. Its plates are large (50 mm). They have crenelated and widely perforated tubercles. The scrobiculae are large, elliptical, without a very distinct scrobicular circles. The spines are slender, with sparse small spines. The base (button) is very strong and crenelated.

Fossil of the Lias of Germany and England.

42. *Cidaris jasius*. D'Orbigny. — Prodr., t, I p, 222. and 7^{e}, no 164.

Spines club-shaped, covered with granules forming more or less distinct longitudinal rows.

Fossil of the Lower Lias (Sinemurian) of Lyon.

43. *Cidaris jarbus*. D'Orbigny. — Prodr., t. I, p. 222. and 7^{e}, n° 163.

Spine oblong, club-shaped, covered with very small irregular granules toward the middle and lower parts, two keels far apart, transverse, slightly oblique, that do not completely circle the spine.

Fossil of the Lower Lias (Sinemurian) of Augys-sur-Aubois (Cher), Coll. D'Orbigny.

44. *Cidaris antiquata*. Cotteau. — Echin. de la Sarthe, p. 3, t, I, f. 7. — *Id.*, Desor, Syn., p. 426.

Spine elongated, sub-cylindrical, covered with strong, very sharp spines.

Fossil of the Middle Lias (Liasian) of Asnières.

45. *Cidaris striatuta*. Cotteau.—Echin. Sarthe, p. 2, t. I, 3–4.—*Id.* Desor, Syn., p. 426.

Spine very slender, finely striated and with small spines in linear rows. Ring protruding, with a strongly crenelated articular facet.

Fossil of the Middle Lias (Liasian) of Asnières.

46. *Cidaris armata*. Cotteau.—Echin. Sarthe, p. 1, t. I, f. 1–2.—7d., Desor, Syn., p. 426.

Spine with strong small spines irregularly arranged. Ring protruding, with strongly crenelated facet.

Fossil of the Middle Liasic (Liasian), Asnières.

47. *Cidaris edwarsii*. Wright. — Ann. and Mag. of nat. Hist., 2nd series, t. XIII, p. 161, pl. II, f. 1 a f. — *Id.*, Pal. soc. Echin., vol. I, p. 27, pl. I, f. a f.

Fossil of the Middle and Upper Lias of Mickleton Tunnel (England).

48. *Cidaris Ilminsterensis*. Wright. — Pal. soc. Echin., p. 31, pl. V, f. 6. — *Id.*, Desor, Syn., p. 426.

Species near *C. edwardsii*, but differs because it has a complete circle of granules around the scrobicula.

Fossil of the Upper Lias (Toarcian) of Ilminster (England).

SPECIES OF THE LOWER OOLITE (BAJOCIAN).

49. *Cidaris lorieri*. Wright. — Brit. foss. Echin. in Pal. soc., t. 1, p. 59.

Fossil of the Lower Oolite (Bajocian). Sarthe. According to Cotteau, it would be the Upper Oolite (Bathonian).

50. *Cidaris bouchardi*. Wright, — Ann. and Mag. of nat. Hist., 2nd series, vol. XIIL, p. 163, t. XI, f. 2, and Pal. soc., vol. I, p. 36, pl. I, f. 2 a b c, pl. VII, f. 3, a b c, — *Cidaris elegans*, Morris, Cat. of Brit. foss., vol. I, p. 49. — *Cidaris bouchardi*, Wright, Desor, Syn, p. 429.

From Birdlip, Crickley Hill and Bridport (England).

51. *Cidaris wrighlii*. Desor. — *Cidaris propinqua*, Wright, Ann. and Mag. of nat. Hist., vol. III, p. 250, pl. II, f. 6. — *Cidaris wrightii,* Desor, Syn., p. 7. — *Id.*, Wright, Pal. soc., vol., I, p. 39, pi. I, f. 3 a f.

From Crickley Hill (England).

52. *Cidaris confluens.* Forbes, mss. — *Cidaris confluens*, Morris, Cat. Brit. foss., 2nd edit., p.74. — *Id.*, Woodward, Mem. of geol. Surv., Dec. V. — *Id.*, Wright, Pal. soc., vol. I, p. 42.

From Frome (Somersetshire).

53. *Ciduris fowleri.* Wright (pars).—Ann. and Mag. of nat. Hist., t, XI, f. 5. — *Id.*, Desor, Syn., p. 6, t. IIL, f. 13.

From Crickley Hill (England).

54. *Cidaris roissyi*. Desor. — Syn., p. 429, t. IV, f. 12.

Species established on a glandiform spine covered with numerous granules without order, surrounded by radiating folds. The stalk has vertical rows. From the vicinity of Privas (Mus. Paris).

55. *Cidaris courlaudina*. Cotteau. — Etudes Echin. foss. Yonne, 1849, t. I, p. 41, pl. 2, f. 1–2, — *Cidaris suboculata*, D'Orbigny, Prodr., t. I, p. 291. and 10, n° 516. — *Cidaris cortaldina*, Desor, Syn., p. 8. — *Cidaris courtaldina*, Cor., Desor, Syn., p. 29, tab. IV, f. 8. — *Cidaris courtaldina*, Cotteau and Triger, Echin. Sarthe, p. 4, pl. 2, f. 5,

From Genivaux, near Metz (Moselle), Semur (Côte-d'Or), Ile-sur-Serein (Yonne), Ste.-Croix (Vaud).

56. *Cidaris saemanni.* Cotteau. — Echin. Sarthe, p . 8, t. II, f. 1–4. — *Id.*, Desor, Syn., p. 429.

Species of medium size (dimen.: 55 mm), having 5 to 6 tubercles per interambulacral row. Circular scrobiculae surrounded by a protruding bourrelet of mamelonate granules. Ambulacra narrow, sub-flexuous, with four rows of granules.

Fossil of the Conlie (Sarthe).

SPECIES OF THE GREAT OOLITE (BATHONIAN).

57. *Cidaris desori*. Cotteau. — Echin. Sarthe, p. 19, t. IV, f, 1–4, — *Id.*, Desor, Syn., p. 432 (Y-21).

Large species (dimen.: 51 mm.), swollen, with deeply crenelated tubercles, eight to nine per row. Scrobiculae elliptical, non-confluenet, surrounded by a mamelonated circle. Miliary zone wide with fine and abundant granules. Ambulacra sub-flexuous.

From Monné near Ruillé in Champagne.

58. *Cidaris davoustiana*. Cotteau in Davoust. — Notes sur les foss. de la Sarthe, p. 6. — *1d*., Cotteau and Triger, Echir. Sarthe, p. 21, t. IV, f. 5–8.— *Id.* Desor, Svn., Echin., p. 432.

Species established on a sub-pyramid spine acuminate on the top and with small and dense granules acuminate at the top and with small spinose and dense granules most often forming linear rows. Collar very long, forming nearly half the spine.

From Yeré (Sarthe).

59. *Cidaris guerangeri*. Cotteau. — Echin. Sarthe, p. 21, t. IV, f. 9–10, — *1d*., Desor, Syn. Echin., p. 432.

Spines very elongated and very slender.

From Pecheseul (Sarthe).

60. *Cidaris schmidlini*. Desor. — Syn., p. 29, t. IV, f. 1 (M. 46).

From Frickthal (Argovie),

61. *Cideris orobus*. Agassiz. — Cat. syst, p. 10. — 7d., Desor. Syn., p. 29, t. IV, f. 1 (M. 46).

From Rouville.

62. *Cidaris bradfordiensis*. Wright. — Brit, foss. Echin., vol. 1, p. 42, t. IV, f. 7, a–d. — *Id.*, Desor, Syn., p. 432 a.

Species known only by isolated plates and spines. The latter are sub-fusiform and have very finely serrated longitudinal keels.

From Tetbury Road (England).

OXFORDIAN SPECIES.

63. *Cidaris ornata*. Quenstedt. — Jura, p . 512, tab. 68, f. 23. — *Id.*, Desor, Syn., p. 435.

Species with confluent scrobiculae, with two rows of granules in the ambulacral areas. Spines clavellate, with distinct collar, serrated keels more pronounced toward the base.

Fossil of the Kellovian stage of Gammelshausen (Wurtemberg).

64. *Cidaris calloviensis*. Cottteau. — Mag. Zool., 1861, p.74, pl. 2, f. 5.

Callovian of Vaucluse.

64 *bis*. *Cidaris vallata*, Quenstent, Jura, p. 642, tab. 79, f. 50.—*Id.*, Desor, Syn., p. 436.

Large species with very large scrobiculae, with tubercles, on the contrary, proportionally small. Scrobicular circles nearly touch, with a nearly absent miliary zone. Two rows of ambulacral granules and five large tubercles per row.

Fossil of the Upper Oxfordian (Argovien) of Weissenstein (Wurtemberg).

65. *Cidaris oculata*. Agassiz. — Echin. Suisse, II, p. 63, t. 21a f. 13–17. — *Id.*, Desor, Syn., p. 8

Upper Oxfordian (Argovian) de Suisse.

66. *Cidaris laeviuscula*. Agassiz. — *Loc. cit*., t. 21 a, f. 18–20. — *Id.*, Desor, Syn., p. 8.

Upper Oxfordian (Argovian), Suisse.

67. *Cidaris laevigata*. Desor. — Syn., p. 10.

Upper Oxfordian (Argovian), Suisse.

SPECIES OF THE CORALLIAN.

68. Cidaris of Blumenbachii. *Cidaris blumenbachii*. Munster. — *Lapides Juda*, Port, Nat, Hist., of Oxford (1677), pl 6 ,f. 8–9.— *Radiolus*, Echin. maxim. laticlivi Lywd. Lithop. Brit. (1760), t. 12, f. 1002, p. 49.— Korr, Delic. Nat. IL, t. E, f. 4-5, t. F, f. VI, (1768).—Parkinson , Organ. Remain., pl. 1, 9, pl. 4, f. 15–17. — *Cidarites blumenbachii*, Munster in Goldfuss, Petref., p. 117, t. XXXIX, f. 3 c d e.— *Cidaris florigemma*, Phillips, Geol. Yorksh., pl. 3, f. 12–13. — *Id. Id.*, Delabech, Man., geol., 3e édit., p. 9395 (1833). — *Cidarites elongatus*, Romer, Dic. verst. Nord, ool, pl.1, f. 14.—*Cidarites florigemma*, Desmoulins, Etud. Echin., p.338, no 31. — *Id. Id.*, Agassiz, Prodr., n° 31. — *Cidaris blumenbachii*, Agassiz, Echin. Suisse, 11, tab, 20, f. 5–6 (except., f. 7), p. 56, n° 40.—*Id.*, Agassiz, Cat. Ectyp., p.10. — *Id.*, Lamarck, 2^{e} édit., III, p. 386. —*Id . Id.*, Morris, Cat. Brit. foss., p. 49.— *Id.*, Wright, Ann. and Mag. of nat. Hist., t. IL, p. 248. — *Id.*, Bronn, Lethæa geog., 1851, p. 140. — *Id.*, Cotteau, Etudes Echin., Yonne, pl. 10, f. 7–8 (except f. 6), p. 108.—7d., Desor, Syn. Echin., p. 5. tab. III, f, 14. — *Cidaris crucifera*, Agassiz, Echin. Suisse, p. 61, t. XXI, f. 1–2 (junior).—*Cidaris florigemma*, Morris, Cat. Brit., 1854, p.74, — *Id.*, Woodward, Mem. geol. Surv., Dec. V. — *Id.*, Wright, Pal. soc., 1355, pl. 2, f. 2 a–f, and pl. VIIL f. 4 a-d.

Species with swollen test, having its ambulacral areas composed of two rows of small, very dense granules. The tubercles are large and slightly crenelated. The scrobiculae, large and circular, touch by their scrobicular circle. Spinescylindrical, clavellate, with a short neck, narrow, with a small ring above the principal ring. Body of the spine covered with small granules arranged longitudinally.

Fossil of the Corallian stage of Châtel-Censoir (Yonne), Saint-Mihiel, Switzerland, etc. It is also found in England at Calne, Malton. Finally, Cotteau indicated it is found in the ferruginous Oxfordian (Callovian) of Gigny (Yonne).

69. Cidarite de Parandier. *Cidaris parandieri*. Agassiz. — *Cidarites blumenbachü*, Munster in Goldf., Petref., 117, t. 39, f. 3 (*testa*). —*Id. Id.*, Cotteau, Echin. foss.,p . 108, t. X, f. G (*testa* exclud. *aculei*).—*Cidaris parandieri,* Agassiz, Echin, Suisse, Il, p. 58, t. XX, f. 1.—*Id.*, Desor, Syn. Echin., P. 5, tab. IL, f. 6-7 (spine).—*Cidaris aspera*, Agassiz, Echin. Suisse, IL, p. 69, t. XXI, f. 29–30. — *Cidaris histricoides*, Quenstept, Petref., p. 572, t. 49, f. 25.

This species has often been confused with the preceding. It differs especially because it has in addition to the two rows of ambulacral granules, two other intermediary rows. The tubercles are also smaller, but strongly crenelated. Scrobiculae elliptical, sunken and surrounded by a protruding bourrelet whose granules are less strong than in *C. blumenbachii*.

From the department of Yonne and the vicinity of Besançon.

70. *Cidaris monilifera*. Goldfuss.— Petref., p. 418, t. 39, f. 6.—Desor, Syn., p. 9.

Species near *coronata*: from Switzerland.

71. *Cidaris perlata*. Quenstent. — Jura, p. 728, t. 88, f. 70–71.

Perhaps only a variety of the preceding ? From Schnaitheir.

72. *Cidaris cervicalis*. Agassiz. — Echin. Suisse II, p. 63, t. XXI, f. 8 (under the name of *propinqua*).— *Id.*, Cotteau, Echin. foss., p. 103, t. X, f. 1–5 (under the name of *coronata*). — *Id.*, Desor, Syn., p. 8, t. III, f. 20–22 (spines).

From the department of Yonne, from the vicinity of Dole (Jura), Fringeli (canton of Soleure).

73. *Cidaris coronata*. Goldfuss. — Petref., p.119, t. 39, f. 8. — *Id.*, Quenstedt, Petref., t. 18, f. 16–21.— Lane, LépId., p. 127.—*Id.*, Agassiz, Echin. Suisse, p. 59, t. XX, f. 8–17. — *Id.*, Desor, Syn., p. 9, t. 1, f. 1, and t. I, f. 28–32 (spines).

Species with circular form, depressed, with very large and few tubercles whose upper one are crenelated. Scrobicular circles very far apart, surrounded by a scrobicular circle. Four rows of ambulacral granules. Spines very variable in form, composed of a very tall and very narrow stalk, covered with granules in parallel ridges.

From Randen of Birnmandorf, the valley of Birse, Wurtemberg and Bavaria.

74. *Cidaris marginata*. Goldfouss. — Petref., p. 118, t. 39, f. 7.—*Id.*, Quenstedt, Petref., p. 572, t. 48, f. 24 (spines). — *Id.*, Desor, Syn., p. 9, t. III, f. 5 (spines).

Species near the preceding but more swollen, with six rows of granules in the interambulacral areas.

From Nattheim.

75. *Cidaris cartieri*. Desor. — Syn., p. 437.

From Oberbuchsitten (canton de Soleure).

76. *Cidaris miranda.* Desor.—Cat. rais., p. 28.—*Id.*, D'Orbigny, Prodr., t . II, p. 27. and 14, n° 436. — *Id.* Desor, Syn., p. 6.

From Angoulin (Charente).

77. *Cidaris drogiaca.* Cotteau.—Echin. foss., p. 111, t. XI, f. 1–2, and t. XII, f. 1–2. — *Cidaris bertrandi*, Michelin, Revue et Mag. de Zool 1851. p. 2, t. III, f.2. — *Id*,, Desor, Syn., p. 7.

This species is one of the largest known fossils. The tubercles strongly crenelated below, at least on the ventral surface, are surrounded by a widely elliptical scrobicula around which is a circle of very large granules that are crenelated, mamelonated and perforated. Ambulacra are narrow with only two rows of granules with some very small warts in the middle.

From Châtel-Censoir and Druyes (Yonne).

78. *Cidaris suevica*. Desor. — Syn., p. 7, tab, I, f. 2.

Fossil of the Corallian of Wurtemberg.

79. *Cidaris curvata*. Quenstent. — Juara, p. 728, tab, 88, f. 69, — *Id.*, Desor, Syn. p. 438.

We know only its spine.

Fossil of the Corallian of the valley of Oerlingen.

80. *Cidaris propinqua*. Munster in Goldf. — Petref., p. 118, tab. XL, f. 1 (non Wright). — *Id.*, Agassiz, Echin. Suisse, p. 62, t. XXI, f. 5–7–9–10 (except f, 8). — *Id.*, Desor, Syn., p. 7, t. III, f. 25–26 (spine).

Small species with very large, smooth tubercles, with spines that are short, clavellate, without collar.

From Bayreuth, Laegern, Randen and Basil, Sirchingen (Wurtenberg).

81. *Cidaris elegans*. Munster in Goldfuss, — Petref., p. 118, t. 39, f, 5. — *Id.*, Desor, Syn., p. 8, t. II, f. 23–24 (v. 78).

From Nattheim, Bayreuth.

82. *Cidaris quenstedtii*. Desor.—*Cidarites elegans*.—*marginatus,* Quenstdt, Jura, p. 729, tab. 88, f. 72–78? — Desor, Syn., p. 438.

From Nattheim, Sirchingen, etc.

83. *Cidaris galeotti*. Desor.—Syn., p. 10.—*Cidaris propinqua*, GaL., Bull, Acad. Brux., 1840, t. VIL, p. 218, t. XV.

Jurassic fossil from Mexico.

It is necessary to add a large number of Jurassic species (35) known only by their spines that sometimes take singular forms. We can cite, in this regard the glandiforms of *Cidaris glandifera* Goldf., *C. cucumifera* Ag., *C. ovifera* Ag.; then, as aculciform spines *C. filograna* Ag., *C. elongata, C. spinosa* Ag, etc., etc.

KIMMERIDIAN SPECIES.

118. *Cidaris philastarte*. Taureau. Mss. — Desor, Syn., p. 26. De Porrentruy.

119. *Cidaris baculifera*. Agassiz. — Echin. Suisse, IL, p. 80, t, XX a, f.12. — *Id.*, Desor, Syn., p. 6, t. III, f. 3 (spines).

We know only isolated plates and spines in the form of rods that are cylindrical and sub-prismatic, with six to eight rows of granules.

From Porrentruy, Mont Saleve and Roeaedersdorf (Haut-Rhin).

120. *Cidaris poucheti*. Desor. — Syn., p.7.

From Hävre.

121. *Cidaris boloniensis*. Wright. — Brit. foss. Echin., p.68, pl. XIL, f. 5.— *Id.*, p. 64. — Davinson, Foss. du Boulon, t. J, f. 11–12. — Desor, Syn., p. 442.

Species known only by isolated plates and spines that are composed and that have some longitudinal ridges, interspersed with rather strong spines.

From Boulogne-sur-Mer and Dorsetshire.

122. *Cidaris pyrifera*. Acassiz. — Cat. syst., p. 19. — *Id.*, Echin. Suisse, IL, p.71, t. XXI, f. 24–26.—*Henicidaris thurmanni*, Agassiz, Desor, Cat. rais., p. 24. — *Cidariis pyrifera*, Desor, Syn., p. 29 (X 6, p. 30).

From Porrentruy.

SPECIES FROM CRETACEOUS TERRAINS.

123. *Cidaris pretiosa*. Desor. —Syn., p. 10 (V. 80), t. V, f. 3 (spine).

Species near *C. marginata*.
Fossil from the Neocomian terrain (Valangien) of Ste.-Croix.

124. *Cidaris gemma*. Desor. — Syn., p.11 (V.81).

Fossil from the Neocomian terrain (Valangien) of Ste.-Croix.

125. *Cidaris hirsuta*. Marcou in Agassiz, and Desor. — Cat. rais., p. 24.— *Cidaris antissiodorensis*, Cotteau, Cat. méth., p. 2.—*Cidaris hirsuta*, Deesor, Syn., p. 11, pl. V, f. 6 (spine). — *Cidaris salviensis*, Cotteau, Cat. méth., p. 2

Fossil from the Necomian terrain of Auxerre, St. Sauveur (Yonne).

126. *Cidaris punclata*. Roemer.— Ool. Gieb., p. 26, t I, f. 15–17 (non Agassiz and Desor). — *Id.*, Desor, Syn , p. 11, tab. V, f. 1 (spine).

Fossil from the Neocomian of Kavagaez (Crimea).

127. *Cidaris lardyi*. Desor.—*Cidaris punctata*, Agassiz (non Roemer), Echin. Suisse, II, p. 60, t. XXI, f. 11–21. — *Cidaris lardyi,* Desor, Syn., p. 11, tab, V, f. 2 (spine).

Fossil of the Neocomian of Mormont (Vaud), Ste.-Croix.

128. *Cidaris pustulosa*. Al. Gnas. — Ours. foss. Isère, p. 24, t. II, f. 5. — *Id.*, Desor, Syn., p. 35, t. VL f. 5.

Only the spine is known.
Fossil from the Neocomian of Fontanil (Isère).

129. *Cidaris cydonifera*. Agass. — Cat. rais,, p.25.—*1d*. Desor., Syn., p. 34.

Species near *Colocynda*, known only by its spines that are shorteor and with striations that are fine, granular and curving.

Fossil of the Neocomian of St.-Aubin (Var).
Desor thinks that it is perhaps only a variety of *clunifera*.

130. *Cideris clunifera*. Agassiz. — Foss. cret. in Mem. soc. Neufch., vol. 1, p. 142, t. XIV, f. 16–18. — *Id.*, Echin. Suisse, II, p. 68, t. XXI, f. 20–23.— *Cidaris cornifera*, Agassiz, Cat. rais., p. 29. — *Cidaris clunifera*, Desor, Syn., p. 35, t. VI, f. 4. — *Hemicidaris neocomiensis*, Cotteau.

Spine pyriform with a stalk that is slender, often constricted toward rhe middle.

Fossil from the Upper Neocomian of St. Aubin (Var), Orgon (Bouches-du-Rhône), Les Laltes, Grasse, etc.

131. *Cidaris unionifera*. Alb. Gras. — Ours, foss,, p . 26, t. III, f. 6. — *Id.*, Desor, Syn., p. 34, tab. VI, f. 2.

Pyriform spine with a very thin neck.

Fossil from the Aptian stage of Fà, near Reneurel (Isère).

132. *Cidaris punctatissima*. Agassiz. — Cat. syst., p. 10. — *Id.*, Alb. Gras, Ours. foss. Isère, p.23, t. IL, f. 4. — *Id.*, Desor, Syn., p. 35, t. VI, f. 5.

Sub-pyriform spine.

Fossil from the Aptian stage of Fà, near Rencurel (Isère),

133. *Cidaris phillipsii*, Agassiz. —- Cat. rais., p. 30, — Phil., Geol. Yorksh., t. IL, f. 3.— Desor, Syn., p. 32, t. V, f. 9 (spine).

Fossil from the clay of Specton (Aptian).

134. *Cidaris speetonensis*. Desor.—Phill., Geol. Yorksh., t. II, f, 5.—Desor, Syn., p. 32, t. V, f. 10 (spine).

Fossil of the clay of Specton (Aptian).

135. *Cidaris raryacantha*. Alb. Gras.—Ours. foss., p. 24, t. III f, 2, and t, V, f. 11. — *Id.*, Desor, Syn., p. 32, t. V, f. 12 (spine).

Fossil of the Aptian stage of Fà (Isère).

136. *Cidaris heteracantha*. Alb. Gras.— Ours. foss., p. 24, t. I, f. 4.—*Id.*, Desor, Syn., p: 32, 1 V, f. 11.

Fossil of the Aptian stage of Fà, near Rencurel (Isère).

137. *Cidaris vesiculosa*. Goldfusss. — Petref., p. 120, ab. 40, f. 2, — *Cidaris perforata*, Roemer, KreId., p.28, t. VI, f. 9. — *Cidaris maluma,* Alb. Gras, Ours. foss., p. 22, tab. 1, f. 1–5.—*Cidaris styloptera*, Al. Gras, Ours. foss., Sup., pl. 1, f. 1? — *Cidaris spinulosa*, Agassiz, Cat, rais., p. 20. — *Cidaris vesiculosa*, Desor, Syn., p. 11, t. V, f. 24, 25.

Species swollen, with very spaced tubercles. Scrobicular circle very pronounced, curving on its periphery. Six row ambulacral granules. Spines cylindrical, with serrated ridges. This species is one of the most characteristic of the Green Limestone.

Fossil of the Cenomanian of Hävre, Vikers, Vernonnet (Eure), Essen and Westphalia.

138. *Cidaris cenomanensis*, Cotteau. — Echin. de la Sarthe, 4e liv. — *Id.*, Desor, Syn., p. 447.

Fossil of micaceous sandstone of (Cenomanian) of Mans.

139. *Cidaris sorigneti*. Deson.—Syn., p. 446, t. VI, f, 16 (under *C. clavigera*) (M. 47).

Fossil of the green sandstone (Cenomanian) of Dieppe, Fleidchercamp near Brunswick.

140. *Cidaris strombecki.* Desor. — Syn., p. 447 (spine only).

Cenomanian fossil of Langelsheim (Brunswick).

141. *Cidaris heberti*. Desor. — Syn., p. 12, t. V, f. 82.

Cenomanian, Cape La Hêve, Vendôme. Coll. Michelin,

142. *Cidaris indignis*. Alb. Gras. — Ours. foss., p. 21, t. I, f, 4–6. — Desor, Syn., p. 12.

From the Cenomanian, Fauge, near Villard.

143. *Cidaris carteri*. Forbes. — Mem. geol. Surv, — Desor, Syns, p. 12.

Upper Green Sandstone, England.

144. *Cidaris oliva*. Desor. — Syn., p. 447.

From the Cenomanian of Langelsheim, near Brunswick.

145. *Cidaris mantelli*. Desor. — Syn., p. 449.

Species near *subvesiculosa*, from the Upper Cenomanian of Limeray (Indre-et-Loire).

146. *Cidaris velifera*. Bronn. — *Cidaris vesiculosus*, Goldfuss (*pro parte*), Petref., t. 40, f. 2k. — *Cidaris pisifera*, Agassiz, Cat. syst, p. 10. — *Cidarites globiceps*, Quenstedt, Petref., p. 577, t. 49, f. 17.— *Cidaris velifera*, Desor, Syn.. p. 34, t. VI, f. 12.

Fossil of the Green Chalk of Essen and Frohnhausen.

147. *Cidaris asperula*. Roemer.—KreId., p. 28, t. VI, f.8.—*1d*. Desor, Syn., p. 34. VI, f 11:

Fossil of the Green Chalk (Cenomanian) of Sarstedt.

148. *Cidaris gibberula*. Agassiz, Desor.—Cat. rais., p. 29.—*Id.*, Desor, Syn., p.34, pl. VI, f.3.

Pyriform spine.
Fossil of the Chalk of Cassis (Beuches-du-Rhône).

149. *Cidaris catenifera*. Agassiz. — Cat. syst., p. 10.—*Id.*, Agssiz, Echin. Suisse, IL, p. 79, t. 21 a f. 23. — *Id.*, Desor, Syn., p. 25, t. VI, f. 14 (X 19).

Clavelate spine, near *clavigera* by its form but without spiny ridges.
Fossil of the Alpin Chalk of Surênes (canton d'Uri). (Stage uncertain.)

150. *Cidaris clavigera*. Koenig.—Koenig, Icon. foss.—Parkinson, Org. Rem., IX, III. IV, f. 1–2.—*Cidaris margaritifera*, authors.—*Cidaris clavigera*, Desor, Syn. p. 12, t. VI, f. 15.

Species of medium size, characterized especially by its club-shaped spines covered with strongly serrated protruding ridges. Stalk more or less long.

Fossil of the Upper Chalk (Senonian) of Dieppe, Fécamp, Evreux, Vernonnet (Eure), Talmont, Corbières, England.

151. *Cidaris sceptrifera*. Mantell. — Mantell, Geol. of Sussex, p. 17. — *Id.*, Parkinson, Org. Rem., I, t. IV, f. 2.—*Id.*, Desor, Syn.. p. 13, t. IV, f. 28–29 (spines) (V. 85).

Fossil of the Upper Chalk (Senonian) Reims, Dieppe, Meudon, Beauvais, Talmont, Touraine, England (Sussex).

152. *Cidaris subvesiculosa. D'Orbigny*. — D'Orbigny, Prodr., t. Il, p. 274.— *Cidaris vesiculosa,* Parkinson (pars), Org. Rem., III, t. IV, f. 3. — Forbes, Mem. geol. Surv., 1854. — *Cidaris subvesiculosa*, D'Orbigny, Desor, Syn., p. 13, t. 5. V, f. 27 (N°786):

Fossil of the Upper Chalk of Rouen, departement of Eure, Varins, Royan, Talmont, Saintes, etc., England.

153. *Cidaris granulato-seriata*. Desor. — Syn., p. 14, t. V, f.26 (spines) (V. 87).

Fossil of the Upper Chalk (Senonian), Cognac, Royan, Bolbec.

154. *Cidaris cornutensis*. Desor.—Syn., p. 14.— ? *C. vendocinensis*, Agassiz, Desor, Cat. rais., p. 24 (V. 83).

Fossil of the Upper Chalk (Senonian), Courtalin (Eure-et-Loire), Vendôme.

155. *Cidaris serrata*. Desor. — Syn., p. 450.

Fossil of the Upper Chalk (Senonian), Meudon, Rugen.

156. *Cidaris mamillata*. Cotteau.— Echin. foss. Pyrus in Bull. Soc. geol. Fr. 2e série, t. XIII, p. 323. — *Id.*, Desor, Syn., p. 450 (Y. 12).

Fossil of the Upper Chalk (Senonian), vicinity of Carcassonne.

157. *Cidaris doliolum.* Desor. — Syn., p. 19.

Fossil of the Chalk at Somolinos (Spain).

158. *Cidaris pleracantha*. Agassiz.— Cat. syst., p. 10.— Sorignet. Qurs. foss. Eure, p. 4.— Desor, Syn., p. 14, t. VI, f. 7–10 (spines) (X 74). — Var. *C. colocynda*, Agassiz, Cat. syst., p. 10, 89–91.

From the White Chalk (Senonian) of Meudon, Givières (Eure).

159. *Cidaris perlata*. Sorienet.— Ours. foss. Eure, p. 8.— Desor, Syn., p. 14.

White Chalk (Senonian) of Giverny (Eure).

160. *Cidaris evata*. Sorienet.— Ours. foss. Eure, p. 9. — Desor, Syn., p. 14. 22° Clachaloze (Eure) — ? *subvesiculosa*.

161. *Cidaris punctillus*. Soriener. — Ours. foss. Eure, p. 9. — Desor, Syn., p. 15.

From the White Chalk (Senonian) of Giverny (Eure).

162. *Cidaris pistillum*. Quenstent. — Petref., p. 577, t. 49, f. 20. — *Cidaris stemmacantha*, Roemer, KreId., p. 29, t. VI, f, 6. — *Cidaris pistillum*, Desor, Syn., p. 32, t. V, f. 17–19 (spine).

Fossil of the Upper Chalk (Senonian) of Rugen, Gerhden.

163. *Cidaris hagenowi*. Desor. — Syn., p. 29, t. V, f, 16.

Fossil of the Upper Chalk (Senonian), Rugen.

164. *Cidaris filamentosa*. Agassiz, Desor.— Cat. rais., p. 26,.—*Id*., Desor, Syn., p. 32, t. V, f, 22 (spine) (R. 21).

Upper Chalk.

165. *Cidaris jouannettii*. Desmoulins. — Prodr., p. 336. — *Cidaris eurynacantha*, Agassiz, Cat. syst. p. 10.— *Cidaris jouannettii*, Desor, Syn., p. 33, t. V, f. 14. X. 75.

Upper Chalk (Senonian) of Périgueux.

166. *Cidaris cyathifera*. Agassiz. — Cat. syst., p. 10. — Desor Syn., p. 33, t V, 120:

Upper Chalk (Senonian), Royan.

167. *Cidaris spinosissima*. Agassiz, Dsor. — Cat, rais., p.21.—Desor, Syn., p. 33, t. V, f. 23 and 21 var.

Upper Chalk (Senonian), Royan. Échinodermes. 31

168. *Cidaris leptacantha*. Agassiz, Desor. — Cat. rais., p. 26. — Desor, Syn., p. 29: t. V, f. 20.

Fossil of the Upper Chalk (Danian), Hauteville.

169. *Cidaris faujasii*. Desor. — Syn., t. V, f. 13. — Faujas, Hist. Mont, Maestricht, t. 30, f. 13–14.

Fossil of the Upper Chalk (Danien), Maestricht, Meudon, etc.

170. *C. regalis*. Goldfuss.— Petref., p. 116, t. 39, f. 2. — Desor, Syn., p. 19.

Maestricht (Danien).

171. *C. danica*. — Desor in Hébert. — Mém. soc. géol. Fr., 1854. — Desor, Syn., p. 19.

From the Danian stage of Faxoe. Cotentin.

172. *C. forckhamnani.* Desor. — Cat. rais., p. 24. — Id., Hébert, Mém. Soc. géol., 1854. — Hisinger, Leth. suec., t. XX, f, 2. — Desor, Syn., p. 15 (V. 88).

From the Danian stage of Faxoe, Coll. Pisol, Vigny.

173. *C. tombeckiii*. Desor in Hébert, — Desor, Syn., p. 16.

From the Danian stage of Orglande.

174. *C. minuta*. Desor in Hébert,

From Montreville (Eure), in the Pisolithic Chalk.

175. *C. distincta*. Somener. — Ours. foss. Eure, — Desor, Syn., p. 16.

Montreville (Eure). Pisolithic Chalk.

176. *C. ramondi*. Lequien. — Mém. Soc. géol. Fr., 2^{e} série, t. IV, f. 192, t. IX, f. 11. — Desor, Syn., p. 16.

Gensac and Mauléon. Pisolithic Chalk.

SPECIES OF THE TERTIARY TERRAINS.

177. *Cidaris nummulitica*. E. Sism. in Bellardi. — Foss. in Mem. Soc. geol. Fr., 2^{e} série, t. IV, p. 263, t. I, f. 3.—Desor, Syn., p. 16. From Palarea.

178. *C. verneuillii*. D'Arch.—Hist. progrès, I, 246.—An. foss. Ind., p. 195, t. XIIL, f. 1 a b. Nummulic stage of the chain of Hala (Sinde).

179. *C. haloensis*. Haime.— An. foss. Inde, p. 196, t. 13, f. 2 and 3 (spines). — Desor, Syn., p. 17, t. VII, f. 16–18. From the chain of Hala (Sinde).

180. *C. avenionensis*. Desmoulins.—Syn., p. 336.—*C. stemmacantha*, Agassiz, Echin. Suisse, IL, p. 73, t. 21, f. 4. — Desor, Syn., p. 17, t. VII, f. 7–8 (spines). S. 14, S. 22.

Molasse of La Chaux-de-Fonds (Switzerland), Anglès near Avignon, St.-Paul-trois-Châteaux, Reims.

181. *C. venulosa.* Agassiz. — Cat, rais., p. 24. — Desor, Syn., p. 47. ?

182. *Cidaris prionota*. Aggasiz, — Cat. rais., p. 31.— *Id.*, D'Archiac, Mém. Soc. géol. Fr., 2^{e} série, t. II, pl. VIL, f. 16, and t. III, p. 419, tab. X, f. 2. — 14., Desor, Syn., p .36, tab. VII, f . 11 (spine). and Nummulitic of Biaritz.

183. *Cidaris acicularis*. D'Archiac. — Mém. Soc. géol. Fr., 2^{e} série, t. III, p. 419, tab. X, f. 5. — *Id.*, Desor, Syn., p. 36, t. VII, f. 15 (spine). and Nummulitic of Biaritz.

184. *Cidaris semiaspera*. D'Arch. — Mém. Soc, géol. Fr., 2^{e} série, t. II, p. 419, tab. X, f. 3. — *Id.*, Desor, Syn., p. 36, t. VIL, f. 14. From Biaritz.

185. *Cidaris subularis*. D'Archiac.—Mém. Soc. géoi, Fr. 2^{e} série, t. IL, p. 419, t. X, f. 4. — *Id.*, Desor, Syn., p. 36, t. VII, f. 10. From Biaritz,

186. *Cidaris striatogranosa*. D'Archiac. And Nummulitic of Biaritz.

187. *Cidaris subcylindrica*. D'Archiac. *Loc. cit*, And Nummulitic of Biaritz.

188. *Cidaris interlineata*. D'Archiac. *Loc. cit*. ns Nummulitic of Biaritz.

189. *Cidaris subserrata*. D'Archiac. *Loc. cit*. Nummulitique de Biaritz.

190. *Cidaris remigera*. Van Den Hecke — *Id.*, Desor, Syn., p. 452.

Spcies known by its whorled spines.
Nummulitic stage of Nice.

191. *Cidaris subprionata*. Al. Rouallt. — Mém. Soc. géol. Fr., 2° série, t. III, p. 467, t. XIV, f. 15.— *Id.*, Desor, Syn., p. 36, t. VII, f. 9 (spine).

Fossil of the Parisian stage (Eocene) of Bos-d'Arros.

192. *Cidaris signata*. E. Sism.— Mem. Acad. di Torino, Sup., série 2^{e}, t. IV, p. 390, t. II, f. 6. — *Id.*, Desor, Syn., p. 37, t, VIL, f. 6 (spine).

Fossil of the Middle Tertiary terrain (Miocene) of Turin.

193. *Cidaris hirta*. E. Sism.—Mem, Acad. Torino, App., 2^{d} série, t . IV, p.391, t. III, f. 10. — *Id.*, Desor, Syn., p. 37, t. VII, f. 2 (spine),

Fossil of the Middle Tertiary terrain of Turin.

194. *Cidaris variola*. E. Sism. — Mem. Acad. di Torino, 2^{e} série, t. IV, p. 392, t. III. f. 9. — *Id.*, Desor, Syn,, p. 38,t, VII, f. 3 (spine).

Miocene of Turin.

195. Cidaris Munsteri. E. Sism.— Mem. Acad. di Torino, p. 392, t. III, f. 8. —*Id.*, Desor, Syn.,p. 38, t, VII, f. 4.—*Cidaris sismondae*, D'Orbigny, Prodr., t, 1, p. 142.

Fossil of the Middle Tertiary terrain (Miocene) of Turin,

196. *Cidaris zeamays*. Sism. — *Loc. cit*., p. 391. — *Id.*, Desor, Syn., p. 38.

Fossil of the Middle Tertiary terrain (Miocene) of Turin.

197. *Cidaris rosaria*. Bronn. — Ital. — Desor, Syn., p. 38. Miozène de Castel-Arquato.

198. *Cidaris limaria*. Bronn. —- Desor, Syn., p. 38. Miocëne de Castel-Arquato.

199. *Cidaris gastaldii*. Michelotti. — Desor, Syn., p. 453 (spine).

Fossil of the Lower Miocene terrain of Dego.

200. *Cidaris spiralis*. Desor, — Syn., p. 493.

Fossil of the Miocene terrain of Turin

201. *Cidaris anceps*. Michelottti. — Desor, Syn., p. 453 (spine).

Fossil of the Miocene terrain, Serravalla di Serivia:

202. *Cidaris miletensis*, Forbes in Wright. — Foss. Echin. Fr., Malta, Ann. and Mag. of Nat, Hist,, t. XV, p. 195, tab. 4, f. 1. — *Id.*, Desor, Syn., p. 453.

Fossil of the Miocene stage of Malta.

203. *Cidaris desmoulinsi*. E. Sism.—App. in Mem. Acad. di Torino, 2° série, t. IV, p. 391, t. II, f. 11. — *Id.*, Desor, Syn., p. 38, t. VIL f. 1 (spine).

Fossil of upper terrain (Pliocene) of Astesan.

204. *Cidaris rugata*. Herkots. — Fossil of Java, Echin., p. 1, t. I, f. 1.

Fossil of a recent Tertiary terrain Tjidamar (Java).

2nd GENUS. **LEIOCIDARIS**. *LEIOCIDARIS*. — DESOR.

— Desor (Syn., *Cidaris* Lamarck),

Pores of the poriferous zones connected by a groove.

This genus, established by Desor at the expense of the Cidarids of Lamarck, contains species that differ from the latter because the ambulacral pores in the same zone are connected by a groove. The spines, in the form of long rods, are always cylindrical and smooth.

All the species known to the present are living.

1. IMPERIAL LEIOCIDARIS. *LEIOCIDARIS IMPERIALIS*. — LAMARCK.

— *Echinometra altera digitata*, Seba, Mus., t. 8, tab. 13, f. 3. — *Cidaris papillata major*, Leske. ap. Klein, p. 126, t. 7, f. A.— Knorr, Delic., tab. D, f. 2. — D'Argenville, pl. 25, f. e. — *Echinus cidaris*, Lin., Gmel., p. 1108. — *Cidaris imperialis*, Lamarck, An. s. vertèb., 2e édit., t. III, p. 378, no 1. —, Encycl. méthod., pl. 136, f. 8.—*Id.*, Deslongchamps , Encycl. méthod., t. I, p. 194.—Blainville, Man. Act., p.23.— *Id.*, Agassiz, Prodr.—*Id.*, Desmoulins, Echin. p. 318. — *Id.*, Agassiz and Desor, Cat. rais., p. 318. — *Leiocidaris imperialis*, Desor, Syn. Echin., p.

Large species with large tubercles with a very large base and scrobiculae surrounded by very protruding granules. Spines of smooth appearance but in reality very strongly granular, with some slight longitudinal grooves toward the tip. Their base is, so to say, covered with a kind of sheath formed of flattened spines inserted on the scrobicular granules.

The spines as well as the rest of the test are a uniform reddish brown. In a very distinct variety, they are marked with whitish rings of spots. Finally, in another variety, the ring still more pronounced, is located toward the end that is ended by a kind of truncation that has striations that are longitudinal, lamellar, very pronounced. It is not impossible that this variety is a distinct species.

Inhabits Australia.

2. PORCUPINE LEIOCIDARIS. *LEIOCIDARIS HYSTRIX*. — Desor.

— *Echinometra gualtieri*, Ind., t. 108, f. D. — *Cidaris papillata*, var. 3, Leske apud Klein, p. 129, t. VII f. B C. — Bonani, Recr., 2, p. 92, f. 17–18, — Favanne, Conch., pl. 56, f. 61. — Scilla, Corp. mar., n° 22.— *Cidaris hystriae*, Lamarck, An. s. vert., 2e édit., t. III, p. 379, n° 3. — Encyclop. méthod., pl. 136, f. 6–7. —*Id.*, Deslong., Encycl. méthod., t. 2, p.194.— *Id.*, Blanv., Dict. sc. nat., t. 9, p.199. *Id.* Blainville, Man.. Act., p. 231, pl. 20, f.5.—*Id.*, Risso, Eur. mérId., t.V, p. 278, n° 28.—*Id.*, Agassiz, Prodr., p.190. — *Id.*, Desmoulis, Echin, p. 320.— *Id.*, Agassiz, Desor, Cat. rais., p . 324, — *Id.*, Sars, Midd. Mem. Acad. Stock., 1857, p. 53, n° 28.— *Leiocidaris hystrix*, Desor, Syn., P.

Sub-spherical species, a little depressed above and below. Scrobicula very deep, surrounded by protruding circled edged with a kind of bourrelet on which the granules are much more pronounced than in the intervals. Spines very elongated, cylindrical and smooth.

Inhabits the Mediterranean (Sicily).

3. PAPILLATE LEIOCIDARIDE. *LEIOCIDARIS PAPILLATA*. — Leske.

— *Cidaris papillata*, Leske apud Klein, p. 125, tab. VII, f. A, and tab. 39, f.2.—Fleming, Brit. anim., p. 477.—*Echinus cidari*s, Linn., Faun. suec., p. 513, et Guez., p. 3175, — Müller, Prodr., p. 235, n° 2848. — Favanne, pl. 56, f. C. — Encycl. méthod. pl. 136, f. 6–7. — *Echinus cidaris*? var. a sow. Brit. misc., pl. 44. — *Cidaris papillata*, Forbes, Brit. Starf. p. 146. — *Id.* Desmoulins, Echin. — *Cidaris hystrix*, Sars, Besk, og. Jagst., p. 40,— *Cidaris borealis*, Dur., Kor., Ofvers. of K. vetensk. Akad., 1844, p. 104. — *Cidaris papillata*, Duben, Koren, Mém. Acad. Stock., p. 114, p.255, t. IX, f. 25–30. — *Cidaris papillata*, Agassiz and Desor, Cat. rais., p. 323.

Species very near the preceding but with a more slender and delicate form.

Inhabits seas of the North, the coasts of Scotland and Norway.

4. RELATED LEIOCIDARIDE. *LEIOCIDARIS AFFINIS*. — -Phil.

— Archiv. für nat., 1845, p. 351.—*Id.*, Sars, Nüidd. littor. Faun., 1857, p. 54, no 29.

Differs from *Hystrix* principally by its more flattened form.

Inhabits the Mediterranean.

5. STOKE'S LEIOCIDARIS. *LEIOCIDARIS STOKESI*.— Agassiz

— Cat. rais., p. 324.

Inhabits the Mediterranean (Mus. Paris).

6. LEIOCIDARIS OF DU PETIT-THOUARS. *LEIOCIDARIS THOUARSII*. — Desor.

— *Cidaris thouarsii*, VaL.— *Id.*, Agassiz and Desor, Cat. rais., p. 326.

Species having four rows of granules in the interambulacral areas. Scrobiculae wide with granules in the intervales. Spines sub-cylindrical, very granular.

Inhabits California, Galapagos (Mus. Paris).

7. DANA'S LEIOCIDARIDE. *LEIOCIDARIS DANAE*.— Agassiz, Desor.

— Agassi, Desor, Cat, rais., p. 326.

Species of small size with subulate spines covered with linear granules. Those of the dorsal surface are smooth.

Inhabits California (Mus. Paris).

3rd GENUS. **Gonocidaris**. *GONIOCIDARIS*, — Agassiz.

— Syn., *Cidaris* (pars), Lamarck.

This genus is characterized by the presence of sunken impressions arranged in a zigzag in the median suture of the ambulacral and interambulacral areas.

By all their characters, species of this genus do not differ greatly from Cidarids.

We know only two living species.

CRANE'S BEAK GONIOCIDARIS. *GONIOCIDARIS GERANIOIDES*. — Lamarck,

— *Echinometra singuiarissima*, Seba, Mus., I, t. 23, f, 8.-— Encycl. méth., p. 136, f. 1. — *Cidaris geranioides*, Lamarck An. s. vert., IL, p. 380, n° 5. — *Id.*, Deslongc., Encycl. méth.,

2, p.195. — *Id.*, Agassiz, Prodr. — *Id.*, Desmoulins, Echin. — *Goniocidaris geranioides*, Agassiz, Desor, Cat. rais., p. 337. — *Id.*, Desor, Syn., p. 41.

Spines cylindrical, subulate, those surrounding the anus being cupuliform.
Inhabits Australia. (Mus. Paris).

2. QUOY'S GONIOCIDARIS. *GONIOCIDARIS QUOYI*. — Val.

— Agassiz, Desor, Cat. rais., p. 337.

Inhabits Australia (Mus. Paris).

4th GENUS. **RHABDOCIDARIS**. *RHABDOCIDARIS* Desor.

Test spherical, swollen, a little depressed above and below. — Ambulacra straight or slightly flexuous. — Poriferous zones with, the two pores of the same pair united by a groove. — Tubercles large, strongly crenelated. Spines very developed, sometimes cylindrical or prismatic and with serrations or spines at their base. Articular facet crenelated.

This genus, established at the expense of *Cidaris* is distinguished from the latter by the arrangements of the poriferous zones in which the pores are united by a groove. The spines are in general remarkable for their large size as well as their varied form. We know approximately thirty fossil species that come from the Jurassic (Oolitic) or Upper Cretaceous (Neocomian) terrains. One species however has been reported from Triassic terrains but as it is known only by fragments, its determination is still doubtful.

1. Moreau's Rhabdocidaris. *Rhabdocidaris moraldina*. Desor.

— *Cidaris moraldina*, Cotteau, and Echin. de l'Yonne, t. 1, p. 33, pl. 1, f. 1–3. — *Rhabdocidaris moraldina*, Desor, Syn , p. 42, pl. VI, f. 11. — *Id.*, Levmerie and Cotteau, Cat. Echin. Pyr. in Bull. Soc. geol. Fr., 2e série, t. XIII, p. 322, 1857. — *Id.* Wright, Mem. Brit. foss. Echin., p. 54, pl. V, f. 8. — *Id.*, Cotteau, Echin. Sarthe, p. 2, n° 3, pl. 1, f. 6.

Species near *R. maxima.* Its scrobiculae are less depressed and surrounded by more apparent granules. Its tubercles are strongly crenelated. Spines in the form of slender rods, cylindrical, covered with small, elongated pustules arranged without order.
Fossil of the Middle Lias (Liasian), of Vassy, near Avallon (Yonne), Asnières (Sarthe).

2. Old Rhabdocidaris, *Rhabdocidaris antiquate*. Cotteau. — Cotteau, Echin. Sarthe, p. 3, n° 4, pl. 1, f. 7.

Species known only by its spines that greatly resemble those of the preceding species.
Fossil of the Middle Lias (Liasian) of Asnières (Sarthe).

3. Very large Rhabdocidaris. *Rhabdocidaris maxima*. — *Cidarites maximus*, Munster in Goldfuss, Petref , p. 116, t. 39, f. 1 ab. — *Cidaris* (épine), Pics, Geol. Yorksh,, t. IX, f.5.— *Cidaris maxima*, Morris, Cat. Brit. foss., t. 2, p. 74. — *Rhabdocidaris maxima*, Desor, Syn., p. 39, and t. VIII, f. 47 (spine), and t. VIII f. 14–16 (the variety), — *Id.*, Wright, Pal. soc., 1855, t. 99.

Species with elevated test with at least seven tubercles per row, 3 scrobiculae that are large, elliptical, nearly touching by the base. No scrobicular circle. Poriferous zones equaling in width the ambulacral area that has only two rows of granule. Spines in the form of sub-fusiform rods with rather strong bur sparse spines.

Varietas. — *Cidarites spinuliosus*, Roemer, Ool. Geb., p. 26, t. I, f. 46. — *Cidaris horrida*, Marcou in Agassiz, Ech. Suisse, II, p. 72, t. XXI a, f. 2.

In this variety, the spine in the form of a cylinder has its ring very protruding.

Fossil of the Great Oolite (Bathonian) of the canton of Basil, Soleure (Switzerland), Yorkshire (England).

4. Blainvillle's Rhabdocidaris. *Rhabdocidaris blainvillii*. Desor. — *Cidaris blainvillii*, Desmarets, Agassiz, Desor, Cat, rais., p. 28.

Fossil of the Lower Oolite (Bajocian), Ranville,

5. *Rhabdocidaris spinulosa*. Roemer (Sp.). — Roemer, Die verst. Nord. 0o!,, p. 26, pl. L, f. 16. — *Cidaris horrida*, Merian, Agassiz, D'Orbigny.— *Cidaris spinulosa*, Roemer, Cotteau and Wright, Echin. foss, Sarthe, p. 10, n° 3, pl. 2, f. 6–7,

Perhaps it is necessary to refer it to *Rhabdocidaris maxima* ?

Fossil of the Lower Oolite (Bajocian) of Tennie and Précigné (Sarthe), Salins (Jura), Basil (Switzerland).

6. *Rhabdocidaris guttata*. Cotteau. — Echin. Sarthe, p. 68, t. XV, f. 1–2. — *Id.*, Desor, Syn., Echin., p. 435 (X. 18).

Fossil of the Kellovian stage of Marolles (Sarthe).

7. *Rhabdocidaris princeps*. Desor. — Syn., p. 40, t. VII, f. 1 (spine).

Large species near *A. maxima*, having large spines cylindrical or sub-prismatic, more or less compressed with rather strong spines on the sides.

Fossil of the Argovian of Laegern (Oxfordian).

8. *Rhabdocidaris nobilis*. Desor. — *Cidarites nobilis*, Munster in Goldfuss, Petref., p. 117, tab. 39, f. 4. — *Id.*, Agassiz, Echin. Suisse, IL, p. 65, t. XXI, f. 21. — *Rhabdociduris nobilis*, Desor, Syn., p. 40, t. VIIL, f, 10.

Var. *C. heteropleura* ? Agassiz, Cat. syst., p. 10.

Fossil of Argovian of Bayreuth (Oxfordian).

9. *Rhabdocidaris prismatica*. Dsor. — Syn., p. 437.

Fossil of Oxfordian of Bætzberg (Argovia).

10. *Rhabdocidaris copeoides*, Desor. — *Cidaris copeoides*, Agassiz, Syst. cat., p. 10. — *Cidaris hastalis*, Desor, Cat. rais., p. 30. — *Rhabdocidaris copeoides*, Desor, Syn., Echin. p. 41, t. IX, f. 3–7 (X 62).

Fossil of the Oxfordian of Latrecy (Haute-Marne), Kellovian of Châtillon sur-Seine, Gigny (Yonne).

11. *Rhabdocidaris remus.* Deson. — *Cidaris spatula*, Agassiz (pro parte). — Desor, Syn., p. 43, t. XI, f. 1-2 (P. 41). Spine.

Fossil of the Kellovian of Percy-le-Grand (Haute-Savoie), Châtillon-sur-Seine, Estrochey (Côte-d'Or).

12. *Rhabdocidaris tricarinata*. Munster. — *Cidaris tricarinata*, Agassiz, Cat. syst., p. 10. — *Id.*, Munster in Goldfuss, Petref., t. 39, f. 4 c d e. — Desor, Syn., p. 44, t. VIIL f. 4 (spines),

Fossil of the White Jura (Argovian ?), Bayreuth.

13. *Rhabdocidaris cristata*. Munster. — *Cidaris cristata*, Agassiz, Cat. syst., p. 10. — Munster in Goldf, Petref., tab. 39, f. 4. — Desor, Syn., p. 44, t. VIIL f, 2 (spine).

Fossil of the White Jura (Argovian), Bayreuth.

14. *Rhabdocidaris trispinata*. Desor. — *Cidaris trispinatus*, Quenstedt, Petref., p. 573, t. 49, f. 9. — *Rhabdocidaris trispinata*, Desor, Syn., Echin., p. #2, tab. VIIL, f. 12 (spine).

Fossil of the Corallian of Nattheim.

15. *Rhabdocidaris trigonacantha*. Desor. — *Cidaris trigonacantha*, Agassiz, Cat. syst.,p . 10. — *Id.*, Echin. Suisse, t . Il, p. 74, t. XXI a, f. 6. — *Rhabdocidaris trigonacantha*, Desor, Syn., p. 43, t. VIIL, f. 30 (spine).

Fossil of the Corallian of Besançon.

16. *Rhabdocidaris ritteri*. Desor. — *Cidaris trigonacantha*, Cotteau, Echin. foss., p. 415, t. X, f. 9. — *Rhabdocidaris ritteri*, Desor, Syn., p . 43, t. VII, f. 6. — Var. *C. spinosa*, Cotteau.

Fossil of the Corallian of Châtel-Censoir (Yonne).

17. *Rhabdocidaris megalacantha*. Desor. — *Cidaris megalacantha*, Agassiz, Cat. syst., p. 10. — Desor, Syn., p. 43, t. VIIL, f. 13 (spine) M. 71.

Fossil of the Corallian of Ile de Ré.

18. *Rhabdocidaris spatula*. Desor. — *Cidaris spatula* (pro parte), Agassiz, Echin. Suisse, IL, p. 79, t. XXI a, f. 24. — Desor, Syn. p. 44.

Spine in the shape of an oar.
Fossil of the Corallian of Besançon, Wurtemberg.

19. *Rhabdocidaris crassa*. Desor.— *Cidaris tricarinata*, Agassiz (pro parte), Cat. syst., p. 10. — *Id.*, Cotteau, Echin. foss., p.107, t. XI, f. 8. — *Rhabdocidaris crassa*, Desor, Syn., p. 44.

Fossil of the Corallian of Besançon, Châtel-Censoir (Yonne).

20. *Rhabdocidaris mitrata*. Desor. — Desor, Syn., p. 439. — Syn., *Cidarites mitratus*, Quexsrenr, Jura, p.731, t. XXXIX, f. 5 (spine).

Fossil of Corallian of Nattheim.

21. *Rhabdocidaris smithii*. Desor. — Desor, Syn.— *Cidaris smithii*, Wright, Pal., Soc., 1855, p. 50, t. IL, f. 1ac, and t. V, f. 5 a-e (spine).

Fossil of the Corallian of Wiltshire (England).

22. *Rhabdocidaris triaculeata*. Desor. — Desor, Syn., p. 439. — Syn., *Cidarites triaculeatus*, Quenstedt, Jura, p.731, t. 89, f. 1 (spine).

Fossil of the Corallian of Wurtemberg.

23. *Rhabdocidaris trilatera*. Desor. — Desor, Syn., p. 439. — Syn., *Cidarites trilaterus*, Quenstedt, Jura, p. 731, t. 89, f, 4 (spine).

Fossil of the Corallian of Nattheim.

24. *Rhabdocidaris orbignyana*. Desor.— *Cidaris orbignyana*, Agassiz, Cat. syst., p. 10. — Var. *Cidaris tripterygia*, Agassiz, Cat. syst., p. 10. — *Cidaris macroucantha*, Thurmann.— *Rhabdocidaris orbignyana*, Dsor, Syn. p. 40, t. I, f. 3, and tab. VIII, f. 7–9 (spines).

Species with scrobiculae more or less elliptical, surrounded by a distinct scrobicular circle. Tubercles large, crenelated, at least six per row. Spines tri-cornered or prismatiac.
Fossil of the Kimmeridian of La Rochelle, Montfaucon (Meuse), Porrentruy, etc.

CRETACEOUS SPECIES.

25. *Rhabdocidaris tournali*. Desor. — Syn. Echin., p. 42.

Fossil of the Upper Neocomian of Clape (Aude).

26. *Rhabdocidaris tuberosa*. Desor. — Syn., p. 42. — *Cidaris tuberosa*, Alb. Gras, Ours. foss., p. 23,t. 1, f. 7-8.— *Cidaris ramifera*, Alb. Gras, Ours. foss., p. 25, t. IL, f. 7 (spines).

Fossil of the Lower Neocomian of Fontanil (Isère).

27. *Rhabdocidaris crenata*. Desor.— Syn., p. 42.— *Cidaris crenata*, Phill., Geol. of Yorksh., t. II, f. 2.

Fossil of the clay of Specton (Aptian), of Yorkshire.

Desor also indicates:

28. *Rhabdocidaris junonis*. Desor. — Syn., p. 425.

"Large plate with tubercles strongly crenelated, with a complete scrobicular circle." Fossil of St.-Cassian (Triassic).

5th GENUS. **DIPLOCIDARIS**. *DIPLOCIDARIS*—Desor.

Test spherical. — Ambulacra straight. — Poriferous zones with two rows of pores not regularly arranged but overlapping alternatively to the right and to the left. Tubercles strongly crenelated. Spines short, massive, cylindrical, with granules or pustules.

This genus, near the two preceding, is distinguished by the singular disposition of the paired ambulacra that overlap in such a way to make us believe there are four pores in each poriferous zone. The spines are short and massive, with granules or pustules instead of spines as in *Rhabdocidaris*.

The genus *Diplocidaris* contains only a very small number of species, most known only by their spines.

They all come from the Jurassic terrains.

1. GIANT DIPLOCIDARIS.. *Diplocidaris gigantea*. Desor. — *Cidaris gigantea*, Agassiz, Echin. Suisse, t. Il, p. 66, t. XXI, f: 22.—*Id.*, Quenstedt, Petref., t. 48, f. 45 and 44 (spine). — *Cidaris pustulifera*, Agassiz, Echin. Suisse, t. Il, p. 75, $. XXI, f. 7 (spine). — *Id.*, Cotteau, Echin. foss., p. 113, t. XXI, f. 3. — *Diplocidaris gigantea*, Desor, Syn., p. 45.

Species of large size, with straight ambulacra, with two rows of granules. Tubercles strongly crenelated. Scrobicular circles surrounded by a circle of distinctly mamelonated

large granules. Spines cylindrical with numerous granules, equal but not in a row. Large articular facet. Protruding ring. Collar distinct.

Fossil of the Corallian of Besançon, Nattheim, Salins, Châtel-Censoir and Druyès (Yonne).

2. ALTERNATE DIPLOCIDARIS. *Diplocidaris alternans*. Desor. — *Cidaris alternans*, Quenstedt, Petref., p. 573, tab. 49, f. 8.—*Diplocidaris alternans*, Desor, Syn., p. 45.

Pores doubled in a way to simulate four very distinct vertical rows. No scrobicular circle. Miliary zone wide. Spines slender, first cylindrical, then bi-ridged or tri-ridged and finally multi-ridged toward the top.

Fossil of the Corallian of Besançon, Salins, Châtel-Censoir, Druyès (Yonne), Nattheim, Ulm.

3. DESOR'S DIPLOCIDARIS. *Diplocidaris desorii*. Wright. — *Diplocidaris gigantea*, Desor, Syn., p. 439, t. I, f. 5. — Quenstedt, Jura, p. 733, t. 89, f. 22. — Wright, Pal. Soc., 1855, p. 56, xl. VII, f. 5,

Fossil of the Corallian of the vicinity of Ulm, of Friednigen (Wurtemberg).

SPECIES OF WHICH WE KNOW ONLY THE SPINES.

4. *Diplocidaris wrightii*. Desor. — *Cidaris coronata*, Murchison, Geol. of Cheltenh., p. 73. — *Id.*, Morris, Cat. of Brit. foss., p. 49. — *Cidaris fowleri*, Wright, Ann. and Mag. of nat. Hist., 2nd serie, vol. VII, p. 246, pl. A, f.5 a b. — *Id.*, Desor, Syn., p. 6, t. 3, f. 13. — *Id.*, Morris, Cat. Brit foss., 2nd edit., p. 74. — *Id.*, Wright, Pal. Soc., 1, p. 32, tab, I, f. 4 abcd. — *Diplocidaris wrightii*, Desor, Syn., p. 46, t. VII, f. 24.

Fossil of the Lower Oolite (Bajocian) of Crickley Hill (England).

5. *Diplocidaris henvelini*. Cotteau. — Echin. Sarthe, p. 11, tab. IL, f, 8. — *Id.*, Desor, Syn., p. 429.

Fossil of the Upper Oolite of Tennie (Sarthe).

6. *Diplocidaris cinamomea*. Deson.—*Cidaris cinamomea*, Agassiz, Cat. syst, p. 10, and Echin. Suisse, t. IL, p. 78, t. XXI a, £.13. — *Diplocidaris cinamomea*, Desor, Syn., p. 45, t. VII, f. 26 (P. 65).

Fossil of the Corallian of Besançon.

7. *Diplocidaris clavifera*. Desor. — Syn., p. 46, t. VIL f. 25. — *Cidaris clavifera*, Agassiz, Cat. syst. p. 10. — *Id.*, Echin. Suisse, I, p.75,t. XXI a, f. 8 (M. 75).

Fossil of the Corallian of Besançon.

8. *Diplocidaris censoriensis*. Cotteau.— Echin. foss., p.118, t. XIL £. 4. — *Id.*, Desor, Syn., p. 46, t. VII, f. 27.

Fossil of the Corallian of Châtel-Censoir (Yonne).

6th Genus. **Porocidaris**. *POROCIDARIS,* Desor.

Test similar as an ensemble to *Cidaris* but having the scrobiculae pierced in their periphery by a circle of pores that are in small grooves that radiate around the scrobicula. Tubercles crenelated and perforated. Spines compressed in the form of strongly serrated lamellae.

This genus was established by Desor based solely on inspection of isolated plates whose character is a circle of pores around the scrobicula. This arrangement, unique so to say, in the Echinoids, perfectly legitimizes the generic distinction it has produced.

We know five species, of which one from the Lower Oolite, two from the Nummulitic stage, one from the Parisian and one from the Falunian.

1. Schmidell's Porocidaris. *Porocidaris schmidelii*. Desor. — *Cidarites schmidelii*, Munster in Goldfuss, Petref., p. 120, t. 40, f. 4.—*Porocidaris schmidelii*, Desor, Syn., p. 47, t. VII f. 22. — *Id.*, Pictet, pl. 97, f. 18.

Fossil of the Lower Oolite of the valley of Frick (Argovia).

2. Porocidaris of Verona. *Porocidaris veronensis*. Merian. — Schmidel, Verst., p. 40, tab. XXI, f. 3–5.— Leske ap. Klein, t. LII, f. 18.— Andrez. Briefe, t. V, f. 6. — Parkinson, Org. Rem. IV, t. IV, f. 12. — *Porocidaris veronensis*, Desor, Syn., p. 47, t. VII, f. 21 (P. 40). — *Id.*, Pictet, Pal., t. 97, f. 17.

Species having from 20 to 25 pores around the scrobiculae. The spines are extremely remarkable and bizarre in form. They are flattened, ridged longitudinally with edges strongly serrated and even spiny.

Fossil of the Nummulitic terrain of the Dominico valley near Vérone. From the vicinity of Nice.

3. *Porocidaris tuberculosa*. Michelin. — Bull. Soc. géol., t. 17, p. 146.

Fossil of the Middle Eocene (Parisian) d'Issy.

4. Serrated Porociparis. *Porocidaris serrata*. Desor. — *Cidaris serrata*, D'Archiac, Mém. Soc. géol. Fr., 2e série, vol, III, p. 419, t. X, f. 6.—Desor, Syn., p. 47, t.. VII, f, 23.

Spine very flat, with strongly serrated edges, with three rows of linear ridges on one of the surfaces.

Fossil of the Nummulitic terrain of Biaritz,

5. *Porocidaris serraria*. Desor. — Syn., p.48. — *Cidaris serraria*, Bronn, Ital. — Agassiz, Desor, Cat. rais., p. 31.

Fossil of the Miocene of Castel-Arquato.

7th GENUS. **HETEROCIDARIS**. *HETEROCIDARIS*.— Cotteau.

Test swollen, sub-convex above. Interambulacral areas wide with eight to ten rows of tubercles that are very large, homogeneous, crenelated and perforated. Ambulacrals very narrow, flexuous. Pores non-conjugated but trigeminate around the peristome. Spines elongated, cylindrical, covered with fine striations and sparse granules.

This genus, established by Cotteau (Bull. Soc. géol. Fr. 1860, 2e série, t. 17, p. 378), is curious in more ways than one. It is part of both Angustistellid and Latistellid Cidarids and its place is rather difficult to fix in a certain manner. The scholarly author who created it thinks that it should be placed next to *Cidaris.*

The only known species is:

TRIGER'S HETEROCIDARIS. *Heterocidaris trigeri*.—Cotteau, *loc. cit*., pl. IV.

Fossil of the Lower Oolite (Bajocian) of Chevani (Sarthe).

2nd TRIBE. **LATISTELLIDS OR ECHINIANS.**

Test sub-spheroidal, sometimes depressed both above and below. Ambulacral areas having a tendency to become wider, equaling and even passing in width the interambulacral areas. Both have tubercles of the same structure, more or less large sometimes crenelated and perforated, sometimes with a small and imperforate base. Peristome of variable size. — Buccal membrane bare, no imbricated scales. A very developed masticatory apparatus with tri-keeled teeth. Ambulacral pores often numerous, diversely arranged, either by single pairs (unigeminate) or double pairs (bigeminate). Or finally by multiple pairs (polygeminate).

This tribe, extremely numerous in genera, either living or fossil, corresponds in a general way to two or three of the large genera established by old authors but that have been much more restricted since, such as the Diademids and Urchins.

It is principally from the point of view of modifications of the poriferous zones, either in number or disposition of the ambulacral pores that the Latistellids are most remarkable. Also, we have believed it necessary to differentiate these different genera and groups into two principal divisions. Some, containing only three pairs of pores have been named *Oligopores*. The others with a larger number, from four to ten, are called *Polypores*.

One of the characters that best serves to distinguish the Latistellids from the Angustistellids is the particular arrangement of the buccal membrane that has neither imbricated scales nor poriferous zones, but on the periphery of the peristome in the corners

of the ambulacra are ten fleshy appendages called buccal gills that correspond to five more or less deep notches on the peristome edge.

The *Oligopores* are composed of three principal types: 1° Urchins with larage crenelated tubercles accompanied with poriferous zones of which the holes are unigeminate or bigeminate (*Diadema, Hemicidaris*); 2° Urchins with a sculptured test, i. e., with fossettes in the corners of the plates (*Temnopleurus*); 3° Urchins with non-crenelated tubercles, with trigeminate ambulacral pores (*Echinus*).

1st Genus. **Hemicidaris**. *HEMICIDARIS*, — Agassiz.

— Syn. *Cidarites* (pars), Lamarck, Goldfuss,

Body spheroidal — Ambulacrals with tubercles on a very small portion of their length. Interambulacral tubercles strongly crenelated and perforated. Scrobiculae protruding, generally contiguous toward their base. Poriferous zones composed of two single rows or pores having a tendency to double near the peristome. These are very large, without deep notches. Spines cylindrical or club-shaped, smooth or longitudinally striated.

The genus *Hemicidaris*, established by Agassiz (1840, Échin. Suisse, IL, p. 42), is, in some way, the first sketch of the large group of Latistellids. In fact, the tubercles are in only a small extent of the poriferous zones, and their size is so small that Desor proposed to call them *semitubercles*.

Hemicidaris are found only as fossils. They appear in the Lower Oolite (Bajocian), crossing all the subsequent stages to reach the Nummulitic stage.

We count about thirty species that are referred to three types: A. swollen species with large tubercles up to the top, Ex. *H. crenularis, H. intermedia*; B. wide and depressed species whose tubercles disappear on the dorsal surface, Ex. *H. diademata, H. cartieri*; C. species with flesuous ambulacra and with tubercles far apart on the dorsal surface, Ex. *H. mammosa, H. thurmanni*.

1. Crenular Hemicidaris. *Hemicidaris crenularis*, Agassiz—*Cidarites crenularis*, Goldfuss, Petref., p. 122, tab. 40, £. 6.—*Id.*, Parkinson, Org. Rem., t..3, tab. I, f. 6. — *Id.*, Lamarck, An. s. vert., III, p. 59. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, p. 197. — *Diadema crenulare*, Desmoulins, Tab. syn. Echin., p. 312,

   Very swollen species, as tall as wide, ambulacra with tubercles (semitubercles) of omedium size, seven or eight per row. Interambulacral tubercle protruding, touching by the base. Peristome very large. Spines cylindricala, swollen into a club at their end.

   Fossil of the Coral-rag (Corallian) of Besançon, La Rochelle, Châtel-Censoir (Yonne), etc.

2. Intermediary Hemicidaris. *Hemicidaris intermedia*. Forbes. — *Cidaris papillata*, var., Parkinson, Org. Rem. t. IL, p. 14, pl. 1, f. 6, and pl. 4, f. 2a. — *Cidaris intermedia*, Fleming, p. 252.

Species near the preceding but distinguished by its spines in the form of cylindrical, non-clavelated rods.

Fossil of the Coral-rag (Corallian) of Calre-Malton, of Yorkshire, Cheltenhem (England).

3. DIADEMA HEMICIDARIS. *Hemicidaris diademata*. Agassiz.—Agassiz. Echin. Suisse, IL, p. 49, t. XIX, f. 15–7.—*Id.*, Cotteau, Echin. foss., p.128, t. XIV, f.1–5. — *Id.*, Desor, Sy. p. 54.

Species rather large, depressed, whose ambulacral tubercles decrease toward the dorsal surface.

Fossil of the Lower Portlandian (Astartian) of Porrentruy.

4. CARTIER'S HEMICIDARIS. *Hemicidaris cartieri*. Desor. — *Hemicidaris diademata*, Asassiz, Cat. syst., p. 8, and Cat. rais., p. 34: — *Id.*, Cotteau, Echin. foss., p. 130, t. 14, f. 6–8. — *Hemicidaris cartieri*, Desor, Syn:, p. 54, tab. X, f. 11–12 (M. 5).

Very large species, depressed as a whole. Interambulacral tubercles decrease very rapidly above the ambitus so that the dorsal surface nearly lacks them. The ambulacral semitubercles are large and dense and form two very distinct rows.

Fossil of the Corallian stage of Druyès (Yonne), Chatelu (canton of Neufchâtel).

5. MAMELONATE HEMICIDARIS.. *Hemicidaris mammosa*. Agassiz. — Agassiz, Cat. syst., p. 8. — *1d*., Desor, Syn. Echin., p. 55, t. X, f. 9–10.

Species with ambulacra very narrow, curving, with large interambulacral tubercles far apart on the dorsal surface and surround by a complete scrobicular circle.

Fossil of the Corallian stage of La Rochelle.

6. THURMANN'S HEMICIDARIS. *Hemicidaris thurmanni*. Agass— Agassiz, Echin. Suisse, t. II, p. 50, t. XIX, f. 1–3 (M. 34, X. 82). —*Id.*, Desor, Syn., p. 56.

Species near the preceding, with very flexuous ambulacra.

Fossil of the Portlandian of Banné, Delemont and Salins (Jura).

7. *Hemicidaris flexuosa.* Merian, — Triassic of St.-Cassian. 8. *Hemicidaris pustulosa*. Agassiz. — Bajocian of England 9. *Hemicidaris sarthacensis.* Cotteau. -- Bajocian, Gueret (Sarthe). 10. *Hemicidaris granulosa*. Wright. — Bajocian, England. 11. *Hemicidaris minor*. Wright. — Bathonian, England, etc, 12. *Hemicidaris luciensis*, d'Orb.—Bathonian, Lue, Langrene ? 13. *Hemicidaris confluens*. M'Coy.— Bathonian, England, 14. *Hemicidaris icaunensis*. Cotteau.— Bathonian, Yonne. 15. *Hemicidaris stokesii*. Wright. — Bathonian, England. 16. *Hemicidaris wrightii*. Desor.— Bathonian, England. 17. *Hemicidaris ramsayii*. Wright. — Bathonian, England. 18. *Hemicidaris bravenderi*. Wright. — Bathonian, England.

CORALLIAN SPECIES.

19. *Hemecidaris maxima*. Desor. 20. *Hemicidaris scolopendra*. Desor. 21. *Hemicidaris quenstedti*. Merian, 22. *Hemiciduris lestocquii*. Thurmann. 23. *Hemicidaris guerinii*. Cotteau. 24. *Hemicidaris meryaca*. Cortteau. 25. *Hemicidaris ricetensis*. Cotteau. 26. *Hemicidaris rathieriana*. Cotteau. 27. *Hemicidaris undulata*. Agassiz. — Portlandian stage, 28. *Hemicidaris alpina*. Agassiz. 29. *Hemicidaris hoffmanni*. Desor. 30. *Hemicidaris mitra*, Agassiz. 31. *Hemicidaris purbeckensis*. Forbes.

CRETACEOUS SPECIES.

32. *Hemicidaris robinaldina*. Coeau. 33. *Hemicidaris pseudohemicidaris*. Desor.

TERTIARY SPECIES.

34. *Hemicidaris mespilium*. Desor. — From the Nummulitic terrain.

2nd GENUS. **HEMIDIADEMA.** *HEMIDIADEMA*. — Agassiz.

Form and general characters of the genus *Hemicidaris*, with this difference that the tubercles at the base of the ambulacral areas (semitubercles) do not for two distinct rows but are tightened in a way to alternate with each other and form only a single row.

This genus contains only a small number of species, all fossils in the Jurassic and Cretaceous terrains.

1. BAKER'S HEMIDIADEMA. *Hemidiadema bakeri.* Desor. — *Pedina bakeri*, Wright, Ann. and Mag., 2nd serie, vol. 13, p. 312, pl. 1, f. 4 to 6. — *Hemidiadema bakeri*, Desor, Syn., p. 58. — *Hemipedina bakeri*, Wright, Pal. Soc., 1855, t. X, f. 1 af.

Fossil of the Lower Oolite (Bajosian) de Crickley Hill (England).

2. SUBCONICAL HEMIDIADEMA. *Hemidiadema subconicum*. Desor.—Syn., p . 448. — *Hemicidaris subconicum,* Cotteau, Mag. zool., 1858.

Fossil of the Upper Oolite (Bathonian) in the vicinity of Dijon (Côte d'Or).

3. SERIAL HEMIDIADEMA. *Hemidiadema serialis*. Desor.— *Cidarites serialis*, Quenstedt, Pal., p.576, t. 48, f. 40, and *Cidarites fistulosus*, Quenstedt. — Desor, Syn., p. 58,

This is the species that has the most developed general character, i. e., that the semitubercles really form only a single row.

Fossil of the Corallian of Nattheim.

4. GAGNEBIN'S HEMIDIADEMA. *Hemidiadema gagnebini*. Desor.— Syn., p. 58, tab, XI, f. 3-4.

Species with numerous and alternate semituercles. Spines cylindrical, subulate.
Fossil of the Corallian of Beaume, near Locle (canton of Neufchâtel), Hobal (Switzerland).

5. STRAMON'S HEMIDIADEMA. *Hemidiadema stramonium*. Desor. — *Hemicidaris stramonium,* Agassiz, Echin. Suisse, II, p. 47, tab. XIX, f. 13–14. — *Id.*, Cotteau, Echin. foss., p. 120, t, 12, f. 5–7. — *Hemidiadema stramonium*, Desor, Syn., p. 58, t. X, f. 4–5 and 6 (spines).— *Cidaris alsatica*, Agassiz, Echin., Suisse, II, p. 78, t. XXI a, f. 14.

Species very swollen, having only a very small number (two or three) of semitubrcles. Ambulacra very narrow.
Fossil of the Lower Portlandian (Astartian) of Delemont, Chablis (Yonne).

6. DAVIDSON'S HEMIDIADEMA. *Hemidiadema Davidsoni*. Desor.Syn., p. 442, — *Hemicidaris davidsoni*, Wright, Brit. foss. in Pal. Soc., 1855, p. 96, t. IV, f.2 a-d.

Fossil of the Portlandian of Boulogne-sur-Mer.

7. RUGOSE HEMIDIADEMA. Hemidiadema rugosum. Agassiz.—Cat. rais.,p , 47. Id., Desor, Syn., p. 58.

Small species whose ambulacral tubercles are as large and even larger as those of the interambulacral area and extend up to the top.
Fossil of Green Sandstone (Albian) of Grand-Pré, Ardennes (Coll. Michelin).

3rd GENUS. PSEUDODIADEMA. *PSEUDODIADEMA*, — Agassiz.

— *Diadema* (pars) authors. |

Circular form, a little depressed, tubercles equal on the two areas. These crenelate and perforate tubercles sometimes form two rows, sometimes four and even six in the interambulacral areas. Poriferous zones single. Spines smooth in appearance and finely striated longitudinally.

This genus was established at the expense of the Diademas. Also, most of the species reported there are under this name in the methods. It is especially characterized by its smooth spines and its tubercles equal in the two areas.

Pseudodiademids are known on in the fossil state. They are numerous in species (approximately 70) belonging Liasic stage where they cross the different stages up to the Lower part of the Tertiary terrain.

The typical species is *Cidarites pseudodiadema*, Lamarck. This species can be divided into two principal groups: 1° those have two principal rows of tubercles in the ambulacral areas and 2° those that have at least four.

JURASSIC SPECIES.

1. *Pseudodiadema mamillanum*. Desor. — *Cidarites mamillanum*, Roemer.

   Fossil of the Corallian of La Rochelle, Verdun, etc.

2. *Pseudodiadema depressum.* Desor.— *Diadema depressum*, Agassiz, Cotteau.

   Fossil of the Lower Oolite (Bajocian) of France and England.

3. *Pseudodiadema hemisphaericum*. Agassiz. — *Cidarites pseudodiadema*, Lamarck. — *Diadema pseudodiadema*, Acassiz.

   Fossil of the Corallian of Besançon, St. Mihiel, etc.

4. *Pseudodiadema homostigma*. Desor. — *Diadema homostigma*, Agassiz.

   Fossil of the Upper Oolite (Bathonian), Marquisas, England.

5. *Pseudodiadema princeps*. Thurmann, Desor.

   Fossil of the Oxfordian of Bendorf (Haut-Rhin).

6. *Pseudodiadema inaequale*. Desor. — *Diadema inaequale*, Agassiz.

   Fossil of the Kellovian of Marolles, Lifol, etc.

7. *Pseudodiadema waldense*. Desor.

   From the Lower Oolite (Bajocian) of Ste.-Croix.

8. *Pseudodiadema parkinsoni*. Desor. From the Bajocian of Stonesfeld.

9. *Pseudodiadema subcomplanatum*. d'Orb. From the Bajocian of Ranville.

10. *Pseudodiadema aequale*. Desor. — (*Diadema aequale*, Agassiz). From Switzerland.

11. *Pseudodiadema wrightii*. Cotteau. From the Bajocian of Sarthe.

12. *Pseudodiadema bailyi*. Wright. From the Bajocian of England.

13. *Pseudodiadema bakeriae*. Wright. From the Bajocian of England.

14. *Pseudodiadema vagans*. Desor. — *Cidaris vagans*, Phill. — *Diadema vagans*, Desmoulins. From the Bajocian of Scarboroug (Yorkshire).

15. *Pseudodiadema superbum*. Desor. — *Diadema superbum,* Agassiz. Oxfordian. From Vaches noires.

16. *Pseudodiadema textum.* Desor. — *Diadema textum*, Agassiz. Oxfordian. From Normandy.

17. *Pseudodiadema lenticulatum*. Desor. — *Diadema complanatum*, Cotteau. From the Kellovian of Marolles, St.-Scolasse.

18. *Pseudodiadema langii*. Desor. Oxfordian, Switzerland.

19. *Pseudodiadema tetragamma*. Desor. — *Diadema tetragramma*, Agassiz. — *Diadema ricordeanum*, Cotteau. From Besançon, Châtel-Censoir (Yonne).

20. *Pseudodiadema orbignyanum*. Desor. — *Diadema orbignyanum*, Cotteau. From Coulanges, Druyes, Châtel-Censoir, etc. From the Corallian.

21. *Pseudodiadema frasi*. Desor. From Nattheim. From the Corallian.

22. *Pseudodiadema placenta*. Desor. — *Diadema placenta*, Agassiz. — *Diadema priscum*, Agassiz. — *Diadema drogiacum*, Cotteau. From the Corailian of Switzerland, Nantua (Ain), Druyes (Yonne).

23. *Pseudodiädema affine*. Desor. — *Diadema affine*, Agassiz. From the Corallian of Besançon (Doubs).

24. *Pseudodiadema radiata*. Wright. From the Corallian of England.

25. *Pseudodiadema planissinum*. Desor. — *Tetragramma planissinum*, Agassiz, From the Portlandian of Porrentruy, Soleure.

26. *Pseudodiadema aroviente*. Thurmann. From the Portlandia of Switzerland.

27. *Pseudodiadema complanatum*. Desor. — *Diadema complanatum*, Agassiz. From the Portlandian of Roedersdorf, Laufon.

28. *Pseudodiadema neglectum.* Thurmann. From the Portlandian of Montbéliard.

29. *Pseudodiadema bruntrutanum*. Desor.— *Diadema bruntrutatum*, Desor. From the Portlandian of Le Banné, near Porrentruy.

30. *Pseudodiadema rathieri*. Desor. — *Diadema rothieri*, Cotteau. From the Portlandian of the department of Yonne.

31. *Pseudcdiadema magnagramma*. Wright. From the Portlandian of Boulonnais.

CRETACEOUS SPECIES.

32. *Pseudodiadema rotulare*. Desor. — *Diadema rotulare*, Agassiz. Neocom.

33. *Pseudodiadema bourgueti*. Desor. — *Diadema ornatum*, Agasszi (non Goldfuss). From the Neocomian of Switzerland, Yonne.

34. *Pseudodiadema perriqueti*. Desor. — *Diadema perriqueti*, Cotteau. From the Neocomian of Auxerre.

35. *Pseudodiadema foucardi*. Desor, — *Diadema foucardi*, Cotteau. From the Neocomian of Auxerre (Yonne).

36. *Pseudodiadema grasii*. Desor. — *Diadema grasii*. Desor. From the Neocomian.

37. *Pseudodiadema macrostoma*. Desor. — *Diadema macrostoma*, Agassiz. From the Neocomian of Switzerland, Censeau,

38. *Pseudodiadema miliare*. Desor.—Syn., p. 70.—*Diadema miliare*, Agassiz, Desor, Bull. Soc. Neufch., III, p. 180. From the Lower Neocomian of Ste.-Croix.

39. *Pseudodiadema picteti*. Desor. — Syn., p. 70.— *Diadema picteti*, Desor, Cat. rais., p . 46. From the Neocomian of Censeau (Jura); Auxerre.

40. *Pseudodiadema repeillini*. Desor. — Syn., p. 71. — *Diadema*; Alb. Gras, Ours. foss., p. 35, tab. Il, £. 10–11. From the Neocomian of Fontanil (Isère).

41. *Pseudodiudema triseriale*. Desor. — Syr., p. 444. Lower Neocomian of Sagne (Switzerland).

42. *Pseudodiademae lucae*. Desor. — Syn., p. 71. — *Diadema lucae*, Agassiz, Echin. Suisse, IL p. 8, t. XVI, f. 11–15. From Aptian on the loss of the Rhône, Ste.-Croix.

43. *Pseudodiadema rhodani*. Desor. — Syn.,p. 71. — *Diadema rhodani*, Agassiz, Echin. Suisse, Il, p. 9, t. XVI, f. 16–18. From Gault (Aptian) of the Loss of the Rhône.

44. *Pseudodiadema carthusianum*. Desor. — Syn., p. 71. — *Diadema carthusianum*, Alb. Gras, Ours. foss., 54, t. Il, f. 1–2. From Gault (Aptian) of Sassenage (Isère),

45. *Pseudodiadema uniforme*. Desor. — Syn., p. 74. — *Diadema uniforme*, Alb. Gras, p. 39, t. II, f. 4–6. From the Lower Neocomian of Fontanil (Isère).

46. *Pseudodiadema brongniartii*. Desor. — *Tetragramma brongniarti*, Agassiz, Echin. Suisse, t. II, p.25, t. XIV, f. 4–6. From Gault at the loss of of the Rhône, Clar, Escragnolles, etc.

47. *Pseudodiadema roemeri*. Desor.—Syn., p. 74.—*Tetragramma depressum*, Roemer, Nord. Deust, KreId., p. 30. From the Lower Chalk of Hildesheim (Hanover).

48. *Pseudodiadema ornatum*. Desor. From the Cenomanian of Essen.

49. *Pseudodiadema roissyi*. Cotteau. From the Cenomanian of Mans.

50. *Pseudodiadema michelini*. Desor. From the Cenomanian of Villers-sur-Mer.

51. *Pseudodiadema benettiae*. Desor. From the Cenomanian of Villers-sur-Mer, etc.

52. *Pseudodiadema annulare*. Desor. From the Cenomanian of Mans.

53. *Pseudodiadema tenue*. Desor. — *Diadema tenue*, Agassiz. — *Id.* Villers,

54. *Pseudodiadema elegantulum*. Cotteau. — *Id.* Soulitré (Sarthe).

55. *Pseudodiadema guerangeri*. Cotteau. From the Cenomanian of Mans.

56. *Pseudodiadema piniforme*. Cotteau. From the Cenomanian of Mans.

57. *Pseudodiadema pulchellum*. Cotteau. From the Cenomanian Mièges.

58. *Pseudodiadema carinellum*, Cotteau. From the Cenomanian of Mans.

59. *Pseudodiadema verneuillii*. Cotteau. From the Cenomanian of Mans.

60. *Pseudodiadema striatulum*. Cotteau. From the Cenomanian of Mans.

61. *Pseudodiadema dimidiatum*. Cotteau. — *Cyphosoma dimidiatum*, Agassiz. — *Phymosoma dimidiatum*, Desor. From the Cenomanian of Mans,

62. *Pseudodiadema granulare*. Desor. From the Cenomanian Mans.

63. *Pseudodiudema blancheti.* Desor. From the Cenomanian of Ste.-Croix.

64. *Pseudodiadema lybicum.* Desor. From the Cenomanian of Egypt.

65. *Pseudodiadema ruppellii*. Desor. From the Cenomanian of Egypt.

66. *Pseudodiadema texanum*. Desor. From the Senonian of Texas.

67. *Pseudodiadema diatretum*. Desor. Senonian of New Jersey.

68. *Pseudodiadema kleinii*. Desor. — *Diadema kleinii*, Desm. From the Chalk with Hippurits from Royan, Périgord, Senonian of Cognac.

TERTIARY SPECIES.

69. *Pseudodiadema blanggianum*. Desor. — Syn., p. 74. — *Diadema blanggianum*, Desor, Act. Soc. Helv., 1853. From the Nummulitic terrain of Blangg, near Yberg (Switzerland).

70. *Pseudodiadema lusseri*, Desor. — Syn., p. 75. — *Diadema lusseri*, Desor, Act. Soc. Helv., 1853, p. 277. From the Nummulitic terrain of Yberg (Switzerland).

71. *Pseudodiadema sismondae.* Desor. — Syn., p. 74. From the Miocene terrain of Superga.

72. *Pseudodiadema pingue*. Desor. — Syn., p. 74, From the Parisian of St.-Palais, near Royans.

4th GENUS. **DIPLOPODIA**. *DIPLOPODIA* — M'Coy.

This genus has all the characters of *Pseudodiadema.* It differs in that the pores are doubled near the top and around the peristome to form two double rows.

The species placed today in the genus *Diplopodia* were for the most part placed in the Diademas. Their number is not very large (20). The first appear in the Oolitic terrains, increasing sensibly in the Coral rag, crossing all the stages of the Cretaceous terrains where they disappear completely.

JURASSIC SPECIES.

1. GROOVED DIPLOPODIA. *Diplopodia sulcata*. Desor. — *Diadema sulcatum*, Agassiz, Cat. syst., p. 8.—*Diadema subangular*, var., Agassiz, Cat. rais., p. 44.

Species of circular form, swollen, covered with abundant and fine miliary granules. Secondary tubercles arrange in rows that go above the ambitus.

Fossil of the Great Oolite (Bathonian) of Normandy.

2. DIPLOPODIA FROM JOBA. *Diplopodia jobae*. Desor. — Syn., p. 76.— *Diadema jobae*, D'Orbigny, Prodr., I, p. 290.

Fossil from the Lower Oolite (Bajocian) of Geniveaux.

3. DIPLOPODIA. *Diplopodia pentagona*. MCoyx.—M'Coy, Ann. and Mag. of nat. Hist., 2nd series, vol. 21, p. 412.—*Diadema pentagonum*, Morris, Brit. foss., 1854, p.77. — *Id.*, Woodward, Geol. Surv. Dec., V. — *Pseudodiadema pentagonum*, Wright, Pal. Soc., 1855, p. 115, pl. VL f. 3 ad.

Species depressed, sub-pentagonal, having protruding ambulacral areas with two rows of tubercle nearly as large as those of the interambulacral area. Pores bigeminate above and below but unigeminate toward the ambitus.

Fossil of the Great Oolite (Bathonian) of Minchinhampton (England).

4. CALLOVIAN DIPLOPODIA. *Diplopodia calloviensis*. Desor. — *Diadema calloviense*, D'Orbigny, Prodr., I, p. 346. — Desor, Syn., p. 76.

Fossil of the Callovian of Marolles (Sarthe).

5. TWO-SPOTTED DIPLOPODIA. *Diplopodia bipunctata*. Desor. — Syn., p. 77.

From the Upper Oxfordian of Birmansdorf (Argovia).

6. *Diplopodia subangularis*. Desor.—Syn. — *Cidarites subangularis*, Goldfuss, Petref., p. 122, t. 40, f. 8. — *Diadema subangulare*, Agassiz, Echin. Suisse, IL, p. 19, tab. XVI, f. 21–23. — *Id.*, Cotteau, Echin. foss., p. 130, pl. 18, f. 1–2.

From the Corallian of the department of Yonne.

7. *Diplopodia icaunensis.* Desor.—*Diadema icaunense*, Cotteau, Echin foss., p. 154, t. 19, f. 1–5. — Desor, p. 76.

From the Corallian of Coulanges (Yonne).

8. *Diplopodia versipora*. Desor. — Syn., p. 76. — *Pseudodiadema versipora*, Phill., Geol. York.— *Diadema versipora*, Woodw. in Morris, Brit. foss., 1843, p. 50. — *1d*., Woodward, Mem. geol. Surv., Dec. V.

From the Corallian of England.

9. *Diplopodia courtaudina*. Desor. — Syn., p. 77. — *Diadema courtaudinum*, Corteau, Echin. foss., p. 153, t. XVIII, f. 9–11.

From the Corallian of Druyes (Yonne).

10. *Diplopodia echinata*. Mertan. — Desor, Syn., p.77.

From the Corallian of Nattheim.

11. *Diplopodia distincta.*Desor.—Syn., p.77.—*Diadema distinctum,* Agassiz, Cat, syst., p. 8. ?

Jurassic terrain of France.

11 *bis*. *Diplopodia baylei*. Desor. — Syn., p. 77.

From the Kimmeridian of Boulogne-sur-Mer.

CRETACEOUS SPECIES.

12. *Diplopodia triboleti*. Desor. — Syn., p. 444.

From the Lower Neocomian of Ste.-Croix.

13. *Diplopodia robinaldina*. Desor. — Syn., p. 78. — *Diadema robinaldinum*, Cotteau, Cat. méthod., p. 6.

From the Neocomian of St.-Sauveur (Yonne).

14. *Diplopodia nobilis*. Desor. — Syn., p. 78. — *Diadema nobile*, Desor, Bull. Soc. Neufch., vol. II, p. 180.

From the Lower Neocomian of Ste.-Croix.

15. *Diplopodia autissiodorensis*. Desor. — Syn., p. 78. — *Diadema autissiodorense.* Cotteau, Cat. méthod., p.5.

From the Neocomian of Auxerre (Yonne).

16. *Diplopodia variolaris*. Desor. — Syn., p. 78. — *Cidarites variolaris*,

Al. Bronn., Géol., Paris, p. 84 and 300, t. V, f. 9 ABC. — *Diadema variolare*, Agassiz, Cat. rais., p. 40. Lower Chalk (Albian), Grand-Pré (Ardennes).

17. *Diplopodia archiaci*. Desor. — Syn., p. 77.— *Diadema archiaci*, Desor, Cat. rais., p. 44.

From the Gray Chalk (Cenomanian) of Beaumont, near Angoulême.

18. *Diplopodia roissyi*. Desor. — Syn., p. 78. — *Diadema roissyi*, Desor, Cat. rais., p. 46.

Turrfeau Chalk (Cenomanian) of the mountain Ste.-Catherine near Rouen.

19. Diplopodia verneuillii. Desor. — Syn., p. 447. — *Pseudodiadema verneuillii*, Cotteau, Echin. Sarthe, 4^{e} liv.

From the Cenomanian of Mans.

20. *Diplopodia subnuda*. Desor.—Syn. p. 78.—*Diadema subnudum*, Agassiz, Cat. rais, p. 46. — *Diadema dubium*, Alb. Gras, Ours. foss., Suppl., p. 3, f. 21-23.

Green Chalk (Cenomanian), Villers-sur-Mer, Vernonet (Eure), Saintes (Charente-Inférieure).

21. *Diplopodia malbosii*. Desor.— *Diadema malbosii*, Desor, Cat. rais., p. 46. — Desor, Syn., p. 78, t. XII, f. 12–14.

Chalk with Hippurites (Turonian) from Corbières; Soulage.

22. *Diplopodia sinaica*. Desor. — Syn., p. 78. — *Diadema sinaicum*, Desor, Cat. rais., p. 44.

Cretaceous terrain (Turonian?) of Mount Sinai.

5th Genus **HYPODIADEMA**. *HYPODIADEMA* — Desor.

Urchins of circular form, depressed. Poriferous zones simple, tubercles crenelated and perforated, Ambulacrals smaller than the interambulacrals and extend all the length of the ambulacra. Peristome without deep notches. Spines smooth and cylindrical.

This genus, established recently by Desor (Synopsis Echin., p. 61), contains *Cidaris, Hemicidaris* and *Pseudodiadema.* It differs from the genus *Hemipedina* only by its non-crenelated tubercles.

We know only a small number of species. The first are from the Triassic. Jurassic terrains contain some, especially in the Corallian, then they pass through the different stages of the Cretaceous terrains that they do not pass.

1. *Hypodiadema regular*. Desor. — *Cidaris regularis*, Munster, Beitr., p. 41, t. IL, f. 6. — *Hemicidaris regularis*, Desor, Cat. rais., p. 35.

From the Triassic of Saint-Cassian.

2. *Hypodiadema admeto*. — *Cidaris admeto*, Munster, Beitr., p. 40, tab. III, f. 3.—Hemicidaris admeto, Desor, Cat. rais., p. 33.

Fossil of the Triassic of Saint-Cassian.

3. *Hypodiadema prisciniacense.* Desor. — *Pseudodiadema prisciniacense*, Cotteau, Echin. Sarthe, p. 4, t. I, f. 8–12. — *Diademopsis prisciniacensis*, Cotteau in Davoust, Echin, Sarthe, 1856, p. 4, p. 244.

Fossil of the Lias of Précigné (Sarthe).

4. *Hypodiadema guerangeri*. Desor. — Syn., p. 436. — *Hemicidaris guerangeri*, Cotteau, Echin. Sarthe, p. 69, t. 15, f. 3–7.

Species sub-circular, depressed. Seven or eight interambulacral tubercles per row, very large and protruding toward the ambitus, decreasing rapidly toward the top. Ambulacra straight, swollen, with two rows of vey small tubercles.

Fossil of the Callovian of Chauffour; Vivoin (Sarthe).

5. *Hypodiadema florescente*. Desor. — Syn., p. 62. — *Diadema florescens*, Agassiz, Echin. Suisse, II, p, 17, tab. 17, f. 26–30.

Fossil of the Corallian of Besançon.

6. *Hypodiadema plotii*. Desor, Syn., p. 62.— Parkinson, Org. Rem., vol. III, p. 10, t. I, f. 4.

Fossil of the Corallian of England.

7. *Hypodiadema calvum*. Desor.— Syn., p. 440. — *Echinopsis calva*, Quenstedt, Jura, p. 739, t. 90, f. 14.

From the Corallian of Nattheim.

8. *Hypodiadema rotula*. Desor. — Syn., p. 244.

Fossil of the Upper Corallian (Astartian) of Oberbuchsitten (canton of Soleure).

9. *Hypodiadema wrightii*. Desor. — *Hemicidaris wrightii*, Cotteau (non Desor), Echin. foss., p. 294, t. 42, f. 5–11.

Fossile of the Upper Corallian of Riceys (Aube).

10. *Hypodiadema dilatatum*. Desor. — Syn., p. 62. — *Diadéma dilatatum*, Agassiz, Echin. Suisse, IL, p. 10, t. 16, f. 19–21.

Fossil of the Kimmeridian; Bernois Alpes.

11. *Hypodiadema desorianum*. Desor. — *Hemicidaris desoriana* , Cotteau, Echin. foss., p. 305, t. 43, F. 1–6.

Fossil of the Kimmeridian de Bar-sur-Aube, Riceys (Aube); Cirey (Haute-Marne).

12. *Hypodiadema patella*. Desor. — Syn., p. 62. — *Hemicidaris patella*, Agassiz, Suisse, Il, p. 53, t. XVII, f, 15–18.

From the Lower Neocomian of Fontanil (Isère); Ste-Croix; Chaux-de-Fonds.

13. *Hypodiadema saleniforme*. Desor. — *Hemicidaris saleniformis*, Desor, Bull. Soc. sc. nat. Neufch., t. III, p. 179.

From the Lower Neocomian of Ste-Croix.

14. *Hypodiadema acinum.* Desor. — Syn., p. 63. — *Hemicidaris acinum*, Desor, *loc. cit*., t. II, p. 179.

From the Lower Neocomian of Ste-Croix,

15. *Hypodiadema inerme.* Desor.— Syn., p. 63.— *Hemicidaris inermis*, Alb. Gras, Ours. foss., p. 26, t. I, f. 17.

From the Neocomian of Fontanil (Isère).

16. *Hypodiadema laeve*. Desor. — Syn., p. 63. — *Hemicidaris laevis*, Desor, Cat. rais., p. 34.

Fossil of the Upper Chalk of Gabillon (Oise).

18. *Hypodiadema heberti*. Desor.—Syn., p.63. — *Diadema heberti*, Desor, Cat. rais., p. 45. — 14., Hebert, Mém. Soc. géol. Fr. 1854.

Fossil of the Danian stage of Orglande.

6th Genus. **HEMIPEDINA.**. *HEMIPEDINA*.— Desor.

Test circular, depressed. Pores simple. Tubercles smooth, not crenelated.

This genus has greater similarity with Pseudodiademids and differs only in a single character that perhaps does not have all the importance that we have attached to it. This character consists in fact in the smooth and non-crenelated state of the tubercles.

It is found until now in the different stages of the Jurassic terrains and in the Cretaceous terrains but in very small number.

The distribution of species is: Lias, 4 species; Oolite, 7; Coral rag, 6; Kimmeridgian clay, 4; Neocomian, 2; Cenomanian, 2.

7th Genus. **DIADEMOPSIS**, *DIADEMOPSIS*. — Desor.

Form of the Pseudodiademids but with smaller tubercles, less protruding and non-crenelated. Four rows of interambulacral tubercles. The external rows alone extend up to the top. Spines very slender and very long of smooth appearance but very strongly striated longitudinally.

This genus is near Pseudodiademids but it is distinguished especially by its smaller tubercles that lack crenellations. The number of rows of interambulacral tubercles would

also bring it closer to the genus we just cited but they have this peculiarity that it is the external rows and not the internals that go up to the top.

The spines are remarkable for their extreme length and slenderness. They completely recall those of Diademids and Asteropygids but they are smooth and not whorled.

The species that constitute the genus *Diademopsis* are confused either with *Diadema* or *Hemicidaris*. They are still less numerous (about 16) and come from all the Liasic terrains with the exception of two only, Oolitic and Oxfordian.

1. BUCCAL DIADEMOPSIS. *Diademopsis buccalis*. Desor. — Syn., p. 79. — *Hemicidaris buccalis*, Agassiz, Cat. rais., p. 35.

Species sub-spherical, a little conical, having very spaced interambulacral tubercles on the dorsal surface and surrounded each by a circle of very small granules. These tubercles are denser on the ventral surface. We find, in addition, two rows of secondary tubercles that do not pass the ambitus. The peristome is very large and widely notched. The pores are strongly doubled on its periphery.

Fossil of the Lower Lias of Berrias (Ardèche).

2. SERIAL DIADEMOPSIS. *Diademopsis serialis*. Desor.—Syn., p. 79, t. XIV, f. 12–14. — *Diadema seriale*, Agassiz, Cat. syst., p. 8. — *Id.*, Leymerie, , Mém. Soc. géol. Fr., t. 3, p. 378, tab. 24, f. 1.—*1d*., Cotteau, Echin. foss., p. 35, t. I, f. 4-8.

Species sub-conical, with a very wide miliary zone on the dorsal surface, moderately doubled ambulacral pores around he peristome. Spines very slender. This species is near the preceding. It is distinguished especially by the smaller size of the peristome as wll as by its less doubled pores.

Fossil of the Lower Lias of Châtillon (Rhône); vicinity of Avallon (Yonne).

3. *Diademopsis beckii*. Desor. From the Lias. 4. *Diademopsis bowerbankii*. Desor. From the Lias. 5. *Diademopsis micropora*. Desor. — *Diadema microporum*, Agassiz. 6. *Diademopsis globula*. Desor. Lower Lias 7. Diademopsis heeri. Merian. Lower Lias 8. *Diademopsis quenstedti*. Desor. Lower Lias. 9. *Diademopsis laffonii*. Merian. Lower Lias. 10. *Diademopsis minima*. Desor. Lower Lias. 11. *Diademopsis crinifera*. Desor. Lower Lias. 12. *Diademopsis movrei*. Desor. Upper Lias. 13. *Diademopsis jurensis*. Desor. Upper Lias. 14. *Diademopsis striospina*. Desor. From the Lower Oolite. 15. *Diademopsis nodoti*. Desor. From the Oxfordian.

8th Genus. **DIADEMA.** *DIADEMA* — Gray.

Form circular, depressed. Ambulacral and interambulacral areas with large crenelated and perforated tubercles. Poriferous zones containing pores arranged in single pairs forming curving and arced zones. Peristome large, without notches. Buccal apparatus very large with granular membrane. Spines in the form of long rods, slender, whorled and fistulose.

The genus *Diadema,* after having some reforms, remains composed only of living species that have two principal types. In the first, the ambulacral tubules are as large as theinterambulacrals and form two spaced parallel rows. Then the spines are very slender and have a fringed edge toward the collar (Ex. *D. europaeum*). In the second, the rows are multiplied (Ex. *D. turcarum; D. Savigny*, Mich.).

We shall see that the two following genera that we have detached, differ only by a small number of characters taken from the form of the tubercles and the disposition of the pores that are unigeminae in the true Diademas and on the contrary trigeminate in Astropygids.

1. DIADEMA FROM EUROPE. *Diadema europaeum.* Agassiz, — Cat. rais., p. 346.

Species with ambulacral and interambulacral tubercles equal and very spaced. Spines very slender with edge fringed at the collar.

Inhabits the Mediterranean.

2. SAVIGNY'S DIADEMA. *Diadema savignyi*. Michelin. — Savigny, Descript. Egypte, Echin., pl. 6.— Michelin. Mag. Zool.— Agassiz, Cat. rais., p. 349.

Species near *D. turcarum.* It differs by its sunken interambulacral areas on the dorsal surface. Near the top, its tubercles are less protruding and the spines, very long, slender and black, reach 30 centimeters in length. *Diaderma lamarckii*, Agassiz, Cat. rais., is probably only a young age.

Inhabits the Red Sea, Seychelles, Reunion, Madagascar. (Mus. Paris.)

3. TURK'S CAP DIADEMA. *Diadema turcarum,* Raumph. — Rumphius, t. XIV, f. 8. — *Cidaris diadema*, Lamarck, An. s. vert., t. II, p. 382. — *Diadema turcarum*, Agassiz, Cat. rais., p. 349.

Species swollen, with protruding interambulacral tubercles, spines subulate, ringed in brown and yellow.

Inhabits the Antilles (Mus. Paris.)

4. DIADEMA FROM PORT CHAUME. *Diadema calamarium*. Gray. — *Echinus calamarius*, Pallas, Spicil. zocl., 10, p. 38, pl. 2, f. 4–8. — *Echinus calamarius*, Linné, Gmel., p. 3173. — *Cidaris calamarius*, Leske apud Klein, pl. 45, f. 14. — Encycl. méthod., pl. 134, f, 9–11. — *Cidarites calamarius*, Lamarck, An, s. vert., 2^{e} édit. t..III,.p 383, n° 13. — *Diadema calamarius*, Gray. — *Id.*, Agassiz, Prodr. — *Id.*, Michelin, Revue zool., and Mag. zool. p. 14, n° 26.

5th Genus. **SAVIGNYA**. *SAVIGNYA*. — Desor.

Test sub-pentagonal, thin. Ambulacra protruding, with pores arranged in triple pairs and irregularly scattered granules. Tubercles crenelated and perforated. Peristome scarcely notched. Spines whorled.

The species of this genus were confused for a long time with the Diademids, but the difference between the disposition of the ambulacral pores in the two genera allowed Desor to characterize them with much clarity, the Diademids, in fact, having unigeminate pores while the Savignyids have trigeminate. Some species belonging to this genus were referred by Agassiz to the Asteropygids but that is a mistake, the latter genus having for type *Diadema radiata*, Lamarck.

1. SUBULATE SAVIGNYA. *Savignya subularis*. Desor.— *Cidarites subularis*, Lamarck. — *Diadema subulare*, Agassiz. — *Diadema desjardinsii*, Michelin.

Inhabits Mauritius.

2. VERY SPINY SAVIGNYA. *Savignya spinosissima*. Desor, Agassiz. — *Cidarites spinosissima*, Lamarck, An. s. vert., 2e édit., p. 383, n° 12. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, p. 196. — *Diadema spinosissima*, Agassiz, Prodr., p. 189. — *Id.*, Desmoulins, Echin., tab. syn., p. 308,

Very large species, approximately 12 cm without the spies that reach up to 8 cm in length. Tubercles arranged in ten rows.

Inhabits Mauritius (Mus. Paris.).

10th GENUS. **ASTEROPYGA**. *ASTEROPYGA*. — Gray.

Test circular in form, depressed. Ambulacra protruding with large tubercles similar to those of the interambulacral areas that are arranged in numerous rows varying from twelve to sixteen. A large smooth band radiating from the top toward the circumference separates the external row from the other rows that, in addition, do not go as high toward the top. Pores arranged in triple pairs. Peristome deeply notched. Genital plates very long, lanceolate, forming a kind of star around the periproct.

The genus *Asteropyga* was established by Gray for a species of *Diadema* already known, *D. radiata*, Lamarck. It differs from this latter genus by its trigeminate pores and contains only a single living species,

RADIATE ASTROPYGA. *Asteropyga radiata*. Gray.—*Diadema radiata*, Lamarck.

Inhabits the coasts of South America.

11th **ACROCIDARIS**. *ACROCIDARIS*.— Agassiz.

Test swollen with rather large crenelated and perforated tubercles, nearly equal to those on the two areas. Pores arranged in single pairs but doubling around the peristome that is large and strongly notched. Each genital plate except the unpaired plate, has a large mamelonate and perforate tubercle. Spines cylindrical, often tri-keeled at the end, smooth or finely striated.

This genus is also very near Diademids but the presence of a mamelonated tubercle on the genital plates distinguishes it easily. All the species come from the Jurassic and Lower Cretaceous terrains.

1. NOBLE ACROCIDARIS. *Acrocidaris nobilis*. Agassiz. — Agassiz, Cat. syst., p. 9. — *Id.*, Echin. Suisse, t. II, p. 3, t. XIV, f. 16–17 and f. 11 (spine). — *Acrocidaris formosa*, Agassiz, Cat. syst., p. 9, and Echin. Suisse, II, p. 29, t. XIV, f. 10–12 (spine).— *Acrocidaris tuberosa*, Agassiz, Cat. syst., p.9, and Echin, f 8–10.

Species sub-conical, flat below. Ambulacral tubercles smaller than the interambulacrals and more numerous. Spines rather large, smooth or finely striated, cylindrical or tri-keeled, without collar.

Fossil of the Corallian of La Rochelle; Nattheim; Druyes, Châtel-Censoir (Yonne).

ACROCIDARIS FROM CENSEAU. *Acrocidaris censoriensis.* Cotteau, — Cotteau, Echin. foss., p. 136, t. XVI, f. 1–4. — *1d*., Desor, Syn., p. 85.

Species small, very depressed and slightly pentagonal. Ambulacral tubercles nearly as large as the interambulacrals.

Fossil of the Corallian of Châtel-Censoir (Yonne).

STRIATED ACROCIDARIS. *Acrocidaris striata*. Agassiz. — Agassiz, Cat. syst., p. 9. — *Id.*, Desor, Syn., p. 85.

Fossil of the Great Oolite (Bathonian) of Langrune (Calvados).

SMALL ACROCIDARIS. *Acrocidaris minor*. Agassiz.—Agassiz, Cat. syst,, p. 9. — *Id.*, Echin. Suisse, IL, p. 30, t, XIV, f. 7-9.— *Acrocidaris formosa*, var. *minor*, Agassiz and Desor, Cat. rais., p. 36.—*Id.*, Pictet, Pal., pl. 96, f.13. — *Acrocidaris depressa*, Alb. Gras, Ours. foss., p. 31, tab. I, f. 18–20. — *Acrocidaris minor*, Desor, Syn., p. 85.

Species small, swollen, having widely perforated tubercles.

Fossil of the Lower Neocomian of Ste-Croix; Fontanil (Isère).

Agassiz has attempted to distinguish under the name of *Acropeltis*, some species that differ only by the tubercles that are neither perforated nor crenelated. These are: *Acropeltis aequituberculata*, Agassiz, Cat. syst. p. 12, and Cat. rais. p. 36, tab. 16, f. 7–8.— *Id.* Desor, Syn. p. 86, t. 14, f. 1–2; from the Corallian of Angoulême near La Rochelle; *Acropeltis concinna,* Merian. — *Acropeltis aequituberculata*, Quenst. (non Agassiz), Petref., p. 576, tab. 49, f. 41. — Desor, Syn. p. 86. From the Corallian of Hobel (canton de Soleure), Nattheim.

12th GENUS. **PHYMOSOMA**. *PHYMOSOMA*.— Haime.

— *Cyphosoma*, Agassiz.

Test circular, depressed above and below. Tubercles equal in the two areas with the base crenelated but not perferorated at the top. Pores in single pairs but doubled at the top and at the periphery of the peristome. Spines cylindrical, smooth in appearance but finely striated lengthwise.

It was under the name of *Cyphosoma* that this genus was known for a long time. Haïme, having shown that this name had been used prior to indicate a genus of Coleopteran insects, proposed to change it.

The genus *Phymosoma* is known only as a fossil. The species, 24 in number, is distributed in the different stages of the Cretaceous terrains. It is in the Upper Chalk (Senonian) that it acquired the greatest numerical development. The distribution of the species in the different stages is: Neocomian stage: *P. paucituberculatum*, Desor; *P. neocomiense*, Cotteau; *P. loryi*, Albin Gras.— Cenomanian stage: *P, granulosum,* Desor; *P. perfectum* Desor; *P. regulare*, Desor; *P. carantonianum ; P. cennmanense*, Cotteau; *P. dimidiatum*, Desor; *P. sulcatum*; *P. delamarrei*, from the Turonian of Algérie; *P. orbignyana*, Cotteau, from the Turonian. —Senonian stage: *P. koenigii*, Desor; *P. saeatile; P. circinatum; P. corollare; P. magnificum,* Desor; *P. beaumonti*, Desor; *P. girummense; P. princeps*, Hagenow; *P. heberti; P. texanum ; P. simpleae,* Forbes ; *P. spatuliferum,* Forbes; *P. wetherelli,* Forbes; *P. delaunayi*, Cotteau; *P. bourgeoisii*, Cotteau; *P. costulatum*, Cotteau; *P. microtuberculatum*, Cotteau. — Nummulitic stage: *P. afacicum*, Cotteau.

13th Genus. **Leiosoma**.. *LEIOSOMA*.—Cotteau.

Cyphosoma and *Phymosoma* (pars).

Distinguished from the preceding by its general physiognomy that is a depressed, sub-pentagonal form. The ambulacra are denser on the dorsal surface by the enlarged poriferous zones. Tubercles protruding, surmounted by an enormous mamelon.

The only species known is:

Rugose **Leiosoma**. Cotteau — *Cyphosoma rugosum*, Agassiz, Cat. syst., p. 1. — *Phymosoma rugosum*, Desor, Syn., p. 89. — *Leiosoma rugosum*, Cotteau, Echin. Sarthe, p. 266.

From the Upper Chalk (Senonian) of La Flèche (Sarthe).

14th Genus. **Coptosoma**. *COPTOSOMA*. — Desor.

This genus, near *Phymosomes*, is distinguished by its ambulacral pores that are not doubled toward the to and by its larger intermediary (miliary) granules. Finally, the plates of the test are separated on the surface of the ambulacral areas by small incisions that seem to radite from each tubercle. It is in some way to *Phymosomes* as the Diplodies are to the Pseudodiademids.

All the species knowon are from the Upper Cretaceous terrains and Lower Tertiary terrains.

1. *Coptosoma cribrum*. Desor.—Syn., p. 91.—*Cyphosoma cribrum*, Agassiz, Cat. syst., p. 11.—*Id.*, E. Sismondi, Echin. foss., Nizza, p . 62, t. IL, f. 14–16.

   From the Nummulitic of Castel-Gomberto.

2. *Coptosoma blanggianum*. Desor.— Syn., p. 92.— *Diadema blanggianum*, Desor (pars), Act. Soc. Helv., 1853, p. 277.

   From the Nummulitic terrain of Blangg near Yberg (Suisse).

3. *Coplosoma archiaci*. Desor. — Syn., p. 92. — *Hemicidaris Id.*, Sismondi in Bellardi, Mém. Soc. géol. Fr., 2^{e} série, vol. IV, p. 264.

   From the Nummulitic terrain of Palarea.

4. *Coptosoma haimei*. Desor. — Syn., p. 92.

   From the Nummulitic terrain of St-Michel-de-Foy (Catalogne).

5. *Coptosoma nummuliticum*. Desor. — Syn., p. 92. — *Cyphosoma Id.*, d'Arcn., Hist. des progr. de la Géol., t. II, p. 274. — *Phymosoma Id.*, Haime, An. foss. de l'Inde, p: 197, t. XIII, d, 4.

   From the Nummulitic terrain of Hala (Sinde).

6. *Coptosoma thomsoni*. Desor. — Syn., p. 92. — *Echinometra Id.*, Haime, An. foss. de l'Inde, p. 207, t. XII, f. 13.

   From the Nummulitic of the chain of Hala (Sinde).

7. *Coptosoma duhium*. Desor. — Syn., p. 292. — *Echinus dubius*, Sow. in Grant, Trans. geol. Soc., 2nd seriea, t. V, t. 24, f. 18.

   From the Nummulitic of Baboa Hill (prov. de Cutch).

8. *Coptosoma degente michelotti*. Desor. — Syn., p. 454.

   From the Lower Miocene of Dego (Piémont).

15th **GONIOPYGUS**. *GONIOPYGUS*. — Agassiz.

Apical system very solid, protruding in the form of a shield. Genital plates not pierced in the middle but crowned on their internal edge with small bourrelets surrounding

the periproct. Ambulacral tubercles a little smaller than the interambulacrals, both imperforate. Spines in the form of small clubs, either smooth or with longitudinal folds.

The species, not very numerous, has been found in the Cretaceous and Lower Tertiary terrains.

1. GONIOPYGUS WITH A SHIELD. *Goniopygus peltatus*. Agassiz. — Agassiz, Monog. des Saléniens, p. 20, t. II, f. 9–18.—*Id.*, Echin. Suisse, II, p. 92, tab. XXIII, f.16–22. — *Salenia peltata*, Agassiz, Foss. crét. Mém. Soc. des sc. de Neufchâtel, I, p.14, tab. XIV, f. 13–15. — *Echinus peltatus*, Desmoulins, Tabl, syn., p. 304.

Species sub-conical, having very sharp genital plates with irregular serrated sutures. Peristome very large and square.

Fossil of the Upper Neocomian of Merdasson near Neufchatel, Ste-Croix (Jura Vaudois); St-Sauveur (Yonne).

2. DECORATED GONIOPYGUS. *Goniopyqus decoratus*. Desor.—Bull. sc, nat. Neufch., t. III, p. 180. — *Id.*, Syn., p. 94.

From the Neocomian Ste-Croix (Jura Vaudois).

The other species are: *G. delphinensis*, Albin Gras, from the Neocomian.,— *G. menardi*, Agassiz, from the Cenomanian. — -*G. sulcatus*, Guér., from the Cenomanian. — *G. heteropygus*, Agassiz, from the Senonian.— *G. bronnii,* Agassiz, from the Senonian. — *G. major*, Agassiz, from the Cenomanian. — *G. minor*, from the Danien stage. — *G. pelagiensis*, D'Archiac, from the Coarse Calc. (Parisian) of Royan.

16th Genus. GLYPTICUS. *GLYPTICUS*.— Agassiz.

Test depressed or sub-conical. Interambulacral areas with irregular, chiseled asperities. Tubercles of the ambulacral areas imperforated and non-crenelated. Genital system very large. Foliaceous oviducal plates. Pores simple. Peristome large, not very notched.

The singular arrangement of the kinds of warts in the interambulacral areas and replacing the secondary tubercles gives this genus a physiognomy that makes it easy to distinguish from all the others.

We know only a small number of species, all fossil and restricted to Cretaceous terrains.

1. HIEROGLYPHIC GLYPTICUS. *Glypticus hieroglyphicus*. Agassiz. — *Echinus hieroglyphicus*, Goldfuss, Petref., p. 126, t. 40, f. 17.—*Id.*, Bronn, Lethea geogn., p. 279, t. 17, f. 4 — Bourguet, Petref., pl. 51, f. 377. — *Arbacia hieroglyphica*, Agassiz, Prodr., p. 25. — *Glypticus Id.*, Agassiz, Cat. syst., p. 13, — *Id.*, Echin. Suisse, IL, p. 96, t. 23, f. 37–39. — ? *Giypticus konninchii*, Desor, Cat. rais., p.97.—*Glypticus hieroglyphicus*, Desor, Syn., p.195:

Species a little depressed, having very irregular and warty interambulacal tubercles, oviducal opening, and genital plates forming a large triangular hole.

Fossil of the Corallian of Bourgogne, Wurtemberg, Switzerland.

2. GROOVED GLYPTICUS.. *Glypticus sulcatus*. — *Echinus sulcatus*, Goldfuss, Petref., p. 126, t. 40, f. 18. — *Glypticus sulcatus*, Desor, Syn., p. 96.

From the Corallian of Nattheim; the vicinity of Vendôme.

3. WHOLE GLYPTICUS. *Glypticus integer*. Desor. — Desor, Syn., p. 96.

From the Corallian of Sainte-Croix.

4. GLYPTICUS FROM BOURGOGNE. *Glypticus burgundioeus*. Michelin. — Michelin, Revue et Mag. zool., 1853, no 1.

Fossil of the Oxfordian of Etrochey.

5. RELATED GLYPTICUS. *Glypticus affinis*. Acassiz.—Agassiz, Echin. Suisse, II, p. 97, t. XXIIL, f. 40–42. — *Id.*, Desor, Syn., p. 96. 3

Fossil of the Middle Portlandian of Olten, Obergæschen (Soleurois Jura).

17th GENUS. **COELOPLEURUS**. *COELOPLEURUS* — Agassiz.

Test depressed, sometimes a little elongated. Ambulacral areas with two rows of imperforate and non-crenelated tubercles. Interambulacral areas with principal rows of tubercles that disappear before reaching the dorsal surface. Secondary rows in some species go up to the top.

The species of this genus are easily recognizable at first glance by five wide smooth bands left by the non-extension of the interambulacral rows.

All are found as fossils coming from the Lower Triassic terrains.

The typical species is:

1. KNIGHT'S COELOPLEURUS. *Coelopleurus equis*. Agassiz. — *Echinus equis*, Encyl. méthod., tab. 140, f. 7–8. — *Cidaris coronalis*, Klein, p. 54, t. IV, f. 10. — *Id*, Leske, t. VIII, f. AB, — *Echinus nitidus*, Koenig, Ie. sect., t. II, f. 36. — *Cooelopleurus equis*, Agassiz, Cat, syst., p. 12. — *Id.*, Desor, Syn., p. 97, t. XVI, f. 4-6.

Species of pentagonal form because of the protrusion of the ambulacra while the interambulacral areas are depressed and lack tubercles on the dorsal surface.

Fossil of the Nummulitic terrain of Biaritz; vicinity of Vich (Catalogne).

2. AGASSIZ' COELOPLEURUS. *Coelopleurus Agassizii*. d'Arcurac.— D'Archiac. Mém. Soc. géol. Fr., 2^{e} série, t. II, p. 205, tab. VII, f. 2, and t. II, p. 421, tab. X, f. 15. — *Id*, Desor, Syn., p. 97.

Species of pentagonal form. Secondary tubercles nearly as large as those of the principal rows. Interambulacral zones with kinds of nettting in zigzag in the middle.

Fossil of the Nummulitic terrain of Biaritz.

3. DELBOS' COELOPLEURUS. *Coelopleurus delbosii*. Desor. — *Coelopleurus agassizii*, var. *a*. D'Archiac, *loc. cit*. p. 421. — Desor, Syn., p. 98.

Species near the preceding but more circular in form and with smooth and very wide interambulacral zones.

Fossil of the Nummulitic of Terre-Nègre near St-Palais (Gironde).

4. PRATT'S COOELOPLEURUS. Haine. — An. foss. Inde, p. 200, tab. XIII, f. 5.—*Id.*, Desor, Syn., p. 98.

Fossil of the Nummulitic of Hyderabad (India).

5. *Forbes' Coelopleurus*. Haime. — *Loc. cit*., t. XIII, f. 6. — *Id.*, Desor, Syn., p. 98.

Fossil of the Nummulitic terrain of the chain of Hala (Sinde).

6. *Coelopleurus spinosissimus*. Agassiz. — Cat. rais., p. 53.— *Coelopleurus radiatus*, Agassiz, Cat. rais., p.53. — Desor, Syn., p. 97.

This species has a row of spines between the principal and secondary interambulacral rows.

Fossil of the coarse Chalk (Parisian).

7. *Coelopleurus wetherelli*. Forbes. — Forbes, Echin. of the Brit. Tertiary, p. 24, t. 3, f. 1.— *Id.*, Desor, Syn., p. 98.

Fossil of the Clay of London, Sheppy.

9. *Coelopleurus infulatus*. Desor. — Syn., p. 98.—*Echinites infulatus*, Mart., Syn., p. 79, t. X, f. 7 e.

Fossil of the Eocene terrain (Parisian) of Santee (South Carolina.).

18th GENUS. **ECHINOPSIS**. *ECHINOPSIS*. — Agassiz.

Body very swollen, sub-conical. Ambulacral and interambulacral areas nearly equally wide, with tubercles perforated but not crenelated. Sutures of the plates well marked. Genital system forms a very narrow ring. Pores arranged as single pairs, sometimes doubled.

This genus, known only as fossils, contains only a small number of species all coming from the Cretaceous and Lower Tertiary.

1. ELEGANT ECHINOPSIS. *Echinopsis elegans*. Agassiz. — *Echinus elegans*, Desor, Tabl. syn., p. 300. — Agassiz, Cat. syst., p. 9, and Cat. rais., p. 50, t. XVI, f. 5–6. — Desor, Syn., p. 99, t. XVI, f. 8–10.

   Fossil of the Nummulitic terrain of Royan (Gironde); Ste-Maure (Loir-et-Cher); St-Estèphe.

2. ECHINOPSIS FROM SENTIS. *Echinopsis sentisiana*. Desor. — Syn., p. 98.

   From the Nummulitic terrain of Sentis.

3. SAND ECHINOPSIS. *Echinopsis arenata*. Desor.—*Diadema arenata*, D'Archiac, Mém. Soc. géol. Fr., 2e série, vol. III, p. 424, t X , f. 14.—*Id*., Agassiz, Desor, Cat. rais., p. 44.

   Fosssil of the Nummulitic terrain of Biaritz.

4. GACHET'S ECHINOPSIS. *Echinopsis gacheti*. Agassiz. — Cat, rais., p. 54. Desor, Syn., p. 100. — *Echinus gacheti*, Desmoulins, Tabl. syn., p. 300.

   Species with trigeminate pores.
   Fossil of the coarse Chalk (Parisian) of Blaye.

5. EDWARDS' ECHINOPSIS. *Echinopsis edwardsii*. Forbes. Echin. of Brit. Tert. p. 24. f. 2.

   Fossil of the Clay of London, Barton and Brackhelsom (England).

6. *Leymeri's Echinopsis*. *Echinopsis leymerii*. Cotteau. — Echin. foss. des Pyrénées in Bull. Soc. géol. Fr., 2e série, t. XIIL, p. 372.—*Id.*, Desor, Syn., p. 452,

   From the Nummulitic terrain of Marsoulas (Haute-Garonne).

7. ECHINOPSIS LIKE A SMALL NUT. *Echinopsis nucella*. Desor. — Syn., p. 446.

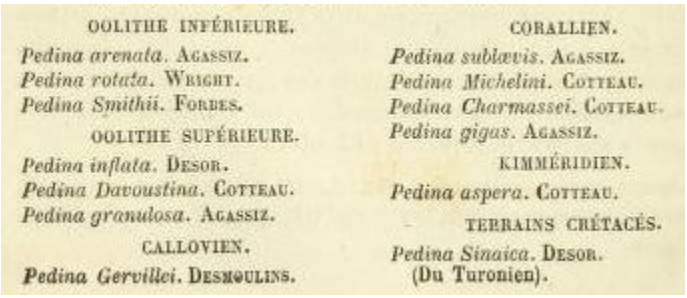
   From the Upper Neocomian of Ste-Croix.

19th Genus. **PEDINA**. *PEDINA* — Agassiz.

Test circular, with small tubercles, crenelated and perforated. Pores arranged in triple, oblique pairs. Peristome small, not very notched. This genus is rather near Diademid by the general form of its crenelated and perforated tubercles. But the arrangement of the oblique triple pairs of its pores brings it near *Salmacis* and related genera that lead to *Echinus* strictly speaking.

Known only as fossils, this genus contains few species coming from the Jurassic and Cretaceous terrains.

The distribution of the species is the following:



OOLITHE INFÉRIEURE.
Pedina arenata. AGASSIZ.
Pedina rotata. WRIGHT.
Pedina Smithii. FORBES.
OOLITHE SUPÉRIEURE.
Pedina inflata. DESOR.
Pedina Davoustina. COTTEAU.
Pedina granulosa. AGASSIZ.
CALLOVIEN.
Pedina Gervillei. DESMOULINS.
CORALLIEN.
Pedina sublævis. AGASSIZ.
Pedina Michelini. COTTEAU.
Pedina Charmassei. COTTEAU.
Pedina gigas. AGASSIZ.
KIMMÉRIDIEN.
Pedina aspera. COTTEAU.
TERRAINS CRÉTACÉS.
Pedina Sinaica. DESOR.
(Du Turonien).

20th GENUS. **GLYPHOCYPHUS**. *GLYPHOCYPHUS*. — Haime.

Test more or less swollen. — Poriferous zones simple and straight. Tubercles small, neither crenelated nor perforated surrounded at their base by a kind of star formed by the miliary granules. Coronal plates separated by small grooves or sutural impressions.

This genus was established for some species that, up to now, were confused with *Echinopsis, Arbacia* and *Phymosoma*. The particular disposition of the sutural impressions with the coronal plates provide an excellent distinctive character and show in some way the design that we find more defined in the following genera.

Glyphocyphus exists only as a fossil. We find then in Cretaceous and Tertiary terrains:

1. *Glyphocyphus depressus*. Desor. — Syn., p. 104. — *Arbacia depressa*, Agassiz, Cat. syst., p. 12. From the Neocomian terrain of Neufchââtel.

2. *Glyphocyphus tenuistriatus*. Desor. — Syn., p. 103. — *Cyphosoma tenuistriata*, Agassiz, Cat. syst., p. 11. From the Gray Chalk of La Flèche (Sarthe).

3. *Glyphocyphus rudiatus*. Desor. — *Echinus radiatus*, Koenig in Goldfuss, Petref., p. 124, t. 40, f. 13.— *Echinopsis latipora*, Agassiz, Cat. syst., p. 9. — *Echinopsis depressa*, Agassiz, Cat. Syst., p. 9. — *Echinopsis pusilla*, Roemer, KreId. nord., p. 30, t. VI, f. 10. — *Temnopleurus pulchellus*, Sorignet, Ours. foss. de l'Eure, p. 31.

Variety *inflata* (*Echinopsis contexta*, Agassiz, Cat. syst., p. 9).

Fossil of the Green Chalk (Cenomanian) of Villers, Cap La Hève; Pouilly, in Auxois; de Gacé (Orne). 4

4. *Glyphocyphus conjunctus*. Desor. — Syn., p. 103. — *Arbacia conjuncta*, Agassiz, Cat. syst., 12.

From the Chalk of Gacé (Orne).

5. *Glyphocyphus difficilis*. Desor. — Syn., p. 104. —Agassiz, Cat. syst.,p . 11. From the Upper Chalk (Senonian) of France.

6. *Glyphocyphus cannabis*. Desor. — Syn., p. 450.

Species the size of a hemp seed.
Fossil of the Upper Chalk (Senonian) of Honguemarre (Eure).

7. *Glyphocyphus pusillus*. Desor.—Syn., p. 104.— *Echinus pusilles*, Munster in Goldf., Petref., p. 125, t. 40, f. 14.— *Diadema pusillum*, Agassiz, Cat. rais., p. 43.

Fossil of the Tertiary sand of Astrupp, near Osnabruck.

21th Genus. **Temnopleurus.** *TEMNOPLEURUS*. — Agassiz.

Test swollen, sub-conical. — Plates of the ambulacral and interambulacral areas with deep impressions but only on the dorsall surface. — Tubercles crenelated, not perforated, forming two principal rows in each area. Pores arranged in simple pairs but forming but forming irregular curving rows.

This species contains some living species that inhabit the seas of hot countries, then some fossil species also in small number coming for the most recent terrains.

The typical species and the oldest known is:

1. *Temnopleurus toreumaticus*. Acassiz.—*Cidaris toreumaticus*, Klein, p. 64, tab. V. — Leske, tab. X, f. DE.— *Echinus toreumaticus*, Gmelin, p. 3180. — *Id.*, Blainville, Zooph., p. 208. — Encycl. méth., p. 142. — *Echinus sculptus*, Lamarck, An. s. vert., 2e édit., III, p. 363, n° 17. — *Temnopleurus toreumaticus*, Agassiz, Cat. rais., p. 360. — *Id.*, Desor, Syn., p. 105.

Species circular, sub-conical, with sutural impressions in the form of triangular fossettes in the ambulacral areas and, on the contrary, elongated in the interambulacral areas.

Inhabits Bombay, the Persian Gulf. Also found in the sub-fossil state on the coasts of the Red Sea, Karrak Island.

2. *Temnopleurus reynaudi*. Agassiz. — Cat, rais., p. 360.

Near the preceding, this species is distinguished especially by the much more pronounced impressions on the internal side than on the external side of the areas. The spines are finely striated and ringed in white and pink.

Inhabits the island of Ceylon, Strait of Malacca. (Mus. Paris).

3. *Temnopleurus areolatus*. Herklotz.— Foss. de Java, Echin., p. 4, t. L, f. 3. — *Id.*, Desor, Syn., p. 105. Fossile des terrains Tertiaires de Java.

4. *Temnopleurus coelatus*. Herklotz. — Foss. de Java, Echin., p. 5, t. L, f. 5. Descr, Syn., p. 305.

Forbes has proposed to distinguish under the name of *Temnechinus*, some species whose tubercles are not crenelated. We can doubt the utility of this genus.

22nd GENUS. **TEMNECHINUS**. *T'EMNECHINUS.*

From impressions on the sutures of the plates. — Tubercles imperforate with a smooth neck.

1. *Temnechinus excavatus*. Wood. — Wood. in Morris, Cat. Brit. foss., p. 60. — *Id.*, Forbes, Brit. org. Rem., Dec. IV, t, I—*Id.*, Échinod. of Brit. Tert., p. 6, t. 1, f. 1.—*Temnopleurus Woodii*, Agassiz, Cat, rais., p. 56.— Desor, Syn., p. 206, t. XVIL, f. 6–7.

Small species depressed and even concave above, with deep and even confluent sutural impressions on the dorsal surface. Apical system very protruding and surrounded by a star whose rays extend a little onto the interambulacral areas.

Fossil of the Corallian Crag (Pliocene) of Ramsholt.

2. *Temnechinus melocactus*. Forbes. — Echin. of Brit. Tert., p. 7, t. I, f. 2. — *Id.*, Desor, Sys., p. 106.

Fossil of the Corallian Crag of Ramsholt.

3. *Temnechinus globosus.* Forbes. — *Loc. cit*., p. 8, tab. I, f. 3.— *Id.*, Desor, Syn., p. 106.

Fossil of the Corallian Crag of Ramsholt.

4. *Temnechinus turbinatus*. Forbes. — *Loc. cit*., p. 8, t. II f. 11. — Dyson, Syn., p. 106.

Fossil of the Corallian Crag of Ramsholt.

23rd GENUS. **OPECHINUS**. *OPECHINUS.* — Desor.

Sutural impressions constitute true multiple fossettes for each plate, varying from three to six or even eight.

The genus *Opechinus* is, as we see it, very near the preceding and differs only by the multiplicity of sutural fossettes that are not found only in the corners of the plates but the entire length of the sutures.

We know only a very small number of species. Some living species inhabit tropical waters. Others, fossils, are special to the Nummulitic terrain, all coming from India.

1. *Opechinus valenciennesii*. Desor. — *Temnopleurus valenciennesii*, D'Archiac, Hist. des progrès de la Géol., t. III, p.217.—*Id.*, D'Archiac and Haine, Au. foss. Inde, p. 203, t. XIIL, f. 7. — *Opechinus Id.*, Desor, Syn., p. 107, t. XVIII, f. 5.

From the Nummulitic terrain of the chain of Hala (Sinde).

2. *Opechinus rousseaui*. Haine.— An, foss. Inde, p. 205, t. XIIL, f. 8.—Desor, Syn., p. 107. Add *O. hockeri*, Desor; *O. tuberculosus*, Desor; *O. costatus*, Desor from the same locality and finally *O. percultus*, Desor frorm the Tertiary of Java.

24th GENUS. **SALMACIS**. *SALMACIS*. — Agassiz.

Test circular, swollen, a little depressed. Tubercles crenelated, not perforate and arranged in multiple rows forming at the same time horizontal rows that are more apparent. — Plates slightly impressionated on their corners. Ambulacral pores bigeminate, or by double pairs. Spines bristly, short and finely striated.

This genus was established by Agassiz for species still not very abundant. It also has the singular character of having the sutures of the plates with small hollows as in the preceding general but with much less development.

We know some living species from tropical seas and only two fossils from the Tertiary terrains, one from the Nummulitic terrain, the other from the most recent stage (Pliocene)

1. *Salmacis bicolor*. Agassiz. — Cat. rais., p. 399.—*Id.*, Desor, Syn., p. 109.

Species with test swollen, having at least ten rows of tubercles in the interambulacral areas. These tubercles also form regular horizontal lines. Sutures of the plates have rather small angular pores. Spines are small, very abundant, striated longitudinally, color a pretty orange and rings of white on the ventral surface.

Inhabits the Red Sea, Bombay. (Mus. Paris.)

2. Salmacis *sulcatus*. Agassiz. — Cat. rais. p. 359.

Species having at least six rows of tubercles on the interambulacral areas and only four on the ambulacrals. Spines very fine and ringed in white and green.

Inhabits the Philippines. (Mus. Paris.)

3. *Salmacis virgulatus*. Agassiz. — Cat. rais., p. 359.

This species is very near *sulcatus* and could well be only a young age.
Inhabits Ceylon. (Mus. Paris).

4. *Salmacis rarispinus*. Agassiz. Cat. rais. p. 359.

Spines not very abundant and ringed in white and red.
Inhabits the Strait of Malacca. (Mus. Paris.)

5. *Salmacis varius*. Agassiz. — Cat. rais., p. 399.

Species near the preceding but less conical and with few tubercles. The angular pores are extremely small and hardly visible.
Inhabits Singapore. (Mus. Paris.)

6. *Salmacis desmoulinsii*. Agassiz. — Cat. rais., p. 399.

Inhabits Singapore. Seas of China. (Mus. Paris.)

7. *Salmacis globator*. Agassiz. — Cat. rais., p. 359.

Inhabits ? (Collection Deshayes.)

8. *Salmacis vandeneckei*. Agassiz. — Cat. rais., p. 95.—*Id.*, Sismonda, Mém. Soc. géol. Fr., 2^{e} série, t. IV, p. 264, tab. XXI, f. 6. — *Id.*, Desor, Syn., p. 109.

From the Nummulitic terrain of the Fontaine du Jarrier, mountain of Palaera.

9. *Salmacis pepo*. Agassiz. Cat. rais., p. 55. — *Id.*, Desor, Syn., p. 109.

Fossil of the Tertiary terrain (Pliocene) of Palermo.

25th GENUS. **MELEBOSIS**. *MELEBOSIS*.— Girard.

This still little-known species is, according to its author, intermediary between *Temnopleurus* and *Salmacis*. It is distinguished first by the absence of sutural fossettes and second by its trigeminate pores.
The only species known is:

Melebosis mirabilis. Girard.— Girard, Proc. Soc. Hist. nat. de Boston, 1850, vol. II, p. 265.

Inhabits the seas of the Antilles.

26th GENUS. **MESPILIA**. *MESPILIA*. — Desor.

Test swollen, having the middle part of the interambulacral areas bare, at least on the dorsal surface while on the ventral surface, the tubercles are very numerous, small non-creneltate and imperforate. Sutural pores in the corners of the plates.

A single known living species.

Mespilia globulus. Agassiz. — Cat. rais. p. 358. — *Echinus globulus,* Lin. — *Cidaris granulata*, Leske, t. II, f. e f. — Desor, Syn., p. 110.

Species with swollen form. The bare parts of the interambulacral areas are colored greenish. The ambulacrals and rows of tubercules are red. The spines are ringed in white and red.

Inhabits Tougatabou. (Mus. Paris.)

27th GENUS. **MICROCYPHUS.** *MICROCYPHUS*.— Agasesiz.

Test swollen, sub-conical.— Ambulacral tubercles in regular series. Those of the interambulacral areas are in the middle of the plates while the edges have wide smooth bands. The sutural pores are in the corners of the plates in both areas. Ambulacral pores are in double pairs. Spines are unknown.

This genus still contains only three or four living species that come from seas of hot countries.

1. *Microcyphus maculatus*. Agassiz. — Cat. rais., p. 358.
2. *Microcyphus rousseau*, Acassiz. — Cat. rais., p. 358. From Mascate.
3. *Microcyphus zig-zac*. Agassiz, — Cat. rais., p. 358. From Southern seas. (Mus. Paris.)
4. *Microcyphus versicolor*. Agassiz. — Cat. rais,, p. 358.

98th GENUS. **AMBLYPNEUSTES**. *AMBLYPNEUSTES*.—- Agassiz.

Test swollen, very thin. — Poriferous zones wide, composed of three rows of double pores. Tubercles small and irregular, often disappearing in the middle of the areas. Peristome small, without deep notches. Spines very small, in the form of small, truncated clubs.

Amblypneustes are charming little Urchins remarkable for the extreme thinness of their test whose form is spherical, the transverse diameter being a little less than the longitudinal.

All the known species are living and inhabit the seas of the South.

1. *Amblypneustes ovum*. Agassiz. — *Echinus ovum*, Lamarck, An. s. vertèb., 2e série, f. III, p. 364, n° 19.—*Id.*, Deslongch., Encycl méth., t. II, p. 590, — *Id*, Desmoul., Echin., p. 274.

2. *Amblypneustes griseus*. Agassiz. — *Echinus griseus*, de Blainville, Man. Act: p.227.

Species near *ovum,* but a little shorter. Ambulacra wide with six rows of spaced tubercles.

Inhabits Vanikoro. (Mus. Paris.)

3. Amblypneustes pallidus. Agassiz. — *Echinus pallidus*, Lamarck, An. sans vert., t. II, p. 364, no 20. — *Id.*, Deslongch., Encycl. méthod., f. 2, p.591.— *Id.*, Desmoulins, Echin., p. 274. — Valenciennes, Voy. de la Vénus. Zooph., pl. 2, f. 1.

Species globular, elevated, sub-oviform. Ambulacra forming smooth bands. Poriferos zones with three oblique rows of double pores. Periproct surrounded by an apical system forming a row of festoons at the top of which are the ovarian pores. The ring formed by this ensemble of pieces, including the madreporite plate, is bordered by a row of small tubercles. The spines, numerous and dense, are finely striated longitudinally, blunt and smooth at their end. Color greenish gray, the ambulacra paler. The spines are reddish with the exception of their end that is whitish.

Inhabits Australia, Vanikoro, Galapagos Islalnds. (Mus. Paris.)

4. *Amblypneustes textilis*. Agassiz. — Cat. rais., p.

Species near *ovum,* but with only two rows of principal tubercles on the two areas, with laces or chains of small tubercles going to the corners of the plates.

Inhabits Australia. (Mus. Paris.)

5. *Amblypneustes scalaris*. Agassiz. — Cat. rais., p. 358.

Species with tubercles more numerous than in the preceding species and the laces formed of larger mamelons. Poriferous zones whitish, detaching on the base from the ambulacral or interambulacral areas whose color is brownish. Plates are greenish

Inhabits Australia (Mus. Paris.)

6. *Amblypneustes serialis*. Agassiz. — Cat. rais., p. 358.

Inhabits ? (Collection Deshayes.)

7. *Amblypneustes formosus*. Var. — Voy. Vénus, Zooph,, pl, 2, f. 2.

Species sub-pentagonal.

Inhabits the Galapagos Islands.

29th GENUS. **CODECHINUS**. *CODECHINUS*. — Desor.

Test swollen, globular. Poriferous zones side. Pores in triple horizontal pairs. Sutures, interambulacral plates marked by smooth impressions. Tubercles very small in the two areas, with a smooth and imperforate neck limited to the two sides of the pair, the middle of these latter being bare. No corner pores.

This genus, very near *Amblypneustes*, differs only by the absence of pores in the corners of the plates.

We know only four fossil species from Cretaceous terrains.

1. *ROUNDED CODECHINUS*. *Codechinus rotundus*. Desor. — *Echinus rotundus*, Abl. Gras, Ours. foss., p. 37, tab. II, f. 13–14.—Desor, Syn., p. 111, t. XIX, f. 10–12.

Species whose ambulacral tubercles form regular rows while those of the interambulacral areas are scattered. The ambulacra equal approximately in length three quarters of the interambulacral areas.

Fossil of the Aptian stage of Rancurel (Isère).

2. PEA-LIKE CODECHINUS POIS. *Codechinus pisum*. Desor. — Syn. p. 111, tab, XIX, f. 13–14.

Species sub-pentagonal, having tubers on all its surface.

Fossil of Green Chalk (Cenomanian) of Mans.

3. CONECHINUS FROM TALLAVIEGNES. *Codechinus talluvignesi*. Cotteau. — Cotteau. Echin, foss. des Pyrénées in Bull. Soc. géol. Fr., 2e série, t. 13, p. 328. — Id., Desor, Syn. p. 451.

Fossil of the Aptian stage of the department of Aude.

4. CONECHINUS FROM GILLIERON. *Codechinus gillieroni*. Desor. — Syn. p. 445.

Fossil from Urgonian stage of La Rusille near Orbe.

30th GENUS. **CODIOPSIS**. *CODIOPSIS*.— Agassiz.

Test swollen, nearly globular, slightly pentagonal. Tubercles perforated, with smooth base, present only on the ventral surface, the dorsal surface lacking them.

This very interesting small genus is distinguished at first glance by the smooth appearance of the dorsal surface, although when examined with a magnifying glass we find however very fine granules scattered in the middle of a finely wrinkled structure.

All the known species are from Upper Cretaceous terrains.

The typical species is;

1. *Codiopsis doma*. Agassiz. — Cat. syst., p. 13, and Cat. rais., p. 53, tab. XV, f. 14–15. — *Echinus doma*, Desmarest, Dic. sc. nat., t. 37, p. 101. — *Codiopsis simplex*, Agassiz, Cat. syst., p. 15.

Species swollen, having the ventral surface ornamented with six rows of tubercles in the inter ambulacral areas and two rows only in the ambulacral areas. These rows never pass the ambitus, leaving the dorsal surface sooth or covered only with very fine wrinkles.

Fossil of the Cenomanian (Tourtia) of Tournay (Belgium), Condrecieux (Sarthe); Essen.

2. *Codiopsis lorini*. Cotteau. — Cat. Echin., p. 7. — Desor. Syn. p. 112.

From the Neocomian of Auxerre (Yonne.)

3. *Codiopsis pradoi*. Desor. — Syn. p. 112.

From the Chalk with Hipparites (Turonian) of Las Bodas near Sabera.

31th GENUS. **ECHINOCIDARIS**. *ECHINOCIDARIS*.— Desmoulins.

Agarites, Agassiz. — *Arbacia*, Agassiz. — *Tetrapygus*, Agassiz.

Test circular, sub-conical, moderately swollen. Tubercles neither crenelated nor perforated, arranged in two rows in the ambulacral areas and at least four in the interambulacrals, but sometimes much more (ten to twelve). None of these rows reach the top. Peristome large, without deep notches. Buccal membrane bare. Periproct closed by four plates placed like a cross. Pores arranged in single rows but multiply greatly on the periphery of the peristome. Spines smooth in appearance but actually finely striated.

The genus *Echinocidaris* was established by Desmoulins. Agassiz proposed to sub-divide it into two sub-genera. One, *Agarites*, contained the species in which the tubercles disappear on the dorsal surface in the interambulacral areas. The other, *Tetrapygus*, for the species that have them up to the top. Desor, having shown intermediary transitions between these two arrangements, the two sub-genera have been abandoned.

Only living species of this genera are known. They come from temperate and hot regions, either from the Mediterranean or from the Atlantic, but the Pacific Ocean appears to be their country of preferences because it is on the American coast that their numerical development is greatest.

1. STARRED ECHINOCIDARIS. *Echinocidaris stellata*. Desmoulins. — *Echinuss stellatus*, de Blainville.. — *Echinocidaris stellata*, Agassiz, Cat. rais., p.309.

Species depressed, having its periproct surrounded by a kind of star whose rays extend into the interambulacral areas. The tubercles are very large.

Inhabits the Galapagos Islands. (Mus. Paris.)

2. SPOTTED ECHINOCIDARIS. *Echinocidaris punctulata*. Desmoulins. — *Echinus nodiformis*, Seba, Thes., t.3, t. 10, f. 10 4b. — An *Rumphius*, Mus., t. 14, f. A ? — *Echinus punctulatus*, Lamarck, An. s. vert., 2e édit., t. II, p. 363, n° 18. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, f. 590. — *Id.* Blainville, Dict. sc. nat., t. 37, p. 75. — *Echinocidaris punctulata*, Desmoulins, Echin., p. 306. — *Arbacia punctulata*, Agassiz, Prodr., p. 190. — *Id.*, Gray, Proc. Soc. Lond., 1835, — *Echinocidaris punctulata,* Agassiz, Cat. rais., p. 353.

Species having at least four rows of large tubercles in the interambulacral areas of which the externals alone reach the top.

Inhabits the Antilles, Senegal.

3. DUFRESNI'S ECHINOCIDARIS. *Echinocidaris dufresnii*. Desmoulins. — *Echinus dufresnii*, Blainville. Man. Act. — *Echinocidaris desmoulins*, Echin., p.306. — *Id.*, Agassiz, Cat. rais., p. 352.

Species sub-conical, with very small tubercles, greenish in color.

Inhabits the Antilles. Cumana. (Mus. Paris.)

4. SPATULATE ECHINOCIDARIS. *Echinocidaris spatulifera*. Agassiz.

— *Cidarites spatuliger*, Vaz., Voy. Vénus, Zooph., pl. V, f. 2. — *Echinocidaris spatuligera*, Agassiz, Cat. rais., p. 353.

Test hemispherical, depressed as a whole but a little conical at its dorsal and central part, the ventral surface being, on the contrary, a little concave. Ambulacra narrow, formed by two double rows of perfectly parallel pores. Ambulacral area narrow. It has two rows of very developed tubercles toward the ventral surface but that do not reach the top. The interambulacral rows, more numerous on the ventral surface, are arranged in chevrons. Spines of two kinds: those of the dorsal surface are short, swollen and blunt. Then, after the ambitus, they become longer and end at their end by a flattened keel.

Color black purple, spines paler.

Inhabits Coquimbo.

5. LOCULATED ECHINOCIDARIS. *Echinocidaris loculata*. Desmoulins. — Echin, — *Echinus loculatus*, Blainville. — Agassiz, Cat, rais., p. 353.

Inhabits the coasts of the English Channel. La Rochelle.

6. ECHINOCIDARIS WITH EQUAL TUBERCLES. *Echinocidaris aequituberculata*. Desmoulins. — *Echinus kermesinus*, Seba, Thes., pl. 10, f. 15. — *Cidaris anulatus pustulosa*, var. b, Klein, pl. 6, f. D. — *Cidaris pustulosa*, Leske, p. 11, f. c. — *Echinus neapolitanus*,

Delle chiaji. — *Echinus aequituberculatus*, Blainv., Man. Act,, p. 226.— Sars, Miäd. Fauna Norw., 1857, p. 54, n° 30.

Inhabits the Mediterranean, Palermo, Algeria.

7. PUSTULOSE ECHINOCIDARIS. *Echinocidaris pustulosa*. Desmoulins. — *Cidaris pustulosa*, Leske apud Klein, p. 150, t. XII, f. D. — *Echinus pustulosus*, Lin., Gmel., p. 3179. — *Echinus pustulosus*, Lamarck, An. s. vert., 2e édit., t. LII, p. 365, no 24. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, f. 591. — *Id.*, Blainville, Dict. sc. nat., t. 37, p. 79. — *Echinocidaris pustulosa*, Desmoulins , Echin. — *Arbacia pustulosa*, Gray, Zool. proc. Soc, Lond., 1835. — *Id.*, Agassiz, Prodr., p. 190. — *Echinocidaris pustulosa*, Agassiz, Cat. syst., p. 354.

8. BLACK ECHINOCIDARIS. *Echinocidaris nigra*. Agassiz. — *Echinus niger*, Morina, Hist. du Chili, p. 175. — *Echinus pustulosus*, Desmoulins (non Lamarck). — *Echinus margaritaceus*, Desmoulins? Encycl. méthod., pl. 141, f. 6-7 (non Lamarck). — *Echinus purpuraceus*, Val., Voy. Vénus, Zooph., pl. 5, f. 1. — *Echinocidaris nigra*, Agassiz, Cat. rais., p. 354.

Inhabits Coquimbo, Payta. (Mus. Paris.)

9. GRAINY ECHINOCIDARIS. *Echinocidaris grandinosa*. Agassiz. — *Echinus grandinosus*, VaL., Voy. Vénus, Zooph., pl. 11, f. 1.— *Echinocidaris grandinosa*, Agassiz, Cat. rais., p. 354.

Inhabits Cartagena (America), coasts of Peru. (Mus. Paris.)

10. *ECHINOCIDARIS WITH SCYTHE*. *Echinocidaris scythei*. Phil.. — Weigm. Archiv., 1857, p. 131, n° 2.

Inhabits the coasts of Chile.

32th GENUS. **COTTALDIA.**, *COTTALDIA*. — Deson.

Test globular. — All the surface with numerous and uniform tubercles forming horizontal rows in the interambulacral areas. Pores arranged in single pairs.

This genus is very easy to distinguish, first by the uniformity of its tubercles, then by the single pores, not double either at the base or at the top.

We know only three species from the Cretaceous and Tertiary terrains.

1. GRANULAR COLTALDIA. *Cottaldia granulosa*. Desor. — *Echinus granulosus*, Munster in Goldfuss., Petref., p. 125, t. 49, f, 5. — *Id.*, Forbes, Mem. geol. Surv., Dec. I, t. VI. — *Arbacia granulosa*, Agassiz, Cat. syst., p. 12. — Var. *Arbacia conica*, Abassiz, Cat. syst.,

p. 12. — *Echinus beneitiae,* Koenig, 1e sect., p. 35. — *Cottaldia granulosa*, Desor, Syn., p. 114, t. XIX, f. 1–3.

Fossil of the Green Chalk (Cenomanian) of Villers-sur-Mer, Le Mans, Aix. Islalnd,

2. SORIGNET'S COTTALDIA. *Cottaldia sorigneti*. DEsor. — Syn., p. 449.

From the Cenomanian of Rouen.

3. BUCH'S COTTALDIA. *Cottaldia buchii*. Desor. — *Echinus buchii*, Stein, Mém. Soc. géol. Fr., t. 1, p. 349, tab. XXI. — *Polycyphus buchii*, Agassiz, Cat. rais., p. 58. — Desor, Syn., p. 114.

From Tertiary terrains ? vicinity of Prum (Rheinish Rhein).

33rd GENUS. **MAGNOSIA**. *MAGNOSIA.* — Michelin.

Test swollen.— Tubercles numerous and uniform, neither perforated nor crenelated, and arranged in vertical or transverse rows. The vertical series does not extend all the way to the top. Only the externals go higher. Pores arranged in single pairs from the top to the ambitus, the after this point multiply, especially toward the periphery of the peristome that is large, pentagonal, notched with unequal lips.

This genus, near *Polycyphus*, is distinguished by the arrangement of the unigeminate pores. It differs from *Cottaldia* by the size of the peristome.

The species are fossil only, from the Middle Jurassic and Cretaceous terrains.

The typical species is:

1. *Magnosia nodoti*. Michelin. — Michelin in Revue et Mag. Zool., 1853, n° 1. — *Id.*, Desor, Syn., p. 415. — *Id.*, Wright, Pal. Soc., 1855, p. 194.

Species hemispherical, whose tubercles do not increase obviously to the ambitus. Ambulacral areas narrow, with four rows of tubercles. The interambulacral areas have at least twelve. Peristome very large.

Fossil of the Lower Oollite (Bajocian) of Avesne (Côte-d'Or).

2. *Magnosia richeriana*. Cotteau. From the Middle Lias of Précigné (Sarthe).

3. *Magnesia forbesii*. Desor. From the Great Oolite (Bathonian) of England.

4. *Magnosia decorata*. Desor. — *Eucosmus decoratus*, Agassiz. From the Oxfordian (Switzerland).

5. *Magnosia nodulosa*. Desor. From the Corallian.

6. *Magnosia jurassica*. Cotteau, From the Corallian.

7. *Magnosia tetrasticha*. Desor. From the Corallian.

8. *Magnosia punctata*. Desor. From the Corallian.

9. *Magnosia lens*. Desor. From the Neocomian.

10. *Magnosia pilos*. Desor. From the Neocomian.

11. *Magnosia pulchella*. Desor. From the Aptian. From Rimet near Rencurel (Isère).

34th GENUS. **POLYCYPHUS**. *POLYCYPHUS*.— Agassiz.

Agassiz established under this name a genus that differs from *Cottaldia* only by its very large and pentagonal peristome and from the genus *Magnosia* by its trigeminate pores.

The number of species is not very great. All are fossils from the Oolite and Cretaceous terrains.

1. *Polycyphus normannus*. Desor. — Syn., p. 177.— *P. nodulosus*, Agassrz. — *Arbacia nodulosa*, Wright. Fossil of the Great Oolite (Bathonian) of Ranville ; Luc.

2. *Polycyphus deslongchampsüi*. Wright. From the Lower Oolite (Bajocian) of Crickley Hill.

3. *Polycyphus stellatus*. Agassiz. (Bathonian) of Ranville.

4. *Polycyphus tertilis*. Agassiz. — *Echinus textilis*, Munster. Callovian stage of Marolles (Sarthe).

5. *Polycyphus corallinus*. Cotteau. From the Corallian of Druyes (Yonne).

6. *Polycyphus distinctus*. Desor. — *Echinus distinctus*, Agassiz. From the Corallian of Angoulême,

7. *Polycyphus arenatus*. Desor. From the Cenomanian of the department of Eure.

35th GENUS. **OURSIN**. *ECHINUS*— Linck.

Test swollen, hemispherical or sub-pentagonal, covered with generally small tubercles, smooth and imperforate. — Ambulacra with trigeminate pores. Peristome deeply notched. — Buccal membrane bare, with ten shields across which pass the buccal tubes. Periproct with small irregular and numerous plates. Spines short and slender, striated longitudinally.

The genus Oursin is no longer nearly as extensive as it was in the times of Lamarck. E.g., there has been successively detachment of some genera. Already de Blainville had in some way foreseen this reform of the genus *Echinus* in establishing divisions that, more completely studied and better specified, have become, for the most part, distinct genera. Thus, *Echinus melo*, being preserved in the genus *Echinus* strictly speaking, we detached, first as a sub-genus then as a distinct genus, a distinct genus under the name *Psammechinus,* species with buccal membrane scaly and peristome not notched. *Ps. miliaris* and a large number of other species constitute it. The Urchins that, with a pentagonal form, have a peristome deeply notched, have become the genus *Stomechinus.* The species differ from the first by a disposition of the tubercles on the dorsal surface, are attenuated by decreasing considerably in size, have formed the genus *Hypechinus* (*H. patagonensis*). Another group having tubercles on vertical keels have constituted the genus *Stirechinus* (*S. scillae*). Urchins whose ambulacral pores are always more than three pairs and that for this reason we call Polypores have furnished several genera. We call *Tripneustes* those whose pores for three vertical double rows (*E. sardicus*). In the genus *Boletia*, with the same number of pores, only one of the rows is irregular and separated from the others by a row of tubercles (*E. pileolus*). The genus *Holopneustes* has its ambulacra wider than the interambulacral areas. Division C de Blainville, whose main representative is the edible sea urchin (*E. esculentus*), has become the genus *Sphaerechinus,* Then, section D from the same author, which contains *Echinus neglectus*, constitutes the genus *Toxopneustes*. Finally, under the name of *Loxechinus*, we form a distinct genus, characterized by pores in ten pairs arranged in arcs (*Echinus albus* Molina). It is necessary still to add the genera *Phymechinus* and *Heliocidaris* that were previously confused with *Echinus*. As a result, the genus *Echinus* strictly speaking is now very restricted.

1. MELON ECHINUS. *Echinus melo*. Lamarck.— *Echinometra*, Gault, Ind. p. 107, f. e.— *Echinus melo*, Lamarck, Anim. s. vert., 2^{e} édit., t. III, p.360, n° 8. — *Id.*, Deslongchamps, — Blainville. — Risso. — Agassiz. — Desmoulins. — Sars, etc.

This species, the largest of the genus, is remarkable for its spherical form and its reddish color.

Inhabits the Mediterranean.

2. ACUTE ECHINUS. *Echinus acutus*. Lamarck.—Lamarck, 2^{e} édit., t. III, p. 361, n° 10. — *Id.*, Deslongchamps. — de Blainville. — Desmoulins.

This species, very near the preceding, has even been united with it with the title of a simple variety by some authors. But the conical form of its top as well as its very different coloration allows distinguishing it.

Inhabits the Mediterranean.

3. ELEGANT ECHINUS. *Echinus elegans*. Duben and Koren.—Mém. Acad. Stock., 1844, p. 272, n° 39, t.IX, f. 40–42, — *Id.*, Agassiz, Cat. rais., p.

Species of hemispherical form, a little depressed, with twenty rows of very different and uninterrupted tubercles, and similar in size above and below.

Color bright yellow orange with spines of the same color at the base but white at the top.

Inhabits the seas of the North.

4. FLEMING'S ECHINUS. *Echinus flemingii*. Forbes. — *Echinus miliaris*, Feming, Brit. anim.—Agassiz, Forbes, Brit. Starf., p. 164. — *Id.*, Duben and Koren, Mém, Acad. Stock., 1844, p. 266, n° 37, t. IX, f. 31–32. — *Id.*, Sars, Midd. litt. Fauna in nyt. Mag. fur Naturv., 1857, t. X, p. 55, no 32.

Species globular, a little conical, tawny-yellow, marked with twenty reddish vertical zones corresponding to the principal rows of the tubercles. Spines purple in color at their base and greenish or tawny toward the tip.

Inhabits the seas of the North.

FOSSIL SPECIES.

5. LAMARCK'S ECHINUS. *Echinus lamarckii*. Forbes.— *Echinus melo*. Leach, Brit. Assoc., 1850, t, I, f. 4. — *Echinus lamarckii*, Forbes, Echin. Brit. Tert., p. 2. — *Id.*, Desor, Syn., p. 125:

Species of large size, swollen, sub-conical, covered with rather large irregular and numerous tubercles. It is in addition very near *Echinus sphara*, but is distinguished because each pair of pores is separated for the adjacent one by a small tubercle.

Fossil of the Corallian Crag of Sutton (England).

6. WOOD'S ECHINUS. *Echinus woodii*. Desor. — *Echinus melo*? Forbes, Echin. Brit. Tert., p. 4, t. IL, f. 10. — *Echinus woodii*, Desor, Syn., p. 124.

Species swollen, sub-conical, with interambulacral tubercles arranged rather irregularly and of an equally irregular size. Those of the ambulacral area form more regular rows.

Fossil of the Corallian Crag of Sutton.

7. LYELL'S ECHINUS. *Echinus lyellii*. Forbes. — Echin. Brit. Tert., p. 4. — Desor, Syn., p. 124.

Fossil of the Corallian Crag of Ramsholt.

8. DIXON'S ECHINUS, *Echinus Dixonianus*. Forbes. — Echin. Brit. Zooph., p. 22, t. II, f. .3. — Desor, Syn., p. 124.

Species established on a spine fragment.
Fossil of the Clay of London, Barton (England).

36th GENUS. **PSAMMECHINUS**. *PSAMMECHINUS*. Agassiz.

Test circular, more or less depressed. Tubercles smooth and imperforate, disposed in multiple whorled rows, then unequal. Pores arranged in triple pairs. Peristome without deep notches. Buccal membrane with small plates or scales. Spines very finely striated but appear smooth.

The genus *Psammechinus*, as we have seen, was dismembered from the Urchins. Agassiz, who is the founder, at first proposed only a sub-genus. The very particular arrangement of its buccal membrane that has scaly or imbricated plates, then the absence of strong notches at the peristome are such charactedrs that permit distinguishing it.

The species are numerous both living and in the fossil state. The first live in nearly all the seas, especially in temperate and cold seas. The second are found in Cretaceous terrains and Tertiary terrains.

1. *Psammechinus miliaris*. — *Cidaris mitiaris saxatilis*, Leske apud Klein, p. 82, t. 2, f. ABCD, and tab. 38, f. 2–3. — Seba, Mus., t. 3, tab. X, f. 1–4. — *Echinus saxatilis*, Mull., Zool. Dan. Prod., p. 235. — *E. miliaris*, Lin. Gmel., p. 3169.—*Echinus miliaris*, Lamarck, An. s. vert., t. II, p. 367, n° 26. — Encycl. méthod., pl. 133, f. 1–2, — *Id.*, Deslongchamps, Encycl. méthod., t. 2, p. 592. — *Id.*, Agassiz, Prodr., p. 190. — *Id.*, Desmolins, Echin., p. 270. — *Id.*, Forbes, Brit. Starf.—*Echinus gaimardi*, Blainv. — *Echinus minutus*, Blainv. (young age). — *Echinus virens*, Dubin and Koren, Mém. Acad. Stock., 1844, p. 274, no 40, t. X, f. 43–45. — *Echinus* (*Psammechinus*) *miliaris*, Sars, Fauna Norw., 1857, p. 60.

Species circular, depressed, with rows of unequal tubercles. Some, very protruding, form the principal rows. Others smaller and in some way miliary. Spines rather long, sharp, violet purple, the base being greenish. General color deep greenish.
Inhabits the coasts of the English Channel, the sea or the North.

This species, one of the most abundant on our coasts of the Channel, should be subdivided into several others. Agassiz has separated three species confused with it: *P. pustulatus, P. pulchellus, P. decoratus*.

3. *Psammechinus norwegicus*.— *Echinus norwegicus*, Duben and Koren, Mém. Acad. Stock., 1844, p. 268, n° 38, t. IX, f. 33–39.

Species depressed, a little conical as an adult, with rows of very unequal, rare and separated tubercles. One very developed row accompanies each poriferous zone. Spines very long and very slender, pale tawny.

The color of the test is yellowish, with four large spots radiating from the top but not passing the ambitus.

Inhabits the seas of the North, Norway.

3. *Psammechinus microtuberculatus*. Agassiz. — Dict. sc. nat, — *Echinus parvitentaculatus,* Blainville, Man. Act. p. 228. — *Psammechinus Id.*, Agassiz, Cat. rais., p. 368,— *Id.*, Sars, Midd. littoral Fauna in nyst., Mag. fur Naturv., 1857, vol. X, pl. 1, p. 99, no 35.

Species hemispherical, a little conical, olive color with ten yellowish green fascies in the ambulacral areas. Small tubercles supporting greenish, sometimes reddish spines, white at the tip. Buccal membrane with imbricated scales, thick and greenish.

This species, near *P. miliaris*, is distinguished by its less dense tubercles that never touch at the base.

Inhabits the Mediterranean.

4. *Psammechinus pulchellus*. Agassiz. — *Echinus* (*Psammechinus*) *pulchellus*, Agassiz, Cat. rais., p. 368. — *Echinus miliaris*, Risso (non Lamarck).

Species small, depressed, with very small tubercles. Yellowish ambulacral zones standing out on the deep green background. Spines slender, greenish at the base, pink at the top.

This species has been confused by authors, in particular by Risso, with *Echinus miliaris.* It is Agassiz who distinguished them.

Inhabits the Mediterranean.

5. *Psammechinus pustulatus*. Agassiz. — Agassiz, Cat. rais., p. 368. — *Echinus miliaris*, authors.

Species with tubercles smaller and denser than in *miliaris.* The spines are also shorter and less pointed. Notches of the peristome less deep.

Inhabits the seas of the North and the coasts of Ireland.

6. *Psammechinus decoratus*. Agassiz. — Agassiz, Cat, rais., p. 368.

Inhabits the Mediterranean.

7. *Psammechinus variegatus.* — *Cidaris variegata*, Leske, Klein, p. 169, t. 10, f. bc. — Knorr, Delic., t. D 11, f. 3. — *Echinus variegatus*, Lamarck, An. s. vert., 2e édit., t. IL, p. 365, no 22. — Encycl. méthod., pl. 141, f. 4–5. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, p. 591. — *Id.*, Agassiz, Prod., p. 190. — *Id.*, Desmoulins, Echin., p. 276, — E. Blainville, Desmolins, *loc. cit*., p. 276. — *Echinus* (*Psammechinus*) *variegatus*, Agassiz, Cat. rais., p. 368.

Species circular, depressed. Ambulacral areas bare on the upper part. Color green varied with white.

Inhabits Yucatan, Mexico.

8. *Psammechinus semituberculatus*. — *Echinus* (*Psammechinus*) *semituberculatus*, Agassiz, Cat. rais., p. 368.

Species near *P. variegatus* but with more numerous tubercles on the ventral surface in the interambulacral areas. Color green.

Inhabits the Galapagos Islands. (Mus. Paris.)

9. *Psammechinus subangulosus*. Agassiz — *Echinus subangulosus*, Lamarck, An. s. vert., t. I, p. 111. — Encycl. méthod., pl. 133, f. 5–6. — *Echinus* (*Psammechinus*) *subangulosus,* Agassiz, Cat. rais., p. 368.

Species whose ambulacral pores are more transverse, the first row being separated from two others by a row of small tubercles.

Inhabits the Cape of Good Hope. (Mus. Paris.)

10. *Psammechinus excavatus*. Agassiz.—*Echinus excavatus*, Blainville, Man. Act., p. 227. — *Echinus* (*Psammechinus*) *excavatus*, Agassiz, Cat. rais., p. 368.

Species near *P. variegatus*. It is distinguished by a smaller size and by a larger number of interambulacral tubercles.

Inhabits Brazil, Martinique. (Mus. Paris.)

11. *Psammechinus koreni*. Desor. — Agassiz, Desor, Cat. rais., p. 368.

Species have genital plates covered with small granules. Tubercles spaced and rather large. Spines short and strong.

Inhabits the seas of the North. (Mus. Paris.)

12. *Psammechinus longispinus*. — *Echinus longispinus*, Blainville. — *Echinus longispinus*, Agassiz, Cat. rais., p. 370.

Species with narrow ambulacral areas, with two rows of tubercles separated only by some miliary tubercles. Color green. Spines violet.

Inhabits ?

13. *Psammechinus laganoides*. Desor. — Agassiz, Desor, Cat. rais., p. 370.

Very small species near *P. longispinus*, Blainville. It differs by its relatively larger tubercles separated by a small number of miliary tubercles. Color green. Habitat ? (Mus. Paris.)

14. *Psammechinus magellanicus*. — *Echinus magellanicus*, Philippi, Archiv Weigm., 1857, n° 1, p. 130.

Small species with flattened circular test with ambulacral areas two times as wide as the interambulacrals. Ambulacral zones formed of three pairs of pores forming a festooned line. Peristome large, slightly angular. Periproct with five unequal plates. Spines rather long, whitish at the ends.

General color violet with white ambulacra.

Inhabits the Strait of Magellan.

15. *Psammechinus aciculatus*. Hupé. — *Echinus aciculatus*. Hupé, Voy. de Castelnau, p. 97. Inhabits the coasts of Brazil.

FOSSIL SPECIES (CRETACEOUS).

16. *Psammechinus fallax*. Desor, — Syn., p. 119.— *Echinus fallax*, Agassiz, Echin. Suisse, II, p. 86, t. XXII, f. 7–9. From the Neocomian of Doubs; Saint-Sauveur (Yonne).

17. *Psammechinus rathieri*. Desor. — *Echinus rathieri*, Cotteau, Cat. méth. Echin. p. 8. From the Neocomian of Tronchoy (Yonne).

18. *Psammechinus theveneti*. Desor. — Syn., p. 119. — *Echinus theveneti*, Alb. Gras, Ours. foss., Syst., p. 4, t. I, f. 2–4. From the Upper Neocomian of Rimet near Rancurel (Isère).

19. *Psammechinus minimus*. Desor. — Syn. p. 119. — *Arbacia minima*, Cotteai, Cat. méth., t. 7. From the Neocomian of Auxerre.

20. *Psammechinus fenuis*. Desor. — Syn., p. 120. From the Lower Neocomian (Valanginian) of Ste-Croix.

21. *Psammechinus hyseleyi*. Desor. — Syn., p. 445. From the Neocomian of Landeron.

22. *Psammechinus montmolini*. Desor. — Syn., p. 445. From the Neocomian of Villers-sur-Doubs.

23. *Psammechinus alutaceus*. Agassiz. — Cat, rais., p. 51. — *Echinus alutaceus*, Goldfusss, Petref., p. 125, t. 40, f. 15. From the Cenomanian of Essen.

TERTIARY SPECIES.

24. *Psammechinus gravesii*. Desor. — Syn., p. 121. — *Echinus gravesü,* Desor, Cat. rais., p. 62. From the Coarse Limestone (Parisian) of Retheuil (Aisne).

25. *Psammechinus serresii*. Desor. — Syn., p. 120, tab. XVIII, f. 1–3 *Echinus serresii*, Desmoulins, Tab. syn., p. 290. From the Tertiary terrain (Molasse) of Martigues and Clausaye.

26. *Psammechinus mirabilis*. Desor. — Syn., p. 120. — *Echinometra mirabilis*, Nicoler in Agassiz, Cat. syst., p.12.— *Echinus dubius*, Agassiz, Echin. Suisse, IL, p. 84, t. 22, f. 4–6. — *Echinus astensis,* E. Sism., Mém. Acad. Tur., t. IV. — *Echinus lineatus*, Sism. (non Goldf.) Echin. foss. du Piém., p. 51. From the Middle Tertiary terrain (Molasse) of Chaux-de-Fonds, Martigues, Asti.

27. *Psammechinus monilis*. Desor. — Syn., p. 121. — *Echinus monilis*, Desmarets in Defr., Dict. sc. nat., vol. 37, p. 100.—*Arbacia monilis*, Agassiz, Cat. rais., p. 51.— *Arbacia globosa*, Agassiz, Cat. Syst., p. 12. From the Middle Tertiary terrain (Falhunian) of Ste-Maure, Doué, Brayes (Oise).

28. *Psammechinus caillaudi*. Desor. — Syn., p. 120. — *Echinus caillaudi*, Desor, Cat. rais., p. 65. From the Tertiary terrain (Molasse) of the south of France.

29. *Psammechinus duciei*. Desor. — Syn., p.121. — *Echinus duciei*, Wright, Foss, Echin. of Malta in Ann. and Mag. of nat. Hist., vol. XV, f. IV, f. 2. From the Tertiary terrain (Miocene) of Malta.

30. *Psammechinus homocyphus*. Desor. — Syn., p. 120. — *Echinus homocyphus*, Agassiz, Cat. syst., p. 12. From the Tertiary terrain (Pliocene) of Italy.

31. *Psammechinus ruffini*. Desor.— Syn., p. 121.— *Echinus ruffini*, Forbes, Quensrenr, Journ., vol. 1, p. 426. From the Middle Tertiary terrain (Miocene) of Boston (United States).

32. *Psammechinus woodwardii*. Desor. — Syn., p. 121. — *Echinus woodwardi*, Desor, Cat. rais., p.65. From the Red Crag of England.

33. *Psammechinus charlesworthii*. Desor. — Syn., p. 121.— *Echinus charlesworthii*, Forbes, Echin. of Brit. Tert., p. 5, v. 1, f. 6. From the Corallian Crag of Ramsholt (England).

34. *Psammechinus henslovii*, Desor. — Syn., p. 121. — *Echinus henslovii*, Forbes, Echin. of Brit. Tert., p. 5, t. 1, f. 7. From the Red Crag of Walton.

35. *Psammechinus catenatus*. Desor. — Syn., p. 122. — *Echinus Id.*, Desor, Cat. rais., p.51. From the Tertiary terrain (Molasse) of the south of France.

36. *Psammechinus spadae*. Desor. — Syn., p. 122.— *Arbacia spadae,* Desor, Cat. rais., 51. From the Upper Tertiary terrain (Pliocene) of mount Mario.

37. *Psammechinus romanus.* Merian. — Desor, Syn., p.122. From the Upper Tertiary terrain (Pliocene) of Palermo.

37th GENUS. **SPHAERECHINUS**. *SPHAERECHINUS*. — Desor.

Test spherical, ornamented with a large number of rows of tubercles that are nearly equal in the two areas. Ambulacral pores form vertical aras of four pairs for each plate. Peristome decagonal, deeply notched. Buccal membrane bare, with ten shields for the buccal tubes.

This genus, established a few years ago by Desor, has for type the *Echinus esculentus* of Linné, and corresponds to section B of the genus *Echinus* de Blainville.

Two perfectly distinct species have been generally confused under the name of *E. esculentus*. That to which Linné gave the name is the same as *Echinus sphaera* Müller, while the *E. esculentus* of Lamarck and some authors is *E. brevispinosus* Risso.

1. SPHAERECHINUS COMESTIBLE. *Spherechinus esculentus*. Lin.—*Echinus sphaera*, Mull., Prodr., p. 235. — Echinometra , Rondeler, from Pise, t. 18, f. 32, P. 581. — *Echinus marinus*, Muel; p. 169, pl. 3, f. 18. — *Echinus esculentus*, Lin. Mus. Lud. Ulr., p. 705. — *Id.*, Syst. nat., p. 3168. — *Echinus globiformis*, Lamarack, *loc. cit*. — *Echinus aurantiacus*, Blainv.. — *Echinus pseudomelo* Blainv., *Echinus esculentus*, Agassiz, Cat. rais., p. 370. — *Echinus sphaera*, Forbes, Brit. Starf., p. 149.—*Id.*, Agassiz, Mon. Echin.. — *Id.*, Duben and Koren.

Species sub-globular, covered with nearly equal tubercles that are very numerous and rather small, with spines that are short and white except toward their base where they are violet.

Color generally reddish. Inhabits the seas of the North.

2. *Sphaerechinus gibbosus*, Agassiz (Sp.). — *Echinus gibosus*, Agassiz, Cat. rais., p.

Species globose and very irregular in form. Four slightly arced pairs of pores. Inhabits the Galapagos Islands. (Mus. Paris.)

3. *Sphaerechinus marii*. Deson.—Desor, Cat. rais., p. 64.—*Id.*, Syn., p. 134.

Species globulose, sub-conical, near *S. esculentus*, but that differs by its smaller and less dense tubercles. The pores of the ambulacra are in arcs formed of four pairs.

Fossil of the Pliocene of Monte-Mario near Rome.

38th Genus. **Stirechinus**. *STIRECHINUS*. — Desor.

Test hemispherical, swollen, covered with tubercles that are rare, imperforate, with a smooth neck, forming very pronounced vertical series because of the protrusion of the parts surmounted by these rows. Trigeminate ambulacral pores. Sutures of the plates very distinct.

Desor, who established this genus in his Synopsis, gave for its principal distinctive character the arrangement of the rows of tubercles that seemed to be on keels. It must be admitted this is a rather slight difference. The usefulness of this new genus is very questionable, and it deserves confirmation.

Only one species is referred to it. It is a fossil that come from very recent terrains of Italy.

Scilla's stirechinus. *Stirechinus scillae*. — *Echinus scillae*, Desmoulins, Tab. syn., p. 290, no 40.— *Echinus è messana*, Scilla. Corp. mar., t. XIII, f. 1, and XXVL, f. B. — *Echinatus costatus*, Agassiz, Cat. rais., p. 66. — *Stirechinus scillae*, Desor, Syn., p. 131, t. 17 *bis*, f, 6–7.

Fossil of the Upper Tertiary terrain (Pliocene) de Palermo, Messina, Monte-Mario (Coll. Michelin).

Desor has established under the name of *Hypechinus*, a genus whose usefulness is still very questionable. It is characterized by a sensible decrease of the ambulacral tubercles on the dorsal surface.

The typical species is *H. patagonicus*, Desor, Syn., p.150, tab. 18 *bis*, f. 4. — *Echinus patagonensis*, D'Orb., Pal, Amér. mérId., p. 155, t. VI, f. 14-16,

From the Middle Tertiary terrain (Miocene) of Port-St.-Julien (Patagonia). (Coll. D'Orb.)

39th Genus. **Toxopneustes**. *TOXOPNEUSTES*, — Agassiz.

Test circular, sub-pentagonal, depressed, with tubercles that are smooth and unperforated, unequal size, forming principal and secondary rows. Ambulacral pores arranged in arcs of 5 or 6 bypassing the ambulacral tubercles. Peristome wide, covered with a bare buccal membrane and ten shield across which pass the buccal tubes. Spines slender, finely striated, longer than those of *Echinus* and *Sphaerechinus*.

Toxopneustes were removed from Urchins (*Echinus*) and contains a large number of species that up to now have been designated under this latter name. *Echinus brevispinosus, lividus* and *neglectus* are the most common representatives.

We know some living in all the seas but particularly in temperate or cold seas of Europe. Some fossil species from recent Tertiary terrains.

1. Toxopneustes with short spines. *Toxopneustes brevispinosus*. Agassiz. — *Echinus esculentus*, Lamar ck, An, s. vert., t. II, p. 3590 (non Linné). *Id*—. Blainville. — *Echinus brevispinosus*, Risso, Eur. mér.. D. — *Id.*, Agassiz, Cat. rais., p. 370.— *Id.*, Sars, Midd, litt. Fauna in nyt. Mag. fur Naturv. 1897, t. X, p. 1, p. 56, n° 33.

Species with small and numerous tubercles. Peristome with deep notches. Ambulacral pors forming rows of five pairs without intermediary tubercles. Color generally violet. Spines also violet but deeper and purple at the base while their top is whitish.

Inhabits the Mediterranean.

2. WHITE TOXOPNEUSTES. *Toxopneustes albidus*. Agassiz. — Cat. rais., p. 370, *E. brevispinosus*, var. Risso.

This species resembles in all its characters the preceding. It differs however by its white tubercles with spines also white. They are longer and sharper.

Inhabits the Mediterranean.

3. TOXOPNEUSTES WITH EQUAL TUBERCLES. *Tozopneustes aequituberculatus*. Agassi, — *Echinus aequituberculatus*, Blains. — *Toxopneustes aequituberculatus* Agassiz, Cat. rais., p. 370.

Species very near *brevispinosus* and for a long time confused with it. It is distinguished by the thinness of the test and uniformity of the tubercles that are white and clearly stand out from the background of the test that is violet. The spines are finer and sharper. They are sometimes all white, sometimes violet and the top is white. The ambulacral pores are arranaged in four pairs. Peristome very deeply notched.

Inhabits Sicily.

4. GRANULAR TOXOPNEUSTES. *Toxopneustes granularis*. Lamarck (Sp). — *Echinus granularis*, Lamarck, An. s. vert., t. III, p. 359, no 3.

Species confused wrongly with *Echinus brevispinosus* and *Echinus aequituberculatus*, Bv. It is a little larger than the latter species and the tubercles are also larger. The peristome is deeply notched. The ambulacra have rows of pores composed of five pairs, each separated by a tubercle. The spines, of moderate size, are acuminate at their end, crenelate at their base that is purple while their tip is white.

Inhabits the Mediterranean, the Atlantic Ocean.

5. PURPLE TOXOPNEUSTES. *Toxopneustes lividus*. Agassiz. — *Echinus miliaris*, var. B. dBaster. — *Echinus saxatilis*, Linné, Gmel., p. 3170. — *Echinus lividus*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 367, n° 28. — *Id.*, Deslongchamps, Encycl. méthod., t. 2, p. 592. — *Id.*, Agassz, Prodr., p. 190. — *Echinus lithophagus* , Leach. — *Echinus purpureus*, Risso. — *Echinus longispinus*, Blainville. — *E. vulgaris*, Blainville. — *Toxopneustes lividus*, Agassiz, Cat. rais., p. 370.— *Id.*, Sars, Middel. litt. Fauna in nyt. Mag., 1857, vol. X, part. 1, p. 56, n° 34.

Species circular, depressed, covered with tubercle larger and closer together in the ambulacral areas Ambulacra formed of five or six pairs of pores. Spines long and sharp. Color uniformly green purple.

Inhabits the Mediterranean.

6. TOXOPNEUSTES DROBACHIENSIS. — *Echinus drobachiensis*, Müller, Prodr., p. 235. — *Echinus saxatilis*, Fibr., Fau. Groenland, n° 368. — *Echinus miliaris*, Fabr., loc. cit., n° 114, p. 346. — *Echinus neglectus*, Lamarck, An, s. vert., t. III, p. 367, n° 25. — *Id.*, Agassiz, Prodr., p. 190. — *Id.*, Forbes, Brit. Starf. p. 172. — *Echinus lividus*, var. Blainv.., Man. Act., p. 228. — *Cidaris miliaris saxatilis*, Leske apud Klein, t. 58, f. 2–3. — *Echinus neglectus*, Duben, Koren, Mém. Acad. Stock., 1844, p. 277, n° 41. — *Echinus drobachiensis*, Lutken, Overs. of Gronl. Echinod., p. 24, n° 10.

Species with depressed body, circular, with smaller tubercles in the interambulacral areas and on the contrary, larger and more separated in the ambulacral areas. Ambulacral pores arranged in five, six, and sometimes even seven pairs. Color greenish, slightly purplish. The spines short, not very sharp are greenish and varied with white and purple. This species, more usually known as *Echinus neglectus*, should replace that given it previously by Müller.

Inhabits the seas of the North.

7. TUBERCULATE TOXOPNEUSTES. *Toropneuptes tuberculatus*. — *Echinus tuberculatus*, Lamarck, An. s. vert., t. III, p.368, n° 29.— *Id.*, Agassiz, Cat. rais., p. 388.

8, DELAND'S TOXOPNEUSTES. *Toxopneustes delalandii*. — *Echinus delalandii*, Agassiz, Cat. rais.

Species depressed with very protruding, not very dense tubercles. Ambulacral pores forming very regular arcs.

Inhabits Australia.

9. *Toxopneustes complanatus*. Agassiz. — Agassiz. Cat. rais., n. 368,

Species flattened above with its pores in rows arced around the tubercles.

Inhabits ? (Mus. Paris).

10. DUBEN'S TOXOPNEUSTES. — *Echinus dubeni*, Agassiz, Cat, rais., p. 368.

Species with uniform tubercles, forming two principal rows in the ambulacral areas. Pores arranged in rows of five transverse pairs, arced only on the external end.

Inhabits the seas of the North. (Mus. Paris.)

11. *Toxopneustes concavus*. Agassiz. — Cat. rais., p. 388.

Species established because of a depression it has on its upper part that is perhaps only accidental. It is in addition very similar to *T. lividus*.

Inhabits the Mediterranean. (Coll. Michelin.)

40th GENUS. **TRIPNEUSTES**. *TRIPNEUSTES*— Agaasiz.

Test thin, very swollen. — Ambulacral areas nearly as wide as the interambulacrals. poriferous zones wide, composed of three vertical double rows. The two external rows are

rectilinear. That of the middle is irregular and often dotted with tubercles. There are at least ten pairs of pores for each ambulacral plate. The tubercles are small, numerous, imperforate and with a smooth neck. The peristome is circular and deeply notched. Spines small.

Nearly all the species of this genus live in tropical seas. The fossil species are from the Middle Tertiary terrains. According to Desor, the genus *Heliechinus* Girard (Proc. soc. Hist. nat. of Boston, vol. II, p. 364) corresponds to it. It is probably the same for the genus *Hipponoe*, Gray in Brit. mus. Cat.

1. SWOLLEN TRIPNEUSTES. *Tripneustes sardicus*. Agassiz. — *Cidaris sardica*, Leske apud Klein, p. 146, t. IX, f. a b. — Scilla, Corp. mar., t. XIIL, f. 1. Müller, Zool., Dan. Prodr., no 2845. — *Echinus sardicus*, Linné, Gmel., p. 3178. — *Id.*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 364, n° 9. — Encycl. méthod., pl. 141, f. 1–2. — Deslongchamps, Encycl. méthod., t. 2, p. 589. Agassiz, Prodr., p. 190. — Desmoulins, Echin., p. 284. — *Echinus inflatus*, Blainville, Dict. sc. nat., t. 37, p. 91. Inhabits the seas of India.

2. TRIPNEUSTES WITH FASCIA. *Tripneusles fasciatus*. — *Echinus fasciatus*, Lamarck, An. s. vert., t. II, p. 360, n° 6.— *Tripneustes sardicus varietas*, Agassiz.

This species is, according to Agassiz, only a simple variety of the preceding.

3. ANGULAR TRIPNEUSTES. *Tripneustes angulosus*. Agassiz. — *Cidaris angulosa*, Leske, p. 92, tab. II, f. F, (*Echinus obtusangulus*, Lamarck, An. s. vert, t. III, p. 362, n° 12. — *Tripneustes angulosus*, Agassiz, Cat. rais,, p. 363.

4. BULGING TRIPNEUSTES. *Tripneustes ventricosus.* Agassiz. — *Echinus ventricosus.* Lamarck, An. s. vert., 2^{e} édit., t, III, p. 359, n° 2. — *Echinus peronii,* Blainville. — *Tripneustes ventricosus*, Agassiz, Cat. rais., p. 363.

Species very near *Sardicus* that differs only by its more irregular rows of ambulacral pores.

Inhabits Martinique, Yucatan. (Mus. Paris.)

5. BLUISH TRIPNEUSTES. *Tripneustes subcaeruleus.* Agassiz, — *Cidaris esculenta*, var. n° 4, Leske, p. 82.— *Echinus esculentus*, var. d, Linné, Gmel, p. 3169.—*Echinus subcaeruleus*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 365. —*Id.*, Deslongchamps, Encycl. méthod., t. 2, p.591.— *Id.*, Blainv., Dict., p° 23, sc. nat., t. 37, p. 52. — *Id.*, Desmoulins, Echin., p. 228. — *Tripneustes subcaeruleus*, Agassiz, Cat. rais., p. 363.

Inhabits Zanzibar.. (Mus. Paris.)

FOSSIL SPECIES.

6. PARKINSON'S TRIPNEUSTES. *Tripneustes parkinsoni*. Agassiz. — Agassiz, Cat. rais., p. 363. — *Id.*, Desor, Syn., p. 132, tab. 18, f. 9.

Species with protruding ambulacra, swollen. Interambulacra areas form at least eight rows and the ambulacrals are reduced to four. Tubercles are in the middle of the poriferous zones.

Fossil of the Middle Tertiary terrains (Molasse) of Foz (Bouches-du-Rhône).

7. FLAT TRIPNEUSTES. *Tripneustes planus*. Agassiz. — Cat. rais., p. 60.— Desor, Syn., p. 132.

Fossil of the Molasse of Villeneuve (Coll, Michelin).

41th GENUS. **BOLETIA**. *BOLETIA*.— Desor.

— *Diplophorus*, TROSCHEL.

Test circular, sub-conical, more or less depressed, with very wide poriferous zones composed of three double rows of pores. The internal row is separated from the two others by a vertical row of small tubercles. Peristome very large with deep notches. The ambulacral pores are very multiplied.

This genus contains up to now only living species. They were previously confused with *Echinus.*

1. BOLETIA WITH A CAP. *Boletia piteolus*, Desor.— *Echinus pileolus*, Lamarck, An. s. vert., 2e édit., t. III, n. 360, ne 7. — *Id.*, Deslongchampss, Encycl. méthod., t. 2, p.589. — *Id.*, Blainville, Dict. sc. nat., p. 90.—*Id.*, Agassiz, Progr. — *Id.*, Desmoulins, Echin., p. 284. — *Id.*, Vaz., Voy. Vénus, pl. 8–9. — *Boletia pileolus*, Desor, Cat. rais., p. 362.

2. HETEROPOROUS BOLETIA. *Boletia heteropora*. — Desor, Cat. rais., p. 363.

Species near *B. piteolus* differing only in that in each pair of ambulacral pores, the external pore is always larger than the internal.

Inhabits the sea of the Indies. (Mus. Paris.)

3. SPOTTED BOLETIA. *Boletia maculata*. Desor. —Desor, Cat. rais., p. 363. — *Echinus maculatus*, Lamarck, An. s. vert., 2e édit., p. 362, n° 14. — *Id.*, Deslongchamps, p. 590. — *Echinus depressus*, Blainville, Man. act., p. — Valenciennes, Voy. Vénus, pl. 3, f. 1.

Species near *B. pileolus* but the form is less conical and with more pronounced tubercles.

Inhabits the Indian Ocean.

4. BIZONED BOLETIA. *Boletia bizonata*. Desor. — Cat. rais., p. 368.—*Echinus bisonatus*, Lamarck, *loc. cit*. — *Echinus trizonalis*, Blainville.

It is wrong to consider this species as the young age of *B. pileolus.* It differs by its less numerous miliary tubercles.

Inhabits the seas of India. (Mus. Paris.)

42nd GENUS. **STOMEHINUS**. *STOMECHINUS*.— Desor.

Test hemispherical, sub-conical, with trigeminate ambulacral pores. Peristome large, deeply notched, pentagonal, bifid corners corresponding to the interambulacral areas.

This genus is, as we see it, very near *Echinus* and differs really only by the pentagonal form of its peristome. It contains only fossil species from different stages of the Jurassic terrains. We count about thirty.

1. STOMECHINUS BIGRANULARIS. Desor. — *Echinus bigranularis*, Lamarck. — *Echinus antiquus*, Defr.— *E. serialis*, Wright.— *E. intermedius*, Agassiz, *E. arenatus*, Lamarck.

   Fossil of the Great Oolite of Ranville.

2. *Stomechinus serratus*. Desor. — *Echinus serratus*, Agassiz. — *E. cadomensis*. Agassiz ?

   Fossil of the Great Oolite (Bathonian) of Marolle, Metz.

3. *Stomechinus subconoideus*. Desor, — *Echinus perlatus*, Wright. *Id.*

4, *Stomechinus germinacus*. Philipp. From the Upper Oolite of England.

5. *Stomechinus laevis*. Agassiz, From the Bajocian of Sainte-Honorine.

43rd GENUS. **LOXECHINUS**. *LOXECHINUS.* — Desor.

Ambulacral pores arranged in nearly transverse arcs separated by parallel rows of tubercles. There are up to nine or ten pairs of pores for each arc. Peristome small, not very notched. Spines are short and subulate.

We know only one single species.

Loxechinus albus. Desor. — *Echinus albus*, Molina, Hist. du Chili, p. 175. — *Echinus porosus*, Val, Voy. Vénus, pl. 4, and pl. 3, f. 2. — *Echinus albus*, Agassiz, Cat. rais., p. 364. — *Loxechinus albus*, Desor, Syn., p. 136.

Species large, hemispherical, depressed, slightly pentagonal. Two principal rows of tubercles distinguished by their size in the interambulacral areas. Color a beautiful green when the spines still are adherent. Under these organs, the test is slightly reddish. The ambulacra form paler rays. Inhabits the coasts of Chili.

44th GENUS. **HOLOPNEUSTES**. *HOLOPNEUSTES.*— Agassiz.

Test nearly spherical with very wide poriferous zones. — The pores form two very regular double row between which is a large number of sporadic and irregularly arranged pores. Peristome narrow without deep notches.

This genus was established by Agassiz (Préface monog. Echinod., par Valentin, 1841, p. 9), who attributed to it, as the typical species *Cidaris granulata* Leske. It has this singularity that each ambulacral demi-area equals in width an entire interambulacral area. If we add the particular arrangement of the poriferous zones, we understand the usefulness of this new section.

VERY POROUS HOLOPNEUSTE. *Holopneustes porosissimus*. Agassiz — Cat. rais., p. 67.

From the seas of India ? (Coll. Michelin.)

45th PHYMECHINUS. *PHYMECHINUS.* — Desor.

Test sub-conical, more or less depressed, covered with numerous tubercles that are imperforate and with a smooth neck. — Poriferous zones wide, formed of pores not arranged in arcs by constituting two double vertical rows. We count at least five pairs of pores for each ambulacral plate. Peristome large, strongly notched.

We refer here a single fossil species from the Corallian stage that was previously confused with *Heliocidaris.*

Phymechinus mirabilis. Desor.—*Echinus mirabilis*, Agassiz, Cat. rais., p. 12. — *Heliocidaris mirabilis*, Agassiz, Cat, rais., p. 68. — *Phymechinus mirabilis*, Desor, Syn., p. 134, pl. XVII *bis*, f. 3-5.

Species slightly pentagonal with two principal rows of large and dense tubercles. Secondary tubercles are also very apparent but irregularly arranged.

Fossil of the Corallian of Clamecy (Nièvre), Saulce-aux-Bois, Wagnon (Ardennes).

46th GENUS. **HELIOCIDARIS**.. *HELIOCIDARIS*.— Desmoulins.

— *Stromopneustes*, Agassiz.

Test circular, depressed, sub-conical, flattened ventrally, with protruding tubercles that are imperforate, without crenelations. Pores arranged in more or less regular arcs on the dorsal surface but spreading out on the periphery of the peristome where they occupy all the ambulacral area. Peristome small, hardly notched.

This genus, established a long time ago by Desmoulins, seems to make a passage between Urchins and Echinometrids. Most of the species are presently living in sea of hot regions. Only one fossil is known coming from Tertiary terrains.

1. *Heliocidaris variolaris*. Desmoulins.— *Echinus Chinensis e viridi flavus*, Seba, t. III, p.11, f. 10. — *Cidaris diadema*, var. *i*, Leske, n° 6, p. 104. — *Echinus variolaris*, Lamarck, t. 37, p. 90.
Inhabits Mauritius, Southern seas, California, Vera Cruz.

2. *Heliocidaris paucituberculata*. Desmoulins. — *Echinus paucituberculatus*, Blainville. — *Heliocidaris paucituberculatu*, Desmoulins, Echin., tab. syn., p. 276. — *Id.*, Agassiz, Cat. rais., p. 371.

Species very near the preceding. Inhabits ? (Mus. Paris.)

3, *Heliocidaris chlorotica*.—Agassiz.—*Echinus chloroticus*, Val., Voy. Vénus, Zooph., pl. 7, f. 2. — *Heliocidaris chloroticus*, Agassiz, Cat. rais., p. 271.

Species whose tubercles are small and more numerous than in *variolaris*. Inhabits New Zealand. (Mus. Paris.)

4. *Heliocidaris margaritacea*. Agassiz, — *Echinus margaritaceus*, Lamarck, An. s, vert., 2e édit., t. III, p. 363, n° 16. — *Id.*, Val., Voy. Vénus, p. 1, f. 1. — *Heliocidaris margaritacea*, Agassiz, Cat, rais., p.371.
Inhabits Southern Seas. (Mus. Paris.)

5. *Heliocidaris eurythrogramma*. Desor.— *Echinus eurythrogrammus*, Val, Voy. Vénus, p. 7, f. 1. — *Heliocidaris eurythrogramma*, Desor, Cat. rais., p. 371. Inhabits the coasts of Chile.

6. *Heliocidaris omalostoma*. Desor. — *Echinus omalostomus*, Val., Voy. Venus, pi. 6, f. 2. Inhabits New Zealand, Galapagos Islands.

7. *Heliocidaris mexicana*. Agassiz. — Cat. rais., p. 372. Inhabits Mexico.

8. *Heliocidaris castelnaudii*. Hupé. — Hupé apud Casteznau, Voy. Amér. du Sud. From the coasts of Brazil.

9. *Heliocidaris variolosa*. Herklotz. — Herklotz, Foss. de Java, Echin., p. 5. t. I, f. 4. — *Id.*, Desor, Syn., p.136. Fossil of the Tertiary terrain of Java.

3rd TRIBE. **ECHIINOMETRIANS**.

Test elliptical.

The Cidarids of this small tribe really differ from all those that have concerned us up to now by their oblong form. The genus *Echinometra*, established a long time ago, is the best-known type and has already been adopted by some authors such as de Blainville, Desmoulins, etc. Agassiz sub-divided, or rather removed some species of which he made two special genera: *Acrocladia* and *Podophora*. The elongated form of the Echinoids of

this group is not, as we would first think, a movement toward the bilateral type because this elongation is not in the antero-posterior axis. Instead, a line passes by the madreporic tubercle and the anterior unpaired ambulacrum, not dividing the body in the rigorous axis of an oval.

1st Genus. **Echinometra**. *ECHINOMETRA*. — Breynius.

Test swollen, more or less depressed, form oval, oblong, covered with tubercles that are imperforate with a smooth base. Those that occupy the ambulacral areas are a little small than the others. Poriferous zones with pores arrange in arcs of at least four pairs. Peristome large, slightly notched. Buccal membrane bare. Masticatory apparatus robust with tri-keeled teeth. Spines cylindrical in form, finely striated.

The genus *Echinometra*, after having been established by Breynius in 1732, was preserved by some authors when Klein substituted it for that of *Cidaris.* Then Linné, as well as Lamarck made it *Echinus.* Gray, Agassiz and de Blainville restored the name of *Echinometra* that has since been preserved.

This genus, such as it is definitively constituted, contains only a small number of species, all living in tropical seas.

1. Cake Echinometra. *Echinometra lucunter*. Gray. — *Cidaris lucunter*, Leske apud Klein, p. 109, t. 4, f. cdef. — Seba, Mus., t. 3, tab. 10, f. 16, 18, and tab. II, f. 11. — *Echinus lucunter*, Lin., Gmel., p. 3176. — *Id.*, Lamarck. — *Id.*, Encycl. méthod., pl. 134, f. 3, 4, 7. — *Echinometra lucunter*, Gray. Blainville, Agassiz, Desmoulins, Agassiz, Cat. rais., p. 371.

Species swollen, very tubercular. Poriferous zones with four or five pairs of pores arranged in arcs. Spines very abundant and very dense.

Inhabits the Antilles, Mauritius, etc.

2. Heteroporous Echinometra. *Echinometra heteropora*. Agassiz.— Cat. rais., p. 371.

Species with ambulacral pores arranged in four or five unequal pairs. Tubercles very numerous and small.

Inhabits Zanzibar, Red Sea and sub-fossil on the edge of the Red Sea.

3. Mauge's Echinometra. *Echinometra maugei.* Blainville. — Man. Act.,

Species near *lucunter*, differing only by its shorter spines, a variety of *lucunter ?*

Inhabits Seychelles, Mauritius.

4. SHORT SPINED ECHINOMETRA. *Echinometra acufera*. BLaivizze. — Man. Act., p. 225. — *Id.*, Agassiz, Cat. rais., p. 371.

Species very large, oval, flattened, with numerous tubercles. Pores arranged in arcs of five to six pairs. Genital plates very developed. Near *E. heteropora*, it is distinguished especially by the presence of a smooth, wavy groove at the junction of the plates of the two areas.

Inhabits Martinique, Vera Cruz, Trinité, Ascension. (Mus. Paris.)

5. MATHIEU'S ECHINOMETRA.. *Echinometra mathaei*. Blainville..—Man . Act., p. 225. — Agassiz, Cat. rais., p. 372. — *Echinometra oblonga*, Blainville., *loc. cit*.

Small species less tubercular than *lucunter*. Pores also arranged in four arced pairs.

Inhabits Zanzibar, Solomon Islands, Waigiou Islands. {Mus. Paris.)

6. LOBATE ECHINOMETRA. *Echinometra lobata*. Blainville. — Blainville. Man. Act., p. 225. — *Id.*, Agassiz., Cat. rais., p. 373.

Species depressed, having its ambulacral pores arranged in arcs of six or seven pairs. Two rows of principal tubercles in the interambulacral areas.

Inhabits the Indian Ocean.

7. MICHELIN'S ECHINOMETRA. *Echinometra michelini*. Desor. — Cat. rais., p. 373.

Species near *lobata* but with much more developed tubercles, especially in the ambulacral areas. The interambulacral areas have two principal rows of tubercles. Poriferous zones with five pairs of arced pairs.

Inhabits Yucatan. (Coll. Michelin.)

8. QUOY'S ECHINOMETRA. *Echinometra quoyi*. Blainville.—Man. Act., p.225.

Inhabits Southern seas.

2nd GENUS. **ACROCLADIA.** *ACROCLADIA*.— Agassiz.

— *Echinometra* (pars), Blainville.

Form elongated, bulging, with very thick test, very large tubercles that are smooth and imperforate. Ambulacral pores arranged in arcs around the tubercles. Peristome large, slightly notched. Spines formed of large rods that are cylindrical or angular, smooth appearance although finely striated, varying in form in addition according to the region of the body. Those surrounding the peristome are much smaller and compressed.

This genus was separated from the Echinometrids by Aggasiz. Its species, not very numerous, are all living and is encountered in tropical seas.

1. ACROCLADIA WITH MAMELONS. *Acrocladia mamillata*. Agassiz. — *Echinometra id*, Rumphius, Mus., t. 13, f, 1–2. — *Cidaris mamillata*, Leske apud Klein, p. 121, t. 6, t. 39, f. 1. — Encycl. méthod., pl. 138. — *Echinus mamillatus*, Lamarck, An. s. vert., 2^{e} édit., t. III, p. 37, n° 34. — *Echinometra mamillata*, Blainville. Man. Act., p. 225. — *Id.*, Agassiz, Prodr., p. 1489. — *Heterocentrotus mamillatus*, Brandt. — *Acrocladia mamillata*, Agassiz, Cat. rais., p. 373.

Varieties: *E. violacea*, Blainville. *E. coronata minor*, Blainville. *E. depressa*, Blainville.

Species well known, whose ambulacral areas do not have large tubercles on the dorsal surface. Spines large, short, cylindrical. It varies greatly in regards to color and some varieties have been considered by de Blainville as distinct species.

Inhabits the Seychelles, Mauritius, Guam, the Philippines, Hawaii etc. The var. *minor* comes from the Solomon Islands.

2. TRIANGULAR ACROCLADIA. *Acrocladia trigonaria*. Agassiz. — *Cidaris mamillatus*, var. 4, Leske apud Kcein. — Gualtieri, t. 108, f. c. — Rumphius, t XIL, f. 1. — Seba, t. 13, f 4. — *Echinus mamillatus*, var. e, Linné, Gme;., p. 3176.— *Echinus trigonarius*, Lamarck, An. s. vert., t. III, p. 370, n° 35.— Encycl. méthod., pl. 139, f. 2. — *Echinometra trigonaria*, Blainville. Man. Act., p. 225. — *Echinometra carinata*, Blainville (young age). — *Id.*, Agassiz, Prodr., p. 189, and Cat. rais., p. 373. — Var.: *Echinometra pugionifera*, Desmoulins, tab. syn., p. 266.

Species whose tubercles are very large up to the top of the test. Spines short and flattened around the mouth and, on the contrary, long and tri-keeled on the ventral surface.

Inhabits Mauritius, Solomon Islands. (Mus. Paris.)

3. SPEAR-BEARING ACROCLADIA. *Acrocladia hastifera*. Agassiz .—Cat. rais., p. 373.

This species differs from *A. trigonaria* by the bare ambulacral areas. It has otherwise all the characters.

Inhabits the Hawaiian Islands. (Mus. Paris.)

4. DE BLAINVILLE'S ACROCLADIA. *Acrocladia Blainvillii*. Agassiz. — Cat. rais., p. 373. — *Echinometra Id.*, Desmoulins, p. 264.

Small flattened species that differs from *H. mamillata* by its ambulacral areas still more bare than in the preceding species. The spines are long, cylindrical. Test broadly flattened towards the end.

Inhabits the Red Sea. (Mus. Paris.)

Obs. The *Echinus carinatus* (*Echinometra carinata*, Blainv.) of the coast of Carolina Island as well as the *Echinus portelsii*, Brandt, coming from the Bonin Islands have been indicated under the sub-generic name of *Heterocentrotus*, Brandt (doubtful species).

3rd GENUS. **PODOPHORA.**. *PODOPHORA.* — Agassiz. — *Colobocentrotus*, Brandt.

Test oblong, thick, wide ambulacral areas, especially on the dorsal surface and covered with tubercles that are smooth, imperforate, ordinarily arranged in two rows in each ambulacral area. Those of the interambulacral area form on the contrary numerous rows. Pores arranged in arcs composed of nine, ten and even twelve pairs surrounding the tubercles of this region. Peristome large, not notched. Buccal membrane bare. Spines of two kinds. Some are in the form of polyhydric plates juxtaposed like mosaics, forming on the dorsal surface a kind of carapace. The others are in the form of pegged rods on the ventral surface.

This genus again was established by Agassiz at the expense of Echinometrids. The singular arrangements of the spines of the dorsal surface suffices to characterize it, if the number of ambulacral pores did not confirm its generic distinction.

We presently know only three species. They are in present seas and encountered in the Pacific Ocean.

1. ARTICHOKE PODOPHORA. *Podophora atrata*. Agassiz. — *Echinus atratus*, Lin., Gmel., p. 3177. — *Cidaris violacea*, Leske apud Klein, p. 117, t. 47, f. 1-2.— *Cidaris fenestrata*, Leske apud Klein, p. 117, t. 47, f. a-b.— *Echinus niger*, Rumphius, p. 31, n° 3. — *Echinus atratus*, Lamarck, An. s. vert., p. 369, no 33. — Encycl. méthod., p. 140, f. 1–4. — *Echinometra atrata*, Blainville, Man. Act,, p. 225, pl. 20, f. 1. — *Id.*, Agassiz, Prodr., p. 189.— *Id.*, Desmoulins, tab. syn., p. 262. — *Colobocentrotus leskei*, Brandt. — *Podophora atrata*, Agassiz, Cat. rais, p. 374.

Species of a beautiful violet color, with moderate tubercles. The spines of the periphery of the ventral surface are sub-cylindrical. *Echinometra quoyi*, Blainv., is only the young age.

Inhabits the Seychelles.

2. PODOPHORA WITH FEET. *Podophora pedifera*. Agassiz. — Cat. rais., p. 374. — *Echinometra pedifera*, Blainv., Man. Act., p. 225.

This species is distinguished from the preceding by the greater size of its tubercles. It has a greenish tint.

Inhabits the Antilles.

Brandt has described under the name of *Colobocentrotus mertensii*, a species that we should probably refer to this group, but we lack information.

4th TRIBE. **SALENIANS.**

Test circular, more or less depressed. Ambulacra narrow, with pores arranged in single pairs. — Interambulacral areas with a single tubercle that is large and imperforate on each coronal plate. All parts of the apical system are united into a kind of shield

composed of five genital plates, five ocular plates and one or several additional plates called *suranals.*

The tribe of Salenians was established by Agassiz for Echinoids that, either in general form or by different specific characters were very near *Cidaris* so that it seemed necessary to make them closer in the method. On the contrary, if we consider the highest characters of the tribe, i. e., the presence or additional plates or suranals, we understand very easily that it is better to place the Salenians completely separately. In such conditions, the numerous Echinians are found after Cidarians because of the similarities these two groups have with each other.

The tribe of Salenians contains only five genera that are only fossils in the Jurassic and Cretaceous formations.

1st GENUS. **SALENIA**. *SALENIA*.— Gray.

Apical system with a single suranal plate, with the result that the anus is projected forward. Flexuous ambulacra composed of small, very dense granules. Interambulacral tubercles large, crenelated but non-perforated.

The genus *Salenia* is in some way the type of this tribe. First instituted by Gray and then accepted by nearly all zoologists, Agassiz included species whose suranal plate is arranged in a way to project the anus backwards. We are going to see that the species that have this arrangement have been considered as forming a distinct genus under the name of *Hyposalenia*, Desor. We count approximately sixteen species of Salenians. They are all from Cretaceous terrains, from the Neocomian stage up to the Senonian stage.

1. SALENIA WITH PETALS. *Salenia petalifera*. Agassiz. — *Echinus petaliferus*, Desmoulins in Defr., Dict. sc. nat., t. 37, p. 101. — *Salenia petalifera,* Agassiz, Mon. Sal., p. 9, t. I, f. 17–24. — *Id.*, Desor, Syn., p. 49, pl. XX, 6, f. .1–3.

Species circular, very flattened ventrally. Ambulacral areas slightly sinuous, with two rows of principal tubercles. Interambulacral areas wide with ten rows of five large tubercles that are surrounded by miliary granules.

Fossil of the Green Limestone (Cenomanian) of Cape la Hève, etc.

2. SALENIA WITH SHIELDS. *Salenia scutigera*. Gray. — *Cidarites scutigerus*, Munster in Goldfuss, Petref., t. 49, f. 4. — *Salenia scutigera*, Gray, Proc. Zool. soc. part. III, 1835, p. 58. — *Id.*, Agassiz, Mon. Sal., p. 12, t. II, f. 1–8. — *Salenia personata*, Agassiz. — *Salenia scripta*, Agassiz. — *Salenia gibba*, Agassiz, and *Salenia geometrica*, Agassiz, Mon. des Sal., p. 11, t. 1, f. 25–32.

Fossil of the Gray Limestone (Cenomanian) of Saintes, Valette (Charente-Inférieure), Essen, etc.

3. *Salenia clathrata*. Agassiz, — *Id.*, Desor, Syn., p. 150, Id.

4. *Salenia rugosa*. d'Archia c.—Mém. Soc. géol. Fr., t. Il, p.209, tab. XIII, f. 6. — *Id.*, Desor, Syn., p. 151. From Tourtia (Cenomanian) of Tournay.

5. *Salenia trigeri*. Cotteau. — Essai Echin. de la Sarthe, 4° liv. From the Cenomanian of Mans.

6. *Salenia prestensis*. Desor. From the Aptian of Presta, Auxerre (Yonne), Rimet (Isère).

7. *Salenia triboleti*. Desor. From the Aptian stage, of Presta.

The Upper Chalk (Senonian) contains: *Salenia areolata*. Agassiz — *S. trigonata*. Afassiz. — *S. anthophora*. Müller. — *S. stellifera*. Hagen. — *S. incrustata*. Cotteau (*S. heliophora*, Sorignet). — *S. minima*. Desor (Danian). From Ciply.

The Neocomian stage has furnished: *Salenia depressa*. Alb. Gras. from Fontanil (Isère). — *Salenia foliacea*. Querci, Desor. from Billeui, Jura, Roc near Neufchâtel. — *Salenia acupicta*. Desor. from Merdasson near Neufchâtel.

2th GENUS. **HYPOSALENIA**. *HYPOSALENIA*.— Desor.

With all the characters of Salenids, this genus differs by the position of the suranal plate that makes the anus project backwards instead of forward.

All the species are fossils coming from different stages of the Cretaceous terrains.

1. *Hyposalenia stellulata*. Desor. — *Salenia stellulata*, Agassiz, Mon. Sal., p. 15, t. IL, f. 25–32. — *Id.*, Echin. Suisse, II, p. 90.—*Peltastes stellulatus*, Agassiz, Cat. rais., p. 38. — *Hyposalenia stellulata*, Desor, Syn., p. 147, t. XX, f. 6,8.

Apical disk large, marbled in appearance, sutural impressions being elongated in form of small grooves. Ambulacral tubercles very small and very dense.

Fossil of the Lower Neocomian of Chaux-de-Fonds and of Yonne.

2. *Hyposalenia punctata*. Desor. — *Salenia areolata*, Agassiz, Mon. Salén., p. 16, t. II, f. 1–8. — *Peltastes punctatus*, Desor, Cat. rais., p. 38. — *Hyposalenia punctata*, Desor, Syn., p. 147.

Fossil of the Neocomian of Ste-Croix, Fontanii (Isère), Censeau (Jura), Auxerre (Yonne).

3. *Hyposalenia courtaudina*. Desor. —Syn., p. 148.—*Pellastes courtaudina*, Cotteau, Cat. Echia., p. 4. From the Neocomian terrain of Auxerre (Yonne).

4. *Hyposalenia studeri.* Desor. — Syn., p. 148. — *Salenia studeri*, Agassiz, Cat. syst., p. 11. From Gault of Perte du Rhône.

5. *Hyposaienia lardyi*. Desor. — Syn., p. 148. From the Aptian of Presta.

6. Hyposalenia meyeri. Merian. — Desor, Syn., p. 148. From the Aptian.

7. *Hyposalenia wrighti*. Desor. — Syn., p. 148. From the Green Sandstone (Cenomanian) of Faringdon.

8. *Hyposalenia heliophora*. Desor. — *Salenia heliophora*, Desor, Cat. rais., p.148. From the Upper Limestone (Danian) of Maestricht, Ciply.

3rd Genus. **Goniophorus**. *GONIOPHORUS*.— Agassiz.

Apical disk forming a regular pentagon composed of five genital plates, five oculars and one suranal in front. Anus moved backward.

This small genus is perfectly characterized by the very regular pentagonal form of the apical disk. The known species is:

Goniophorus apiculatus. Acassiz. — Agassiz, Monogr. Salén., p. 32, t. V, f. 23–32. — *Goniophorus lunulatus*, Agassiz, *loc. cit*., t. V, f. 17–24.

Fossil of the Green Limestone (Cenomanian) of Cape la Hève, Sainte-Croix, England.

4th Genus. **Peltastes**. *PELTASTES*.— Agassiz.

Apical disk very undulose. Genital plates in the form of very elongated lobes. The oculars resemble small crescents. Suranal plates in front of the periproct.

A single species known as a fossil.

Peltastes acanthodes. Agassiz.— Monog. Salén., p. 29, t. V, f. 9–16,— *Echinus acanthodes*, Desmoulins, tab. syn., p. 302. — *Peltustes pulchellus* Agassiz, *loc. cit*., t. V, f. 1–8. — *P. marginalis*, Agassiz, *loc. cit*., t. V, f. 9–16.
Fossil of the Cenomanian of Grasse, Causols (Var).

5th Genus. **Acrosalenia.**. *ACROSALENIA*.— Agassiz.

Apical system not very protruding and not very extended. One or two suranal plates in front of the periproct. The latter pushed back. Genital plates unequal, the posteriors smaller than the anteriors. Interambulacral tubercles very large, crenelated and perforated. Peristome large, more or less notched. Spines cylindrical, smooth in appearance.

The species of this genus exist only as fossils. They are strictly from the Jurassic terrains. One only comes from the Neocomian (Lower Cretaceous terrain).

We presently know 25 species, of which 1 from the Lower Oolite (Bajocian), 13 from the Middle and Upper Oolite (Bathonian), 2 from the Callovian, 1 from the Oxfordian, 3 from the Corallian, 2 from the Kimmeridian, 2 from the Portlandian, and then 1 from the Neocomian.

Obs. The genus *Milnia* Haïme, based on an error in interpretation of characters should be rejected and united with this one. The species that serves as type is *Acrosalenia decorata* Wright.

THIRD FAMILY. ECHINOCONIDAE.

Test circular or pentagonal. Peristome central on the ventral surface. Periproct independent of the genital system, very variable in its position, never centro-dorsal. Ambulacra single, not petaloid, with pores also single. The Echinoids of this family are placed sometimes among the Clypeastroids, sometimes in the group of Cassidulids under the name of Echinoneids. By their general circular form, their single, non-petaloid ambulacra, the Echinoconids evidently approach the regular or Endocyclic Echinoids, without, however, making part of them because the regularity is not as complete here because the periproct or anus is not at the top of the test but is, on the contrary, moved towards the edge. This family contains, in addition, two very distinct types: in ECHINOCONIDAE in fact we find a masticatory apparatus. These are the Echinoconians or the Galeritians of some authors. In the other, there is the complete absence of this masticatory apparatus. These are the Echinoneans, the tribe of which the genus *Echinoneus* is the best known representative.

1st TRIBE ECHINONEANS

Ambulacral areas simple. No masticatory apparatus. This tribe contains only a single genus of the present period, Genus *Echinoneus*, but we associate there several fossil genera such as *Pyrina, Galeropygus, Desorella, Pachyclypus, Hyboclypus.*

1st *Genus.* ***Echinoneus.*** *ECHINONEUS*.— Van Phels.

Test swollen, oblong. Peristome central and oblique, located in the center of the ventral surface. Periproct pyriform-shaped, located between the peristome and the edge. Tubercles numerous, small, arranged in more or less regular rows. These tubercles are mamelonated but neither crenelated nor perforated. — No jaws and, as a consequence, no internal auricles. We know only a small number of living species coming from the seas of the Antilles. The oldest known is:

1. ECHINONEUS CYCLOSTOMUS. *Echinoneus cyclostomus*. Leske. — Leske apud Klein, t. XXXVII, f. 3-4.—Rumphius, Mus., t. 14, f. D.—Breynius, Echin., t. 2, f. 5–6, — *Echinus cyclostomus*, Lin., Gmel., p. 3183.—Encycl. méth., pl. 153, f. 19-20. — *Echinoneus cyclostomus*, Lamarck, An. s. vert., III, p. 304, no 1. — *Id.*, Blainville. — Desmoulins. — Agassiz. — *Echinoneus elegans*, Desor, Mon. Gal., p. 47, t. VI, f. 7–9.— *E. conformis*, Desor, Mon. Gal., p. 46, t. VI, f. 17–21.

   Var. *gibbosa*, Agassiz, (*Echinoneus gibbosus*) Lamarck, loc. cit., p. 305. — *Id.*, Desor, Mon. Gal., p. 46, t. 6, f. 4–6.

Inhabits the Antilles, the Philippines. It has been found as a subfossil in the limestone tufts of Guadeloupe, Cuba and Puerto Rico.

2. *Echinoneus minor*. Leske. — Leske apud Klein, t. 49, f. 8–9. — Seba, Thes., t. 10, f. 7 a b. — Van Phelsen, p. 32, n° 2. — D'Argenville, t. 97, f. B, 6 and 7. — *Echinoneus seminularis*, Lamarck, An. s. vertèb., 2e édit., p. 304, n°2, — Encycl. méth., p. 193, f. 21–22. — *Id.*, Deslongchamps. — de Blainville. — Agassiz. — Desmoulins. — *Echinoneus minor*, Desor, Mon. Gal., t. VI, p. 16, n° 2. Var. *E. cruciata* Des. (*Echinoneus cruciatus*) Agassiz, Desor, Mon. Gal., p. 46, t. VI, f. 1–3.

Inhabits La Trinité, Cuba.

3. *Echinoneus serialis*. Desor. — Mon. Gal., p. 48, t, VL, f. 10–12, n° 26.

Inhabits the Antilles. (Collection Michelin.)

4. *Echinoneus crassus*, Agassiz, Desor. — Cat. rais., p. 40. — *1d*., Gray, Cat. Brit. Mus. Sp. 4.

Inhabits Zanzibar. (Mus. Paris.)

5. *Echinoneus ventricosus*. Agasszi, Desor. — Cat. rais., p. 40. — *Id.*, Gray, Cat. Brit. Mus. Sp. 5.

Inhabits New Zealand. (Mus. Paris.)

6. *Echinoneus orbicularis*. Desor. — Cat. rais., p. 40. — *Id.*, Gray, Cat. Brit. Mus. Sp. 6.

Inhabits Cuba (subfossil). Collection D'Orbigny.

2nd Genus. **Pyrina**. *PYRINA*. — Desmoulins.

Test swollen, ovoid, sometime cylindrical. Periproct large, pyriform, located toward the posterior surface in the edge. Peristome central, oblique, pentagonal. Apical system elongated. Tubercles numerous, uniform.

This genus was established by Desmoulins who gave it more extended limits than we preserve today. In fact, several generic divisions have been made since at its expense. Agassiz separated under the name of *Globator*, the species having a circular form. D'Orbigny, for his part, has proposed to unite in a single genus *Pyrina, Globator* and *Nucleopygus*. This opinion has been corroborated by Cotteau who has not hesitated to unite at least *Globator*. The genus *Pyrina* has rather numerous species. It exists only as fossils. It occupies all the Cretaceous stages: Neocomian (3 species); Aptian (1); Albian (2); Cenomanian (5); Turonian (1); Senonian (9); Danian (2).

3re GENUS. **GALEROPYGUS**, *GALEROPYGUS.* — Cotteau.

Test circular, depressed, posterior edge truncated. — Periproct dorsal in a deep groove. — Peristome central, decagonal, deeply notched. Posterior ambulacra flexuous.

This genus contains only fossil species in Jurassic terrains.

1. *Galeropygus agariciformis*. Cotreau. — *Hyboclypus Id.*, Forbes, Mem. geol. Surv., Dec. IV, t. IV. — *1d*., Wright, Pal. Soc., pl. 21, f. 1 ag. — Cotteau, Bull. Soc. geol., juin 1856.

From the Lower Oolite (Bajocian) of England.

2. *Galeropygus discutus*. Cotteau. — *Hypoclypus Id.*, Desor, Syn., p. 193.

Fossil of the Great Oolite (Bathonian) Avoise (Sarthe).

3. *Galeropygus caudatus*. Cotteau. — *Clyboclypus Id.,* Wright, Forbes.

From the Lower Oolite (Bajocian) of England

4. *Galeropygus nodoti*. Cotteau. — Bull. Soc. géol. Fr., 1856, p. 299.

From the Oolite (Bathonian) of Selonges (Côte-d'Or).

4th GENUS. **DESORELLA**.. *DESORELLA*. — Cotteau.

Peristome central, decagonal. Periproct on the dorsal surface, very large and pyriform, not in a groove. Ambulacra disjointed but straight. Tubercles small, arranged without order.

This genus, to which Cotteau had first given the name of *Desoria*, has since been changed by the author to that of *Desorella.*

It is intermediate to *Pygaster* and *Hyboclypus*. The known species are found in the Corallian stage. These are:

1. *Desorella orbignyana*. Cotteau. — Echin. foss., p. 227, t. 33, f. 9–11. — *Id.*, Desor, Syn., p. 194, t. 26, f, 1–3.

Species of very shortened form, the transverse diameter exceeding the longitudinal. Periproct large, elliptical, very near the top, opening into a short groove. Peristome subdecagonal, transverse and eccentric forward.

Fossil of the Corallian of Druyes (Yonne).

2. *Desorella elata*. Cotteau. — Echie. foss., p. 228, t. 36, f. 13. — *Hyboclypus elatus*, Agassiz, Cat. syst., p. 94.

From the Corallian of Druyes (Yonne).

3. *Desorella drogiaca*. Cotteau. — Echin. foss., p.231, t. 34, f. 4–7. — *Id.*, Desor, Syn., p. 195.

From the Corallian of Druyes, Châtel-Censoir.

5th GENUS. **PACHYCLYPUS.** *PACHYCLYPUS*. — Desor,

Test ovoid, moderately swollen. Peristome central, subpentagonal. Periproct located near the posterior edge. Ambulacra convergent but fully disjointed.

Pachyclypus semiglobus. Desor. — *Dysaster semiglobus*, Desor, Mon. Dyct., p. 18, t. 4, f. 10–12. — *Nucleolites Id.*, Munster and Goldfuss, Petref., p. 139, t. 49, f. 6.

Fossil of the Corallian? From Moulins and Pappenhem (Bavaria).

6th GENUS. **HYPOCLYPUS.** *HYBOCLYPUS*.— Agassiz.

Test depressed, dilated. — Periproct located on the dorsal surface in a rather deep groove of the unpaired interambulacral area near the apical top. Peristome more or less eccentric. Ambulacra flexuous, disjointed with doubled pores in the vicinity of the peristome. Apical system elongated. Tubercles dense, uniform.

The position of this genus in the method has varied several times. First placed by Agassiz in the family of Clypeastroidae, it was later placed near *Dysaster* then finally classed definitively in the family of Echinoconidae.

The genus *Hyboclypus* is found only as fossils and all the species are Jurassic. The principal ones are: *H. gibberulus*, Agassiz. — *H. ovalis*, Wright. — *H. canaliculatus*, Desor. From the Bajocian. — *H. marcou*, Desor. From the Bathonian. — *H. sandalinus*, MERIAN from the Kellovian. — *H. stellatus*, Desor. from the Corallian.

2nd TRIBE. **ECHINOCONIANS**.

Test circular or pentagonal in form. Ambulacra single. A masticatory apparatus.

Separate from the interest this small group has different intermediary characters that connect it to the preceding families and tie it to those that will follow, it still offers us, in the instability of the location of its periproct, important considerations most often used to characterize the genera. In fact, the periproct is located sometimes above (super), sometimes near the edge, or marginal. In others, it is below (infer). The form and dimensions of this organ are no less variable and it reaches, in *Pygaster*, for example, a truly extraordinary range. The peristome varies also but only in regard to its form. We have

seen that it has a masticatory apparatus that, unfortunately, has been observed with certainty in two genera (*Echinoconus* and *Pygaster*). But in proceeding by analogy and especially in taking into account the traces often left on the interior molds of these Echinoids in the fossil state, the auricles that support this masticatory apparatus, we compensate for more precise knowledge.

Echinoconians also have in the arrangement of their apical system, two distinct forms. In one, in fact, it is compact, i. e., the five genital plates form together a ring with five rays around the madreporite body, while the ocular plates occupy the external corners of the genital plates. Such is the case in the genera *Pygaster, Pileus, Discoidea, Echinoconus, Nucleopyqus, Globator* and *Pyrina*. This apical system is said to be elongated when the ocular plates are located on the same plane as the genital plates and thus give the system an elongated form. As a result of this arrangement, the ambulacra do not converge toward a single point. The second type contains the genera *Hybocypus, Desorella, Pachyclypus* and *Asterostoma,* which leads us naturally toward the group Dysastéridae, which we make a distinct family.

1st Genus. **Echinoconus.** *ECHINOCONUS* — BREYN.

— *Conulus*, Klein. — *Galerites*, Lamarck, Agassiz.

Test rounded, oval or pentagonal. Top conical and central. — Peristome decagonal, located in the center of the ventral surface with auricles in the interior that would support the masticatory apparatus. Periproct round or oval, opening on the posterior edge. Ambulacra linear, flush with the test, formed of zones of pores obliquely arranged and toing toward the ventral surface, enlarging and having trigeminate pores. Genital and ocular systems forming a quadrangular ensemble.

This genus, established by Breynius in 1732, was designated by Klein under the name of *Conulus*. Then Lamarck gave it the name of *Galerites*. We must recognize that D'Orbigny reestablished the priority in resuming the term given by Breynius. Desor has since proposed to preserve the genus *Galerites*, independent of that of *Echinoconus*, in limiting it to a single species: *Galerites albogalerus* (type *veré conicus* Breynius). But it appears difficult to adopt this point of view because it appears scarcely possible to place *Galerites albogalerus* and *Galerites hemisphericus* into two different genera.

The number of species in the genus *Echinoconus* is very great. They are known only as fossils, all belong to Cretaceous terrains and limited to four stages: Aptian (1), Albian (4), Cenomanian (2) and Senonian (20).

2nd Genus. **Discoidea**. *DISCOIDEA*. — KLEN.

Test circular or subpentagonal, hermispheric or subconical. — Peristome central, decagonal. — Periproct elongated, pyriform, located on the ventral surface. Ambulacral pores in very regular single rows. Tubercles numerous, crenelated and perforated. Interior of the test with partitions.

This genus, established by Klein under the name of Discoidea, was misunderstood for a long time until Gray integrated it into the Method. It is near *Galerites* (*Echinoconus*) but differs especially by the presence of partitions in the interior of the test.

All the species are fossils. They belong exclusively to the Cretaceous terrains and are found in the Gault (Albian), 4; Cenomanian, 6; Senonian, 3.

3rd GENUS. **HOLECTYPUS.** *HOLECTYPUS*— Desor.

Test circular or subpentagonal, generally conical. — Peristome large, central, decagonal and notched. — Periproct large, pyriform, located on the ventral surface and sometimes occupying all the space between the peristome and the edge. Tubercles numerous.

This genus, previously confused with Discoidids, is distinguished by several very important characters. First, it lacks interior partitions, then the extremely large periproct gives it a very special appearance. We know it only as fossils in the Jurassic and Cretaceous terrains. The number of species is large (30). It is distributed in the stages as follows:

Lower Oolite (Bajocian), 3 ; Upper Oolite (Bathoniea), 2; Kellovian, 3; Oxfordian, 3; Corallian, 5; Neocomian, 3; Aptian, 2; Turonian, 2; Senonian, 1.

4th GENUS. **PILEUS.** *PILEUS*.— Desor.

Test swollen, circular or subpentagonal form. Peristome central, notched, with internal auricles. Periproct located on the dorsal surface. tubercles small, scattered, perforated.

This genus, very near *Pygaster* with which it was confused for a long time, is distinguished by the smalless of the periproct, the irregular arrangement of the tubercles and finally by the arrangement of its ambulacral pores that are doubled and bigeminate.

It contains until now only a single fossil species from the Corallian stage.

PILEUS HEMISPHERICUS. *Pileus hemisphericus*. Desor. — *Pygaster pileus*, Agassiz, Cat. rais., p.86.—*Id.*, Cotteau, Echin. foss., p.205, t. XXIX, f. 1–2 a, t. XXX, f. 1–3. — *Pileus hemisphaericus*, Desor, Svn., p. 167, t. XXII, f. 6.

Species of large size (approximately 15 centimeters), swollen, hemispherical, with sporadic tubercles. It has, however, two principal rows in each area that extend up to the top. Periproct small.

Fossil of the Corallian of Coulanges-sur-Yonne and Châtel-Censoir (Yonne).

5th GENUS. **ANORTHOPYGUS**. *ANORTHOPYGUS*. — COTTEAU.

Test circular, depressed. Peristome sunken, transverse, without distinct notches. Periproct irregular, supra-marginal. Tubercles small, dense. Apical system compact.

We know only two species from the Cretaceous terrains. One was previously united with the genus *Pygaster* from which it differs by its irregular periproct and its transversely elongated peristome.

1. *Anorthopygus costellatus*. Cotteau. — *Pygaster costellatus*, Agassrz, Cat. syst., p. 7. — Desor, Mon. Gal., t. XI, f. 1–4.
   Fossil of the Cenomanian of the Ile d'Aix, Fourras, etc.

2. *Anorthopygus michelini*. Cotteau. —Echin. foss. Sarthe, 1860, pl. 39 *bis*, f. 11–13. From the Cenomanian of Viilaines (Sarthe).

6th GENUS. **PYGASTER.** *PYGASTER* — Agassiz.

Test depressed or subconical, circular or slightly angular. Ventral surface concave, peristome decagonal, incised by ten notches. Periproct very large, located on the dorsal surface and sometimes occupying the entire space between the top and the edge. Tubercles perforated and crenelated, arranged in regular rows.

This genus comes from Jurassic and Cretaceous terrains. Its general form completely recalls that of regular Echinoids, like Cidaridae for example, but the position of the anus establishes a great difference between these two types.

The 12 species are distributed thus in the different stages:

Lower Oolite (Bajocian): 1. *Pygaster semisulcatus*. Wright. — From Sarthe, France, England. 2. *Pygaster conoideus*. Wrght. From England. 3. *Pygaster laganoides*. Agassiz. From Ranville. 4. *Pygaster morrisii*. Wright. From England. 5. *Pygaster umbrella*. Agassiz. — (*Galerites umbrella*, Lamarck. — *Pygaster edwardseus*, Buvic.). From Saint-Mihiel, Druyes (Yonne), Châtel-Censoir, Coulanges-sur-Yonne. 6. *Pygaster gresseyi*. Desor. From Tonnerre. 7. *Pygaster dilatateus*. Desor. — *Pygaster umbrella*. Agassiz. From Switzerland. 8. *Pygaster patelliformis*. Agassiz, Desor. From Switzerland. 9. *Pygaster tenuis*. Agassiz, Desor. From Fringeli (Soleure). 10. *Pygaster pumilus*. Desor. From Ste.-Croix. 11. *Pygaster macrocyphus*. Wright. From Kimmeridian from Boulogne. 12. *Pygaster truncatus*. Agassiz, Desor. From Cenomanian of the Ile d'Aïix; Fourras.

This species served Cotteau to establish a particular genus under the name of *Macropygus*. Some new observations have allowed this scholar to suppress this section as being useless.

7th GENUS. **NUCLEOPYGUS**. *NUCLEOPYGUS*. — Agassiz.

Test depressed, circular or oblong in form. — Peristome circular or elliptical, decagonal. — Periproct opening on the dorsal surface, not far from the edge.

This genus shares characteristics of *Pygaster, Galercpygus* \and *Pyrina.* Consequently, these genera belong to two very distinct groups because one has a masticatory apparatus while the others miss it.

We know only three fossil species of this genus, one from the Jurassic terrain, the other two from Cretaceous terrains:

G. jeannensis, Cotteau; *G. depressus*, Desor; *G. koechlini*, Desor.

8th GENUS. **ASTEROSTOMA.** *ASTEROSTOMA*.— Agassiz.

Test swollen, suboval. Peristome central, subangular. Ambulacra in pairs, subpetaloid, convergent but disjointed. Unpaired ambulacra a little different. Periproct located on the posterior edge. Ambulacral grooves on the ventral surface.

This genus, established by Agassiz, was placed by the author near the family of Cassidulidae. D'Orbigny, on the contrary, based on the arrangement of pores of the unpaired ambulacra, placed it in the family of Spatangoids. Finally, Desor took into consideration all the characters and especially the central location of the peristome. He thought it better to place them closer to the Asterostomes than the Echinoconids.

We know only a single fossil species of still uncertain deposits but D'Orbigny has thought it should be before Tertiary terrains.

Asterotoma excentricum. Agassiz. — Cat. rais., p. 110.—Desor. Syn., p. 196,
t. 37, f. 1–2 —? *Clypeaster excentricus*, Lamarck.

According to D'Orbigny, *Clypeaster excentricus* of Lamarck should be referred rather to a species of *Echinolampas*.

Fourth Family. DYSASTERIDAE.

Test ovoid, more or less cordiform. Peristome eccentric on the ventral surface. Periproct located on the dorsal surface. Ambulacra disjointed, formed of simple pores.

For a long time, the Echinoids that made part of this family were placed in groups very different from each other. This was because, in fact, they had, in their various characters clear similarities with several distinct types.

The most remarkable and most essential arrangement of this group consists in the form of its disjointed ambulacra and not united in a single point toward the top but divided into two groups, one of which is pushed backwards so that the anterior top is composed only of three ambulacra with the three corresponding ocular plates and the two other ambulacra forming a second group above the anus. Desor has correctly insisted on the reasons that should be attributed to the family of Dysasteridae the relations we preserve here. It is especially the consideration taken from the organs of respiration, i. e., the ambulacra, that he based his opinion. These ambulacra, in fact, being simple and related consequently in this regard to Cidarids. The classification of Desor receives confirmation when we recall that in some genera of the family of Echinoconians, which precedes them, there is already a slight disjunction of the ambulacra. But it is necessary to remark that it I in a manner more apparent than real, in the sense that the genital system is not involved in the disjunction while it occurs in the species that concern us now.

The family of Dysasteridae contains only 4 genera that are all fossils. Some appear in Liassic terrains. Others arrive and grow in notable manner up to the Upper Cretaceous terrains.

1st *Genus.* ***Dysaster.*** *DYSASTER.*— Agassiz.

Test elongated, more or less cylindrical, truncated posteriorly where the periproct opens. Peristome irregularly circular. Apical system compact.

The genus *Dysaster* is no longer understood today as it was when it was established by Agassiz. We have recognized, in fact, that it contains two very distinct types in regard to the structure of the apical system. In one type, the anterior portion of this system is compact while in the other it is elongated. This correction permits preservation of the genus *Dysaster*, in reserving to one of these types of which *Dysaster granulosus* is the principal representative while the name of *Collyrites* imposed by Desmoulins will be assigned to species whose apical system is elongated and that is represented by *Collyriles ellipticus*. Without this important distinction, it is not possible to preserve the name imposed by Agassiz (1836) because it is after that given by Desmoulins (1835).

1. *Dysaster granulosus*. Agassiz, — *Collyrites granulosus*, Desmoulins. Var. *D. ampia*, Cotteau, Echin. foss., p. 253, t. 40, f. 1–4.
   Fossil of the Corallian of Courson (Yonne).

2. *Dysaster anasteroides*. Leymerie (non Agassiz).— *Dysaster sugrajurensis*, D'Orbigny, Prodr., Il, p. 55. From the Kimmeridian of Bar-sur-Aube.

3. *Dysaster moeschii*. Desor. — Syn., p. 202. From the Kellovian of Hornussen.

4. *Dysaster subelongata*. Desor.— *Dysaster anasteroides*, Agassiz (non Leymerie). — *Collyrites elongata*, D'Orbigny, Pal. Fr. Echin., p. 52.

From the Lower Neocomian of Escragnolles (Var), Castellane (Basses-Alpes), Fontanil (Isère).

2nd GENUS**. COLLYRITES.** *COLLYRITES.* — Desmourins.

Test generally depressed, with a groove on the anterior part. Peristome subpentagonal. Periproct in the middle of the posterior surface. Apical system elongated, the ocular plates intercalated between the genital plates.

Most of the species of this genus figure in the works under the name of *Dysaster*. We have seen that this latter name should be restricted to species whose apical system is compact.

All the species are fossil coming from Jurassic and Cretaceous terrains.

Bajocien stage, 2; Bathonian stage, 1; Kellovian stage, 4; Oxfordian stage, 5; Corallian stage, 8; Neocomian stage, 3; Albian stage, 4; Danien stage, 1.

3rd GENUS. **METAPORHINUS**. *METAPORHINUS*.— Michelin.

This genus differs from the preceding by its raised form rounded in front, truncated in back. The anterior ambulacral top occupies the culminating point and is very eccentric. It has not been accepted by all zoologists. D'Orbigny and Cotteau have united it with *Collyrites.* Desor on the contrary has acccepted it.

The species referred to are the following:

1. *Metaporhinus michelini*. Michelin.— *Pygaster michelin*, Cotteau.—*Collyrites michelin,* d'Obigny, From the Corallian of Druyes and Châtel-Censoir (Yonne).

2. *Metaporhinus censoriensis*. Desor.— *Collyrites censoriensis*, Cotteau and *Pygaster mickelini*, Cotteau, (pars). From the Corallian of Yonne.

3. *Metaporhinus gaymardi*. Alb. Gras. — *Dysaster gaymardi*, Alb. Gras. — *Collyrites gaymardi*, D'Orbigny. From the Lower Neocomian of Fontanil (Isère).

4. *Metaporhinus munsteri*. Desor. — *Dysaster munsteri*, Agassiz. From Cretaceous terrains of Mecklembourg.

4th GENUS. **GRASIA**. *GRASIA*.— Michelin

Michelin has established under this name a genus that has a very elongated form, a central peristome and a dorsal periproct in a deep groove on the dorsal surface. The only species known is:

GRASIA ELONGATA. *Grasia elongata*. Michelin.— Revue et Mag. Zool., 1854. *Hyboclypus elongatus*, Alb. Gras. — *Collyrites elongata*, D'Orbigny.

From the Corallian of Échaillon (Isère).

FIFTH FAMILY. CLYPEASTROIDAE.

Test more or less depressed. Ambulacra petaloId. Peristome central. Masticatory apparatus very simple, composed of five triangular jaws, flattened.

It is especially by the petaloid form and ambulacra that this family is characterized. These parts often occupy a rather large extent of the test and exceed the width of the interambulacral areas. The ventral surface has important characters we can use to distinguish the genera. The median peristome is sometimes surrounded by wedge-shaped plates forming a kind of rosette (buccal rosette). Then, on the periphery of this opening, are also in some cases tubes thought to be related to their buccal gills and designated by the name buccal tubes. The periproct, or anal opening, is generally small. Its position, although variable, is however most often marginal. All the external surface of these

Echinoids is covered with extremely fine spines, nearly uniform and resembling bristles. The interior of the test is very remarkable in that instead of a single cavity, its is crossed by partitions, pillars or processes serving to support the different viscera and consolidate the test itself at the same time.

The masticatory apparatus is much simpler than in Cidarids. The jaws, in fact, are composed of only 10 pieces fused by pairs, each pair for the insertion of a tooth. These pieces are triangular in form and placed horizontally.

These jaws rest themselves on ten raised supports of the internal surface of the test and on which they pivot with the aid of a small intermediary rotula. All the apparatus is thus reduced to triangular, horizontal lamellae without any accessory pieces nor intermediaries as exists in Cidarids.

The masticatory apparatus at first glance at the organs of digestion appears to have an equally particular arrangement. The first part of this intestine that follows the mouth is directed toward the top in a hollow of the apical system. This is bent forward to make a circuit of the test by passing two times on the right side and one time only on the left side. This results in two distinct cavities. One contains the intestine. It is the intestinal cavity. The other contains the masticatory cavity and its annexes. These two cavities are in addition separated by a wall either membranous or calcareous.

The internal cavity of the test also has a disposition particular and special to this family. It consists in the presence of small, spongy lamellae that are related to the ambulacra and must function in respiration.

From the paleontological point of view, Clypeastroids have some interesting particularities. The fossil species are not found in the Secondary terrains but only in the Tertiary terrains where their number increases successively and finally to a peak in the present time.

The family Clypeastroidae has been divided into three tribes. The 1st Laganians, has a form that is very flattened, orbicular and subpentagonal with simple and straight ambulacral grooves on the ventral surface.

The 2nd tribe is that of Scutellians that contains species that are very flattened, perforated and notched on the edges with branched and anastomosed groove on the ventral surface.

The 3rd finally, Clypeastroidians , contains species in which the petals reach in some way their maximum development. The jaws, instead of being supported on the auricles, pivot on them

1st Tribe. **LAGANIANS**.

1st Genus. **Echinocyamus**.. *ECHINOCYAMUS*. — Van Phels.

— *Anaster*, Sismondi.

Test depressed, enlarged and truncated posteriorly, swollen at the edges. Ambulacra subpetaloId. Peristome central on the ventral surface. Periproct on the same side located between the peristome and the edge. In the interior are ten partitions corresponding to the interambulacral areas.

This genus contains the smallest species of all the Echinoids. It has been confused with the Fibularids that are in fact very near but differ because they do not have partitions in the interior.

The imperfectly petaloid ambulacra are sometimes so little visible that we have been able to think in some cases that they do not exist. It was in fact on an error of this nature that was

The genus *Echinocyamus* contains some living species but most are fossils, with very few exceptions, in the Tertiary terrains.

1. VERY SMALL ECHINOCYAMUS. *Echinocyamus pusillus*. Fleming. — Brit. amim., p. 481. — *Id.*, Forbes, Hist. of Brit. Starf., p. 175. — *Spatangus pusillus*, Müller, Zool. Dan., t. 91, f. 5–6. — *Echinus prinutus*, Lin. — *Echinocyamus minutus*, Blainville, — *Echinocyamus pusillus*, Agassiz, Desor.

Small species very variable in form, having its periproct located between the top and the edge. The tubercles are proportionally large and very apparent.

Inhabits the seas of the North, the coasts of England. We find fossils in the Red Crag of Suffolk (England).

2. ANGULAR ECHINOCYAMUS. *Echinocyarnus angulosus*. — Leske apud Klein, p. 215. — *Fibularia angulosa*, Lamarck, Blainville.

Inhabits the coasts of Ireland, Belfast Bay.

3. SOUTHERN ECHINOCYAMUS. *Echinocyamus australis*. Desmoulins. — Echin. Crét.; Echin., t. 9. — *Id.*, Agassiz, Cat. rais., p. 82. — Michelin in Revue et Mag. zool., 1859, n° 9, pl. 14, f. 2.

Inhabits the seas of the South.

FOSSIL SPECIES.

4. *Echinocyamus tenuistriatus*. Cotteau.—Echin. Sarthe, pl. 39 *bis*, f. 10–13. — *Glyphocyphus Id.*, Desor. From the Upper Limestone (Senonian) of Sarthe.

5. *Echinocyamus placenta.* Agassiz, Mon. Scut., p. 127. — *Fibularia placenta*, Lamarck, An. s. vert., 2^{e} édit. t. III, p. 302. Upper Chalk (Dapian), Saint-Pierre of Maëstricht,

Among the Tertiary species: Nummulitic stage: *E. alpinus*, Agassiz. Parisian stage (Coarse limestone): *E. pyriformis*, Agassiz.—*E. altavillensis*, Agassiz.— *E. inflatus,* Agassiz.— *E. subcaudatus*, Acassiz.— *E. affinis*, Desor.— *E. camypbonensis*, Cotteau. And from the Eocene of Campbon (Loire-Infér.) and Falunian: *E. ovatus*, Agass. — *E. studeri*, Agassiz. — *E. scutatus*, Desor and Pliocene: *E. suffolkiensis*, Agassiz. — *E. siculus*, Agassiz, — *E. hispidulus*, Forbes. —. *F. oviformis*. Forbes.

2nd GENUS. **FIBULARIA**. *FIBULARIA*.— Lamarck.

Test swollen, ovoid, more or less spherical. Peristome central. Periproct located on the ventral surface, nearer the peristome than the edge. Ambulacra subpetaloId. No partitions in the interior.

This genus truly differs from the preceding only by the absence of interior partitions in the test. Thus. species have been attributed arbitrarily to one or the other of these genera before knowing this major difference.

We know only a rather small number of living and fossil species. It exists only in the Upper Chalk.

1. FIBULARIA OF TARENTINA. *Fibularia tarentina*. Lamarck. — 2nd édit., t. III, p. 300, no 3. — *Id.*, Blainville, Russo, Desmoulins, Agssiz.
   Inhabits the Tarento

2. OVAL FIBULARIA. *Fibularia ovulum*. Lamarck. — *Loc. cit*. — *Id.*, Blainville.ss Desmoulins, Agassiz. From seas of the North.

Then *Fibularia trigona*, Lin. — *F. craniolaris*, Lamarck. From seas of India. — *F. lathyrus*, Lamarck. — *F. inaequalis*, Lamarck. — *F. nuclus*, Lamarck.

3. *Fibularia subglobosa*. Desor.—Cat. rais., p. 84—*Id.*, Syn., p. 221, t. 27, f. 4–5. Fossil of the Danian stage of Maestricht.

3rd *Genus.* ***Runa***. *RUNA*.— Agassiz.

Test oval, swollen. Ambulacra subpetaloId. The two kinds of areas separated by groves that form notches on the periphery. Periproct medio-marginal.

This small genus, very remarkable for the incisions on its edge, is found only as fossils. It contains two species from Tertiary terrains.

1. *Runa comptoni.* Agassiz.— Mon. Scut., p. 32, t. I, f. 11–19. — *Id.*, Desor, Syn., p. 221, tab. 27, f. 17–19.

Species regularly convex, a little longer than wide. The edges are swollen. Periproct a little nearer the edge than the peristome.

Fossil of the Upper Tertiary terrain of Palermo.

2. *Runa decemfissa* Agassiz, Desmoulins.
   Species scarcely measuring 2 mm.
   Fossil of the Tertiary terrains of Terre-Négre near Bordeaux.

4th GENUS. **MOULINSIA**. *MOULINSIA*.— Aggassiz.

Test ovoid, festooned on its periphery. Peristome central. Periproct located in the middle of the space between the mouth and the base. Tubercles proportionally large.

CASSIDULID MOULINSIA. *Moulinsia cassidulina*. Agassiz.—Desor, Syn., p. 222, i. 27, f. 14–16.

Inhabits Martinique.

5th GENUS. **LENITA**. *LENITA*.— Desor.

Test depressed, elongated. Ambulacral petals open. Periproct supra-marginal. Ventral surface marked with a zone in the center. Peristome circular. No partitions in the interior.

PATELLAR LENITA. *Lenita patellaris*. Desor. — *Echinus patellaris*, Lin. — *Cassidulus complanatus*, Lamarck. — *Cassidulus lenticulatus*, Defr.

Very small species scarcely convex above.
Fossil of the Coarse Limestone (Parisian) of Parnes, Grignon in Belgium.

6th GENUS. **SCUTELLINA**. *SCUTELLINA*.— Agassiz.

Test very flat, circular or elliptical. Ambulacral petals convergent but not closed at the end. — Partitions in the interior. Periproct marginal.

The *Scutellina* are very near *Echinocyamus* but they are distinguished by the position of the periproctl All the species are fossil in the Coarse Limestone (Parisian stage).

NUMMULAR SCUTELLINA. *Scutellina nummuluria*. Agassiz. — *Scutella Id.*, Defr. -

Species very flat, circular or elliptical. Periproct in a small notch of the posterior edge. Ventral surface undulating. Interior partitions at regular intervals.

A more elliptical variety was considered by Agassiz as forming a distinct species under the name of *S. lenticularis* Ag.

The other species are: *S. elliptica*, Agassiz (*S. obovata*, Agassiz), from Grignon. — *S. placentula*, Mérian (*S. rotunda*, Galeotti), from Chaumont, Belgium. — *S. fibularoïdes* (*Cassidulus fibularoides*, Desmoulins), from Parnes.—*S. hayesiana*, Agassiz (*S. supera*, Agassiz), from Grignon, Fourras. — *S. porpila*, Desor (*Scutella porpila*, Enc. Méth., pl. 452, f. 3-4), from Terre-Nègre near Bordeaux.

7th GENUS. **SISMONDIA**. *SISMONDIA*. — Desor.

Genus sharing many characteristics with *Echinocyamus* but that is distinguished by several characteristics. Thus, the ambulacral petals have their pores conjugated. Then the internal partitions form very complicated processes. It also has some resemblance to Laganids but it lacks the peristomal star of the latter that lacks in addition internal partitions.

The genus *Sismondia* exists only as a fossil in Tertiary terrains.

Two in the Nummulitic: *Sismondia annonii*, Desor, and *S. planulata*, Desor; and eight in the Coarse Limestone (Parisian stage). These are: *S. occitana* Desor (*Scutella occitana*, Defr.). — *S. incida*, Desor (*Echinarachinus incisus*, Agassiz). — *S. marginalis*, Desor (*Laganus reflexus*, Agassiz). — *L. tenuissimus*, Agassiz (*Scutella polygona*, Desmoulins). — *S. profunda*, Desor (*Echinocyamus profundus*, Agassiz). — *S. maxima*, Desor. — *S. costulata*, Desor.— *S. lyellii* Desor (*Scutella Id.*, Conran) from Santee (South Carolina). — *S. crustuloides* Desmoulins (*Scutella Id.*, Morton). Santee (South Carolina). — *S. gracilis*, Cotteau. Eocene, Machecoul (Loire-Inférieure).— *S. caillaudii*, Cotteau. Campbon (Loire-Inférieure).

8th GENUS. **LAGANA**. *LAGANUM*.— Klein.

Test depressed, ovoid or subpentagonal, swollen on the edges. Ambulacra lanceolate, nearly closed, formed of conjugated pores. Interambulacral areas very narrow. Peristome median, surrounded by a star with five buccal tubes. No interior partitions. Masticatory apparatus very developed. Periproct between the peristome and the edge. Five genital pores, sometimes four.

The genus *Laganum* has already been subjected to reform and some species have been removed. Those that remain are all remarkable for their swollen edge and by their more or less arced ambulacral petals. As for species whose edge is thin and the periproct more marginal, they have served to establish the genus *Rumphia*.

Most species are found living in seas of hot countries. The fossil species, in very small number, come from recent Tertiary terrains so it is, so to speak, a present form.

1. SCUTIFORM LAGANUM. *Laganum scutiforme*. Desor. — *Clypeaster scutiformis*, Lamarck, An. s. vert., t. III, p. 291, n° 4.—*Scutella clypeastreiformis*, Blainville, Dict. se, nat., t. 48, p. 228. — Encycl. méth., pl. 147, f. 3–4. — *Laganum depressum* Lesson, Voy. Uranie. — *Id.*, Agassiz, Mon. Scut., p. 110., t. 23, f.1-7. *Laganum scutiliform*. Desor. p. 29.

Species of pentagonal form, enlarged in front with slightly swollen edges. Ambulacral petals lanceolate, pointed, not completely closed, grooves of the ventral surface very distinct extending nearly to the edge.

Habitat, living in the Indian Ocean, Persian Gulf, found also as fossil in the Arabian Gulf.

2. ELLIPTICAL LAGANUM. *Laganum ellipticum.* Acassiz. — Mon. Scut., t. 23, f. 13–15. — *Laganum attenuatum*, Agassiz, Cat. syst, p 74.
Inhabits the Red Sea, Karrak Island (Persian Gulf), and as fossil in the latter locality.

3. LAGANUM FROM BONANI. *Laganum bonani*. Klein. — *Laganum minus bonani*, Klein, t. 22, f. ab. — *Echinodiscus laganum*, Leske apud Klein, t. 22, f. c. — *Echinus laganum*, Linné. — *Echinus planus*, Rumphius, t. 14, f. e. — *Echinodiscus*, Gualtieri, t. 110, f. c. — Seba, Thesaurus, t. 15, f. 25–26. — *Clypeaster laganum*, Lamarck, An. s. vert., 2^{e} éd., t. III, p. 291, n°5. — *Sculella laganum*, Blainville.. — *Lagana minor*, Gray. — *Laganum bonani*. Agassiz, Mon., t. 23, f. 8–12, t. 22, f. 25–29,
Inhabits Australia.

4. DECAGONAL LAGANUM. *Laganum decagonum*. Lesson. — *Id.*, Agassiz, Mon., t. 23, f. 16–20.
Inhabits Waigious Island. (Coll. Mus.)

5. LAGANUM FROM TONGA.. *Laganum Tonganense*. Quoy and Gaimard. — Agassiz, Mon. t. 26, f. 7–19. Inhabits Tonga. Quoy and Gaimard, (Mus. Paris.)

6. LESUEUR'S LAGANUM.. *Laganum lesueurii*. Agassiz. — Mon., t. 24, f. 3–6.
Inhabits the Southern seas, Guadeloupe.

7. *Elongated Laganum. Laganum elongatum*. Agassiz. — Mon., t. 24, f. 2.
Inhabits the Antilles?

8. ORBICULAR LAGANUM. *Laganum orbiculare*. Agassiz. Mon. Scut., p. 121, t. 22, f. 16–20. — *Echinodiscus orbiculatus*, Less, p. 208, t. 45, f. 6–7.— *Echinus orbicularis*, Lin. — Encycl. méth., p. 147, f. 1–2, 16–20. — *Laganum orbiculare* Herkz., Foss. Java, Echin., p. 4, t. II, f. 3, and *Laganum rotundum*, Herkz., *loc. cit*., t. I, f. 8.—*Laganum orbiculare*, Desor, Syn., p. 228.
Inhabits the coasts of Java and as a fossil, Tjidamar (Java).

9. STAR LAGANUM. *Laganum stellatum*. Agassiz.—Monog. Scut., p. , t.22, f. 7–10. Inhabits New South Wales.

FOSSIL SPECIES.

10. *Laganum tenuatum*. Herklotz. Fossiles de Java, Echin., p. 9, t. I f. 7. — *Id.*, Desor, Syn., p. 228. From the Tertiary terrains of Java.

11. *Laganum angulosum.* HerkL., Foss. Java, Echin., p. 8, t. 2, f. 4. — *1d*., Desor, Syn., p. 228. From the recent Tertiary terrain of Tjidamar (Java).

9th GENUS. **MICHELINIA**. *MICHELINIA*.— Nobis.

Test of rounded form, subdecagonal, depressed, with slightly swollen and undulating edges. Dorsal part swollen. Ventral part flat, marked with scarcely indicated ambulacral grooves. Top subcentral. Ambulacrals petaloid, elongated, not very open, formed of nearly parallel poriferous zones composed of two rows of double pores united by small grooves. Plates of the two surfaces very distinct, forming kinds of irregular stars, overlapping and increasing in size toward the periphery. Periproct inframarginal.

This genus was established by Michelin (*Revue et Mag. zool*., 1859, n° 9) under the name of *Polyaster*. But as this term had already been used by Gray to designate a genus of Asteroid, we have believed it necessary to change it and we have made a duty a pleasure to dedicate it to one of the most distinguished Echinophiles. It appears necessary to place it after *Laganes* in the tribe of Laganians. It contains only one species whose origin is unfortunately unknown.

Michelinia elegans. Nobis.—*Polyaster elegans*, Michelin, *loc. cit*., pl. 14, f. 1.

10th GENUS. **RUMPHIA**.. *RUMPHIA*.— Desor.

Desor has established under this name a genus that differs from *Laganum* by the position of its periproct that is very near the posterior edge. The ambulacral petals are also not very pointed. There are no partitions in the interior. Finally, only five peristomal auricles. Five genital pores.

This genus is especially from the present period. Some species are also found as fossils in the most recent terrains.

The typical species is *Rumphia rostrata* (*Laganum rostratum*, Agassiz). We refer to it with doubt *Rumphia peroni*, Desor (*Laganum peronii*, Agassiz), both from New Zealand.

Rumphia decagona. Desor. — *Scutella id*,, Herklotz, Foss. from Java, Echin,. p. 9, t. , f. 6.
Small species as wide as long with decagonal periphery.
Fossil from the recent Tertiary terrain of Java.

11th GENUS. **ARACHNOIDES**. *ARACHNOIDES*.— KLEIN.

Test very flattened. Petals widely open. Periproct supramarginal. Ventral surface with five straight ambulacral grooves, not branched. Four genital pores.

This genus contains only one living species.

FLAT ARACHNOIDES. *Arachnoides placenta*. Agassiz. — *Arachnoides*, Klein apud Leske, p. 26, t. 20, f. ab. — *Scutella placenta*, Lamarck. — Encycl. méthod., pl. 143, f. 11–12. — *Echinodiscus placenta*, Blainville.

Species very flattened, have ambulacra of triangular form, elongated, constricted toward the middle but widening considerably afterwards. Poriferous zones are regular up to have their length. Then, afterwards, the pores are isolated pairs to the circumference of the test. All the surface is covered with extremely fine bristles.

Inhabits the seas of the North.

2nd TRIBE. **SCUTELLIANS**.

Contains the genera whose test is circular, often notched or perforated. The ventral surface has anastomosed and branched grooves.

This tribe is essentially from the present period. The few fossil species do not go back beyond the Middle Tertiary. It contains the genera:

1. *Echinarachnius,* Van Phels.
2. *Mortonia,* Desor
3. *Scutella*, Lamarck
4. *Dendraster,* Agassiz
5. *Mortonia*, Desor
6. *Amphiope*, Agassiz
7, *Lobophora*, Agassiz
8. *Mellita*, Agassiz
9. *Encope*, Agassiz
10. *Rotula*, Agassiz
11.*Echinodiscus,* Breynius

1st GENUS. **ECHINARACHNIUS**. *ECHINARACHNIUS*.— Van Phels.

Test discoidal, depressed — Petals widely open. Peristome very small, median flush with the test. Periproct marginal or infra-marginal. Four genital pores. Ambulacral grooves on the ventral surface anastomosed only one time toward the edge.

This genus is found living in the seas of the American continent.

The fossil species are from Tertiary terrains.

1. *Echinarachnius parma*. Gray. — *Scutella parma*, Lamarck. — *Echinodiscus parma*, Blainville, Man. Act., p. 199.—*Echincarachnius parma,* Gray, Echin., p. 6 — *1d*., Agassiz, p. 188.— *Id.*, Mon. Scut., pl. 20, f. 7–18.

Species subcircular, more or less rostrate in back, regularly sloping toward the edges. Ambulacral petals open and slightly flared at their end that does not pass half-way. The pores of the zone extend as isolated pairs to the periphery of the test. The ventral surface has ambulacral grooves. Each groove has two principal branches near the periphery, the other small branches are scarcely visible. All the surface is finely granular. Those of the ventral surface are a little lager. Very short and very dense bristles. Inhabits Canada.

2. *Echinarachnius rumphii*. Agassiz. — *Echinodiscus rumphii*, Blainville. Man. Act., p. 189. — *Echinarachnius rumphii,* Agassiz, Prodr., p.188.— Id., Mon. Scut., p. 91, pl. 20, f. 1–6. — *1d*., Cat. rais., p. 75. — *1d*., Michelin, Revue and Mag. Zool., 1859, no 9.

Species whose posterior edge is truncated and not rostrate as in the preceding species. Its ambulacra are also more arced. The ambulacral grooves of the ventral surface are all marked and riddled with a multitude of small pores. Inhabits Amboine.

3. *Echinarachnius atlanticus*. Gray.— Gray, Echin, Brit, Mus.—*Id.*, Agassiz, Mon. Scut., p. 92, pl. 21, f. 32–34.—*Id.*, Cat. rais., p.75.—*1d*., Michel, Revue et Mag. Zool., 1859, no 9.

Species nearly circular but, however, a little wider than long, slightly sinuose in back. Ambulacral petals close together toward their end although open. Peristome central, circular, surrounded by a rosette composed of ten wedge-shaped plates. Periproct entirely marginala, located in a notch on the posterior edge. Ambulacral grooves not very marked. Apical rosette with four genital pores and five oculars not very visible. Inhabits Newfoundland.

4. *Echinarachnius australiae*. Michelin, — Michelin, Revue et Mag. de Zool., 1859, n° 9, pl. 13, f. 2. Inhabits Australia.

5. *Echinarachnius asiaticus*. Michelin. — Revue et Mag. Zool.; 1859, n° 9, pl. 15, f. 3. Inhabits Kamtschatka.

6. *Echinarachnius undulatus*. Michelin. — Revue et Mag. Zool., 4859, no 9, pl. 13, f. 1. Inhabits ?

7. *Echinarachnius juliensis*. Desor. — Desor, Bull. Soc, géol. Fr., 2^{e} série, t. IV, p. 287. — *Id.*, Synopsis, p. 231.

Species of the same form as *parma* only the periproct is infra-marginal instead of being marginal as in this latter species.

Fossil of the Tertiary terrains of Port St-Julien (Patagonia).

2nd GENUS. **MORTONIA**. *MORTONIA*.— Desor.

Test circular with swollen edges. Petals elongated, open. Groove of the ventral surface anastomosed two times. Periproct located between the peristome and the edge. Five genial pores.

This genus, intermediary between *Echinarachnius* and *Scutella*, contains only a single species.

Mortonia rogersi. Desor. — *Scutella rogersi*, Morton, Syn. — *Lagana rogersi*, Agassiz. From the Tertiary terrains of Monroe (Alabama).

3rd GENUS. **SCUTELLA**. *SCUTELLA*.— Lamarck.

Test flattened, nearly circular, a little wider than long, subrostrate posteriorly. Petals wide, rounded, closed. Peristome circular, surrounded by a rosette of ten wedge-shaped plates and five buccal tubes. Periproct infra-marginal. Grooves of the ventral surface anastomose several times. Four genital pores.

Since its establishment, the genus *Scutella* has received many modifications. Agassiz has removed successively first all the species lacking notches and lunules that he has made the genera *Rotula, Runa, Mellita, Lobophora, Amphiope;* then, those whose anus is marginal, such as the genera *Echinarachnius, Arachnoides*; finally, some forms nearer Clypraster, such as *Laganum, Echinocyamus, Moulinia*, etc. As a result, we no longer understand in the genus *Scutella* species with entire edges, convergent and even closed ambulacra and with a infra-marginal periproct.

All the species are fossils in the Tertiary terrains.

1. *Scutella caillaudii*. Cotteau. — 1861, Echin. Sarthe, p.67. From the Eocene (Parisian stage) of Machecoul (Loire-Inférieure).

2. *Scutella subrotunda*. Lamarck.—*Echinus subrotundus*, Lin. Gmel., p. 3191 (non Leske). From the Miocene (Falunian) of Bordeaux, Podolie.

3. *Scutella siriatulata*. Marcel de Serrers, Agassiz. — *Scutella subrotunda*, Gratel. From the Miocene (Falunian) of Terre-Nègre, Bordeaux, Malta, etc.

4. Scutella subtetragona. Gras. Ours. foss., p. 37, f. 1, p. 4.— *Id.*, Acassiz, Mon. Scut., t. XIX, f. 7. From the Miocene of the yellow Faluns of Dax.

5. *Scutella producta*. Agassiz. — Mon. Scut., p. 82, t. 18, f. 6–10. From the Miocene (Falunian) of the vicinity of Saumur, Doué.

6. *Scutella faujasii*. Defr. — *Scutella truncata*, Brug. — *Scutella stellata*, Agassiz.— *S. gibberula*, de Serres.— *S. brongniarti*, Agassiz.— *S. Smithiana*, Agassiz. — *S. propinqua*, Agassiz.

Species very variable in form that is distinguished by the truncation of its posterior edge.

7. *Scutella paulensis*. Agassiz. — Mon. Scut., p. 83, n° 8, t. 19, f. 8–10. From the Miocene (Falunian) of Saint-Paul-Trois-Châteaux near Dax.

8. *Scutelia germinaeus*. Beyrich. From the Miocene (Falunian) of Germany.

9. *Scutella patagonensis*. Desor. From the Tert. terr. of Port-St-Désiré (Patagonia).

10. *Scutella michelini*. Duchassing. From the recent Tert. terr. of Guadeloupe.

4th GENUS. **DENDRASTER.** *DENDRASTER*. — Agassiz.

Test discoidal, very flattened. Ambulacral top eccentric. Petals unequal. Grooves of the ventral surface very branched, extending less on the dorsal surface. four genital pores.

Dendraster excentricus. Agassiz. — *Echinarachnius excentricus*, Val, Voy. Vénus, pl. 10. Inhabits the coasts of California.

5th GENUS. **MONOPHORA**. *MONOPHORA*. — Agassiz.

Test flattened, with a lunule in the posterior interambulacral pair.

Monophora darwinii. Desor. — Bull. Soc. géol. Fr., 2e série, vol. IV, p. 287, et Synopsis, p. 234. From the Tertiary terrain of Patagonia.

6th GENUS. **LOBOPHORA**. *LOBOPHORA*.— Agassiz.

Test flattened with two elongated notches or lunules located in the prolongation of the posterior ambulacra. Grooves of the ventral surface not vey branched. Periproct ventral rather far from the edge.

This genus contains only living species. They belong to two distinct types. In one, the lunules are closed. E.g.: *Lebophora bifora*; in the other, there are only notches, E.g., *Lobophora bifissa*.

1. *Lobophora bifora*. Agassiz. — *Scutella bifora*, Lamarck (pars).

Test flattened, irregularly circular, rounded anteriorly. The posterior side, wider and truncated, has a slight notch in the extension of the periproct. Lunules very oblique, narrowed in the middle. Ambulacral petals unequal, the posteriors sensibly longer than the anteriors that are truncated at their end. Periproct very small, circular, located at the end of a notch of the posterior side. Color an olive brown.

Inhabits the coasts of Cafrerie.

2. *Lobophora truncata*. Agassiz. — *Scutella bifora*, Lamarck, var, (2). — Encycl. méthod., p. 147, f. 7–8.

Species distinguished from the preceding by the form of its lunules that are wider and shorter. The petals are not truncated and the poriferous zones are less wide. Inhabits the seas of India. (Coll. du Mus.)

3. *Lobophora bifissa*. Agassiz. — *Scutella bifissa*, Lamarck. — Encycl. méth., pl. 152, f. 1–2. — *Echinus inauritus*, Lin. Gmel., p. 3190.

Large species flattened, rounded anteriorly that is narrower. The posterior side, truncated and auriculate, has two notches located in the extension of the ambulacral areas. Small ambulacral rosette, with posterior petals shorter than the others. Ventral surface uniform with grooves that are not very pronounced. Inhabits the Red Sea.

4. *Lobophora aurita*. Agassiz. — *Echinoglycus auritus*, Van Phels., p. 34. — *Scutlella bifissa,* Lamarck, var. (2). — Encycl. méth., p. 151, f. 5–6.

Very near the preceding. This species differs in the form of its notches that, instead of widening, tend on the contrary to narrow. They are also shorter. Periproct nearer the edge. From the Red Sea.

7th GENUS. **AMPHIOPE.** *AMPHIOPE*.— Agassiz.

Differs from *Lobophora* only by its circular lunules.

The species that we report are fossils found in the Middle Tertiary terrains (Miocene).

1. *Amphiope bioculata*. Acassiz. — *Scutella bioculata*, Desmoulins. From the Falunia stage of Touraine.

2. *Amphiope elliptica*. Desor. From the Falunian of St-Restitut (Drôme), St-Paul-Trois-Châteaux.

3. *Amphiope perpicillata*. Agassiz.— *Scutella bifora*, Lamarck, var. B.— Encycl. méth., pl. 147, f. 5–6. From the Falunian of Rennes, Bollène (Vaucluse.)

4. *Amphiope bisperforata*. Desor. — Cat. rais., p. 78. — *Echinodiscus bisperforatus*, Parkinson, Org. Rem., III, p. , f. 6. From the Tertiary terrain in the vicinity of Vérone.

8th GENUS. **MELLITA**. *MELLITA*.— Klein.

Test very flattened, truncated posteriorly, pierced with six narrow holes, always closed. Ambulacral petals complete, very limited. Periproct near the peristome, which is central Four genital pores. Grooves of the ventral surface very branched. Interior with pillars separating the buccal cavity from the intestinal cavity.

This genus was established by Klein in 1734. This author included some species that have been removed and that form now the genus *Lobophora.*

Mellitas are all of the present period and appear limited to the American continent.

1. MELLITA WITH FIVE HOLES. *Mellita quinquefora*. Agassiz. — *Mellita*, Klein, pl. 11, f. c.—*Echinodiscus quinquies perforatus*, Leske apud Klein, p. 197, tab. 21, f. c-d. — Seba, Mus. II, t. 15, f. 9–10. — *Echinus pentaporus*, Lin., Gmel., p. 3189.—*Scutella quinquefora*, Lamarck, An. s. vert., t. III, p. 280, n° 5. — *Mellita quinquefora*, Agassiz, Mon. Scut., p.36, pl. 3.

Species subcircular in form, a little wider posteriorly and more or less widened posteriorly and more or less rounded and truncated anteriorly. There are five lunules, one in the extension of each ambulacrum and one in the unpaired interambulacral area. It is the largest. Ambulacral petals with, extending beyond mid-way. The two posterior pairs of petals are usually a little larger than the others and more or less truncated at their end. Ambulacral grooves irregularly branched. Peristome subcentral, a little nearer the anterior edge. Periproct ovoid, very near the mouth. Apical rosette small with a spongy structure. Four genital pores. All the dorsal surface is covered with a homogeneous granulation. The edges of the lunules have larger granules. Color rather intense green.

Inhabits the Antilles, Puerto Rico, Vera Cruz.

2. TESTUDINATE MELLITA. *Mellita testudinata*. Klein. — *Mellita testudinea*, Klein, Leske, t. 25, f. cd. — *Id.*, Agassiz, Mon. Scut., t. 40, f. 7–9. — *Scutella quinquefora*, Lamarck, var. — Encycl. méth., t. 149, f. 3–4.– *Scutella pentapora*, Blainville.

This species differs from the preceding in that its greatest transverse diameter corresponds to the anterior region.

Inhabits the Antilles, Texas, Vera Cruz; found in the subfossil state (Post-Pliocène) in South Carolina.

3. MELLITA WITH SIX HOLES. *Mellita hexapora*. Agassiz. — *Echinus hexaporus*, Lin., Gmel., p. 3189.—*Echinodiscus sexies perforatus*, Klein, p. 199, t. 50, f. 3–4. — *Echinonanthus*, Seba, Mus., II, t. 15, f. 7–8. — *Scutella sexforis*, Lamarck, An. s. vert., 2^{e} édit., t, I, p. 279, no 4. — Encycl. méthod., tab. 149, f. 1–2. — *Scutella hexapora*, Blainville. — *Mellita hexapora*, Agassiz, Mon. Scut., p. 41, pl. IV, f. 4-7, 11–12.

Species nearly as long as wide. Posterior side truncated or subtruncated. The anterior is, on the contrary, slightly rostrate. Lunules or vacuoles number six, very elongated, narrow. Those of the unpaired interambulacral area being less developed. Ambulacral petals do not reach half the distance between the top and the edge. All the surface is covered with bristles, clavellate on the dorsal surface and cylindrical on the opposite surface. Color an olive green.

Inhabits the Antilles, Puerto Rico, Mexico; found in the subfossil state in the Post Pliocene of South Carolina.

4. LOBATE MELLITA. *Mellita lobata*, Agassiz. — Agassiz, Mon. Scut., tab. 4a, f. 13, and tab. 16, f. 4–7.

Species near *M. hexapora* but with wider lunules and open posterior ambulacra. Five ocular pores as large as the genital pores that are four in number. Finally, the grooves of the ventral surface are very fine and not very marked. Inhabits the Antilles ? (Mus. Paris.)

5. SIMILAR MELLITA. *Mellita similis*. Agassiz. — *Mellita hexapora* (pars), Agassiz, Desor, Cat, rais.—*Mellita similis*, Agassiz, Mon. Scut., p .4 3, pl. IV, f. 1–3.

Species subcircular in form, a little longer than wide. Posterior side more or less truncate, the anterior slightly rostrate. The culminating end located in front of the top. Grooves of the ventral surface very pronounced. Inhabits Puerto Rico. (Collection Michelin.)

6. MELLITA WITH A LONG FISSURE. *Mellita longifissa*. Michelin. — Revue et Mag. Zool., 1858, n° 8, pl. 8, f.1. Inhabits ? (Collection Michelin.)

7. LARGE MELLITA. *Mellita ampla*. Holmes. — Michelin, Revue and Mag. Zool., 1858, n° 8, pl. 9. Subfossil of the Post Pliocene of South Carolina.

8. *Mellita nummularia*. Vas. in Agassiz, Cat, rais., p. 81. — Michelin, *loc. cit*., pl. 8, f. 2. (Coll. Mus.)

9th GENUS. **ENCOPE** *ENCOPE*. — Agassiz.

— *Echinoglycus*, Leske.

Lunules and notches enlarged, often open. — Five genital plates instead of four.

This genus differs very little from Mellitids. To the previously cited characters, it is necessary to add the particular disposition of the internal partitions such as the separation into two cavities does not take place only by simple pillars but by a continuous wall. The intestinal cavity is, in addition, separated into two levels by a horizontal wall.

This genus is entirely of the present periods. All the species are living on the coasts of the American continent. Some authors had adopted the name given by Leske (*Echinoglycus*).

1. EMARGINATE ENCOPE. *Encopa emarginata*. Agassiz. — *Echinodiscus emarginatus*, Leske, pl. 50, f. 5–6.— *Echinoglycus frondosus*, Van Phels, 34. — *Scutella emarginata*, Lamarck, An. s. vert., 2e édit., t. III, p. 279, n°3. — *Id.*, Blainville. — Agassiz. — Desmoulins. — Encycl. méth., pl. 150, f. 1–2. — *Encope emarginata*, Agassiz, Mon. Scut., pl. 10.

Species with subcircular test more or less truncated in front and in back, pierced by six lunules, five in the ambulacral areas and the sixth in the posterior interambulacral are,

this being much farther from the edge than the others that are sometimes incompletely closed. Posterior ambulacral petals are longer and narrower than the anteriors that are short, wide and very rounded. Apical rosette in the form of a star whose rays intercalate in the interambulacral areas where they end in five genital pores. Peristome pushed a little forward, with five branchial tubes in its periphery. Periproct protruding, subconical, located near the middle of the space between the internal edge of the posterior lunule and the peristome. Inhabits the Philippines.

2. ENCOPE WITH MICROPORES. *Encope micropora*. Agassiz. — Mon. Scut., t. 10 a, f. 4–8, and t. 19 a, f. 7.

Species very near the preceding and that differs only in the smallness of the posterior lunule, the width of the ambulacral petals and finally some other characters. Gray placed some others there with the title of variety. Inhabits the Antilles?

3. ENCOPE WITH FOUR HOLES. *Encope tetrapora*. Agassiz.—*Echinodiscus quaterperforatus*, Leske apud Klein, p. 204.—*Echinus tetraporus*, Lin, Gmel., p. 3190. — *Scutella quadripora*, Lamarck. A n. s. vert., 2^{e} édit., t. III, p. 280, n° 6. — Encycl. méth., pl. 148, f. 1–2.—*Scutella tetrapora*, Blainville. Man. Act., p. 219. — *Id.*, Agassiz, Prodr., p. 188. — *Encope tetrapora*, Agassiz.

Species with a nearly circular form but, however, a little wider than long. The periphery is slightly notched in the extension of the ambulacra. The lunules of the posterior ambulacra are open, those of the anterior ambulacra are small, ovoid and completely closed. Circular peristome central. Periproct small, nearer the edge than the peristome. Ambulacral petals wide. The bristles that cover all the body are very abundant and vary in form according to the location they occupy. Those of the dorsal surface are club-shaped while those of the opposite surface are cylindrical and much longer. Examined with a great magnification, all these bristles have longitudinal folds and are finely serrated. Inhabits the Galapagos.

4. PERSPECTIVE ENCOPE. *Encope perspectiva*. Acassiz. — Mon. Scut., t. 10, f. 1–5.

Species resembling *E. micropora* but with the unpaired lunule very large, enlarged and ovoid. The petals are narrower, more flexuous in the sense that the lunule disrupts the regularity a little. The anterior petals are also shorter and more rounded than the posteriors. The grooves of the ventral surface are very branched. The tubercles are more developed on the periphery of the test as well as in the interambulacral areas. The peristome is curved or slightly pentagonal. It is surrounded by branchial tubes. Inhabits the Antilles. (Mus. Paris.)

5. CYCLOPORE ENCOPE. *Encope cyclopora*. Agassiz.— Mon. Seut., t. 10 b, f. 6–9.

Species wider than long, with a high top. Posterior edge wider and notched in the axis of the lunule of the unpaired interambulacral area. The lunules of the posterior ambulacra are open. Petals straight, regular, uniform, anteriors smaller. Madrepore body very developed. Ventral surface has extremely variable ambulacral grooves. Moderate

peristome. Periproct pyriform, located on the internal edge of the posterior lunule. Inhabits the Antilles? (Collection Michelin.)

6. OBLONG ENCOPE. *Encope oblonga*. Agassiz.— Mon. Scut., p. 53, n° 6, pl.9.

Species more elongated than all its congeners, forming a regular oval if the posterior side were not a little truncated. Lunules very large. Petals with poriferous zones with small tubercles between the tranverse grooves. Internal pores of these zones are round, sometimes the externals are elongated. Periproct very near the peristome. Inhabits the Antilles? (Mus. of Geneva.)

7. VALENCIENNES' ENCOPE. *Encope valenciennesii.* Agassiz. — Mon, Scut., p. 54, t.7 and 8.

Species very large, remarkable for the regular development of all its parts. Notches very large, not closed, forming incomplete lunules whose elongated posterior is swollen on the edges. Anterior petals wider than the posteriors that are in some way pushed back laterally because of the great development of the posterior lunule. Grooves of the ventral surface branched in all directions and with pores toward the branches. Cylindrical bristles swollen in a kind or ring above the articular facet. Inhabits Martinique. (Mus. Paris.)

8. HALF-CLOSED ENCOPE. *Encope subclausa*. Agassiz. — Mon. Scut., pl. 5.

Species near *E. valenciennesii* but having closed posterior notches and a narrower unpaired interambulacral area. The edges of the test are thinner, sharper. The grooves of the ventral surface shallower, narrower. The secondary branches are less apparent. Inhabits the coasts of Brazil. (Mus. Geneva.)

9. LARGE ENCOPE. *Encope grandis*. Agassiz. — Agassiz, Mon, Scut., p.97, t. 6.

Species also near *E. valenciennesii* but the edges are much thicker. Posterior petal wider than the others. Notches of the periphery deeper and widely open, the posteriors larger. Lunules of the unpaired interambulacral area wide, oval and with protruding edges in the form of a crest. Inhabits the Antilles. (Collection Michelin.)

10. MICHELIN'S ENCOPE. *Encope michelini*. Agassiz. — Mon. Scut., t. 6, f. 9–10.

Species longer than wide, with thick edges, very raised, its highest point very posterior so that its posterior side is very steep. The edge of the same side is truncated and slightly notched. Notches of the ambulacral areas very open. The posteriors are deeper. They all have a tendency to close. The lunule of the unpaired interambulacral area is small, its edges slightly swollen. Apical rosette forming a regular pentagon. Groove of the ventral surface not very deep, very branched. Inhabits the Antilles? (Collection Michelin.)

11. STOKES' ENCOPE. — *Encope stokesi*. Agassi—Mon. Scut., t, 6, f. 1–8.

Species intermediary between the Mellitids and the Encopids. The interior of the test does not have partitions but only calcareous pillars. It also has the exterior appearance of a Mellitid by its green color. We know a variety with a lilac color. Inhabits the Galapagos. (Mus. Paris.)

12. AGASSIZ' ENCOPE. *Encope agassizii*. — Michelin, Revue et Mag. Zool., 1851, no 2, pl. 2, f. 1.

Species with a thick test, rounded edges. The posterior notches are large and open, the anterior is oval and nearly closed. The lunule of the unpaired area is very elongated. Periproct rather near the peristome. Habitat?

10th GENUS. **ECHINODISCUS**. *ECHINODISCUS*. — BREYNIUS.

— *Scutella*, Lamarck, 1732 (pars).

Test flattened, circular, with posterior edges deeply digitate by notches that correspond to the sutures of the plates. The anterior edge is undulating but without lunules. Ambulacral petals lanceolate, open at their end, formed of narrow zones. Peristome central. Periproct located nearly half distance from the edge. Grooves of the ventral surface anastomosed two times. No interior partitions. The edges corresponding to the digitations are only cellular.

This genus was confused by Lamarck with the Scutellids. It was Agassiz, in re-establishing it, who gave it the name of *Rotula* under which Klein had designated it, and to which he referred two species belonging to two distinct types, in the sense that one had no lunule in the anterior part (*Echinodiscus breynius*) while the other had one (*Rotula klein*). Desor proposed to preserve the two genera.

The species are from the present period.

Rhumpius' Echinodiscus. *Echinodiscus rumphii*. Breynius.— *Rotula rumphii*, Klein, t. 22, f. ef. — *Echinodiscus, Breynius*, t. 7, f. 3–4.— *Echinus solaris*, Rhumpius, p. 37, pl. 14, f. 1. — *Echinodiscus dentatus*, Klein, t. 22, f. 6–7. — Encycl. méth., pl. 151, f. 1–4. — *Scutella dentata*, Lamarck, An. s. vert., t. III, p.277. — *Scutella dentata* and *radiata*, Blainville, —*Rotula rumphii*, Agassiz, Mon. Scut., t, 1.

Species with short digitations.

Inhabits the Philippines.

Desor had accepted a second species:

Echinodiscus digitatus, Desor, whose digitations are much deeper. Finally, he indicated a third making part of the collection Michelin.

11th GENUS. **ROTULA**. *ROTULA*.— Klein.

Test flat, circular, digitated in back, pierce with lunules in front. Periproct nearer the peristome than the posterior edge. A single living species:

AUGUST'S ROTULA. *Rotula augusti*. Klein. — *Echinus decadactylos*, Lin., Gmel., p. 3191.— *Echinodiscus decies digitatus*, Leske apud Klein, p. 209, t, 22, f. ab. — Copied from Encycl. méth., pl. 150, f. 5–6. — *Scutella digitata*, Lamarck, An. s. vert., 2e édit., t. III, p. 278, n° 2.—*Rotula augusti*, Agassiz, Mon. Scut., t. 2, f. 1 and 10, tab. 4, f. 1–6.

Species with deep and numerous posterior digitations, with two lunules on the anterior side. Inhabits the west coast of Africa.

3rd TRIBE **CLYPEASTREANS**.

Petals very developed. — Peristome sunken in an infundibular cavity. Grooves of the ventral surface straight and not branched. Jaws robust, pivoting on two articular pieces instead of supporting only.

This tribe contains only one large genus, *Clypeaster*,

1st GENUS. **CLYPEASTER**. *CLYPEASTER*.— Lamarck,

Test thick, more or less elevated, elliptical or pentagonal in form. Petals very developed, with very wide proliferous zones. Peristome located in the middle of a depression on the ventral surface. Periproct small, infra-marginal. Internal cavity, cavernous on the edges, with partitions and very variable calcareous processes. Jaws robust. Teeth placed vertically at the end of dental pieces and not enclosed is a groove. Five genital pores.

The genus *Clypeaster* is one of the most wide-spread and most known types, especially by the genus *Clypeaster rosaceus* Lamarck, which has its place in the middle between very depressed species, like *Clypeaster placunarius*, and hose on the contrary, whose to is very high like *Clypeaster altus*.

Clypeasters are found living and as fossils. The latter already appear in the Nummulitic terrains, but in very small number, while they become extremely abundant in the Middle Tertiary terrains (Miocene). Finally, some species go up to the very recent layers so that it is possible they are even found in present seas.

1. CLYPEASTER ROSACEUS. *Clypeaster rosaceus*. Lamarck. — *Echinus rosaceus*, Lin., Gmel., p. 3486. — *Clypeaster rosaceus*, Lamarck. — Encycl. méth., p. 145; f. 7–8. — *Clypeaster incurvatus*, Desmoulins, Tab. syn., p. 212.

Species oval, narrower in front, with thick, rounded edges. Petals very marked. It is the most common and the most wide-spread of the living species. It often has anomalies in

regard to the number of ambulacra. Some individuals have only four while others have six. Inhabits Southern seas.

2. CLYPEASTER FROM RANGIA. *Clypeastre Rangianus*. Desmoulins. — *Clypeaster rosaceus*, var. (2) Lamarck.

Species with nearly equal ambulacra, open petals at their end.

Inhabits the coasts of Africa.

3. SCALLOP-SHAPED CLYPEASTER. *Clypeaster placunarius*. Lamarck,— *Scutum angulare humile*, Klein, p. 23.— *Echinanthus humilis*, Leske, p. 185, t. 19, f. cd. — *Scutella ambigena*, Lamarck, An. s. vert., t. III, p. 286.

Species wide, flattened, pentagonal, with petals not swollen, having in addition the general appearance of a Scutellid but clearly distinguished by its non-anastomosed ambulacral grooves.

Inhabits the Red Sea and in the sub-fossil state on the edges of the same sea.

4, CLYPEASTER FROM MERIDA. *Clypeaster meridanus*. Michelin. — Michelin, Revue et Mag. Zool., 1850. Sub-fossil in the vicinity of Merida (Yucatan).

5. SMALL CLYPEASTER. *Clypeaster parvus*. Duchassing. — Duchassing, Bull. Soc. géol. Fr., 2^{e} série, vol. IV, p. 1093. — *1d*., Desor, Syn., p. 244. From the White Tufts of Guadeloupe.

6. ELEVATED CLYPEASTER. *Clypeaster altus*. Lamarck.—*Echinus altus*, Lin., Gmel, p. 3187. — *Echinanthus altus*, Leske, p. 189, t. 53, f. 4. — Scilla, Corp. mar., t. 9, f, 1–2.—Encycl. méthod., pi. 146, f. 1–2.—Lamarck, t. III, p. 290, n° 2. Var. *minor*: *Clypeaster agassizii*, Sismonda, Fossil of the Miocene of Italy, Cosica.

7. BORDERED CLYPEASTER.. *Clypeaster marginatus*. Lamarck.—Scilla, Corp. mar., t. XI. — Knorr, Petref., t. E, f. 1–2. — *C. tarbellianus*, GrateL, Echin., foss., p. 40, t. I, f. 5–6. Fossil of the Miocene of Touraine, Dax.

8. TOWERED CLYPEASTER. *Clypeaster turritus*. Agassiz. — Agassiz, Cat. syst., p. 6. — Philippi in Meyer, Palæont., vol. I, t. 38, f. 1–5. — ? *Clypeaster portentosus*, Desmoulins, Tab. syn., p. 218. — *C. turritus*, Desor, Syn., p. 240.

Species of large size, very elevated, pentagonal at the base and with very thick edges. Genital pores very close together. From the Miocene of Dax.

9. CLYPEASTER FROM TAURUS. *Clypeaster tauricus*. Desor. Cat. rais., p. 73.

Species even larger than the preceding, equally pentagonal, but more elongated form. The poriferous zones are enlarged toward their end.

Fossil of the Miocene of Taurus, island of Crete.

10. CLYPEASTER WITH LARGE FLOWERS. *Clypeaster grandiflorus*. Bronn.—Leth. geog:, t. II, p. 324, t. 36, f. 9. — *Clypeaster crassus*, Agassiz, Cat. syst., p. 6. — Scilla, Corp. mar., t. X, f. 3. Fossil from the Miocene of Hungary.

11. CLYPEASTER OF SCILLA. *Clypeaster scilla.* Desmooulins.—Desmoulins.,Tab., syn., D. 218. — *C. intermedius*, Desmoulins, *loc. cit*.
From the Middle Tertiary terrain (Miocene) of Martigues, Bonifacio; Taurus, etc.

12. CLYPEASTER WITH LARGE SIDES. *Clypeaster crassicostatus*. Agassiz.— Cat. syst., p. 6.—*Id.*, Sismonda, Echin. foss. Piémont, t. II, f. 1–3.—*Id.*, Desor, Syn., p. 241.
From the Middle Tertiary terrain (Miocene) from Superga near Turin.

13. *Clypeaster with scutes*. *Clypeaster scutellatus*. Marcel de Serres..—Scilla, Corp. mar., t. X, f. 2. — C. latirostris, Agassiz, Cat. syst., p. 6. — *Clypeaster michelotti*, Agassiz, *loc. cit*., — *C. laganoides*, Agassiz, Cat. rais.,— *Clypeaster scutellatus*, Desmoulins, Echin., p. 216. -— *1d*., Desor, Syn., p. 242.

Species flattened, wide, thinned toward the edges, swollen at the top, with petals short and wide, with flattened sides.

From the Middle Tertiary terrains (Miocene) of Villeneuve, Bonifacio, Savone, Morée, Corsica.

14. *Clypeaster placenta*. Michelotti. — Desor, Syn., p. 243. From the Miocene of Dego (Piedmont).

15. *Clypeaser beaumonti*. Sismonda. — Echin. foss. Piémont, p. 44, £. IL, f. 4-5. — Desor, Syn., p. 245.
From the Middle Tertiary terrain of Superga, Savone.

16. *Clypeaster foliacum.* Agassiz. — Cat, rais., p.73. Wright, Foss. of Malta. — ? *C. martinianus*, Desmoulins, Tab. syn., p. 218.
From the Tertiary terrain (Miocene) of Palermo, Malta.

Some species have been reported from the Tertiary terrains of India, either from the Nummulitic stage or from more recent stages of the Nummulitic terrain. *Clypeaster profondus. D'Archiac*, from the chain of Hala (Sinde). — *C. halaensis*, D'Archiac. — *1d*., *C. oblongus*, Sow.— *C. depressus*, Sow. from Somrow, prov. de Cutch. — *C. latus*, Herklortz, Foss. of Java, p. 6, t. 2, f. 1, and *C. tumescens*, Herlotz. Recent Tertiary terrains of Tjidamar (Java). — *C. jonesii*, Desor (*Scutella jonesii*, Forbes). Eocene ? from Jacksonborro (Georgia).

17. UMBRELLA CLYPEASTER. *Clypeaster umbrella*. Acassiz. — Cat, syst., p. 72. — *Clypeaster gibbosus*, Marcel de Serres, Géog., p. 157.

Species whose interambulacral areas are swollen and protruding in the form of ribs.
Fossil of the Middle Tertiary terrains (Miocene) of Bonifacio, Nice, Montpellier, etc.

Perhaps should be referred to *Clypeaster dilatatus*, Desor, Cat. rais., p. 72, of Taurus and the island of Crete,

Observation. — For a long time a *Clypeaster gueynardi*, Alex. Brongniart has been cited as belonging to this species. Michelin, in a note (*Bull. soc. Géol. de France*, t. XVI, p. 767) has perfectly demonstrated that there are two errors in this point s view: first is the spelling of the specific name that is *gueymardi* and not *gaymardi.* The second is the examination of the type has shown to him that the so-called *Clypeaster* must belong to the genus *Conoclypus*.

18. REID'S CLYPEASTER. *Clypeaster Reidii*. Wright. — Wright, Ann. and Mag. of nat. Hist., vol, 15, p. 14.

Species more elongated than *C. umbrella*, with interambulacral areas that are not swollen.

From the Middle Tertiary terrain (Miocene) of Malta.

SIXTH FAMILY. CASSIDULIDAE.

Ambulacra petaloId. Peristome angular, central of sub-central. No jaws.

The family of Cassidulidae was instituted by Agassiz who included some types that had to be removed, such as those contained in the family Galeridae. It corresponds to either the Nucleolidae of Albin Gras or to the Echinobrissidae of D'Orbigny. If we try to summarize in a few words the differences that it has with other families, we see that, by the absence of jaws, it is distinguished perfectly from the Clypeastroides. Then from the Galeridae by the petaloid ambulacra, finally from the Spatangoidae by a more or less angular and non-labiate peristome.

Among the other specific characters of this family, it is necessary to indicate a test uniformly with small, dense tubercles with short bristles. These tubercles are mamelonnated but never perforated. The central or sub-central peristome is never bilabiate either but most often has bourrelet and groups of pores forming very elegant figures to which Desor has given the name of Phyllodes and that furnishes excellent characters for the distinction of genera of this species.

These Phyllodes, five in number, accompanied by an equal number of bourrelets form a kind of star designated previously under the name of buccal rosette but that Desor now calls floscelle. This floscelle is in addition very variable and does not exist in all the genera of this family. We can cite, as having this condition, *Caratomus amblypygus*, etc.

The periproct also has large variations, either in regard to its form or to the cause of it location.

The interior of the test has neither partitions nor pillars. From the paleontological point of view, this family offers some interesting facts. We see species appear in the Jurassic terrain and maintain themselves in all the stages of this period without increasing sensibly in number. It is not the same for the Cretaceous period where they seem to reach their maximum development. The Lower Tertiary terrains still contain a good number, then we see them decrease sensibly in the Middle stages (Miocene). Finally, in the present period, we scarcely count 4 or 5 species that inhabit tropical seas.

This family, extremely numerous in genera and species, can be subdivided into three tribes: 1° species lacking a floscelle, containing the genera *Caratomus, Pygaulus, Amblypygus* and *Haimea*; 2° those that have a floscelle, such as the genera *Nucleolites, Echinobrissus, Clypeopygus, Clypeus, Botriopygus, Catopygus, Rhynchopygus, Cassidulus, Echinanthus, Pygorhynchus, Echinolampas, Pygurus, Faujasia* and *Conoclypus*; 3° species having a very different unpaired ambulacrum from the others and are nearer because of this to Spatangoids such as the genera *Archiacia* and *Claviaster*.

1st Tribe. CARATOMIANS.

No floscelle. Ambulacra incompletely petaloId. Peristome often oblique. Periproct ventral.

1st Genus. **Caratomus**.. *CARATOMUS*. — Agassiz.

Test ovoid or circular, swollen, with a thick edge, rostrate or sub-rostrate posteriorly. Ambulacra incompletely petaloid, open at their end, with non-conjugated pores. Peristome central, oblique. Periproct infra-marginal triangular in form. Four genital pores. No floscelle.

This genus is known only as fossils. The species are not numerous (9), all from Cretaceous terrains and only in two stages: Chalk and Green Chalk (Cenomanian) and Upper Chalk (Senonian).

1. *Caratomus trigonopygus*. Desor. — Cat. rais., p. 93. !
   Fossil of the Cenomanian of Rochefort, Fourras, Le Mans, etc,

2. *Caratomus orbicularis*. Agassiz. — Cat, rais., p. 93. — (*Catopygus Agassiz*, Cat. syst., p. 7).
   From the Cenomanian of Cap la Hève, Villers, etc.

3. *Caratomus faba*. Agassiz, — Cat. syst., p. 7. — (*C. latirostris*, Desor).
   From the Cenomanian of Fourras, Port-des-Barques, Le Mans, etc.

4. *Caratomus rostratus*. Agassiz. — Cat, syst., p. 7.
   From the Cenomanian of Hävre, Fourras, Vaches-Noires, etc.

5. *Caratomus avellana*. Agassiz. — Cat. syst., p. 7. — *Catopygus avellana*, Dubois, Voy. Caucase, pl. 1, f. 19–21.
   From the Senonian of Ste-Colombe (Manche).

6. *Caratomus sulcato-radiatus*. Desor, D'Orbigny.—(*Galerites*, Goldfuss, Petref., pl. 41, f. 4).
   From the Senonian of Maëstricht, Ciply (Belgium).

7. *Caratomus truncatus*. D'Orbigny. — Pal, Fr.; p. 872, pl. 943, f. 1–6.
From the Senonian of Ste-Colombe (Manche).

8. *Caratomus peltiforimis*. Agassiz. — Cat, rais., p.53. — *Clypeaster peltiformis*, Hising, Leth. suec., pl, 26, f. 2. — *Echinites Id.*, Wahl., Act. Soc. Ups., VII, pl. 3, f. 4–5.
From the Senonian of Scanie, Bulsberg.

9. *Caratomus gehrdensis*. Roemer. — Nordd. KreId., p, 31, t. VI, f. 11. — *Id.*, Desor, Syn. p. 251.
From the Senonian of Gehrden (Hanover).

2nd GENUS. **PYGAULUS**. *PYGAULUS*.— Agassiz.

— *Catopygus*, Agassiz,

Test elongated. Subcylindrical, top rostrate posteriorly. Ambulacral petals long, open, with conjugated pores. Peristome elongated, oblique. Periproct infra-marginal, not visible from above.

This genus is near *Caratomus*, It differs especially by its elliptical periproct, instead of being triangular, then by its unequal ambulacral pores and by the doubling of these pores around the periproct, which is without bourrelets.

1. *Pygaulus depressus*. Agassiz. — Cat, rais,, p. 101.—*Catopygus depressus*, Agassiz.— *Pygaulus desmoulinsii*, Agassiz.—*Nucleolites depressa*, À. Brong. — *Pyrina depressa*, Desmoulins.
From the Neocomian of Sassenage, Grande-Chertreuse, Orgon (B.-du-Rhône).

2. *Pygaulus cylindricus*. Desor. — Cat. rais., p. 101.
From the Neocomian of Sassenage, Villers-de-Lans, etc.

3. *Pygaulus expansus*. Desor. — Syn., p. 254.
From the Upper Neocomian of Sentis.

4. *Pygaulus sentisianus*. Desor. — Syn., p. 254.
From the Neocomian of Sentis.

5. *Pygaulus subniferus*. Desor. — Syn., p. 254.
From the Neocomian of Ste-Croix, Morteau.

6. *Pygaulus morloti*. Desor. — Syn., p. 255.
Desor refers here with doubt *Botriopygus campicheanus* D'Orbigny that does not have bourrelets around the peristome and would not belong to *Botriopygus*.
Fossil from the Neocomian of La Bretonnière.

7. *Pygaulus zonatus*. Desor. — Syn., p. 255.
From the Neocomian of Mormont.

8. *Pygaulus ovatus*. Agassiz, — Cat. rais., p.101,
From the Albian stage of the loss of the Rhône (Ain).

The Green Chalk contains: 9. *Pygaulus macropygus*. Desor. from Fourras. 10. *Pygaulus puivinatus*. Agassiz. (*Pygurus Id.*, D'Archiac). 11. *Pygaulus subaequalis*. Agassiz. (*Catopygus Id.*, Agassiz.) 12. *Pygaulus columbaris.* Desor. (*Echinolampus Id.*, Agassiz). From the Turonian stage: 13. *Pygaulus toucasanus*, D'Orbigny.

3rd GENUS. **AMBLYPYGUS**. *AMBLYPYGUS.* — Agassiz.

Genus near *Pygaulus*, distinguished by its peristome that is elongated posteriorly, acuminate toward the center and located completely ventrally at equal distance between the edge and the peristome.

All the species are from the Nummulitic stage of the Tertiary terrain.

1. *Amblypygus apheles*. Agassiz. — Cat, rais., p. 108.

Species elongated, slightly depressed, having its ambulacral petals very open and formed of very narrow poriferous zones. Periproct elongated, pyriform, occupying moreo than half of the space between the edge and the peristome.
Fossil of the Nummulitic stage of Vérone,

2. *Amblypyqus dilatatus*. Agassiz. — Cat, syst., p. 5.
From the Neocomian of Salghir (Crimea).

3. *Amblypygus michelini*. Cotteau.
From the Neocomian of Ausseine (Haute-Garonne).

4. *Amblypygus arnoldi*. Agassiz. — Cat. syst., p. 5.
From the Tertiary terrain of the valley of Era (Toscany).

5. *Amblypygus americanus*. Michelin.
Species circular, near the preceding but with much longer poriferous zones.
Fossil from the Tertiary terrain of Jamaica.

4th Genus. Haimea. *HAIMEA*.— Michelin.

Test swollen, top central. Ambulacra imperfectly petaloid, open and with non-conjugated pores. Peristome central, pentagonal. Periproct open in the middle of the space between the peristome and the edge.

This small genus is extremely interesting in the sense that its position in the series of Echinoids is still uncertain and that it shares characteristics of both Clyprastroids and Cassidulid,

It contains only a single fossil species whose deposit is unknown.

Haimen caillaudi. Michelin. — Revue et Mag. zool., 1851, n° 2, t. II, f. 2. — *Id.*, Desor, Syn., p. 257, tab. XXX, f, 1–3.

Species swollen, subspherical, a little truncated posteriorly, with ambulacra that are protruding, swollen, whose pores are not contiguous. Periproct small, elongated, nearer the peristome than the edge. Peristome with five notches.

Fossil of the Tertiary terrains ? (Mus. of Nantes.)

2nd TRIBE. **ECHINOBRISSIANS**.

Test more or less depressed, sometimes elongated, enlarged in back. Ambulacra petalaloid or subpetaloid, opoen at their end with unequal zones. Ambulacral top eccentric. Peristome a little eccentric forward, regular and oblique, surrounded by a floscelle with or without bourrelets. Periproct posterior often in a groove. Genital and ocular apparatuses forming a rounded group composed of four genital pieces, of which the largest supports the madrepore plate that is in the center of the apparatus.

The tribe of Echinobrissians is extremely numerous in genera and species. It corresponds to a part of the Echinobrissidae of D'Orbigny and has been designated by the name of Nucleolitians by some authors and by that of Echinanthians by Desor.

One of the principal types of this tribe is the genus *Nucleolites* of Lamarck, whose name was changed in recent times to *Echinobrissus* that, as perfectly demonstrated by D'Orbigny, had been given in the past to these small Urchins by Breynius. Desor has attempted to demonstrate the possibility of preserving a genus *Nucleolites* independent of *Echinobrissus*. This author invokes to support his opinion a difference in the disposition of the ambulacral pores that are not conjugated in the true *Nucleolites* and would join to this character that of a more widened form. Despite the advantage, more apparent than real, of preserving a generic name known for a long time, we doubt its utility and, following the example of D'Orbigny, we shall unite it to *Echinobrissus*, mentioning however the species attributed to it.

Table of the genera of the tribe of Echinobrissians:

Echinobrissus (*Nucleolites*)	*Echinanthus*
Clypeopygus	*Pygorhynchus*
Clypeus	*Echinolampus*
Bortriopygus	*Pygurus*
Catopygus	*Faujasia*
Rhynchopygus	*Conoclypus*
Cassidulus	

1st GENUS. **ECHINOBRISSUS**. *ECHINOBRISSUS*. — BREYSIUS.

— *Nucleolites*, Lamarck.

Test depressed, subcircular or quadrangular, sometimes rounded in front, truncated in back. Petals more or less elongated, open, with poriferous zones more or less narrow with pores most often conjugated. Ventral surface concave. Peristome eccentric. Transverse and oblique, without bourrelets but with rudiments of phyllodes.

As we have said, this genus corresponds to that of *Nucleolites* of Lamarck and of most authors. D'Orbigny, who is concerned particularly with this group of Echinoids, has recognized that the species united under this name by Agassiz can be divided into three distinct genera: *Echinobrissus, Trematopygus* and *Clypeopygus*.

The genus *Echinobrissus* is represented in the present period by a single species coming from the seas of Australia. As for the fossil species, they are on the contrary very numerous and found in the Jurassic, Cretaceous and Tertiary terrains.

RECENT ECHINOBRISSUS. *Echinobrissus recens*, (Sp.) Edwards. — *Nucleolites recens*, Edwards. Reg. an. Cuv. illustr., t. 14, 1. 3. — *Id.*, Agassiz, Cat. rais., p.193.
Inhabits the Antilles.

The fossil species are thus distributed:

Oolite (Bajocian), 2 species — Great Oolite (Bathonian), 6. — Kellovian, 4. — Oxfordian, 2. — Corallian, 1. — Kimmeridin, 1. — Portlandian, 4. — Neocomian, 7. — Aptin, 1. — Cenomanian, 2.— Senonian, 5.

It is necessary to add 14 species that Desor leaves in the genus *Nucleolites*.

2nd GENUS. **TREMATOPYGUS**. *TREMATOPYGUS*.— D'Orbigny.

Contains the species with the peristome oblique, irregularly compressed, sometimes pentagonal and without bourellets nor floscelles.

Desor has united this genus with *Nucleolites*. D'Orbigny has referred there the following species:

T. archiaci, D'Orbigny (*Nucleolites Id.*, Cotteau). From the Nevcomian of St.-Sauveur (Yonne). — *T. grasanus*, D'Orbigny (*Echincbrissus Id.*, Desor). From the Neocomian. — T. olfersii, D'Orbigny (*Echinobrissus Id.*, Desor). From the Neocomian from the island of Wrigth. — *T. campicheanus*, Desor (Sp.). From the Neocomian of Ste.-Croix. — *T. ricordeanus,* Desor (Sp.). From Gault. — *T. analis* (Sp.). Agassiz. Senonian of Ciply. — *T. oblongus*, D'Orbigny *Id.* — *T. crucifer*, Morron. (Sp.) *Id.*, from New Jersey.

3th GENUS. **CLYPEOPYGUS**. *CLYPEOPYGUS*—D'Orbigny.

Test depressed, oblong, enlarged posteriorly, top eccentric in front, concave below. Peristome very eccentric, with bourrrelets and phyllodes. Periproct supra-anal in a deep and oblique groove.

This genus was established by D'Orbigny for species that previously had been confused with *Nucleolites*. The existence of bourrelets and phyllodes around the mouth joined with their very circular anal groove permits distinguishing it very easily.

All the species (8) are fossils in Cretaceous terrains.

The eight species are: *C. paultrei*, (Sp.) Cotteau. From the Neocomian of St. Sauveur. — *C. robinaldinus*, (Sp.) Cotteau. *Id., Id.* — *C. michelini*, (Sp.) Alb. Gras. — *C. subquadratus,* (Sp.) Agassiz. *Id.*, Ste. Croix.—*C. renaudi,* (Sp.) Agassiz. *Id.*, Switzerland. — *C. cerceleti*, (Sp.) Desor. From the Albian (Ardennes). According to Desor, it is necessary to add: *C. quadratus,* (Sp.) Michelin. From the Oolite (Bathonian).

Clypeopygus gresslyi, D'Orbigny has become the type of a new genus established by Cotteau in his beautiful work on the Echinoids of the department of Yonne. It is the genus *Phyllobrissus*, Cotteau characaterized by its swollen ovoid form, its nearly vertical posterior periproct, its flat ventral surface and its peristome surrounded by a rosette of very developed pores.

Clypeopygus oviformis, D'Orbigny should also make part of this new genus.

4th GENUS. **CLYPEUS**. *CLYPEUS*. — Klein.

Test thick, discoidal, clypeiform, top central. Ventral surface with convergent grooves. Peristome subcentral, surrounded by a rudimentary floscelle. Periproct above, located in a deep groove sometimes extending to the top. Ambulacra subpetaloid, wide, reaching the edge.

The genus *Clypeus* is near *Nucleolites* and *Clypeopygus*. We encounter it only as a fossil. All the species are Jurassic and found in Oolitic stages.

Clypeus sinuatus. Leske. — T. XII, p. 157. — *Galeriles patella*, Lamarck, Encycl. méth., p. 143, F. 1–2. — *Nucleolites patella*, Defr. — *Clypeus palella*, Agassiz. — *Clypeus angustiporus*, Agassiz (*varietas*). — *Clypeus excentricus*, M'Coy.

Species circular, slightly truncated in back with the top eccentric posteriorly. Periproct in a deep groove extended to the top. Ambulacra wide, lanceolate. Peristome slightly eccentric, surrounded by large bourrrelets.

Fossil of the Lower Oolite and also the Great Oolite.

Belonging to the same stage: *Clypeus agassizii*, Desor.—*C. solidurinus*, Agassiz. — *C. michelini*, Desor. — *C. rimosus*, Agassiz. From the Great Oolite (Bathonian). — *C. osterwaldii*, Desor. — *C. davoustianus*, Cotteau. — *C. rostratus*, Desor. — *C. rathieri*, Cotteau.

5th GENUS. **BOTRIOPYGUS**. *BOTRIOPYGUS*.— D'Orbigny.

— *Pygurus* (pars), Agassiz.

Test ovoid, with regularly arced back, ambulacral top eccentric. Petals long, lanceolate, open, scarcely conjugated. Periproct posterior in a flared groove. Peristome even more eccentric than the top, pentagonal, oblique, surrounded by a rudimentary floscelle.

This genus was established by D'Orbigny for species that were until then confused with *Pygurus, Nucleolites* and *Pygorhynchus*. Its affinities are still closer with the genus *Clypeopygus* that differs only by the higher position of the periproct.

All the species of *Botriopygus* are fossils in Cretaceous terrains.

Botriopygus obovatus. D'Orbigny, — *Catopygus obovatus*, Agassiz, Prodr.,p. 18 (1836). — *Nucleolites Id.*, Desmolins. — *Pygorhynchus Id.*, Agassiz (1839). — *Pygurus Id.*, Agassiz, Cat. rais. — D'Orbigny. — Alb. Gras.— Cotteau. — *Botriopygus Id.*, D'Orbigny, Pal., Fr., n° 2230, pl. 929.

Species elongated, depressed, enlarged posteriorly. Ventral parts very undulating. Peristome obliqiue, surrounded by not very pronounced phyllodes and bourrelets. Periproct infra-marginal, located in a short and flared groove. Ambulacral petals very long.

Fossil of the Neocomian of St-Sauveur (Yonne), Ste-Croix (Vienne).

The other species are, for the Neocomian: *Botriopygus minor*, D'Orbigny, *(Catopygus minor*, Agassiz. — *Pygurus minor*, Agassiz), — *P. testudo*, Desor.—*P. cylindricus* (*Pygaulus cylindricus*), Desor.—*P. meyeri* (*Pygurus meyeri*), Deson. From the Gault.—*P. campicheanus,* D'Orbigny.—*P. sueurii*, Desor. From the Aptian. — *P. elegans*, Desor. From the Turonian. — *B. toucasanus*. From the Turonien. — *B. cotteauanus*, D'Orbigny. From the Turonian. B. *coarctatus* (*Pygurus*), Desor. From the Nummulitic terrain.

6th GENUS. **CATOPYGUS**. *CATOPYGUS*.-— Agassiz.

Genus separated from the *Nucleolites* by Agassiz, characterized especially by a very developed floscelle. The ambulacral pores are united by distinct grooves, like those of the petals.

All the species are fossils in the Cretaceous terrains. They are distributed thus:

Neocomian: *C. switensis*, Desor.— Albian: *C. cylindricus*, Desor. — Cepomanian: *C. columbarius*, D'Archiac (*Nucleolites columbaria*, Lamarck).— *C. carinatus*, Agassiz. — Turonin: *C. ebrayanus*, d'Obigny. — *C. gallinus*, Desor. — Senonian: *C. elongatus*, Desor. — *C. affinis*, D'Orbigny. — *C. fenestratus*, Agassiz. — *C. obtusus*, Desor. — *C. subcarinatus*, D'Orbigny. — *C. pyriformis*, Agassiz.—*C. ovulus* (*Nucleolites ovulus*, Lamarck).—*C. brevis*, Agassiz (*Nucleolites Id.*, Defr.). — *C. conformis*, Agassiz.— *C. fenestratus*, AgaassiIz.

7th Genus. **Oolopygus.** *OOLOPYGUS*.— D'Orbigny, 1856.

D'Orbigny established under this name a genus distinguished from *Catopygus* by the disposition of its ambulacral pores that, instead of being unequal and conjugated, are single, equal, rounded, very close together to form a very narrow poriferous zone. The genital system also has some differences.

We know only two species from Cretaceous terrains.

1. *Oolopygus bargesii*, D'Orbigny. From the Neocomian. 2. *Oolopygus pyriformis*, D'Orbigny. From the Senonian stage.

8th Genus. **Rhynchopygus**. *RHYNCHOPYGUS*.— D'Orbigny.

Test depressed, convex above, concave below.— Petals narrow, nearly linear. Periproct supra-marginal, transversal, surmounted by a swelling in the form of a rostrum. Peristome nearly central, with a floscelle composed of large bourrelets and deep phyllodes in which the pores are doubled.

It is because of the transverse form of its periproct that D'Orbigny distinguished this genus from Cassidulids. It is necessary to add to this character, according to Desor, the absence of a ventral median band so characteristic in Cassidulids.

This genus exists only as fossils in the Cretaceous terrains.

1. *Rhynchopygus marmini*, D'Orbigny (*Nucleolites marmini*, Desmoulins).— (*Cassidulus marmini*, Agassiz). From the Upper Chalk (Senonian) of Tours, Orglande.

2. *Rhynchopyqus nasutus*. Desor. — Syn., p. 288. From the Gault of Switzerland.

3. *Rhynchopygus galeatus* (*Stigmatopygus galeatus*, d'Orbogy). From the Upper Chalk of Beaumont.

9th Genus. **Cassidulus**. CASSIDULUS, — Lamarck.

Test oblong, convex above, flat below, slightly eccentric at the ambulacral top. Petals short, lanceolate. — Periproct dorsal, oblong, located in a very flared groove. Peristome eccentric, surrounded by a conspicuous floscelle and protruding bourrelets separated by wide and deep phyllodes without additional pores.

The genus *Cassidulus*is is no longer completely the same as in the time Lamarck established it. Several generic sections have been made at its expense, such as *Scutellinus*, *Lenita* and *Pygorhynchus*.

Extant Cassidulids are represented by a single species. Fossils belong to the Upper Cretaceous but are more abundant in the Tertiary terrains.

1. SOUTHERN CASSIDULUS. *Cassidulus australis*. Lamarck.—An. s. vert., t. III, p. 339, n°2. — Encycl. méthod., p. 143, f. 8–10. — *C. caribeorum*, Lamarck. — *Cassidulus richardi*, Deslonchamps. — *Nucleolites richardi*, Desmoulins. — Cuvier, R. an. illustré, t. 15, f. 5.
Inhabits the Antilles. (Mus. Paris).

2. *Cassidulus guadalupensis*. Duchassing. — Bull. Soc. géol. Fr., 1847, vol. IV, p. 10. F.. 3.— *Rhynchopygus Id.*, Desor.
Subfossil species (Quaternary) of Guadeloupe.

3. *Cassidulus lapis-cancri*. Lamarck. — *Echinites lapis-cancri*, Leske in Klein, pl. 43, f. 10–11.— *Echinus lapis-cancri*, Lin, Gmel., p. 3201. — *C. belgicus*, Lamarck. — Encycl. méth., p. 143, f. 6–7.
Species depressed, oval, rounded in front. Top very eccentric in front. Ambitus subangular, ventral surface small, located a little anterior and with a little protruding floscelle and borrrelets. Periproct round, located behind and below in a non-prolonged gutter. Ambulacra not very marked. Unequal.

This species, the oldest known, comes from the Upper Chalk of St-Christophe (Loir-et-Cher), La Fléche (Sarthe), Maëstricht, etc.

4. *Cassidulus elongatus*. D'Orbigny. From the Senonian of Maëstricht

5. *Cassidulus aequoreus*. From the Senonian of Alabama.

6. Cassidulus amygdala. Desor. From the Nummulitic terrain of Switzerland.

7. *Cassidulus patelliformis* (*Catopygus)*. Bouvé. From Georgia (United States).

8. *Cassidulus faba* (*Lenita faba*, Agassiz). From the Parisian terrain of Grignon.

9. *Cassidulus ovalis*. Cotteau. — Bull. Soc. géol., t. XIII, p. 33. From the Parisian terrain of Boussan (Haute-Garonne).

10. *Cassidulus sorigneti*. Michelin, — Bull. Soc. géol., t. XVII, 1859, p. 146. From the lower sands of the Coarse Limestone of Fontenay-en-Four (Eure).

10th GENUS. **ECHINANTHUS**. *ECHINANTHUS*, — Breynius.

Test swollen, ovoid, with eccentric top. Periproct marginal or supra-marginal in a groove that is prolonged below. Petals small, unequal. Ventral part concave. Peristome not very eccentric, surrounded by a floscelle and protruding tubercles.

This genus goes back to Breynius (1732), only it must have had limitations because in the mind of the author and especially after the terms of his diagnosis, it obviously included genera very different from each other. Thus, it is evident that we find in the section of Breynius elements of three genera that are going to concern us: *Eckinanthus,*

Pygorhynchus, Echinolampas. It is for this reason that D'Orbigny proposed to unite these latter two genera with that of *Echinanthus* as having priority. This point of view has not been accepted by Desor who persists in accepting the separation of the three genera in attributing distinctive characters to each. Thus, we avoid a regrettable confusion of the species.

In the opinion of Desor, *Echinanthus* differs from *Pygorhynchus* by its form and the vertical disposition of their periproct, by its small petals, and finally by the absence of a smooth band on the ventral surface and they differ from *Echinolampas* by their dorsal periproct, by their small petals.

Thus limited, the genus *Echinanthus* contains fossil species from the Tertiary terrains with the exception of two or three that come from the Upper Cretaceous terrain.

Species from the Upper Cretaceous terrain. Danian: 1. *Echinanthus tumidus* (*Pygorhynchus*), Agassiz. Var. *Pygorhynchus crassus*, Agassiz. 2. *E. michelini*. Desor. D'Orglande.

Tertiary species. From the Nummulitic stage: 3. *E. testudinarius* (*Cassidulus*), Al. Brong. From Vicentin. 4. *E. scutella* (*Cassidulus*), Lamarck. (*Pygorhynchus*, Agassiz). 5. *E. cuvieri* (*Clypeaster*), Munster. (*Echinolampas* and *Pygorhynchus cuvieri*, Agassiz). 6. *E. bovaricus*, Desor. 7. *E. brongniarti* (*Clypeaster*), Munsgter, (*Pygorhynchus*, Agassiz). 8. *E. heptagonus* (*Nucleolies*), Gray., (*Pygorhynchus*, Desor). 9. *E. delhosii* (*Pygorhynchus*), Desor. 10. *E. depressus,* Desor. 11. *E. munsteri* (*Nucleolites*), Desmoulins; (*Nucleolites testudinarius*), Munster, (non Brongt.); *Pygorhynchus soutella*, Var. *inflata*, Agassiz. 12, *E. sopilianus* (*Pygorhynchus*), D'Archiac. In the Parisian stage. 13. *E. desmoulinsii* (*Pygorhynchus*), Delbos, Agassiz. 14. *E. minutus* (*Nucleolites*), Herklotz. From Java. In the Falunian stage: 15. *E. vassalii* (*Pygorhynchus*), Wright. From Malta. 16. *E. subcarinatus* (*Nucleolites*), Goldfuss; (*Pygorhynchus*, Agassz.) From the Pliocene of Bunde. 17. *Echinanthus mortoni*, Desor; (*Pygorhynchus mortoni*, Michelin); *Hardouinia mortoni*; D'Archiac and Haime, Foss. de l'Inde, p. 214.

It is this species that D'Archiac and Haime have attempted to establish a particular genus under the name of *Hardouinia* that does not seem to have any usefulness.

11th Genus. **Echinolampas**. *ECHINOLAMPAS*, — Gray.

Test swollen, ovoid or discoidal. Ambulacral petals elongated, often swollen, unequal, the anteriors shorter. Peristome transverse, pentagonal, more or less eccentric, surrounded by a little developed floscelle. Periproct infra-marginal.

This genus was established by Gray (1835) at the expense of *Clypeaster*, Only it is necessary to note that this author included very different types, i.e., *Echinanthus* of Breynius and *Pygorhynchus* of Agassiz. It is on this occasion that D'Orbigny, finding in the genus established by Gray a form name previously by Breynius, proposed returning to the name of the latter author and included the genus *Echinolampas* in *Echinanthus.* We have seen in dealing with this that this was not the view of Desor who accepted the two genera as perfectly distinct, *Echinolampas* differing from *Echinanthus* by the form of the infra-marginal periproct and their longer petals. Thus limited, *Echinolampas* forms a genus

numerous in species, of which 3 only are living and 36 are fossils in different stages of the Tertiary terrains, one in the Danian stage (Upper Chalk).

1. *Echinolampas francii*. D'Orbigny. — *Clypeaster oviformis*, Defr. (non Lamarck). D'Orglande, Valognes, in the Danian stage.

Species of the Nummelitic stage: 2. *E. politus*, Desmourins (*Clypeaster politus*, Lamarck). 3. *E. subsimilis*, D'Archiac, (*Echinanthus Id.*, d'Orb.), 4. *E. beaumonti*, Agassiz, (*E. curtus*, Agassiz; *E. eurypygus*, Agassiz; *E. stelliformis*, Agassiz (from Desmoulins). 5. *E. ellipsoidalis*, D'Archiac, (*Echinanthus Id.,* d'Orb.). 6. *E. subacutus*, Desor. 7. *E. brevis*, Agassiz. 8. *E. pulvinatus,* Desor. 9. *E. subcylindricus*, Desor. 10. *E. escheri*, Agassiz. 11. *E. ellipticus* (*Clypeaster*), Munster. 12. *E. amygdala*, Desor. From Egypt. 13. *E. discus*, Desor. 14. *E. sluderi*, Agassiz. 15. *E. jacquemontii*, D'Archiac.. From Sinde. 16. *E. sphaeroïdalis*, D'Archiac. From Sind. 17. *E. discoideus*, D'Archiac. From Sinde, 18. *E. Vicaryi*, D'Archiac. From Sinde. 19. *E. sindensis*, D'Archiac. From Sinde.—Species from Parisian terrain: 20. *E. affinis*, Desmoulins, (*Clypeaster affinis*, Goldfuss); *E. eurydomus* and *dilatatus*, Agassiz, varieties. 21. *E. blainvillei*, Agassiz. 22. *E. ovalis* (*Galerites Id.*, Brug., Encycl., pl. 143, f. 13–14); *Clypeaster ovalis*, Grat. Var. *E. burdigalensis*, Agassiz. 23, *E. stelliformis*, Desmoulins, (*Clypeaster Id.*, Lamarck; *Clypeaster fornicatus*, Goldfuss). 24. *E. dorsalis*, Agassiz. Var. *E. subdorsatus*, Agassiz. 25. *E. similis*, Agassiz. Var. *E. intermedius*, Agassiz. 26. *E. albert*i, Michelin. 27. *E. subangulatus*, Herklotz. From Java. 28. *E. galeottianus*, Forbes. 29. *E. dekini*, Gal.—From the Falunian stage: 30. *E. angulatus*, Merian. 31. *E. hemisphaericus*, Agassiz, (*Clypeaster Id.*, Lamarck, Gratael; *Echinanthus Id.*, D'Orbigny). 32. *Echinolampas laurillardi*, Agassiz, (*E. richardi*, Desmoulins). 32. *E. scutiformis*, Desmoulins, (*Echinoconus Id.*, Leske; *Galerites*, Lamarck; *E. francii*, Desmoulins (non Desor) ; *E. fungiformis*, Merian. 33. *E. hayesianus*, Desor. From Oran, Algeria. 34. *E. hoffmanni*, Desor. From Palermo. 36. *E. linckii*, Agassiz, (*Clypeaster Id.*, Goldf.). 37. *E. kleinii*, Desmolins, (*Clypeaster Id.*, Goldf). From the Pliocene of Bunde.

12th Genus **Pygorhynchus**. *PYGORHYNCHUS*. — Agassiz.

Test swollen, periproct supra-marginal and transverse.— Petals very long extending nearly to the edge. Peristome eccentric, transversal, with a distinct floscelle. Ventral part concave with a median band smooth in appearance.

This genus is very near *Echinolampas* but independently of the position of the periproct that is little different, it is especially characterized by the presence of a band or ridge, smooth in appearance but really composed of very small tubercles that occupy the ventral surface.

All the species are fossils in Upper Cretaceous and Tertiary terrains.

1. *Pygorhynchus desnoyersii*, Desor. Danian stage, Orglande, Hauteville, 2. *P. wrightii*, Cotteau. 3. *P. latus*, Cotteau. 4. *T. rotundus* Cotteau. 5. *P. testudo*, Forbes. Pondichéry. 6. *P. planatus*, Forbes. Pondichéry. — Tertiary species: 7. *P. desorii*.

D'Archiac. Nummulitic stage of Biarritz. 8. *P. grignonensis*, Agassiz, (*Nucleolites grignonensis*, Defr., Breynius , t. IV, f. 4–5). Parisian stage, Grignon, Parnes. 9. *P. subcylindricus*, Agassiz. Parisian. 10. *P. gouldii*, Bouvé, (*Nucleolites mortoni*, Conrad). From the Eocene (Parisian) of Georgia (United States). 11. *P. collombi*, Desor. From the Miocene of Bonifacio. 11. *P. jamaicensis*, Michelin. Foss. Jamaica.

13th GENUS. **STIMATOPYGUS**. *STIGMATOPYGUS*, — D'Orbigny (1855).

Test swollen with the top nearly central. Petals wide, not very extended with a tendency to close. Ventral surface flat. Peristome eccentric forward, surrounded by phyllodes and bourrelets. Periproct supra-marginal, longitudinal, narrow above, enlarged below.

It is the form of the periproct that is the basis of this genus that is in addition very near *Echinanthus* but that is distinguished, also, by its flat ventral surface while it is, on the contrary, very concave in the latter.

The species are fossils in the Upper Cretaceous terrains.

1. *Stymatopygus elatus*. D'Orbigny. — *Cassidulus elatus* , Forbes. — *Pygorhynchus elatus*, Agassiz. From the Danian stage of Pondichéry. 2. *Stymatopygus bervillei*., Desor.— *Nucleolites analis*, Sorignet. Ours. foss., p.41 (non Agassiz). From othe Danian stage of Meudon, Montainville (Eure).

14th GENUS. **EURHODIA**. *EURHODIA*. — D'Archiac and Haime (1853).

Test elongated, cylindrical, with small petals, transverse supramarginal periproct in a shallow groove.

This genus, established by D'Archiac and Haime is distinguished especially by its small, nearly closed petals. It contains only a single species.

Eurhodia morrisi. D'Archiac, Haime. — An. foss. Inde, p. 214, f. XIV, f. 7.

Froom the Nummulitic terrain of the chain of Hala (Sinde).

15th GENUS. **PYGURA**. PYGURUS —Agassiz.

Test discoidal, clypeiform, more or less truncated in front, rostrate in back. Ambulacra long and tapered, unequal. Ventral surface concave, marked by wide and smooth grooves corresponding to the ambulacra. Peristome eccentric, surrounded by a very elegant floscelle composed of wide phyllodes and large bourrelets. Periproct inframarginal surrounded by a distinct area with 4 genital plates.

This genus contains species largest of all the family of Echinobrissians. It is sufficiently characterized by its undulating ventral surface, its very developed floscelle and the form of its ambulacra very widened at their base. D'Orbigny has removed some types

that became particular species under the names of *Botriopygus, Faujasia* and *Echinopygus*. We note, however, in regard to the latter, which has for its principal representative *Pygurus rostratus*, that it is only based on the form of the periproct and that, considering the little importance of this character, this section truly does not deserve to be preserved. Such is also the opinion of Desor.

Pygurus, very numerous in species, belongs to Jurassic and Cretaceous terrains.

1. *Pygurus emarginatus*, Desor, (*Clypeus Id.*, Phil.; *Nucleolites semarginatus* , Forbes). From the Great Oolite of Scarboroug. 2. *Pygurus michelini*, Cotteau, *Id.* 3. *Pygurus marmonti*, Agassiz, (*P. fungiformis*, Agassiz). From the Kellovian of Mamers. 4. *P. orbiculatus*, Agassiz. Kellovian, *Id.* 5. *P. depressus*, Agassiz, (*P. pentagonalis*, Wright; *P. nasutus*, D'Orbigny, Cotteau, from the Kellovian. 6. *P. blumenbachii*, Agassiz, (*Clypeus acutus*, Agassiz). From the Corallian. 7. *P. fragilis*, Cotteau. *Id.* 8. *P. icaunensis*, Cotteau. *Id.*; *P. hausmanni*, Agassiz, (*Clypeaster Id.*, Kock., Desk). *1d*. 9. *P. pentagonalis* (*Clypeaster*), Phill. *Id.* 10. *Pygurus rogerianus*, Cotteau. From the Kimmeridian. 11. *P. tenuis*, Desor. From the Portlandian. 12. *P. jurensis*, Marcou. *Id.* Cretaceous species: 13. *P. montmolini*, Agassiz, (*Echinolampus triloba*, Desmolins; *Pygurus orbignyanus*, Cotteau. From the Neocomian. 14. *P. rostratus*, Agassiz (*Echinus catraphractus*, Brug., Encycl., pl. 146, f. 3). *Id.* 15. *P. productus*, Agassiz. 16. *P. columbianus*, Agassiz (*Laganum*? *columbianus*), D'Orbigny. *Id.* 17. *P. conicus*, Agassiz. From the Albian stage. 18. *P. ricordeanus*, D'Orbigny. Albian stage. 19. *P. oviformis*, D'Orbigny (*Clypeaster oviformis*, Lamarck). Var. *P. frisobus*, Agassiz. From the Cenomanian of Mans; *P. geometricus* (*Clypeaster*), Morton. Senonian from the United States.

16th GENUS. **FAUJASIA**. *FAUJASIA*.— D'Orbigny.

Test very convex and even conical above, flat below without ambulacral grooves. Petals lanceolte, slender, reach half the distance between the top and the edge. Peristome subcentral with a distinct floscelle. Periproct infra-marginal, transversal, without a distinct area.

This genus was established by D'Orbigny at the expense of *Pygurus* Agassiz from which it differs by its more convex form above, its flat ventral surface without grooves, its transvese anus without a distinct area, finally by its shorter ambulacra.

1. *Faujasia apicalis*. D'Orbigny. — Pal. Fr., n° 2218, p. 922. — Echinites, Fausas, 1799, pl. 30, f. 3. — *Pygurus apicalis*, Desor, Cat. rais., p. 104. From the Upper Chalk (Senonian) of Maëstricht.

2. *Faujasia faujasii*. D'Orbigny, — Pal. Fr,, n° 2219. — *Echinites, Fausas*, 1799, pl. 30, f. 7 ab. — *Echinolampas faujasii*, Desmoulins. — *Pygurus faujasii*, Agassiz, Cat. rais., p. 104, and D'Orbigny, Prodr. Et. 22, no 1182.

It differs from the preceding by its raised form, non conoical, as wide as long and truncated in front.

Fossil from the Senonian of Lanquais.

3. *Faujasia florealis*. D'Orbigny. — Clypeaster *Id.*, Monton, Syn. crit., pl. 3, f. 52, and pl. 10, f. 12. From the Senonian of Delaware (United States.).

4. *Faujasia delaunayi*. D'Orbigny. — *Loc. cit*., no 2220, pl. 924. From the Senonian of Authou (Loir-et-Cher).

17th GENUS. **CONOCLYPUS**. *CONOCLYPUS*.— Agassiz.

Test of oval form, swollen, rounded or subconiical above, flat below. Petals very long, straight, equal, open at their end, poriferous zones very acuminate. Peristome pentagonal with large bourrrelets. Periproct infra-marginal, triangular.

This genus was established by Agassiz for species that had until then been confused either with *Galerites, Clypeaster* or *Echinolampas*. We encounter it only as fossils. The rather numerous species come from the Upper Cretaceous terrains and Lower Tertiary terrains where they reach their maximal numerical development.

1. *Conoclypus rhotomagensis*. D'Orbigny. 1855, Pal. Fr., n° 2235, pl, 944. From the Cenomanian of mountain Sainte-Catherine (Rouen).

2. *Conoclypus ovatus*. D'Orbigny. — 1855, Pal. Fr., p. 345, n° 2236, pl. 943. — *Galerites ovatus*, Lamarck. — *Clypeaster leskei*, Goldf. – *Echinolampas leskei*, Agassiz.— *Echinolampas ovata*, Desmourins.— *Conoclypus leskei*, Agassiz, Desor, Syn., p. 320. Fossil from the Senonian of Meschars, Lanquais, etc.,

3. *Conoclypus acutus*. Agassiz.— *Echinolampas acuta*, Desmoulins. From the Senonian of Port-Lena (Dordogne).

4. *Conoclypus ovum*. Agassiz. — *Echinolampas ovum,* Desmoulins. — *Galerites ovum*, Grat. From the Senonian of Montfort, Saintes (Charente-Inférieure).

Species of the Nummulitic stage. 5. *Conoclypus bordeae*, Desor (*Galerites Id.*), Grat, Ours. foss., t. 2, f. 1. From Dax. 6. *C. conoideus,* Agassiz, (*Galerites Id.*, Lamarck; *Clypeaster Id.*, Goldf.; *Echinolampas agassizü,* Dubois). From Egypt, Sardaigne, Kressenberg. 7. *C. leymerianus*, Cortteau? 8. *C. ybergensis*, Desor. From Yberg (Switzerland). 9. *C. bouei*, Agassiz, (*Clypeaster Id.*, Munster, Goldfouss, t. 41, f. 7. From Kressenberg. 10. *C. anachoreta*, Agassiz, (*C. microporus*, Agassiz; *Discoidea maxima*, Dubois). From Yberg, Crimea. 11. *C. duboisii*, Agassiz. From Crimea, Sentis. 12. *C. aequidilatatus*, Agassiz. Var. *C. crassissimus*, Agassiz. From Kressenberg. 13. *C. costeilatus*, Agassiz. From Kressenberg. 14. *C. subcylindricus* (Munster). From Kressenberg. 15. *C. osiris*, Desor. From Egypt. 16. *C. marginatus,* Desor, From Vicentin. 17. *C. pyrenaïcus*,Cotteau. Haute-Garonne. 18. *C. flemingü*, D'Archiac and Haime. From Penjaub. 19. *C. pulvinatus*, Desor, (*Galerites Id.*, Sow.) From the prov. of Cutch. 20. *C. varias*, Desor, (*Clypeaster Id.*, Sow.). Prov. of Cutch. Miocene species: 21. *Conoclypus*

semiglobus, Desor (*Galerites Id.*, Lamarck). Grateloup; *Echinolampas semiglobus*, Desmoulins. Blue faluns of Garry. 22. *C. gueymardi*, Michelin, (*Clypeaster Id.*, Al. Brong.). 23. *Conoclypus plagiosomus*, Agassiz.; *C. lucae*, Desor. Miocene of Martigues.

18th GENUS. **ARACHIACIA**. *ARCHIACIA*.—Agassiz.

Test ovoid, enlarged in back, narrowed in front, top very protruding and extremely eccentric, located completely at the front end. Ventral surface concave. Petals short and slender, unequal. Peristome large, very eccentric, decagonal. Periproct infra-marginal.

This genus, extremely remarkable because of its bizarre form, is rather difficult to classify in the numerous series of Echinoids. D'Orbigny placed it near Spatangoids in consideration of the abnormal structure of its unpaired ambulacrum that is not petaloid like the others as well in Spatangoids. Desor, while recognizing the correctness of this observation, thought the relations of this genus are not clearer with Spantagoids than with Cassidulids and, for this reason, he proposed to make a special tribe under the name of Claviaster and joined the genus that had been designated thus by D'Orbigny. The author we just cited even proposed to form with these two genera a special family.

The genus *Archiacia* is found only as fossils in the Middle Cretaceous terrains. It contains only three species that are: *Archiacia santonensis* D'Archiac, *A. gigantea* D'Orbigny, and *A. sandalina* Agassiz, all three from the Cenomanian.

19th GENUS. **CLAVIASTER**. CLAVIASTER.— D'Archiac.

Near the preceding by the singularity of its form, it is distinguished by the structure of its unpaired ambulacrum that has two zones of pores on each side.

The species known is:

Claviaster cornutus. D'Orbigny. — *Archiacia cornuta*, D'Archiac. From Cretaceous terrains of Mount Sinai.

3rd TRIBE. **ANANCHYTIANS**.

Test of oval form, swollen above, flat below. Petals flush with the test, open at their end. Apical system elongated.

This tribe, although attached by the ensemble of characters to the true Spatangoids, differs especially by a character of great value that consists of the ambulacra not having the petaloid form as exists in Spatangians and also because the difference we see in the form of these ambulacra in relation to each other is less obvious.

The tribe of Ananchytians contains eight genera:

Ananchytes, Offaster, Holaster, Cardiaster, Infulaster, Stenonia, Hemipneustes.

20th GENUS. **ANACHYTES**. *ANANCHYTES*.— Mercati (1717).

— *Echinocorys*, Breynius (1732).

Test thick, oval, raised. Ambulacra disjointed, flush with the test, formed of zones equal in width and pores equal and non-conjugated. Peristome bilabiate, located on the ventral surface and in front. Periproct oval, infra-marginal at the posterior edge. Tubercles crenelated, equal and rather rare.

The name of *Ananchyte*, imposed for the first time for this genus for the first time by Mercati (1717), was used also, much later (1811) by Lamarck and in some way used exclusively until recent times when D'Orbigny found a name given by Breynius (1732), *G. echinocorys*, that he believed older. It is, in fact, under this name that D'Orbigny described *Ananchytes* in the *Paléontologie française*. Desor, having found the name of Mercati, it is therefore possible to preserve the term given by Lamarck and that everyone is used to using for a long time.

The genus *Ananchytes* is found only as fossils in the Upper Cretaceous (Senonian).

1. *Ananchytes vulgaris*. Lamarck. — *Echinocorys vulgaris*, Breynius (1732), pl. 3, f. 2. — *Echinocorytes ovatus*, Leske, pl. 93, f. 3. — *Ananchytes ovatus*, Lamarck. — Encycl. méth., pl. 154, f. 13.

This species is too well known for it to be useful to give here a description. In addition, its for is so variable that it has even received a very large number of names and is synonymy is one of the most complex. We recognize several principal varieties that are: 1° Cylindrical variety (*A. gravesii*, Desor).—*A. gibbose variety* (*A. gibba*, Lamarck; *A. rustica*, Desor; *A. striata* var. *subglobosa*, Goldfuoss).—3° Hemispherical variety (*A. striata*, Lamarck; *A. conoidea*, Goldfuss; *A. hemisphaerica*, Al. Brong.; *A. scutatus*, Leske. — 4° Conical variety (*A. conica*, Agassiz; *A. pustulosa*, *A. pyramidata*, Portland). —5° Keeled variety (*A. carinata*, Defr.), etc.

Fossil of the Upper Chalk (Senonian), nearly everywhere where this stage exists, either in the Anglo-Parisian basin or in the Pyrenean bases, or finally in the Mediterranean basin.

1. *Ananchytes sulcatus*. Goldfuss.— 1829, Petref. Germ., p. 145, pl. 45, f. 1. — *Id., Id.*, Agassiz, 1840, Cat. rev., p. 2. — *Id., Id.*, Agassiz and Desor, Cat. rais., 1847, p. 136.— D'Orbigny, 1847, Prodr. 2, p. 268. and. 22, n° 1153. — *Echinocorys sulcatus*, D'Orbigny, 1853, Pal. Fr., terrain Crét., p. 70, no 2104, pl. 809. Fossil of the Upper Cretaceous terrain. (Senonian) of Maëstricht.

2. *Ananchytes papillosus*.— *Cassis papillosa*, Klein, 1734, p. 82, pl. 16, f. c. — *Echinocorytes minor* (pars). Var, 1, *papillosa*, Les, 1778 in Klein, p. 183, pl. 16, f. CD. — *Echinus minor*. Var.? *papillosus*, Gmel., 1789, Syst. nat., p. 3186.—*Ananchytes semiglobulus*, Lamarck,1816, An. s. vert., 3, p. 27, n° 10. — *A. corculum*, Goldfuss, 1829, Petref., p. 147, pl.. 45; f.2. — *A. minor*, Blainville, 1834, Man. Act., p. 187. — *A. crassissima*, Agassiz, 1836, Cat. syst., p. 2. — *A. corculum*, Grat.., Desmoulins. — *A. semiglobus*, Desmoulins, *loc. cit*., Agassiz and Desor, 1847, Cat. rais., Echin., p. 136.

— *Id., Id.*, D'Orbigny, Prodr., 1847, t. 2, p. 268. Stage 22, no 1152. — *Echinocorys papillosus*, D'Orbigny , 1853, Pal. Fr., terrain Crét. p. 69, pl. 808, f. 4–6.

Fossil still uncertain that has the greatest affinity with *E. vulgaris*.

Fossil of the Upper Cretaceous terrains (Senonian) of Picanville (Channel), Tercis (Landes), Ciply (Belgium), Jutland (Sinde).

21st GENUS. **STENONIA.** *STENONIA.* — Desor.

Test conical, completely similar to *Ananchytes* but having its ambulacral and interambulacral plates protruding and convex. Compact apical system, not elongated.

The establishment of this genus is based on two important characteristics. On one hand, the form of the plaes constituting the test that are convex. Then, on the other, the structure of the apical system that, instead of being elongated as in all the other genera of the tribe, is on the contrary compact as occurs in true Spatangoids.

We know only a single species.

Stenonia tuberculata. Desor. — *Ananchytes tuberculata*, Dufrance, 1816, Dict. sc. nat., 2, Supp., p. 41, n° 3.—*Id. Id.*, Agassiz, 1836, Cat. syst., p. 2. — Desmoulins, Echin., p. 374. — *Id.*, Agassiz, 1840, Cat. Neoc., p.2, and Agassiz and Desor, 1847, Cat. rais., p. 136. — *Id.*, *Id.*, D'Orbigny, 1847, Prodr., 2, p. 268. Stage. 22, no 1151. — *Echinocorys tuberculatus*, D'Orbigny, Pal. Fr., 1853, p. 67, n° 2102, pl. 807.

Species have nearly the same form as *A. vulgaris* but distinguished especially by the convexity of all the plates at the same time that the test is generally thicker.

Fossil of the Senonian stage, Upper Chalk of Italy, at Padua and finally of Monte-di-Magre.

22nd GENUS. **OFFASTER**. *OFFASTER*.— Desor.

Test swollen, ovoid, Ambulacra wide, not very distinct. Periproct posterior. Apical system oblong. A lateral fasciole.

The species of this genus have completely the appearance of *Ananchytes* but they differ by the position of their periproct that is on the posterior surface instead of being inframarginal.

All are from the Upper Cretaeous terrains.

1. *Offaster rostratus*. — *Holaster Id.*, Desmoulins, Agassiz. — *Cardiaster Senonensis*, D'Orbigny. From the Senonian of Beauvais, Sens, 2. *Offaster pilula*. Desor. — *Ananchytes pilula*, Lamarck. — *Cardiaster pilula*, D'Orbigny. From the Senonian of Meudon, Sens, etc. 3. *Offaster inflatus*. Desor. — *Holaster Id.*, Desor. — *Toxaster Id.*, D'Orbigny. Species still doubtful as to genus. From the Gault of Senegal, 4. *Offaster zignonanus*. Desor. — *Cardiaster Id.*, D'Orbigny. Chalk from the vicinity of Padua. 5. *Offaster bourgeoisanus*. Desor. — *Cardiaster Id.*, D'Orbigny. From the Senonian of the department of Loir-et-Cher.

23rd GENUS. **CARDIASTER**. — *CARDIASTER*. — Forbes.

Test swollen, cordiform, with ambulaca flush with the test, formed of unequal zones, unpaired ambulacrum in a groove. Peristome oval, sub-bilate, located above on the anterior part. — Periproct supra-marginal, often in an anal area. A fasciole forms a transverse band on the anus and continues on the sides.

In the beginning, the character differentiating this genus and those of *Holaster* was only the presence of a marginal fasciole so that rigorous determination could be made only on specimen with perfect preservation. Desor has shown another character easier to know: it is that the very deep anal groove is edged with strong keels.

The genus *Cardiaster* is restricted to Cretaceous terrains.

One comes from the Neocomian, it is: *C. benstledis*, Forbes; one from the Cenomanian, *C. fossarius*; then ten from the Senonian: *C. ananchytis*, D'Orbigny. — *C. bicarinatus*, D'Orbigny. — *C. ligeriensis*, D'Orbigny. — *C. cotteauanus*, D'Orbigny. —*C. pygmeus,* Forbes.— *C. italicus*, D'Orbigny. — *C. hagenowi*, D'Orbigny. — *C. fimbriatus*, D'Orbigny.— *C. cinctus*, D'Orbigny.

24th GENUS. **INFULASTER**. *INFULASTER* — HAGENOW.

Test with the top very eccentric in front, more projecting than the back itself. Anterior groove deep, accompanied laterally by two ridges that extend from the peristome to the top. A sub-anal fasciole extends on the lateral parts and passes under the periproct.

This genus is extremely remarkable for the bizarreness of its form. It is in some way a *Cardiaster* exaggerated in its form. Some naturalists, notably D'Orbigny and Forbes, unite it with the latter genus.

Known as a fossil in the Upper Chalk.

1. *Infulaster borschardi*. Hagenow. From the Senonian of Wollin (Pomerania). 2. *Infuluster excentricus*. — *Cardiaster excentricus*, Forbes, D'Orbigny, From the Senonian of Norfolk. 3. *Infulaster rostratus*.—*Cardiaster rostratus*, Forbes, D'Orbigny.

25th GENUS, **HOLASTER**. *HOLASTER* — Agassiz.

Test cordiform with wide ambulacra, the anterior pairs very separated, the posteriors closer together. Peristome oval, transverse, ventral and anterior. — Periproct on the posterior surface at the upper end of an anal area, wide, shallow. No fasciole.

This genus, since its establishment, has undergone some reforms. Successively created at its expense are the genera *Cardiaster, Offaster* and *Infulaster*. It differs from *Ananchytes* by the presence of an anterior groove (area) and by its supra-marginal periproct instead of being infra-marginal.

All the species belong to the Cretaceous terrains.

The Neocomian contains: *H. intermedius*, Agassiz. — *H. conicus*, D'Orbigny.— *H. campicheanus*, D'Orbigny.— *H. grasanus*, D'Orbigny.— The Albian (Gault) stage: *H. laevis*, Agassiz. — *H. perezii*, Sismondi.— *H. transversus*, Agassiz. — *H. inflatus*, D'Orbigny. — *H. amplus*, D'Orbigny.— *H. latissimus*, Agassiz. — The Cenomanian: *H. suborbicuiaris*, Agassiz. — *H. Cenomunensis*, D'Orbigny. — *H. subglobosus*, Agassiz.— *H. irecensis*, Leym. — *H. carinatus*, D'Orbigny. — *H. marginalis*, Agassiz.— The Turonian: *H. integer*, Agassiz, — The Senonian stage: *H. pianus*, Agassiz. — *H. senonensis*, D'Orbigny. — *H. semistriatus*, D'Orbigny.— *H. vernonnetensis*, Sorignet. — *H. rehsteineri*, Desor.— *H. pyriformis* , Desor. — *H. indicus*, Forbes.

26th Genus. **Hemipneustes**. *HEMIPNEUSTES*. — Agassiz.

Test cordiform, very swollen, with ambulacra flush with the test, very wide, open at their end, with unequal poriferous zones Peristome ventral with a groove that is anterior, narrow and deep. Periproct located on the posterior edge.

This genus is very near *Holaster* and differs truly only by its generally more swollen form, the greater depth of the anterior groove and finally by the smallest and homogeneity of the tubercles. D'Orbigny has united it with *Holaster*.

We know only two species from the Upper Chalk.

1. *Hemipneustes radiatus*. Agassiz.—*Spatangus radiatus*, Lamarck.—*Spatangus striato-radiatus*, Leske.— *Holaster striato-radiatus*, D'Orbigny. From the Chalk of Maëstricht. 2. *Hemipneustes africanus*. Deshayes. From the Upper Chalk of Betna (Algeria).

Seventh Family. SPATANGOIDAE.

Ambulacra petaloId. Peristome eccentric, bilabiate. No jaws. Periproct posterior or infra-marginal. Genital system compact or elongated, with four genital plates. The ventral surface most often has two spaces that are elongated, smooth, surrounding a space that is cordiform and tubercular that is called the plastron. The fascioles are bands that are smooth in appearance but in reality formed of microscopic tubercles.

The family of Spatangoidae is one of the most numerous of the order of Echinoidea. It is rather well circumscribed and characterized, first by the absolute absence of jaws. Another character that is completed special to it is the presence of variously conformed fascioles. Finally, the general form shows a bilateral symmetry clearer than in any other group.

The number of genera is very great, both living or fossil, and the latter never before the Cretaceous period and are constantly increasing up to the present period.

2nd TRIBE. **SPATANGIANS**,

This tribe is especially characterized by its paired ambulacral, completely petaloid, and by its compact apical system. We find in addition very variable fascioles, giving good generic characters that we have designated by the different parts they occupy and circumscribe by the names of *peripetalous fasciole* (on the lateral parts of the body); *sub-anal,* surrounding the posterior surface; *lateral fasciole*, that is detached from the peripetalous fasciole to pass under the anus. Some genera, however, lack these fascioles.

The generic forms belonging to this tribe are very numerous and show a great development in the present period.

1st GENUS. **ECHINOSPATAGUS**. *ECHINOSPATAGUS*. — BREYNIUS.

— *Toxaster*, Agassiz.

Test cordiform, thin. Ambulacra subpetaloid, imperfectly limited, unequal, the unpaired located in a groove and composed of different pores. Ambulacra paired, superficial or in a slight depression, the unpaired having two kinds of pores. Peristome pentagonal, transverse, not labiate, located in front. Periproct oval, supra-marginal, often at the top in a not very distinct region. No fascioles.

This genus is more generally known under the name of *Toxaster* given by Agassiz. But D'Orbigny has demonstrated that it had been named by Breynius (1732) and proposed to return to that name. However, as Breynius had included species belonging to very different genera, Desor though that it is arbitrary to use the name *Echinospatagus*, one rather than another of these species, and preserves the name *Toxaster*. However, it is well established that one of the Breynusian species is *Echinospatagus cordiformis* that, therefore, can be considered the type. There is still another point on which D'Orbigny and Desor do not agree. It is that the latter author referred to the same genus as a mere division designed by D'Orbigny by the term *Heteraster*.

Echinospatagus is found only as fossils in the Lower Cretaceous terrains. There are 6 species in the Neocomian stage; 3 in the Aptian and 2 in the Albian.

Neocomian stage: *Echinospatagus cordiformis*, Breyn. (whose synonymy is very complicated). — *E. gibbus*, D'Orbigny. — *E. nevcomiensis*, D'Orbigny. — *E. roulini*, D'Orbigny. — *E. verranyi*, D'Orbigny. — *E. granosus*, D'Orbigny.— From the Aptian stage: *E. subcylindricus,* D'Orbigny.—*E.ricordeanus*, Cotteau (*Echinospatagus argilaceus*, D'Orbigny).—From the Albian stage: *E. collegnii*, D'Orbigny. — *E. inflatus*, D'Orbigny (*Holaster inflatus*, Desor). — *E. breynusianus*, D'Orbigny. — *E. brunneri*, Mérian, — *E. sentisianus*, Desor. — *E. leymerianus*, Cotteau.— *E. amplus* (*Toxaster amplus*, Desor).

2nd Genus. **Heteraster**. *HETERASTER*, — D'Orbigy.

Differs from *Echinospataqus* by its unpaired ambulacrum composed of three kinds of pores: single pores, external pores that are elongated and transverse, and accessory pores that are intercalated.

We know only three species of this fossil from the Upper Neocomian (Urgonian).

1. *Heteraster oblongus*. D'Orbigny. (*Toxaster Id.*, Agassiz.) 2. *Heterastler couloni*. D'Orbigny. (*Toxaster Id.*, Acassiz.) — *Toxaster bertheloti*, Al. Gras.) 3. *H. collombi* (*Toxaster Id.*), Desor. From the Turonian.

3rd GENUS. **ENALLASTER**. *ENALLASTER*.— D'Orbigny

— *Hemipneustes*, Forbes (non Agassiz).

Genus near *Echinospatagus* by the ensemble of characters, distinguished principally by the structure of its unpaired ambulacrum that, instead of being formed of equal successive pores or of three kinds of pores as in *Heteraster*, with pores of very disparate forms alternating with each other.

The species belong to Cretaceous terrains.

1. *E. filtoni*. Desor.— (*Hemipneustes fittoni*, Forbes). From the Aptian stage of La Presta. 2. *E. greenovii*. D'Orbigny. — (*Hemipneustes,* Forbes). From Green Sandstone of Blackdown. 3. *E. texanus*. Desor. From the Senonian ofTexas. 4. *E. tschudii*. Desor. From the Senonian of Peru.

4th GENUS. **ISASTER**. *ISASTER*.— Desor.

General form a little different from that of *Epiaster*. Periproct infra-marginal. No anterior groove.

This genus is intermediary between the two tribes of Spatangoids. It contains only two species from the Upper Cretaceous (Senonian).

1. *Isaster aquitenicus*. D'Orbigny. — (*Micraster aquitanicus*, Agassi— *Spatangus Id.*, Grat.) 2. *Isaster amygdala*. D'Orbigny.— (*Spatangus amygdala*, Goldfuss. — *Holaster amygdala*, Agassiz.)

5th GENUS. **MICRASTER**. *MICRASTER*, — Agassiz.

Test cordiform. Paired ambulacra, petaloid, located in grooves. The unpaired, also sunken, is composed of uniform pairs of pores. Peristome bilabiate, sinuous, transverse, located in front and below. Periproct oval longitudinally, marginal to the top of the anal area. A sub-anal fasciole forms a ring around the posterior end.

The genus *Micraster* is very well circumscribed and sufficiently characterized. Desor united it with the genus *Epiaster* of D'Orbigny and does not maintain it as a division.

Micraster comes from all the Middle and Upper Cretaceous terrains

Species of the Turonian stage: 1. *Micraster matheroni*, Desor. 2. *M. brevis*, Desor, (*M. latus*, Syn.). 3. *M. michelini*, Agassiz.— Species from the Upper Chalk (Senonian): 4. *M. coranguinum*, Agassiz, (*Spatangus* Id., Klein). 5. *M. gibbus*, Agassiz, (*Spatangus* Id., Lamarck, Encycl. méthod., t. 156, f. 4–6, 6. *M. leskei*, D'Orbigny. 7. *M. laxoporus*, D'Orbigny. 8. *M. inleger*, D'Orbigny. 9. *M. brongniarti*, Hébert. 10. *M. desorii*, Hebert. 11. *M. cor-columbarium*, Desor. 12. *M. gleizezei*, Leymerie. 13. *M. corbovis,* Forbes. 14, *M. brevisulcatus*, Agassiz (*Pericosmus* Id., Agassiz, D'Orbigy).

6th GENUS. **EPIASATER**. *EPIASTER*.— D'Orbigny.

Similar to *Micraster* but having no fasciole.

Fossil of different stages of the Cretaceous period.

1. *Epiaster polygonus*. D'Orbigny. (*Micraster* Id., Agassiz.) Fromo the Aptian stage. Perte du Rhône (Ain). 2. *Epiaster trigonalis*. D'Orbigny. — (*Micraster* Id., Agassiz). From the Albian (Gault) stage of Estragnolles (Var). 3. *Epiaster koechlinanus.* D'Orbigny. From the Cenomanian of Castellane (Basses- Alpes). 4, *Epiaster tumidus*. D'Orbigny. From the Cenomanian of Jabron (Var). 5. *Epiaster crassissimus*. D'Orbigny (*Spatangus crassissimus*, Defr.). From the Cenomanian of Villers. 6. *Epiaster distinctus*. D'Orbigny. — (*Micraster* Id., Agassiz). From the Cenomanian of Villers, Le Havre, etc. 7. *Epiaster varusensis*. D'Orbigny. From the Cenomanian of La Malie (Var).

7th GENUS. **HEMIASTER**. *HEMIASTER*.— Desor.

Test swollen, cordiform, short and stocky. Petals unequal, the unpaired non-petaloid, located in a groove more or less prolonged toward the peristome. Paired ambulacra, petaloid, crenelated, anteriors longer. Periproct oval longitudinally, sometimes round or transverse, supra-marginal, in a very pronounced area. A peripetalous fasciole surrounding the ambulacra.

The species of this genus are recognized first by their appearance, short and swollen. The genus *Hemiaster* differs from *Epiaster* by its fasciole, from *Micraster* by its peripetalous fasciole and no sub-anal. The species are very numerous and can be separated into two principal groups, one of which includes those that have unequal petals and the other species with equal petals.

All the species are fossil and are found in all the stages of the Cretaceous and Tertiary terrains. We count about 50 species of which 5 are from the Green Sandstone, 3 from the Cenomanian, 5 from the Turonian, 25 from the Senonian and 12 from the Tertiary terrains.

8th GENUS. **BRISSOPSIS**. *BRISSOPSIS* — Agassiz,

— *Tripylus*, Phill. — *Cyclaster*, Cotteau.

Test swollen, ovoid, with a more or less median top. Ambulacra unequal, the anteriors straight and divergent, the unpaired in a shallow groove. Two fascioles, a peripetalous and a sub-anal.

This genus, near *Brissus*, is distinguished by its nearly median top and by the distance between the anus and the shield formed by the sub-anal fasciole. We refer there the genus *Trepylus* Philippi and Gray, that is based only on the absence of the sub-anal fasciole. According to Desor, it is also necessary to unite here the genus *Cyclaster* of Cotteau.

The genus *Brissopsis* is found living in present seas and as fossils in the Tertiary terrains.

1. BRISSORSIS LYRIFERA. *Brissopsis lyrifera*. Agassiz.—*Brissus lyrifera*, Forbes, Brit. Starf., p. 187. — *Id., Id.,* Duben and Koren, Mém. Acad. Stockh., 1844, p. 280, tab. X, f. 46.

Species moderately swollen, oval, having a not very sinuous peripetalous fasciole crossing the two posterior ambulacra that, on the ventral surface, are very wide. The shield on the contrary is narrow.

Inhabits the seas of the North, the coasts of England.

2. EXCAVATED BRISSOPSIS. *Brissopsis excavatus.* — *Tripylus excavatus*, Philip., Erichs. archiv., 1845, p. 342, t. 2, f. 1.

Test cordiform, sub-orbicular. Ambulacra oblong, linear, the lateral posterior part double or triple in length.

Inhabits South America.

3. PHILIPP'S BRISSOPSIS. *Brissopsis philippii.* — *Tripylus philippii*, Gray, Ann. and Mag. of Nat. Hist., 1851, and Cat. Brit. Mus., t. 5, f. 1.

Species cordiform, a little depressed.

Inhabits South America.

4. *SOUTHERN BRISSOPSIS*. *Brissopsis australis*, Agassiz.— *Tripylus Id.*, Philipp.

Inhabits South America.

5. CAVERNOUS BRISSOPSIS, *Brissopsis cavernosa*. Afassiz. — Cat. rais. — *Tripylus cavernosus*, Paper, Archiv. Erich.

Inhabits South America.

Gray accepts the genus *Tripylus* that he forms with *T. excavatus* and *T. philippi*, Gray. Then *Tripylus australis* and *cavernosus* (Philip.) become the types of a particular genus under the name of *Faorina*, to which he joins two species: *F. chinensis* and *F.*

antarclica, Gray. Finally, the same author establishes a genus *Meoma* that is distinguished by the absolute loss of pores in the unpaired ambulacrum. The species he refers there is *Meoma grandis*, Gray, of Australia.

FOSSIL SPECIES.

Nummulitic stage: 1. *B. contracta*, Desor. From Nice. 2. *B. angusta*, Desor. From Egypt. 3. *B. oblonga*, Agassiz. From Nice. 4. *B. alarici*, Desor, (*Hemiaster*) *Id.*, *Tallav*. D'Alaric. 5. *B. decliva*, Desor; (*Cylaster declivis*, Cotteau). From Bresse (Landes). 6. *B. obliquata*, Desor (*Spatangus obliquatus*, Grant. From the prov. of Cutch. 7. *B. branderiana* (*Hemiaster*), Forbes. From Boston, clay of London. 8. *B. intermedia*, Desor (*Schizsaster intermedius*, Sism.). From the Miocene, Turin. 9. *B. sismondae,* Agassiz. From Corsica. 10. *B. romuli*, Desor. Miocene from Mount Mario. 11. *B. borsoni*, Agassiz. From the Miocene of Castiglione. 12. *B. duciei*, Wright. Miocene of Malta. 13. *B. nicoleti*, Desor. Molasses of Switzerland.

9th GENUS. **PERIASTER**. *PERIASTER*. — D'Orbigny.

Test swollen, with an angular peripetalous fasciole complicated by a second branch (fasciole latéral) that is directed backwards and surrounds the anus. The petals are generally deeper and less unequal than in *Hemiaster.* The top is also more central.

This genus is very near *Hemiaster* and differs only by the presence of an additional lateral fasciole. It is necessary to add to this character the position of the more central ambulacral tope and the deeper and wider petals.

The species found living and as a fossil in the Cretaceous and Tertiary beds.

1. *Periaster fragilis*. D'Orbigny. — *Brissus fragilis*, Duben and Koren. — *Schizaster Id.*, Agassiz. Inhabits the coasts of Finmarck. 2. *Periaster gibberulus*. D'Orbigny. (*Schizaster gibberulus*, Agassiz , Savigny, Ouvr. d'Egypte, pl. 7, f. 6.) Inhabits the Red Sea. 3. *Periaster cubensis*. D'Orbigny. (*Schisaster cubensis*, Agassiz.) From the contemporary stage of Cuba.

FOSSIL SPECIES.

Cenomanian stage: 1. *Periaster undulctus*, D'Orbigny, (*Micraster Id.*, Agassiz). 2. *P. elatus* D'Orbigny, (*Hemiaster Id.*, Desor). 3. *P. conicus*, D'Orbigny. 4. *P. bucklandi*, Desor, (*Spatangus Id.*, Goldfouss; *Hemiaster Id.*, D'Orbigny). 5. *D. fourneli*, Desor, (*Hemiaster fourneli*, Desor). 6. *P. oblongus*, D'Orbigny. From the Turonian of Biskra (Algeria). Senonian stage: 7. *P. bucurdium*, Desor. 8. *P. altissimus*, (*Hemiaster globosus*, D'Orbigny, non Desor). From the Danian stage of St.-Mathias near Vérone. 9. *P. texanus*, Desor, (*Hemiaster Id.*, Roemer). 10. *P. rana*, Desor, (*Brissus Id.*, Forbes). From Pondichéry. 11. *P. inaequalis*, Deson, (*Brissus Id.*, Forbes). From Pondichéry, 12. *P. expansus*, Desor, (*Brissus Id.*, Forbes). From Pondichéry. Species from Tertiaryterrans: 13. *Periaster aequifissus*, Desor, (*Schizaster Id.*, Agassiz). From the Nummulitic stage. 14. *P, spatangoides*, Desor, (*Linthia Id.*, Desor). 15. *P. verticalis*, Desor, (*Schisaster Id.*, Agassiz,

and *Sch. culiratus, S. cerasus,* Agassiz). 16. *P. canaliculatus*, Desor, (*Hemiaster Id.*, Cotteau) 17. *P. leymeriei* (*Schisaster*), Cotteau. 18. *P. complunatus,* Desor, (*Hemiaster Id.*, Agassiz, D'Archiac). 19, *P. latisulcatus* (*Hemiaster*), Desor. D'Egypte. 20. *P. suborbicularis*, Desor, (*Spatangus Id.*, Goldfuss). 21. *P. obesus*, Desor, (*Spatangus Id.*, Leymerie). 22 *P. subquadratus*, Desor. 23. *P. inflatus*, Desor. From the Parisian stage from the vicinity of Paris. 24. *Periaster passyanus*, (*Hemiaster Id.*, Sorignet). Parisian stage, Vely, Fontenay. 25. *P. subglobosus,* (*Spatangus*, Lamarck; *Hemiaster orbicularis*, Sorigner, *Id.*) 26. *P. herklotsi*, Desor, (*Pericosmus Id.*, Herklots). Recent terrain of Java.

10th GENUS. **LINTHIA**. *LINTHIA*. — Mérian.

Scarcely differs from *Periaster* by the nature of the tubercles and the disposition of the peripetalous fasciole that is attached in some way to the petals.

Two species only from the Tertiary terrains.

1. *Linthia insignis*. Mérian. From the Nummulitic stage of Blangg near Yberg. 2. *Linthia cruciata*. Desor. (*Brissus cruciatus*, Agassiz.) From the Miocene of Capri.

11th GENUS. **PERICOSMUS**. *PERICOSMUS*. — Agassiz.

Test depressed. Anterior groove wide. A peripetalous fasciole and a marginal fasciole go around the test and pass under the periproct.

This genus is scarcely different from *Periaster*.
All the species are fossils in the Tertiary terrains.

1. *Pericosmus pomum*, Desor. Danian stage of Orglande. 2. *P. scutiformis*, (*Brissopsis Id.*, D'Archiac). Nummulitic stage of Hala (Sinde). 3. *P. latus*, Agassiz. Miocene of Corsica. 4. *P. edwardsii*, Agassiz, (*Schizaster agassizii*, Sism.). Miocene of Superga. 5. *P. aequalis,* Desor. Miocene of Dego. 6. *P. granuiosus*, Herkl. 7. *P. rotundatus*, Herkl. 8. *P. asperulatus*, Herkl. 9. *P. distinctus*, Herkl.. 10. *P. planulatus*, Herkl. 11. *P. parvus*, Herkl.. 12. *P. altus*, Herk, are from Tertiary terrains of Tjidamar (Java).

12th GENUS. **KLEINIA**. *KLEINIA*. — Gray.

Test ovoid, elongated, with subcentral top in front. Petals concave, linear, confluent at the top. Anterior groove deep. Peripetalous fasciole wide and sinuous. Subanal fasciole surrounding the latter that is located on the upper part of the posterior edge.

According to Gray, this genus differs from *Brissus* by the form of the petals and the size of the spines as well as the size of the dorsal tubercles.
A single living species.

Kleinia luzonica. Gray, from the Philippines,

13th GENUS. **LESKIA.** *LESKIA*.— Gray.

Petals wide, spread out, non-linear. Peristome anterior, flush with the test. Periproct circular. Both formed by five valves that are triangular, convergent, forming a cone covered with small spines.

A single living species.

Leskia mirabilis. Gray. —An. and Mag., vol. VII, p. 130.

Inhabits the Philippines.

14th GENUS. **EUPATANGUS**. *EUPATAGUS*.— Agassiz.

Test depressed in front, have interambulacral areas with large tubercles that are crenelated and perforated. Petals spread out, rounded and closed. A peripetalous fasciole, not sinuous. A sub-anal fasciole surrounding the shield.

This genus is perfectly characterized by its flared petals, its large tubercles on the interambulacral areas except the unpaired where they are not found.

The species is found living and as a fossil. The latter are all from the Tertiary terrains.

Eupatagus valenciennesi. Agassiz.

Species whose tubercles are not very numerous and are near the peripetalous fasciole.

Inhabits Australia (Mus. Paris.)

FOSSIL SPECIES.

1. *E. veronensis*, Agassiz. Pisolithic of Verona. 2. *E. ornatus,* (*Spatangus Id.*, Desor; *Spat. tuberculatus*, Agassi). From the Nummulitic stage of Biarritz. 3. *E. naviceila*, Agassiz. *Id.* 4. *E. elongatus*, Agassiz, *Id.* 5. *E. patellaris*, D'Archiac. *Id.*, of Hala (Sinde). 6. *E. rostratus*, D'Archiac. *Id., Id.* 7. *E. duvalii*, Desor. Parisian stage. 8. *E. nummulinus*, Agassiz. *Id.* 9. *E. lateralis*, Agassiz. Miocene of Superga. 10. *E. koninchkii*, Wright (Sp.). *Id.*, of Malta. 11. *E. simplex*, Agassiz. *Id.*, Corsica. 12. *E. pulchellus* (*Spatangus*), Herklots. Recent Tertiary of Java. 13. *E. atticus* (*Spat*.) Herklots. *1d., Id.*

15th GENUS. **HEMIPATAGUS**. *HEMIPATAGUS*. — Desor,

Test not very elevated, dilated.— Paired interambulacral areas with tubercles, the unpaired having none. Plastron smooth. Petals flared, elongated. Four genital pores. No fascioles.

This genus was established by Desor for species confused until now with *Spatangus* and that correspond to the second division of Agassiz.

It differs from *Eupatagus* by the absence of a fasciole and from the true *Spatangus* by its smooth unpaired interambulacral area.

All the species are fossils in the Tertiary terrains.

1. *Hemipatagus depressus*, Desor, (*Spatangus Id.*, Dubois, Voy. Caucase, t. I, f. 16. From the Nummulitic stage of Crimea, from Mount Sinai. 2. *H. pendulus* (*Spatangus*), Agassiz. Nummulitic from Mount Sinaï. 3. *H. grignonensis* (*Spatangus*), Agassiz; Sp. *Omalii*, Galiott.? Parisian stage of Grignon. 4. *H. archiaci* (*Spatangus*), Agassiz. Parisian stage, Monchy. 5. *H. integer* (*Spat. id,*, Sorignet). Parisian stage of Fours (Eure). 6. ? *H. cosoni* (*Hemiaster*). Sorigner. *1d., Id.* 7. *H. simplex* (*Spatangus*), Agassiz. Miocene of Corsica. 8. *H. pustulatus* (*Spatangus*), Bronn. Melisse of the Bavarian Alps. 9. *H. proelongus* (*Spat*), Henrkl. Recent Tertiary of Java. 10. *H. affinis* (*Spat.*), Herkl. *1d., Id.* 11. *H. pulchellus* (*Spat.*), Herkl. *1d., Id.* 12. *H. hoffmanni* (*Spatangus*), Goldfuss. Pliocene terrain of Bünde,

16th *Genus.* ***Gaulteria***. *GUALTERIA*—Desor.

Test rather similar to *Eupatagus* and *Spatangus* but having the peristome surrounded by large folds and bourrelets. The peripetalus fasciole passes over the ambulacra at two thirds of their length.

We know up to now only a single species from the Nummulitic stage.

GAULTERIA OF D'ORBIGNY. *Gualteria orbignyana*. Desor. Cat. rais., p. 116.

Fossil of the Nummulitic of St-Palais near Royan.

17th GENUS. **BREYNIA**. *BREYNIA*. — Desor.

Test swollen, cordiform, with three distinct fascioles, a peripetalus, an internal fasciole and a sub-anal fasciole. Tubercles large, scrobiculate, existing only in the space circumscribed by the peripetalus fasciole.

This genus, distinct from the *Spatangus* of Lamarck, has for type *Spatangus crux andrae,* the only living species. The fossils, which are not very numerous, come from Tertiary terrains.

1. *Breynia crux andrae*. Desor— *Spatangus crux andrae, Brissus crux andrae*, Agassiz, Desor. — *Breynia australasi* Gray. *Breynia carinata*. Have. From the Nummulitic stage of Hala (Sinde). 3. *Breynia sulcata*. Haime. From the Nummulitic stage of Biarritz. 4. *Breynia magna*. Desor.—*Eupatagus magnus*, Herklots. From a Recent Tertiary terrain of Java.

18th GENUS. **ECHINOCARDIUM**. — *ECHINOCARDIUM.* — Gray.

— *Spatangus* authors. — *Amphidetus*, Agassiz.

Test swollen, gibbous, cordiform, very thin. An internal fasciole surrounding the ambulacral top and embracing the unpaired ambulacrum as well as a part of the other ambulacra. These portions of the ambulacra thus circumscribe have only small and siimple pores while the rest have larger and circumflex pores.

Echinocardium is of the present period and also found as a fossil in Upper Tertiary terrains.

1. *Echinocardium cordatum. — Echinus cordatus*, Pennant, Brit. Zool., IV, p. 69, tab. 34, f. 75. — *Spatangus arcuarius* , Lamarck. — *Amphidetus cordatus*, Agassiz.
   Inhabits the Mediterraneum and as a fossil in the Corallian Crag of England.

2. *Echinocardium ovatum*. —- *Spatangus ovatus*, Leske in Klein, p. 252, t. 49, f. 12–13. — Seba, Mus., t. IL, pl. 15, f. 27–29.—Copied in Encycl. méth., pl. 159, f. 5–6. — *Amphidetus ovatus*, Agassi— Var. *minor A. roseus*, Forbes. — *Amphidetus ovatus*, Duben, Koren, Mem. Acad. Stockh., 1844, p. 283, tab. X, f. 50. Inhabits the coasts of Sweden and England.

3. *Echinocardium gibbosum*. — *Amphidetus cordatus*. Agassiz.
   This species differs from *E. cordatus* by the absence of an anterior ambulacral groove. The internal fasciole approaches the top. Inhabits the Mediterranean, Palermo, Bone.

4. *Echinocardium mediterranemn*. — *Amphidetus mediterraneus*, Forbes, An. and Mag. of nat. Hist. vol. 13, 1844, p. 518. — *Id.*, Sars, Midd. Faun. litt. in nyt. Mag. for Naturv., 1857, tab. X, f. 1, p. 61, n° 38. Inhabits the Mediterranean.

5. *Echinocurdium zelandicum*. Gray. Australia.

6. *Echinocardium australiae*. Gray. Inhabits Australia.

FOSSIL SPECIES.

7. *Echinocardium subcentrale. — Amphidetus subcentralis*, Agassiz, D'Archiac, Mém. Soc. géol., vol. IL, t. XI, f. 3. From the Nummulitic stage of Saint-Palais near Royan.

8. *Echinocardium virginianum.— Amphidetus virginianus*, Forbes.— *Spatangus orthonosus*, Conrad. From the Miocene of Alabama.

9, *Echinocardium deikei*. Desor. From the Molasse of Krobell.

10. *Echinocardium depressum.— Amphidetus depressus*, Agassiz. From the Molasse of Couronne (Martigues).

11. *Echinocardium sartorii. — Amphidetus sartorii*, Agassiz. From the Upper Tertiary of Palermo.

19th GENUS. **SCHIZASTER**. *SCHIZASTER*— Agassiz.

Test thin, oval, swollen, with unequal petals, very deep. Anterior groove forming an equally deep canal. Ambulacral top very eccentric in front. Anterior petals longer, deeper, flexuous. Two fascioles, a peripetalus closely circumscribing the ambulacra and a lateral that detaches from it at the end of the anterior petals to pass under the anus.

The genus *Schizaster* was established by Agassiz for some species previously placed by Lamarck in the genus *Spatangus*. Since its establishment, it has received some modifications and we have removed several types that have given rise to the genera *Periaster* and *Mera* so that there remains only the very asymmetrical species that are often very eccentric posteriorly and with flexuous petals more or less parallel to the anterior groove. The genital pores, although variable, number three in *Schizaster canaliferus* that we can regard as the typical species.

It is on a consideration of this genus that is based the genus *Tripylus philippi*.

Schizaster exists as a living genus and also as fossils in all the Tertiary terrains.

Species from the Nummulitic stage: 1. *Schizaster ambulacrum*, Agassiz. From Biarritz, Vicentin. 2. *S. rimosus*, Desor. *Id.* 3. *S. studeri*, Agassiz, (*S. incurvatus*, Agassiz; *S. djulfensis*, Dubois). 4. *S. vicinalis*, Abassiz. 5. *S. beloutchistanensis*, D'Archiac and Haime (*Spat. acuminatus*, Sow.). From Hala (Sinde), Babou Hill (prov. Cutch). 6. *S. newboldi,* Haime. From Hala (Sinde). 7. *S. latus*, Desor. Parisian stage of Blaye. 8. *S. durbani*, Forbes. *Id.*, clay of Barton. 9. *S. desorii*, Wright. From the Miocene of Malta, Corsica. 10. *S. bellardi*. Agassiz. Miocene of Superga. 11. *S. scillae*, Agassiz, (*Spatang. scilae*, Desmoulins; *Schiz. eurynotus*, Agassiz; *S. groeaecus*, Agassiz). From the Miocene of Malta, Morée, Corsica, Perpignan, Palermo. 12. *S. major* (*Hemiaster Id.*, Desor; *Schizaster canaliformis*, Sism.). From Vastezan. 13. *S. parkinsoni*, Agassiz, (*Spat. Id.*, Defr.; *Spat. lacunosus* , Park.; *S. goldfussii*, Agassiz; *S. raulini*, Agassiz). Miocene of Martigues, Sardinia, Malta. 14. *S. subrhomboidalis*, Herkl. Recent Tertiary of Java. 15. *S. costifer* (*Hemiaster*), Hertklos. Recent Tertiary of Java. 16. *S. amplus* (*Hemiaster Id.*, D'Orbigny). From Chalk ??

18th GENUS. **MOIRA**. *MOIRA* — Michelin.

Test swollen, ovoId. — Ambulacra extremely narrow, forming five deep slits leaving from the top. A peripetalus fasciole surrounds them with a smooth zone. There is also a lateral fasciole. Two genital pores.

Michelin established this genus with *Spatangus atropos* authors, a species that Agassiz had placed in *Schizaster*. The completely particular form of the ambulacra justifies perfectly this creation.

1. *Moira atropos* Michelin. — *Spantangus atropos*, Lamarck, Encycl. méth., p. 155, f. 9–11. — *Schizaster atropos*, Agassiz. Inhabits the Mediterranean.

2. *Moira lachesis*. Desor. — Syn., p. 395. — *Schizaster lachesis*, Girard, Proc. Bost. Soc., 1850, vol, IL, p. 368. Species near *Atropos* but smaller, narrower. Inhabits the coasts of Texas and as a fossil (post-Pliocene) in South Carolina.

21th GENUS. **AGASSIZIA**. *AGASSIZIA*. — Val.

Test swollen, ovoId. Petals composed of a single poriferous zone. Peripetalus fasciole, very flexuous, with a lateral fasciole passing under the anus. Four genital pores.

Agassizia scrobiculata. Val. — Voy. Vénus Zool., tab. 1, f. 2. Living on the coasts of Peru.

22nd GENUS. **TOXOBRISSUS**. *TOXOBRISSUS* — Desor.

Test depressed. Top nearly median. Petals very arced. A peripetalus fasciole.

This genus was established for species that previously had been placed by the form of the petals that are very curved and whose posteriors unite with the anteriors forming two arcs or crescents that touch by their convexity toward the top.

All the species are found in Tertiary terrains.

1. *Toxobrissus elegans* (*Brissopsis elegans*), Agassiz. From the Coarse Sandstone (Parisian) of St. Estèphe.

2. *Toxobrissus genei*, Desor. — *Schizaster Id.*, Sism. From the Miocene of Turin.

3. *Toxobrissus michelotti*. Desor. From the Miocene of Turin.

4. *Toxobrissus crescenticus.— Brissopsis Id.*, Wright. From the Miocene of Malta.

5. *Toxobrissus latior*. — *Brissopsis*, Herklots. Recent Tertiary of Java.

23rd GENUS. **PRENASTER**. *PRENASTER.* — Desor.

Test swollen, ovoid. Ambulacral top very eccentric. Petals narrow, not very deep, very divergent. A peripetalus fasciole that is incomplete, not closed on the anterior part. A lateral fasciole goes around the test.

This genus is near *Brissus*. It is distinguished by its general form that is a little different but especially by the particular disposition of the peripetalus fasciole combined with the lateral fasciole.

The species that are not very numerous are found in Upper Cretaceous and Lower Tertiary terrains.

Nummulitic stage: *Prenaster helveticus* (*Brissus*), Agassiz. — *P. alpinus*, Desor. — *P. subacutus* (*Brissus*), Desor. — *P. perplexus*, Desor. — *P. sowerbyi* (*Brissopsis*), D'Archiac. — *P. julieri* (*Brissus*), Schlum.— P. sorigneti, Defr. (Danian), Eure. — *P. birostratus* (*Hemiaster*), Sorignet.

It is probably to the genus *Prenaster* that it is necessary to refer a group established by Gray under the name of *Desoria*. In any case, as the name has already been used previously, as *Desorella*, it is impossible to accept it here.

24th GENUS. **BRISSUS**. *BRISSUS*.— Arist., Klein.

Test ovoid, more or less elongated. Top very eccentric in front. Paired ambulacra, narrow, in a shallow groove, the anteriors nearly transverse. Unpaired groove scarcely pronounced. There are two fascioles, one peripetalus, very sinuous, the other sub-anal. Four genital pores.

This genus was reported by Aristotle under the name that has kept since been restored to it because all the species that constitute it were previously confused with *Spatangus*. It was Klein who circumscribed it nearly as completely as it is today. However, some genera have been removed such as *Plagionotus, Prenaster. Brissus* constitutes one present form. Most species are found living in seas of warm countries. As for fossils, they are all from Upper Tertiary terrains.

1. BRISSUS VENTRU. *Brissus ventricosus.* (*Spatangus ventricosus*, Lamarck. Encycl. méth., pl. 158, f. 11.) Very large species with a nearly median ambulacral top. Inhabits St. Domingo, the Antilles.

2. BRISSUS STERNAL. *Brissus sternalis*. Agassiz. (*Spatangus sternalis*, Lamarck.) Inhabits Australia.

3. *Brissus bicinctus*. Val., Afassiz. — Cat. rais., p. 13.
   This species differs from *sternalis* in that the fasciole is double in the anterior ambulacral area as well as at the posterior edge of the paired ambulacral areas. Inhabits the Red Sea.

4. *Brissus carinatus*. Agassiz. (*Spatangus carinatus* , Lamarcck, Encycl., p. 199, f. 1.)
   This species is remarkable for the character of its unpaired ambulacral area. Its posterior edge is cut very obliquely. Inhabits Australia.

5. *Brissus columbaris*. Agassiz. (*Spatangus columbaris*, Lamarck.)

6. *Brissus dimidiatus*. Agassiz.
   Species raised, keeled a little like *B. carinatus* but with the posterior edge truncated vertically like *B. scillæ*. The tubercles of the anterior half of the test are larger than

those of the posterior half. Inhabits Cuba, Guadeloupe and a sub-fossil of the same countries.

7. *Brissus scille*. Agassiz. (*Spatangus ovatus*, var. B. Lamarck, III, p. 524, Encycl. méth., pl. 158, f. 7.) — *Brissus placenta*, Philippi, Archiv. Weis., 1845, p. 349.
Species more depressed than *B. carinatus*, with a vertical posterior edge while it is comparataively oblique in the cited species. Inhabits the Mediterranean, Palermo and a fossil of the Crag of England, Malta.

8. *Brissus compressus.* (*Spatangus compressus*, Lamarck.) From the island of Mauritius.

9. *Brissus areolatus*. Var, Agassiz, — Cat. rais. Species near *B. columbaris.* Agassiz thinks it is perhaps only a variety of *B. sternalis*. Inhabits Australian seas. (Mus. Paris.)

10. *Brissus panis*. Grub. — Archiv. Weigm., 1857, p. 344.

FOSSIL SPECIES.

1. *Brissus antiquus*, Desor. From the Nummulitic stage of Aurillac. 2. *Brissus dilatatus*, Desor, (*Spatangus columbarius*, Desmoulins). From the Parisian stage of Rioms (Gironde). 3. *Brissus cordieri*, Agassiz. From the Molasse of St. Paul-Trois-Châteaux, Malta, 4. *Brissus latus*, Wright. Miocene, Malta. 5. *Brissus cylindricus*, Agassiz, (? *B. oblongus*, Forbes). Tertiary of Palermo. 6. *Brissus declivis*. Herkl. Recent Tertiary of Java.

25th GENUS. **LOVENIA**. *LOVENIA*.— Agassiz.

Agassiz established under this name a genus very near *Brissus* and *Plagionotus*, remarkable for the large tubercles in the interambulacral areas that support very elongated and very sharp spines.

The typical species is:

PORCUPINE LOVENIA. *Lovenia hystrix*, Agassiz.— Savigny. Egypte, Echin., pl. 2, f. 3. From the Red Sea.

26th GENUS. **PLAGIONOTUS**. *PLAGIONOTUS*. — Agassiz.

— *Spatangus*, Lamarck.

Test very large, depressed, with large tubercles on the dorsal surface. A very distinct peripetalus fasciole and a sub-anal fasciole. Petals long and slender, the anteriors arced in front. Ambulacral top central.

This genus, created at the expense of *Spatangus*, is nearest *Brissus* and especially *Eupatagus* because of the disposition of the tubercles on the dorsal surface as well as by the form of the peripetalus fasciole, but their petals are even more linear while those of *Eupatagus* are enlarged.

Two species of the present period.

1. *Plagionotus pectoralis*. Agassiz. (*Spatangus pectoralis*, Lamarck. — Encycl. méth., pl. 159, f. 2–3. — *Brissus pectoralis*, Agassiz.) Inhabits the coasts of Brazil.

2. *Plagionotus desorii*. Gray. — Gray, Ann. and Mag. Habite ?

27th GENUS. **MACROPNEUSTES**. MACROPNEUSTES. — AGASSIZ.

Test swollen, oval, a little depressed, with large tubercles distributed without order on the interambulacral areas. Petals long, not very sunken. Peripetalus fasciole very near the edge.

All the species are fossils in Tertiary terrains.

1. *Macropneustes beaumonti*, Agassiz. Danian stage of Montecchio-Maggiore. 2. *M. pulvinatus*, Agassiz. Nummulitic stage of Biarritz. 3. *M. meneghini*, Desor. *1d*., from Vicentin. 4. *M. crassus*, Agassiz, *Id.*, from Egypt. 5. *M. brissoides,* Desor (*Spatangus Id.*, Leske; *Spat. punctatus*, Grat., non Lamarck). *Id.*., from Montfort. 6. *M. desorii*, Mexan. *Id.*, from Kressenberg. 7. *M. deshayesii*, Agassiz (*Micraster major*, Agassiz). *Id.*, from Blangg (from Switzerland), from the Eocene of St. Gervais. 8. *M. subovatus*, Sorigner. Eocene, St. Gervais. 9. *M. minor,* Desor. (*Eupatagus Id.* Agassiz). From Ecos (Eure), sands of Beauchamp. 10. *M. prevostii*, Desor. From the Eocene, vicinity of Paris. 11. *M. Requieni* (*Spat*.), Agassiz. From the Miocene, France. 12. *M. chitonosus* (*Spat*.), Sismonda. Miocene, Turin. 13. *M. gibbosus*, Merian. *Id.* 14. *M. marmorae*, Desor. From the Miocene of Balistro, Corsica.

28th GENUS. **SPATANGUS**. *SPATANGUS*.— Arist., Klein.

Test swollen, cordiform, with tubercles that are large, perforated, crenelated and scrobiculate on the five interambulacral areas. Petals flared, very wide. A very undulating sub-anal fasciole.

The genus *Spatangus*, known for a long time, has been subjected to a good number of transformatios that have given the establishment of a large number of new generic sections. It is limited now to species whose ambulacra are very flared, whose test is covered with large tubercles and that has only a single sub-anal fasciole, consequently without peripetalus, lateral or marginal fascioles.

The living species are not very numerous and come from temperate seas. The fossils are encountered in recent Tertiary terrains.

1. HEART OF THE SEA SPATANGUS. *Spatangus purpureus*. O.F. Müller.—Müller, Zool. Dan. Prodr., p. 236, n° 2850, tab. 6. — *Spatangus purpureus*, Leske in Klein, t. 45, f. 3–5. — *Echinus purpureus*, Lin., GmeL., Syst., nat., p. 3197. — d'Orgueville, Conchyl. pl. 25, f. 3 Pas de Poulain), Encycl. méthod., p. 157, f. 1, 4. — Lamarck, An. s. vert., p. 324. — Blainville, Man. Act., p.202, pl. 14, f. 1–3. — *Id.*, Cuvier, Règ. animal illustré, pl. 11 *bis* and 17, f. 2.

Species in the form of a rounded heart, depressed, obtuse posteriorly, covered with large tubercles arranged in zigzags in rows of five or six. All these tubers are surmounted by numerous spines, those of the largest being more or less greenish. The others have, like the rest of the test and violet or purple color.

This species is the most common of all. For a long time it was confused with another species that lives in the Mediterranean (*Sp. mediterraneus*). Inhabits the western and northern coasts of Europe up to Norway. It is a fossil in the Crag of Ramsholt (England), but there is still doubt about its identity.

2. SOUTHERN SPATANGUS. *Spatangus meridionalis*. Risso.—Risso, Hist. nat. Eur. mérId., t. V, p. 280. — *Id.*, Part, Arch. Weigm., 1845, 1, p. 350. — *Id.*, Agassiz, Cat. rais., p. 6. — *Id.*, Sars, Nyt. Mag. fur Naturv., v. X, pl. 1, p. 62, n° 40.

Species near the preceding but larger, more swollen and more elevated, its size corresponding to the environment. The anterior groove also is deeper and the posterior area has dorsally a kind of keel. It also has a purple color. Inhabits the Mediterranean.

3. Flat SPATANGUS. *Spatangus planulatus*. Lamarck.

Species depressed, flat, having large tubercles that are rather numerous, regularly spaced, extending to the edges. The plastron is smooth. The peristome is a kind of broken crescent. Inhabits southern seas, Java, Waigiou.

FOSSIL SPECIES.

1. *Spatangus siculus*. Agassiz. — Cat. rais., p. 6. — Parkinson, Org. Rev., Pl. 3, f. 9.

Species near *meridionalis*, whose tubercles form equally distinct chevrons on all the interambulacral areas, paired and unpaired.

Fossil of the Upper Tertiary terrain of Palermo.

2. *Spatangus philippi*. Desor. — Cat. rais., p. 7, and Syn., p. 420.

Species having more affinity with *Sp. meridionalis*, with a wide anterior groove, keels.

Fossil of the recent Tertiary terrain of Cape Safran near Palermo.

3. *Spatangus regina*. Gray.—Ann. and Mag. of nat. Hist., 2nd series, t. VII, p. 133. — *Id.*, Forbes, Brit. tert., p. 14, t. 2, f. 2.

Large species, swollen, more than ten centimeters in length. Tubercles arranged in well-designed chevrons on the paired ambulacral areas, those of the unpaired area being irregular and confined to the middle.

Fossil of the Corallian Crag of England.

4. *Spatangus rissoi*. Desor. — Syn., p. 420.

Species intermediate between *phillippi* and *S. siculus*. It is very swollen, moderately notched and without keels along the anterior groove.

Fossil of the Miocene ? (Coll. Michelin).

5. *Spatangus delphinus*. Defrance.— Dict. Sc. nat., t. 50, p. 96.—*Id.*, Desor, Syn., p. 421. Var. *Spat. corsicus*, Desor. Cat. rais., p. 113.

Fossil of St.-Paul-Trois-Châteaux, the variety coming from Balistro.

6. *Spatangus desmarestii*. Munster. Tertiary terrain of Bunde (Westphalia).

7. *Spatangus asterias*. Agassiz. From Morée.

8. *Spatangus petalodus*. Agassiz. Miocene of ?

9. *Spatangus ocellatus*. Defr. (Sp. *nicoleti*, Agassiz.) Miocene of St.-Paul-Trois-Châteaux, etc.

10. *Spatangus pareti*. Agassiz. Miocene of Italy.

11. *Spatangus loncophorus*. Meneg. From the Nummulitic of Vicentin.

SIXTH BOOK.

HOLOTHURIDAE.

DEFINITION

Animals of cylindrical form, more or less elongated, sometimes vermiform, with soft skin, coriaceous with calcareous particles and across which are often retractile tentacular feet, scatter of arranged in ambulacral rows. Mouth located on the anterior part of the body, with in the interior a circle of calcareous pieces and surrounded by appendices in the form of more or less branched fronds. Anus opening at the posterior end of the body in a kind of cloaca. Sexes separated.

REVIEW

The singular form of Holothuroids has always attracted the attention of naturalists to these animals. The names of *Pudenda marina, Purgamenta maris*, ete., by which they have been designated, expresses the idea of a gross resemblance with some organs of our economy. It is in this kind of idea that Linné had applied for a moment the name of *Priapulus* that he soon changed to the of *Holothuria* that was since generally adopted. Many authors have been occupied with the animals of the group of Holothurians and we find graphic representations in the old works of Fabius Columna (1616), O. F. Müller (1776), Pennant (1777) and so many others up to Bruguière in the Encyclopédie méthodique (1792). It is from (1816) that date the somewhat serious work on the natural history and classification of these animals. At the same time, Tiedmann (*Anatom. der Roher Holothurien*) made an extremely important work on their anatomy and that still forms the basis of our present knowledge. Then. Eschscholtz (1829), Jaeger (1833) treated them specially. The latter made a complete revision of the group and established several new genera (*Mülleria, Bohadshia, Trepang*.). Cuvier, in the *Régne animal*, mentions the Holothurians under the name of Echinodermes pédicellés and made the 2nd order of the Echinodermes sans pieds for the Siponcelids and near genera. Brandt (1835, *Prodr. Descript. Anim. a Mertensio observ*.) presented a new classification of Holothurians in dividing them first into *H. pedicelles* and *H. apodes.* But these divisions are not equivalent to those proposed by Cuvier because they contained only Holothurians strictly speaking and not the Siponcles. Agassiz (1836, in his *Prodrome*) accepted 11 genera in his group of

Holothurians, among which was the genus *Minyas* that since has correctly been brought closer to the Actinians. De Blainville (1836), taking advantage of the work of his predecessors and most particularly those of Brandt, established five divisions among the Holothurians: A, *H. vermiformes* (G. *fistularia*); B. *H. ascidiformes* (G. *Psolus cuvieria);* C. *H. veretilliformes* (G. *Holothuria);* D. *H. cucumiformes (*G. *cucumis);* E. *H. sipunculiformes* (G. *molpadia*). Grube (1837, *Archiv, Weigm*.) made extremely important observations on the anatomy of Holothurians, studied the group of Siponcles that, according to the observations of this author, should be nearer the Annelids. Krohn (1841) made known the nervous system of Holothurians. Forbes (*Brit. Starfish*.), the species of the coasts of England. Duben and Koren (1846, *Mém. acad. Stock*.) have described the species of the seas of the North and finally Sars (1857) worked with the species of the Mediterranean.

DESCRIPTION.

The general form in Holothurians scarcely deviates from a kind of more or less elongated cylinder, sometimes vermiform. While it is sometimes very short and in the form of a barrel. In some cases, the body, instead of being simply cylindrical, is more or less angular, pentagonal or polyhedric. The extremely variable dimensions are, at least some centimeters but can reach in some species up to a meter in length.

The general body wall or skin is generally thick, coriaceous, rarely it is thin, transparent. It contains in its thickness an equally thick muscular layer composed of two layers: one superficial with circular fibers, the other deeper, formed of longitudinal fiber. These latter are most often well marked and constituting five bundles, more or less wide and far apart, tendinous in appearance that insert on one part, the bony ring of the anterior part and on the other part, i. e. toward the posterior end, to a ring of the same nature when it exists or simply to soft parts of this region in the more usual case where the ring is absent. The skin contains in addition some calcareous particles of varied forms. These are sometime round or angular; sometimes, as we see in Synaptids, some kind of small hooks having the form of anchors or fishhooks, that protrude from the skin and serve to attach the animal momentarily to foreign bodies. Each of these small organs is on a small scaly plate pierce with holes. These organs were observed first by De Quatrefages who has described and represented those of *Synapta duvernaea*. Ehrenberg (*Mém. acad. Berlin*, 1841) has described under the name of *Spongolithes anchora* and *Dictyocha splendens*, some calcareous concretions found in a marine mud at Vera Cruz (Mexico) that, in all probability, have belonged to Holothurians.

The most important solid parts are the buccal ring of which we just spoke. This bony ring, or rather calcareous, located under the skin and surrounding the esophagus, can be regarded as representing the skeleton of the Echinoid and probably corresponds to the bony circle in which is embedded the buccal apparatus when it exists. It is composed of ten or twelve pieces serving, as we have said, as the point of insertion of the longitudinal muscles as well as the buccal tentacles. It is often serrated on its anterior edge and when it is composed of twelve pieces, as in the Synaptids, the pieces that constitute it have oval openings to provide passage for the water canals. The skin of the Holothurians also has most often hollow organs that are cylindrical, extensible, ended by a sucker that constitute what are called tentacular feet. They are completely similar to what we find both in

Asteroids and in Echinoids and serve the same functions, i. e., they are both organs of movement and of touch and play a passive role in respiration. In some species, they take a disposition completely identical to what we observe in other Echinoderms in the sense they form five perfectly distinct ambulacral rows. In other cases, these tentacular feet are gathered together on one of the surfaces of the body, either on the ventral or the dorsal. In others. Finally, in others they appear irregularly dispersed without apparent order. We add that one entire group of Holothurians, the Synaptids, completely lack these organs.

The mouth opens at the anterior end of the body. It is located in the middle of a kind of funnel surmounted by a circle of more or less branched tentacles, variable according to species either by their number of mode of division. At the base of these tentacles are elongated vesicles that protrude into the body cavity. These are called *tentacular vesicles*. These organs are in communication with the tentacle branches that we just mentioned and very probably serve as a diverticulum with ambient liquid because we easily see the liquid flowing from the vesicles into the tentacles, and it is under their influence that we see these latter expand and enter into a true turgescence. They thus serve in respiration. However, they do not constitute the essential organs because the Holothurians have internal gills.

Immediately aft er the mouth begins the very muscular pharynx and surrounded by a circle of bony pieces of which we have already spoken. The intestinal canal is generally very long and nearly the same diameter for its entire length if not for a slight swelling at the stomach. This digestive tube makes several circumvolutions maintained by a kind of mesentery. It ends toward the posterior end where it opens into a vast cloaca with very thick walls into which also open the openings of the respiratory system. The intestine is moreover not always this great development because it is in Synaptids on the contrary, short, nearly straight and without cloacal dilation.

We consider as annexes of the intestinal canal some particular appendages in relation to the anterior part of the digestive tube and that resemble to some degree salivary glands. These organs vary greatly in regard to their form and number, either according to genus or species and even individual. They form in some cases (*Holothuria tubulosa*) bundles that appear to be inserted into the digestive canal by short stalks located a little beyond the pharynx. However, as these organs do not communicate with the intestinal cavity, their role as salivary glands is still very doubtful. We can also regard as very problematic the opinion of some authors such as Delle Chiaje and Tiedmann who consider them as testicles.

Respiration in Holothurians is effected in two ways: an external one by means of the ambulacral feet and the branched tentacles that surround the mouth. The other internal one by means of special organs. These organs are kinds of gills originating in the cloaca and are branched tubes that nearly fill the general cavity of the body. In some cases, one of the branches has connections with the intestine while the other is attached to the internal wall of the body cavity. These gills are moreover very variable in their structure and their development.

The circulatory system of Holothurians does not appear to have a central agent, i. e., a heart strictly speaking. This organ is replaced by a vascular ring surrounding the esophagus from which leaves a principal trunk comparable to a kind of aorta that branches on the intestine and genital organs. A second trunk, formed by the union of smaller branches, is similar to the preceding and serves as the venous cava. It is divided into two brachial arteries that lead to the gills from which originate brachial veins that go to join the aorta and thus complete the circulatory circuit.

The nervous system of Holothurians consists first of an esophageal ring located on the anterior edge of the bony circle and from which leave five nerve cords that go along the median lines of the longitudinal muscle bands and go toward the posterior end of the body. Nerve nets also originate from the esophageal ring, going across the notches left between the different buccal bony pieces and go to the ambulacral vesicles.

Holothurians have separate sexes (dioecious). The genital organs consist of branched caeca floating freely in the general cavity of the body in the form of free bundles. The open to the exterior by a single excretory duct located above the body circle between the buccal tentacles. In males, the testicle has a milky appearance and is constituted of a bundle of cylindrical tubules that are branched and close together. In females, the ovarian tubules are pale red, very long, a little flattened, also branched and extend the entire length of the body.

The species of the tribe of *Synaptids* appear hermaphroditic. They are thus the only one of the Echinoderms that has this peculiarity. The testicles and ovaries are mixed in a single organ. This is at least what the observations made by De Quatrefages have established for *Synaptids*.

From the point of view of natural history strictly speaking, Holothurians are still little known because we know very little of the behavior and habits. All the species inhabit sea water and are distributed to nearly all latitudes from polar to equatorial regions. They are generally found at great depths. Their movements are rather limited. They have a kind of crawling that occurs by means of more or less active undulations of the body. But it is especially with the help of the tentacular or ambulacral feet that their motility occurs. The species that lack tentacular feet have their body surface covered with organs in the form of small fishhooks or anchors that permit them to attach to underwater bodies. Such are, for example, the *Synaptids*.

The benefits that humans can take from them are rather limited. In some localities, however, particularly in China, Holothurians are used for food and are the object of a rather important commerce. We only add a word on a kind of parasitism of some species. Several times the presence of fish living as parasites in the interior of the body of Holothurians has been shown. These fish, belonging to the genus *Fierasfer* are established in the cloacal portion of the intestine. Quoy and Gaimard, as well as Risso, have made observations on the subject.

The classification of Holothurians still leaves much to be desired, and the numerous species described by different authors are often difficult to place in well defined generic groups, lacking sufficient information on important characters on which these groups are based. We can say that this insufficiency extends to the order Holothurians itself because its limits are still poorly traced. Some authors include, for example, the group of Sipunculids while others exclude them and think that they that they should be grouped with the Annelids. These are the results especially from the works of Grube. This opinion has also been expressed by Dujardin. The group of Sipunculids being eliminated, the Holothurians can be divided into two principal tribes: *H. apodes* or Synaptians and *H. pedicules* or Holothurians. The 1st tribe is characterized, as the name indicates, by the absence of tentacular feet. It contains only a very small number of genera of which the Synaptids are the principal representative. The 2nd tribe contains, on the contrary, the species with tentacular feet, variously arranged. The genera are rather numerous.

1st TRIBE **SYNAPTIANS**.

Body very elongated, vermiform, with tentacular feet. The organs in the form of fishhooks protrude from the surface of the skin.

1st GENUS. **SYNAPTA**. *SYNAPTA*.— Eschscholtz.

Body elongated, vermiform, with thin skin, transparent, with five white, opaque bands of fibrous appearance. This skin in addition has calcareous dermal productions in the form of small fishhooks. Mouth flat, surrounded by twelve buccal tentacles, pinnafided. Anus round, bare, subterminal.

The genus *Synapta* was established by Eschscholtz for animals near Holothurians having for the distinctive character the absence of tentacular feet and the presence, in the thickness of the skin, small calcareous organs in the form of fishhook destined to give the animals that have them the property of adhering to foreign bodies.

Most of the species in this group were previously confused with the Holothurians. They formed for de Blainville his division of *Holothuries vermiformes* (Fistulaire).

Nearly all the species come for the seas of warm countries. One or two species are encountered in our seas of Europe. One of them is *Synapta duvernaea*, Quatrefages.

1. ADHERENT SYNAPTA. *Synapta inhaerens.— Holothuria inhaerens*, Müller, Zool. Dan., t. 31, f. 17. — *Synapia inhaerens*, Durem andt Koren, 1844, Mém. Acad. Stock,, p. 322, n° 61, 1. V, f. 56–62.

Species elongated, transparent, alternately swollen and constricted along its length. Buccal tentacles pinnafidid, with five divisions, without warts at their base. Inhabits the seas of the North.

2. DIGITATED SYNAPTA. *Synapta digitata.— Holothuria digitata*, Montagu, Act. Soc., Lin., t. XI, p. 22, t. 4, f. 6. — *Synapta digitata*, Sars, Midd. litt. Fauna in Nyt. Mag., 1857, t. 10, f. 98. Inhabits the Mediterranean.

3. DUVERNOY'S SYNAPTA. *Synapta duvernaea*. Quatrefages.— Quatrefages, Ann. des Sc. nat., 2e série, t. XVII (1842), p. 19, pl. 2–3–4.

This species is extremely near *S. inhaerens*, even if it should not be united with it. It has been used for an extremely interesting and very complete work by De Quatrefages. Inhabaits the Chaussey Islands, St. Malo.

4. GLUTINOUS SYNAPTA. *Synapla reciprocans. — Fistularia reciprocans*, Forsk., Egypt., p. 21, t. 38, f. A. — Encycl. méthod., pl. 87, f. 7. — *Holothuria glutinosa*, Lamarck, An. s. vert., t. 3, p. 441, no 7. — *Id.*, Blainville. Inhabits the Red Sea.

5. BANDED SYNAPTA. *Synapta vittata*. Jaeger. — *Fistularia vittata*, Forsk., Egypt., p. 123, t. 37, f. e f. — Encycl. méth.. pl. 87, f. 8–9. — *Holothuria vittata*, Lamarck. — *Synapta vittata*, Jaeger. — *Tiedemannia vittata*, Linck. Inhabits the Red Sea.

6. OCEANA SYNAPTA. *Synapta oceanica*. Jaeger. — *Holothuriu oceanica*, Lesson, Centurie zool., p. 99, pl. 35. — *Synapta oceanica*, Jaeger, de Holoth., p. 14. — *Id.*, Brandt, Prodr.

This species that attains a length of nearly 1 meter is reddish gray with two silvery white lines separated by black line on each of the longitudinal muscular bands. The small fishhooks of the skin are yellow. If attached to the skin of the hands they cause a burning sensation. Inhabits Tahiti.

7. MAMELONNATED SYNAPTA. *Synapla mamillosa*. Eschscholtz. — Eschscholtz. Zool. Atlas, H, t. X, f. 1. — *Id.*, Jaeger, de Holoth., p. 14. — *Id.*, Brandt, Prodr. Habite ?

8. SPOTTED SYNAPATA. *Synapta maculata*. Jaeger. — *Holothuria maculata*, Chamisso, Act. nat. Cur., t. 10, p. 352, pl. 25. Inhabits the Radack Islands.

9. BESEL'S SYNAPTID. *Synapta beselii*. Jaeger.— Jaeger, de Hol., p. 15, t. I, f. 1. Inhabits the Celebes Islands.

10. RADIANT SYNAPTA. *Synapta radiosa. — Holothuria radiosa*, Lesson, Centurie zool., p. 58. — *Reynodia Id.*, Brandt, Prodr, Inhabits the coast of Coromandel.

11. DOTTED SYNAPTA. *Synapta punctulata*. Brant. — *Fistularia punctulata*, Quoy and Gaimard, Astrol., p. 425, tab. 7, f. 13–14. — *Synapta Id.*, Brandt. Inhabits New Guinea.

12. DOREY'S SYNAPTA. *Synapta doreyana*.Brandt.—*Holothuria doreyana*, Quoy and Gaimard, Voy. Astrol., Zooph., pl. 7, f. 11–12. — *Synapta Id.*, Brandt. Inhabits New Guinea.

13. HYDRA SHAPED SYNAPTA. *Synapta hydriformis. — Holothuria hydriformis*, Lesueur, Acad. sc. Phil., t. VI, p. 6, n° 7. Inhabits Guadeloupe.

14. GREEN SYNAPTA. *Synapta viridis. — Holothuria viridis*, Lesueur, *loc. cit*., p. 6, n° 8. Inhabits St. Thomas, Antilles.

2nd GENUS. **CHIRODOTA**.— Eschschlotz.

Body elongated, cylindrical, vermiform, with bare skin, without tentacular feet. Buccal tentacles elongated, cylindrical at the base and digitate at the end. No internal arborescent respiratory organ but in its place some cylindrical bodies more or less divided and fixed to the mesentery.

This genus, whose oldest known type is *Holothuria laevis*, Fabricius of the seas of Europe, especially contains foreign species that are mostly described under the generic name of *Fistularia*.

1. SMOOTH CHIRIDOTA. *Chirodota laevis*. Grube.—*Holothuria laevis*, Fabricius, Fauna Gronl., n° 345.— *Dactylota laevis*, Brandt.—*Chirodota laevis*, Grube ? — *Chirodota discolor*, Eschschlotz, Zool. Atlas, t. X, f. 2. Inhabits seas of the North.

2. PURPLE CHIRIDOTA. Jaeger.—*Holothuria purpurea*, Lesson, Centurie zool., p. 155, pl. 52, f. 2.—*Chirodota Id.*, Jaeger, Brandt, Inhabits the Falkland Islands.

3. EARTHWORM CHIRIDOTA. *Chirodota lumbricus*. Eschsch.—Eschsch., Zoo. Atlas, t. X, f. 4. — *Id.*, Jaeger, Brandt. Inhabits the Radack Islands.

4. WARTY CHIRIDOTA. *Chirodota verrucosa*. Eschscholtz. — Eschsch, *loc. cit*., t. X, f. 5. — *Id.*, Jaeger, Brandt. Inhabits Sitcha Island.

5. RED CHIRIDOTA. *Chirodota rufescens*. Brandt. — Brandt, Prodr., p. 259. Inhabits the northern Pacific Ocean.

6. BROWN CHIRIDOTA. *Chirodota fusca*. — *Fistularia fusca*, Quoy and Gaimard, Astrol. Zooph., pl. 8, f. 1–4. Inhabits New Ireland.

7. REDDISH CHIRIDOTA. *Chirodota ruheola. — Fistularia rubeola*, Quoy and Garmard, Voy. Astr. Zooph., pl. 8, f. 5–6. Inhabits New Ireland.

8. LOOSE CHIRIDOTA. *Chirodota tenuis*. — *Fistularia tenuis*, Quoy and Gaimard, Astrol., pl. 8, f. 7–9. Inhabits New Ireland.

Brandt has established under the name of *Liosoma*, a genus that differs from the preceding by a less elongated form and the presence of nearly arborescent internal respiratory organs.

Liosoma sitchaense. Brandt. From Sitcha Island.

2nd TRIBE. HOLOTHURIANS.

Body with ambulacral feet or tentacles.

This tribe, infinitely more numerous than the preceding, contains all the species that have tentacular feet. These organs vary, moreover, greatly in regards their number and their disposition. It is in taking for base his consideration that the genera can be arranged in an ascending series from those in which the tentacular feet are irregularly scattered on the entire surface of the body to reach those where the organs are on the contrary localized and form longitudinal series recalling completely the ambulacra of Echinoids or Asteroids.

1st GENUS. **HOLOTHURIA.** HOLOTHURIA. — Lin.

Body cylindrical, more or less elongated, rounded toward the ends. Sparse tentacular feet, more numerous on the ventral surface, those of the back being on the contrary rarer and producing elevated conical papillae. Mouth surrounded by twenty tentacles that are short, peltate and ramose at their end and arranged in an alternating double row. Calcareous buccal pieces are slender.

The genus *Holothuria* is in some way the type of the entire tribe, only most of the species that have been described or mentioned under this name should not remain in the genus *Holothuria* so that it is actually decreased and there has been successive removal of some genera or sub-genera.

Brandt has attempted to sub-divide the genus *Holothuria* into two sub-genera: 1st sub-genus *Thelenota*; 2nd sub-genus *Microthele*. The first refers to *H. quadrangularis*, Lesson, *H. monacaria*, Lesson, *H. umbrina*, Leuckart, *H. grandis*, Brandt. The second refers to *H. fuscocinerea*, Jaeger, *H. atra*, Jaeger, *H. punctata*, Jaeger, *H. scabra*, Jaeger, *H. maculata*, Jaeger, *H. sordida*, Brandt, *H. aethiops*, Brandt, *H. affinis*, Brandt (*H. radackensis*, Charhisso).

1. *Holothuria tubulosa*. Gmel. — *H. tremula*, Sol, Ellis, t. 8. — Encycl. méth., pl. 86, f. 1–2. — Forskal, Egypte, t. 39, f. A, Lin., Gmel., Syst., nat., p. 3138. — *Fistularia tubulosa*, Lamarck. — *Holothuria* (*Thelenota*) *tubulosa,* Brandt, Prodr. — Sars, Midd. litt. Fauna, 1857, pl. 2, f. 75–77.

This species, one of the most common of the genus, is at the same time one of the most variable. It is for this reason that some authors have proposed to unite with the title of varieties the following species described by Delle Chiaje: *H. forskelii; H. polii; H. sanctori; H. cavolini; H. petagnae; H.stellasi*?

Inhabits the Mediterranean.

2. *Holothuria tremula*. Gunner. — Gunner, Act. Holm., 1767, p. 119, t. IV, f. 3. — Linné, Syst. nat., p. 1090. — *H. elegans*, Müller, Zool. Dan. t. E, f. 3. — Encycl. méthod., pl. 86, f. 9–10. — *Fistularia elegans*, Lamarck.

Inhabits the seas of the North.

3. *Holothuria regalis*. Cuvier. — *Pudendum regale*, Fab., Coluuna. — *Holothuria regalis*, Cuvier, Règ. anim., t. IV, p. 239. — Sars, Midd. litt. Fauna, 1857, p. 96, t. 2, f. 78–81. Inhabits the Mediterranean.

It is in an individual of this species that Risso found a fish (*Fierasfer fontanesii*) that lived as a parasite in the cloacal portion of the intestine.

4. *Holothuria intestinalis*. Ascan. — Ascantas and Rathke, Icon. rar. nat. p.5, f. 45. — *H. mollis*, Sars, — *H. intestinalis*, Duben and Koren, 1844, t. IV, f. 28–33. Inhabits the seas of the North.

5. *Holothuria impatiens*. Linné. — Forskal, Egypte, p. 121, t. 39, f. B. — Linné, Gmel., Syst. nat., p. 3142. — Encycl. méthod., pl. 86, f. 11. — *Fistularia impatiens*, Lamarck, t. III, p. 448, n° 3.—*Trepang impatiens*, Jaeger, — *Holothuria* (S. G. *Thelenaea*) *impatiens*, Brandt. Inhabits the Red Sea.

6. *Holothuria hillae*, Lesson. — Lesson, Centurie zool., p. 226, pl. 79. Inhabits Archipelago of Tonga.

7. *Holothuria maxima*. Linné. —Lam., GmeL., Syst. nat., p. 3142.— Forskal, Egypte, t. 38, f. b-c. — *Fistularia maxima*, Lamarck, p. 448, n° 4. Inhabits the Red Sea.

8. *Holothuria fasciola*. Quoy, Gaimard. — Quoy and Gaimard, Voy. Astr. Zool. Zooph., p.130. Inhabits New Ireland.

9. *Holothuria fulva*. Quoy and Gaimard. — Astr., p. 135. Inhabits Australia.

10. *Holothuria subrubra*. Quoy and Gaimard. Inhabits Mauritius.

11. *Holothuria aggiutinata*. Lesueur. From the Antilles.

12. *Holothuria obscura*. Lesueur. From the Antilles.

The genus *Trepang,* Jaeger, whose usefulness is still doubtful, includes

13. *Holothuria edulis*. Lesson. — Centurie zool., p. 125, pl. 46, f. 2. From the Moluccas Islands.

14. *Holothuria peruviana*. Lesson. — *Loc. cit*., pl. 16, f. 1.

15. *Holothuria ananas*. Quoy and Gaimard. — Voy. Astr., pl.6, f. 1–3. Inhabits New Ireland.

2nd GENUS. **MÜLLERIA**. *MÜLLERIA*. —- Jaeger.

With the general characteristics of Holothurians, this genus differs in the presence of five calcareous pieces surrounding the anus and serving for the insertion of the longitudinal muscles. We refer there the following species described in various works under the name of *Holothuria.*

1. *H. gigas*. Jaeger, Savigny, Egypte, pl. 8, f. 2. 2. *H. mauritania*. Quoy and Gaimard, Astrol. 3. *H. tuberculosa*. Quoy and Garmard. Astrol. 4. *H. guamensis*. Quoy and Gaimard. From Guam. 5. *H. miliaris*. Quoy and Gaimard. From Vanikoro. 6. *H. lineolata*, Quoy and Gaimard. From Tonga. 7. *H. echinites*. Jaeger. Celebes Islands 8. *H. lecanora*. Jaeger. Celebes Islands.

3rs GENUS. **BOHADSCHIA.** *BOHADSCHIA*.— Jaeger.

This genus, also very near *Holothuria*, is characterized by the radial or star-shaped anal opening that otherwise lacks calcareous species.

We refer there:

1. *B. marmorata*. Jaeger. 2. *B. ocellala*. Jaeger. 3. *B. argus*. Jaeger. (*Holothuria id*., Quoy and Gaimard). 4. *B. albiguttata*. Jaeger.

4th GENUS. **CLADOLABES.** *CLADOLABES*. — Brandt.

Body elongated, convex above, flat below, with very numerous scattered tentacular feet. The dorsal surface has a kind of rose formed of warts that let pass in their intervals some tentacular feet. 20 ramified buccal tentacles.

Brandt has established this genus at the expense of *Holothuria* and refers there:

1.*C. limaconotos*. Brandt. Bonin. 2. *C. spinosus* (*Holuthuria spinosa*. Quoy and Gaimard, Voy. Astrol., p. 128, pl. 7, f. 1–10). from Sidney. 3. *C. aureus* (*Holothuria aurea*. Quoy and Gaimard, Voy. Astrol., pl. 7, f. 15–17). From the Cape of Good Hope.

5th GENUS**. STICHOPUS**. *STICHOPUS*.— Brrandt.

Brandt gave for distinctive character three rows of tentacular feet on the ventral surface and referred there:

1. *S. chloronotus*. Brandt. Lugunor Island. 2. *S. cinerascens*. Brandt. Bonin Island. 3. *S. leurospilota*. Brandt. Uala. 4. *S. flammenus*. Brandt, (*Holothuria flammea*), Quoy and Gaimard, Astrol., pl. 6, f. 5–7. Vanikoro. 9. *S. luteus*. Brandt, (*Hol. lutea*), Quoy and Gaimard. 6. *S. unituberculatus*. Brandt, (*H. unituberculata*), Quoy anad Gaimard. 7. *S. albofasciatus*. Brandt (*A. albofasciata*), Quoy and Gaimard. 8. *S. lucifugus*. Brandt, (*H. lucifuga*), Quoy and Gaimard. 9. *S. pentagonus*. Brandt, *(H. pentagona*), Quoy and Gaimard.

The genus *Diploperideris*, Brandt, differs only by its buccal tentacles that are not very divided.

D. sitchœnsis. Brandt. From Sitcha Island.

The genus *Aspidochir*, Brandt, has tentacular feet arranged in five rows.

A. mertensi. Brandt. Sitcha Island.

The genus *Sporadipus*, Brandt, has tentacular feet scattered without order on all the body. 20 small buccal tentacles.

S. ualensis. Brandt. Uala Island. — *S. maculatus*. Brandt. Bonin Islands.

6th GENUS. **PSOLUS**. *PSOLUS*.— Oken.

Body subcylindrical with ventral surface flat and soft with a large number of tentacular feet. Dorsal surface swollen, wrinkled, coriaceous especially toward the ends.

The genus *Psolus*, established by Oken for a species previously known as *Holothuria phantapus*, has been accepted by all zoologists. Some authors have thought that it should be united with that Péron has described under the name of *Cuvieria* with the type *H. squamata* although the point of view has still some uncertainty in the sense that this latter species has very developed calcareous plates. We believe it is necessary to join them because the name *Cuvieria* is a duplicate of a name used with a genus of the class of Pteropods that is generally accepted.

The genus *Psolus* contains a rather good number of species that, for the most part, come from the seas of the North of both hemispheres. However, some are found in equatorial regions.

1. *Psolus phantopus*. Oken.—*Holothuria phantopus*, Struss.—Linné, Müller, Zool. Dan., t. 112, 11–13.— Erncycl. méthod., pl. 86, f. 1–2.— *Psolus phantopus*, Oken. — Jaeger, Agassiz, Forbes. — *Cuvieria phantopus*, Blainville, Fleming, Johnson. Inhabits the seas of the North.

2. *Psolus appendiculatus*. Jaeger. — *Holothuria appendiculata*, Blainville. Inhabits Mauritius.

3. *Psolus timanus*. Jaeger. — *Holothuria timana*, Lesson, Cent. zool. Inhabits Waigiou Island.

4. *Psolus squamatus*. Oken.. — *Holothuria squamata,* Müller, Zool. Dan., pl. 10, f. 1–2. — *Id.*, Encycl. méthod., pl. 87, f. 10–12. — *Cuvieria squamata*. Péron, Jaeger, Duben and Koren, Mém. Acad. Stock., 1844, t. IV, f. 35–41. — *Id.*, Cuvier, Règ. an. III., pl. 15, f. 9. Inhabits the seas of the North.

5. *Psolus fabricii*. Duben and Koren. Inhabits the seas of the North.

6. *Psolus sitchænsis* (*Cuvieria*). Brandt. Inhabits Sitcha Island.

7. *Psolus antarcticus* (*Cuvieria*). Phil. Inhabits the Strait of Magellan.

7th GENUS. **THYONE**. *THYONE*. — Oken.

— *Phyllophorus*. Grube.

Body sub-fusiform, elongated. Tentacular feet very slender, non-retractile, scatter on all the surface of the boy. Ten buccal tentacles, ramose and arborescent.

The oldest known typical species of this is *Holothuria fusus*.

1, *Thyone fusus*. Oken. — *Holothuria fusus*, Müller, Zool. Dan. t. 10, f. 6. — Encycl. méthod., pl. 87, f. 5–6.—*Id.*., Lamarck, An. s. vert., t. III, p. 74, n°9, — *Thyone fusus*, Oken, Agassiz, Forbes, Duben and Koren, Mém. Acad. Stock., 1844 p. 308, t. XI, f. 52, t. V, f. 42–48. Inhabits the seas of the North.

2. *Thyone raphanus*. Dube and Koren. — Mém. Acad. Stock., 1844, p. 311, n° 56, t. XI, f. 58–59. Inhabits the seas of the North.

Grube has distinguished, under the name of *Phyllophorus*, a genus that it seems necessary to unite with this one. The species that he reported are:

Phyllophorus urna. Grube. — *Holothuria penicillus*, Delle Chiaje, Sars, Nyt. Mag. Naturv., 1857, t. 2, f. 52–57.— *Phyllophorus granulosus*, Sars, *loc, cit*., t. 2, f. 68–74. Inhabits the Mediterranean.

8th GENUS. **THYONIDIUM**. *THYONIDIUM*.— Duben and Koren.

Body elongated, cylindrical. Tentacular feet more or less scattered on all the surface but forming five longitudinal rows that are equidistant and parallel. Ten buccal appendages that are arborescent, unequal and paired. Calcareous esophageal ring formed of elongated pieces of which some are wider and bifidid. Genital tubes divided.

This genus, intermediary between *Thyone* and *Cucumaria* contains only a very small number of species.

1. *Thyonidium pellucidum.* — *Holothuria pellucida*, Wahl., Müller, Zool. Danic, t. 135. — *Id.*, Fleming. — *Cucumaria hyalina*, Forbes.— *Thyonidium pellucidum*, Duben and Koren, Mém. Acad Stock., 1844, p. 303, n° 53, t. X, f. 57, t. IV, f. 15–47. Inhabits the seas of the North.

2. *Thyonidium commune*. Dub., Kor. — *Cucumaria communis*, Forbes. — *Cucumaria drummondi*, Forbes. — *Thyone portlocki*, Forbes. — *Thyonidium commune*, Duben and Koren, Mém. Acad. Stock., 1844, p. 305, n° 54, t. XI, f. 51, t. IV, f. 18–23. Inhabits the seas of the North.

9th GENUS. **CUCUMARIA**. *CUCUMARIA*.—Blainv.

— *Pentacta*. Goldfuss. — *Cladodactyla* and *Dactylota*, Brandt.

Body cylindrical, sub-pentagonal, oval or oblong. Tentacular feet long, arranged in five longitudinal ambulacral rows. Buccal tentacles ramified and pinnate. Genital tube simple. Skin thick, strong with deeply embedded calcareous corpuscles.

This genus contains a rather large number of species that can be divided into two very distinct forms. Some, in fact, are cylindrical, the others pentagonala. It was in considering this difference that Jaeger established two sections in the genus. Brandt, for his part also divided them into two sub-genera. He named *Cladodactyla* the species that have arborescent respiratory organs and very ramified buccal tentacles, and *Dactylota*, whose tentacles are simply digitate or pinnate.

1. *Cucumaria frondosa*. Blainville.. — *Holothuria frondosa*, Gusser, Act. Holm., 1767, p. 115, t. IV, f. 1–2. — *Id.*, Linné,, Syst. nat., p. 1089.— *Id.*, 0. Fabr., Fauna Gronl., p. 359. — Encycl. méthod., pl. 85, f. 7–8. — *Cucumaria frondosa*, Blainville, Forbes. — *C. fucicola*, Forbes. — *Dactylota frondosa*, Brandt, Prodr. Inhabits the seas of the North.

2. *Cucumaria pentacta. — Holothuria pentacta*, O. F. Müller, Zool. Dan., t. 31, f. 8, and t. 108, f. 14. — *Id.*, Linné, Syst. nat., p. 1091. — Encycl. méthod., pl. 86, f. 5. — *Pentacta pentactes*, Agassiz, Prodr,— *Cucumaria pentactes*, Forbes. Inhabits the northern seas of Europe.

3. *Cucumaria doliolum*. Grube. — *Actinia doliolum*, Pallas, Misc. Zool., t. 9–10. — Encycl. méthod., pl. 86, f. 6–8.—*Holothuria doliolum,* Lamarck, An. s. vert., t. III, p. 443, n° 4. — *Id.*., Delle Chiaje ; *Id.*, Blanville. — *Pentacta doliolum*, Jaeger. — *Cucumaria doliolum*, Grube, Sars, Midd. Fauna litt. in Nyt. Mag., 1857, p. 164, no 41, t. I, f. 18–23. Inhabits the Mediterranean.

4. *Cucumaria syracusana*. Sars. *Cladodactyla syracusana*, Grube. — *Cucumaria syracusana*, Sars, *loc. cit*., p. 67, n° 42, t. I, f. 24–29. Inhabits the Mediterranean.

5. *Cucumaria dicquemarii*. Jaeger. — *The Flowering Dicquemaro,* Journ. phys., 1778, pl. 1, f. 1. — *Holothuria dicquemarii*, Cuvier. — *Cucumaria dicquemarii,* Jaeger, Grube, Sars, *loc. cit*., p. 69, n° 43, pl. 1, f. 30–35. Inhabits the Channel.

6. *Cucumaria tergestina*. Sars.—Sars, *loc. cit*., p.71, n° 44, pl. 1, f. 36–40. Inhabits the Mediterranean.

7. *Cucumaria hyndemanni*, Forbes. — Forbes, Brit. Starf., p. 235. — *Id.*, Duben and Koren. Mém. Acad. Stock., 1844, p. 299, n° 51, pl. XI, f. 56, pl. IV, f. 8–14. Inhabits the seas of the North.

8. *Cucumaria lactea*. Duben and Koren. — *Ocnus lacteus*, Forbes, *loc. cit*. p. 231. — *Cucumaria lactea,* Duben and Koren, *loc. cit*., p.297, no 50, t. XI, f. 55, t. IV, f. 3–7. Inhabits the seas of the North.

9. *Cucumaria cucumis*. Risso. —— Risso, Hist. Europ. mérid., t. 5, p. 991. — *Id.*, Blainville, Faune franç., pl. 1, f. 2.—*Id.*, Sars, *loc. cit*., p. 74, n° 45, t. 2, f. 41–43. Inhabits the Mediterranean.

10. *Cucumaria assimilis*. Duben and Koren.—Mém. Acad. Stock , 1844, t. 291, n° 49, t. XI, f. 54, and t. IV, f. 2. Inhabits the seas of the North.

11. *Cucumaria elongata*. Duven, Koren, — Duben. Koren. *Loc. cit*., p. 301, no 52, t. XI, f. 56, and t. IV, f. 14, ab. — *Id.*, Sars, Midd. litt, Fauna, 1857, p. 76, n° 46, pi. 2, f. 44–48. Inhabits the seas of the North.

12. *Cucumaria minuta*.—*Holothuria minuta*, Fabricius, Fauna Gronl., n° 346. — *Dactylota minuta*, Brandt, Prodr., p. 245.— *Ocnus ayresii*, Stimrson. — *Cucumaria minuta*, Lutken. Inhabits the seas of the North.

13. *Cucumaria korenii*. Lutken. — Lutken, Overs. Gronl. Echin., 1857, p. 4, n° 2. Inhabits the seas of the North.

14. *Cucumaria tentacula*. Jaeger. — *Pentacta tentacula,* Jaeger, Blainville. Inhabits the seas of the North.

15. *Cucumaria laevis. — Holothuria laevis*, O. Fabr., Fauna Gronl. n° 345. — *Pentacta laevis*, Jaeger. — *Dactylota laevis*, Brandt. Inhabits the seas of the North.

16. *Cucumaria miniata. — Cladodactyla miniata*, Bransr, Prodr.

17. *Cucumaria nigricans., — Cladodactyla Id.*, Brandt, Prodr.

18. *Cucumaria albidu*.— *Cladodactyla Id.*, Brandt. These three species inhabit Sticha Island.

19. *Cucumaria crocea.— Holothuria crocea*, Lesson, Cent. zool., p.152, t. 52. — *Cladodactyla crocea*, Brandt, Prodr. Inhabits the Falkland Islanlds.

20. *Cucumaria tetraquetra. — Holothuria tetraquetra*, Delle Chiaje. Inhabits the Mediterranean.

21. *Cucumaria* (*Holothuria*) *gaertneri*. Blainville.

22. *Cucumaria* (*Holothuria*) *montaqui*. Fleming?

23. *Cucumaria* (*Holothuria*) neillii. Fleming.

24. *Cucumaria* (*Holothuria*) *dissimilis*. Fleming.

25. *Cucumaria quadrangularis* (*Holothuria quadrangularis*). Lesson, Cent. zool., f, 52,

FIN.

EXPLANATION OF THE PLATES

OF

ECHINODERM ZOOPHYTES

PLATE I. – COMATULIDS.

Fig. 1. *Comatula mediterranea*, seen from above, enlarged three times.

Fig. 2. The same, same from the side and reduced.
mm, spines.

Fig. 3. The same, showing the disk seen from above or the ventral side.
a, anal tube; cec, ambulacra lined with red sacs.

Fig. 4. The same, showing a part of the integument of the ambulacra of the ventral surface;
d, tubes leaving the sacs.; e, sacs; f, tentacles with cilia.

Fig. 5. Sac seen separately and more enlarged.

Fig. 6. One of the calcareous reticulated plates, secreted into the integument of the ventral surface.

Fig, 7. The ventro-dorsal piece of the same species, showing the basals and the first radials fused together.

Fig. 8. One of the articles of the arms showing its radial articular facet.
n, the ambulacral gutter; at the center, a food canal (?).

Fig. 9, The end of one of the non-reproductive pinnules.
h, the oblong body that supports the pinnules as well as the phlanges. I, a double membranous festoon supporting and protecting the tentacles; j, the fleshy tentacles and papillae, arranged in four rows on each side of the ambulacral gutter.

Fig. 10. One of the tentacles seen separately and more enlarged. It is curved back on itself as often happens. It shows the soft papillae on its surface that are arranged in four rows.

Fig. 11. Base of a swollen reproductive pinnule and an egg leaving by the ruptured end.

Fig 12. Embryo of five days (?) (after De Buch).

Fig. 13. Polypiform embryo, from nature, figured by Dujardin.

Fig, 14. Embryo more advanced in development, showing the developing arms (after Thompson).

Fig. 15. Embryo still more developed, showing the very recognizable young comatulid (after Thompson) and designated as *Encrinus europaeus*, Thompson; (*Phytocrinus id.*, Blainville).

PLATE II. — OPHIUROIDS.

Fig. 1. *Ophioderma longicauda*, Müller and Troschel, seen from above.
1[a], the same, seen from below. 1[b], fragment of an arm showing the ventral plates. 1[c], the lateral plates and their papillae.

Fig. 2. *Ophiolepis dubia* (after Savigny).
2[a], disk seen by its ventral surface and showing the buccal opening. 2[b], trunk of an arm showing the dorsal plaes and the lateral spines. 2[c], the same trunk seen for the opposite side and showing the ventral plates. 2[d], transverse section of the same.

Fig. 3. *Amphiura tenera*, Lutken (after Lutken).
3[a], disk seen by the ventral surface and showing the buccal opening. 3[b], the same seen from the opposite side and showing the radial plates.

Fig. 4. *Ophiocoma serpentaria*, Müller and Troschel (after Lutken).
Disk seen by its ventral surface and showing the buccal openings.

Fig. 5. *Asterochema oligactes* (seen from above).

Fig. 6. *Asteroporpa annuluta* (disk and the origin of the arms).

Fig. 7. *Asterophyton caecilia* (disk seen from above).
7[a], the same, seen from the opposite side.

Fig. 8. Vertebral piece of the arm of an *Asterophyton* (Euryale).

PLATE III. — CRINOIDS.

Fig. 1. *Dorycrinus mississipiensis*, seen from the side.
a, lateral points above the arms; *b*, culminating point; *m*, corresponding openings at the base of the arms; *n*, anal opening (?).

Fig. 2. The same, seen from above.
a restricting lateral points; *m*, insertion of the arms; *n*, anal opening (?).

Fig. 3. The same seen from below and showing the origin of the stalk.

Fig. 4. *Stephanocrinus angulatus* (after Roemer).

Fig. 5. The same, seen from above. *m*, base of broken points.

Fig. 6. The same, showing the anal opening.

Fig. 7. The same, showing the separated basal and radial pieces.

Fig. 8. *Caryocrinus ornatus*, seen from the side of the ovarian opening.

Fig. 9. The same, seen from the opposite side.

Fig. 10. The same. seem from below and showing the origin of the stalk.

Fig. 11. The same, seen from above and showing the mouth closed by five valves.

Fig. 12. The same, showing the separated basal and radial pieces.

Fig. 13. Portion of the lateral surface, enlarged.

Fig. 14. Group of pores of one of the radial pieces (enlarged eight times).

PLATE IV. — CRINOIDS.

Fig. 1. *Encrinus liliformis*, 1^{b}, one of the separated arms. 1^{c}, the calyx seen from below; 1^{d}, upper scapular row; 1^{e}, second upper costal row; 1^{f}, second lower costal row; 1^{g}, third row; 1^{h}, terminal piece of the stalk; 1^{j}, an article of the stalk seen from the front.

Fig. 2. *Apiocrinus roissyanus*, 2^{a}, the head; 2^{b}, the base.

Fig. 3. *Apiocrinus parkinsoni* (after D'Orbigny), ^{a}, the head; ^{b}, longitudinal section of the calyx; ^{c}, the calyx seen from below; ^{d}, zone of scapular pieces; ^{e}, second row of costal pieces; ^{f}, first row of costal pieces; ^{g}, segment of the stalk.

Fig. 4. *Guettardicrinus dilatatus*.

Fig. 4. *Actinocrinus triacondactylus* (after Pictet).

Fig. 5. *Apiocrinus murchisonianus*.

Fig. 6. *Actinocrinus triacondactylus* (after Pictet).

Fig. 7. *Actinocrinus tricuspidatus* (after Pictet).

Fig. 8. Disposition of the plates of an *Actinocrinus*.

PLATE V. — CRINOIDS.

Fig. 1[a]. *Pentacrinus briareus*, Müller (after Goldfuss); 1[b], second article; 1[c], the five basal pieces resting on the corners of the top of the stalk; 1[d], the five first radial (lower costals); 1[e], the five second radials (upper costals); 1[f], the five third radials.

Fig. 2. *Pentacrinus fasciculosus*, 2[a], article of the top of the stalk; 2[b], article of the base of the stalk.

Fig. 3. *Poteriocrinus radiatus*, Austin.

Fig. 4. *Hemicosmites pyriformis*, De Buch.

Fig. 5. *Echinosphaerites aurantium*, De Buch.

Fig. 6. *Caryocystites testudinarius*, Hising.

Fig. 7. *Cryptocrinus cerasus*, De Buch.

Fig. 8. *Agelacrinus parasiticus*.

Fig. 9. *Haplocrinus mespiliformis*; [a], seen from above; [b], in profile; [c], from below.

Fig. 10. *Coccocrinus rosaceus*; [a], from above; [b], from below.

Fig. 11. *Epactocrinus irregularis*.

Fig. 12. *Cupressocrinus crassus*.

PLATE VI. — EMBRYOGENESIS.

Fig. 1. Larva of *Echinus pulchellus*, two days after artificial fertilizaton.

Fig. 2. The same, seen from the front.

Fig. 3. The same, seven days after artificial fertilization.

Fig. 4. The same, sixteen days after fertilization.

Fig. 5. Larva of *Echinus lividus*, eleven days after fertilization.

Fig. 6. Sporadic larva of the same.

Fig. 7. *Idem*.

Fig. 8. Sporadic larva transforming into an urchin.

A. Larvae of *Asteroids* (*Asterias*).

B. Larvae of *Oursins* (*Echinus*).

C. Larvae of *Ophiuroids* (*Ophiura*).

D. Larvae of *Holothurians* (Holothuria).

PLATE VII — ASTEROIDS.

Fig. 1. *Astropecten crenaster* (*Asterias aurantiaca* auct.).

Fig. 1a. Transverse section of an arm showing: *a* the ambulacral tentacles, *b,* the lateral spines; *c*. the dorsal papillae or the flattened plates.

Fig. 1b. Transverse section of an arm showing: *a,* the ambulacral tentacles, *b*, Isolated ambulacral tentacle, enlarged.

Fig. 1c, 1d, 1e. Isolated dorsal papillae, enlarged.

Fig. 2. End of a tentacle of *Asteracanthion rubens*, greatly enlarged.

Fig. 3. Pedicaellariae of the same species.

Fig. 4. *Oreaster mamillatus*, section of an arm showing the dermal tubercles.

Fig. 4a. The same tubercles, enlarged (after Savigny).

Fig. 5. *Astrogonium geometricum*, end of an arm showing the marginal plates.

Fig. 5a. The marginal plates; interbrachial space showing the ambulacral tentacles.

Fig. 6. *Astrogonium souleyeti* (seem by the back).

PLATE VIII. — HOLOTHURIANS.

Fig. 1. *Mulleria gigas*, showing in *a*, the tentacular feet distributed over the entire surface of the body; *b*, the buccal tentacles, *c*, the buccal opening, *d*, the anal opening.

Fig. 1a. An isolated tentacle.

Fig. 2. *Cucumaria quadrangularis* (*Holothuria*), Lesson.

Fig. 2a, Transverse section.

Fig. 3. *Cucumaria crocea* (*Holothuria*), Lesson.

Fig. 4. *Synapta reciprocans*.

Fig. 4a. An isolated tentacle.

Fig. 5. *Thyone* (*Phyllophorus*) *urna* (*Holothuria penicillaris*), Delle Chiaje.

Fig. 3a. The calcareous pieces of the mouth.

Fig. 5b. The same, extended.

Fig. 6. Hooks of the skin of *Synapta duvernoea* (enlarged).

PLATE IX. — ECHINOIDS.

Fig. 1. *Conoclypus acutus*, Agassiz; *a*, the mouth opening showing the floscelle and the phyllodes.

Fig. 2. *Loxechinus albus*, Desor; an isolated ambulacrum.

Fig. 3. *Holaster laevis*, seen from above.

Fig. 3a. Seen from below.

Fig. 4. *Boletia pileolus*, seen from below.

Fig. 5. *Goniocidaris geranioides*, portion of the ambulacrum, enlarged.

Fig. 6. *Mellita longifissa*, seen from below.

Fig. 7. *Brissus scillae*, with half of its spines removed.

Fig. 8. *Echinocorys vulgaris*, enlarged detail of the periproct showing the ambulacral top, the ovarian plates, etc.

Fig. 9. *Boletia maculata*, Desor. *a*, auricular piece of the mouth.

Fig. 10. *Salenia personata*, apical system (periproct), enlarged.

Fig. 11. *Lovenia hystrix*; *a*, the periproct with its sub-anal fasciole; *b*, longitudinal section showing the interior of the wall with its partitions.

PLATE X — ECHINOIDS.

Fig. 1. *Clypeaster rosaceus*, lacking half its spines.

Fig. 2. The same species; its periproct enlarged shown in *m* the madreporite plate; in *n* the ovarian pores.

Fig. 3. *Idem*; portion of the ambulacrum, enlarged.

Fig. 4. *Idem*; One of the jaws formed of two joined pieces.

Fig. 5. *Idem*; One of the teeth, located in a groove of the jaw.

Fig. 6. *Idem*; One of the two pieces constituting the jaw, seen by its internal surface.

Fig. 7. The same piece, seen by its external surface and showing the muscular impressions.

Fig. 8. A portion of the same, more enlarged.

Fig. 9. *Echinobrissus recens* (*Nucleolites recens*, Edw.), with half of its spines removed.

Fig. 10. The same species showing the periproct surrounded by its plates.

Fig. 11. *Mellita hexapora*, with half its spines removed and seen from below.

Fig. 12. The same, seen from above.

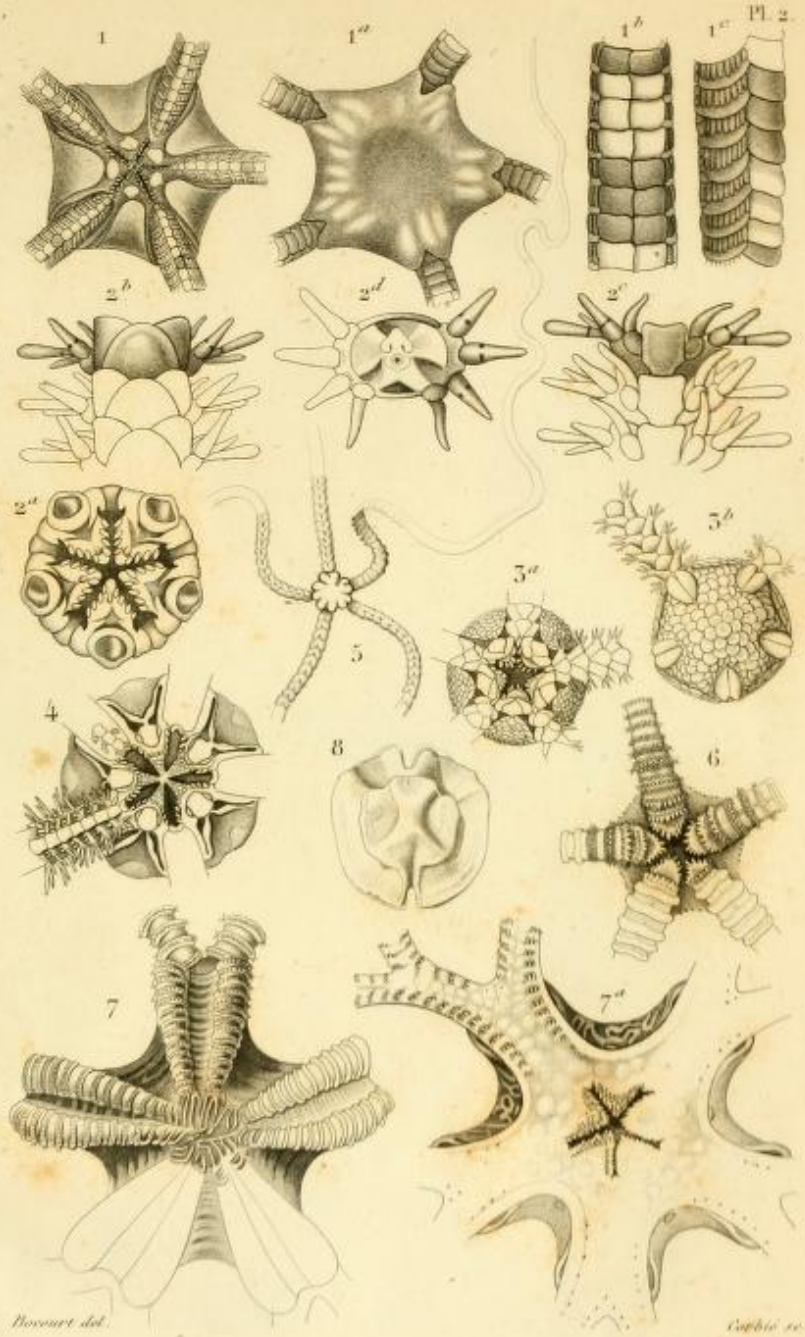
Fig. 13. *Echinarachnius parma*, seen from above.

Fig. 14. The same species, transversely sectioned and showing the interior of the ventral wall.

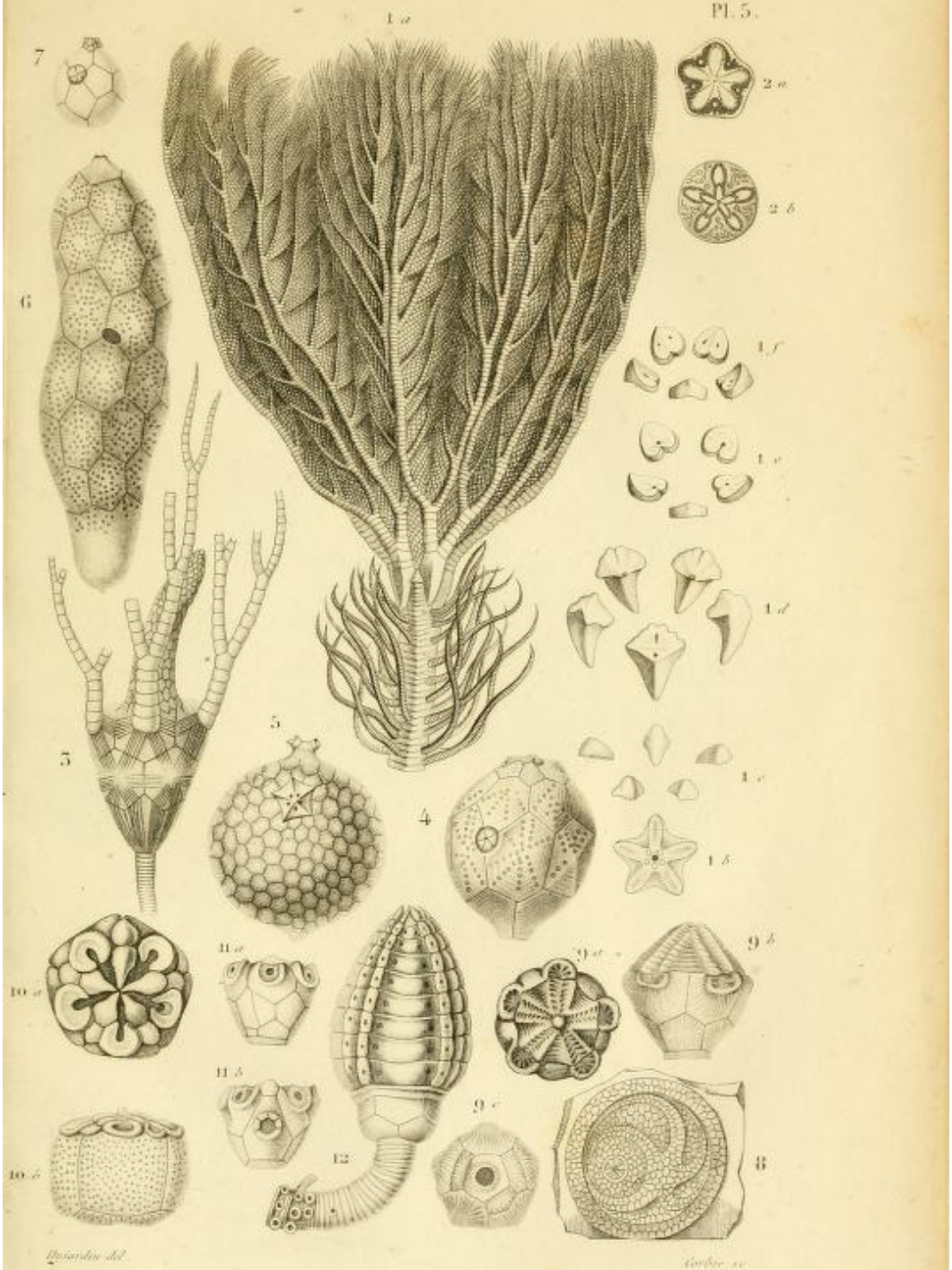
Fig. 15. The five jaws joined.

Fig. 16. A jaw seen separately.

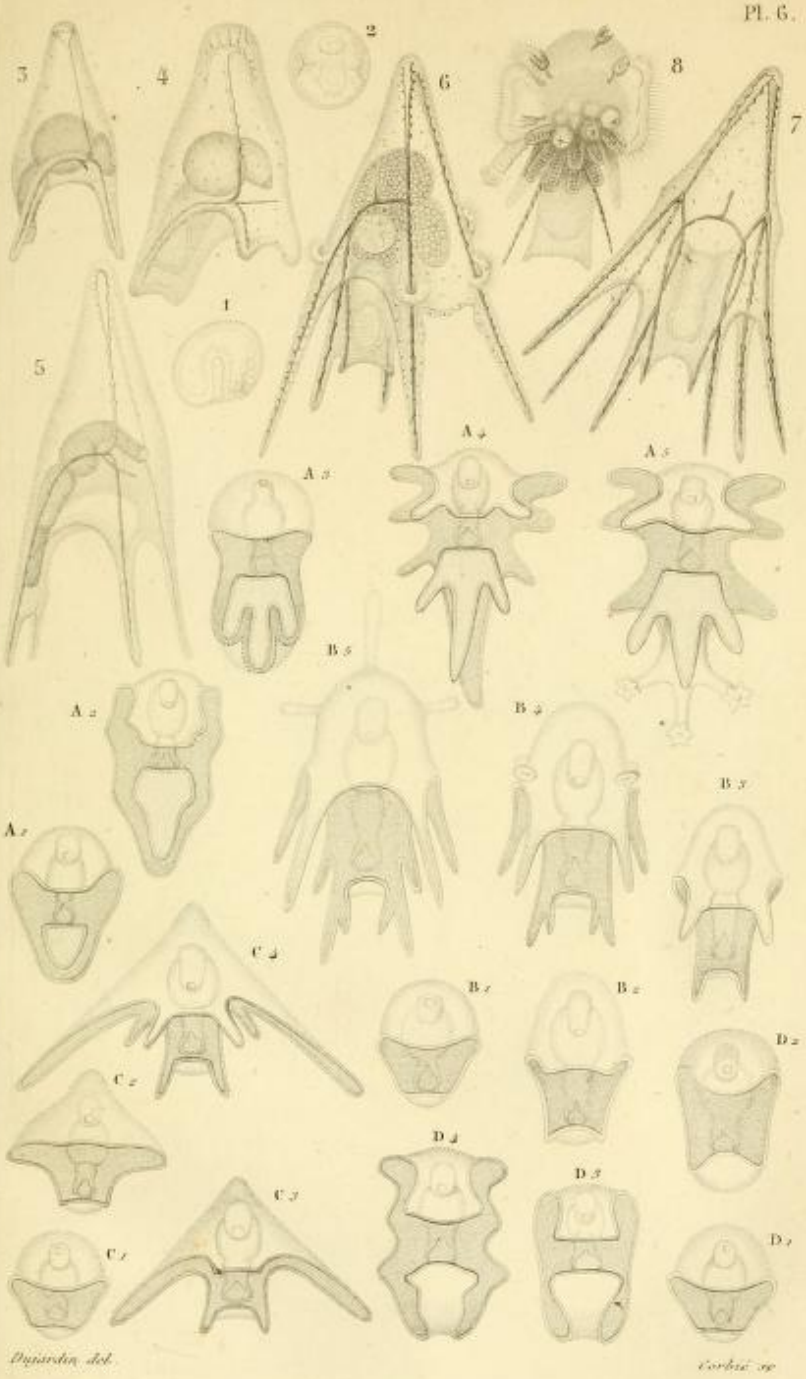
Fig. 17. Jaw showing the end of the tooth that it surrounds.



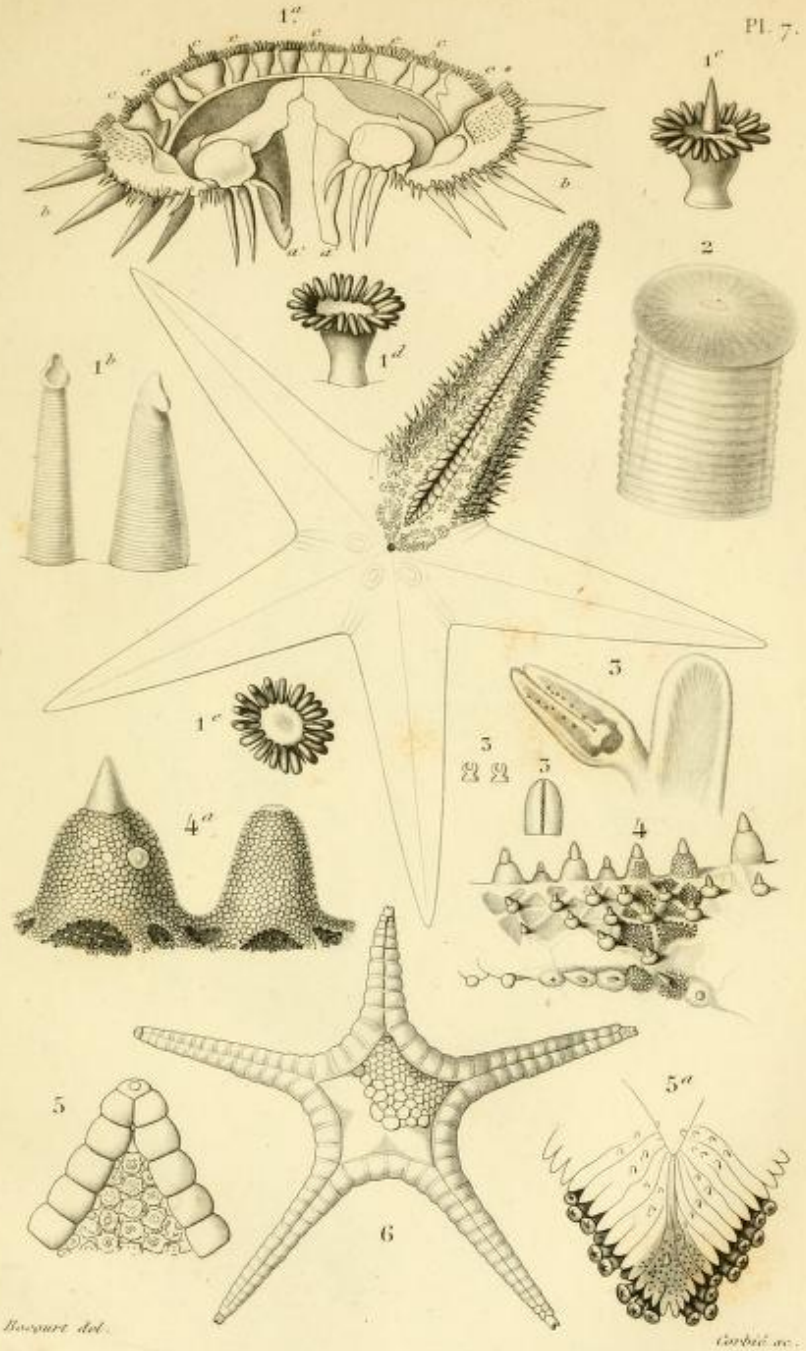
Ophiurides.



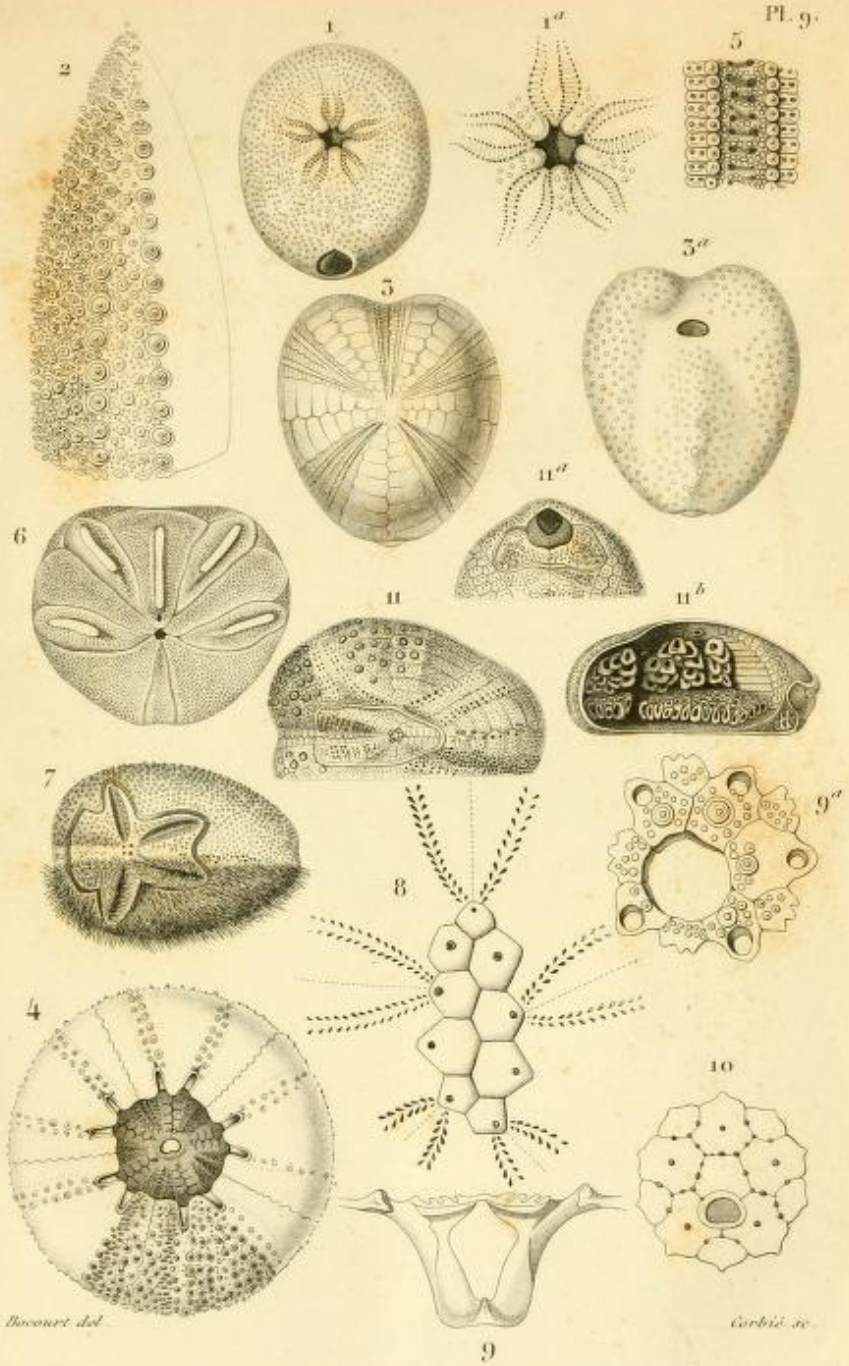
Crinoides.



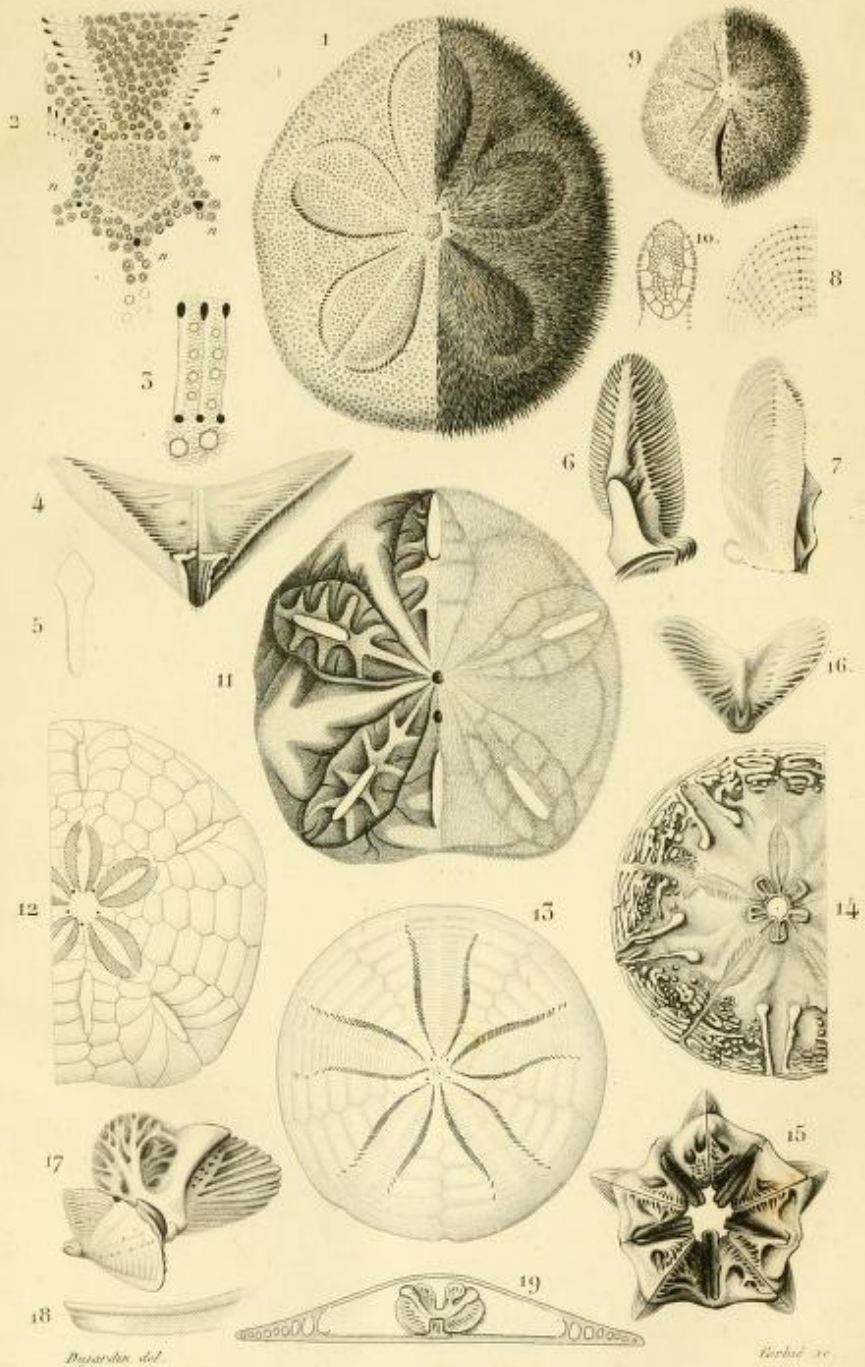
Embryogenie.



Asterides.



Echinides.



Echinides.