1841

**Monographies d'Échinodermes vivans et fossiles. Échinites.
Famille des Clypéasteroides. 2 (Seconde Monographie). Des
Scutelles** A translation of Agassiz, L. 1841. *Monographies
d'Échinodermes vivans et fossiles. Échinites. Famille des
Clypéasteroides. 2 (Seconde Monographie). Des Scutelles*

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Agassiz, L. 1841. Monographies d'Echinodermes vivans et fossiles. Échinites. Famille des Clypéasteroides. 2 (Seconde Monographie). Des Scutelles A translation of Agassiz, L. 1841. *Monographies d'Echinodermes vivans et fossiles. Échinites. Famille des Clypéasteroides. 2 (Seconde Monographie). Des Scutelles. Author. Neuchâtel, 151 p.* J. M. Lawrence and J. C. Fletcher, Trans.).

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Translator's notes:

Échinites in the title refers more specifically to fossil echinoids. The monograph includes both living and fossil echinoids.

Anatomical terms

1. In his first monograph, Agassiz referred to the “appareil oviducal”. In this monograph he said that term is too restricted and changed it to “apical rosette”. We have used the term “apical disc”.
2. Agassiz refers to “tubes” associated with the gills. These are the branches from the water vascular system. He uses “suoirs” (suckers) for the tube feet with disks.
3. Agassiz used the term Charles DesMoulins introduced for the demi-pyramids, “osselets” (little bones). In one place, he wrote, “osselets or demi-jaw”. We used demi-pyramids.
4. Agassiz used several terms for lunules. He used the term “vacuole” for elongated lunules and “ouvertures citulaires” (“circular openings”) for round lunules.

We have not attempted to make inconsistencies uniform. E.g.

1. Agassiz abbreviated his name as Ag. and Agass. in different sections.
2. Agassiz was inconsistent in italicizing species' names. Usually, the genus and the epithet together are italicized. Usually, the genus name alone is not italicized. We have not changed the printed style.

We have not changed obvious errors in the text. E.g.

- VI. ECHINOCYAMUS OBTUSDS Ag.
- VI. ECHINOCYAMUS SICULUS Ag.
- VIII. ECHINOCYAMUS ANNONI Mer.

We thank James Nebelsick for his help with some troublesome anatomical terms.

ÉCHINITES.

FAMILLE DES CLYPÉASTROIDES.

Seconde Monographie.

DES SCUTELLES.

1841.

PREFACE

Starting from the point of view that fossil organisms are intimately linked with living organisms and to reach complete understanding of the relations that exist between the various member of a family of animals, it is necessary to follow its development in different periods of the history of the earth. I have united in this monograph the fossil and living species of the group of Scutellids of which I have been able to obtain specimens. I hope that for geologists, as for zoologists, the study of modifications of this remarkable type has undergone since its first appearance on the earth up to now will not be the least interesting part of this memoir.

Despite the very special interest that seems to relate to Scutellids because of their bizarre form and large size, these animals are no less very rare, which is understandable in a way when we consider that the living species inhabit for the most part tropical seas, where they have been reported by only a few naturalists and the fossils are restricted for the most part to Tertiary terrains. So, I would not have considered making a monographic work of this tribe if I had not had the happiness of meeting in all my colleagues who possess or are directors of collections the most generous willingness to support my enterprise with by sending me the originals at their disposal or in permitting me to figure them. Friends of science will not be surprised to hear named again, as having the right to my most full recognition the names of Valenciennes, Gray, Stokes, Michelin, DesHayes. I must also thank particularly Alex. Brongniart, the Doct. Mayor de Geneva, Pictet de la Rive, Alcide d'Orbigny, and Mérian of Basel. In the synonymy of the species, I have mentioned only those authors who have studied the originals: the principal ones are Klein, Leske, Lamarck, DeBlainville, Gray and DesMoulins. The works of these authors to whom my synonymy relates are of Lamarck, the second edition of his *Histoire naturelle des animaux sans vertèbres*; of Charles DesMoulins, his *Etudes sur les Echinides*, extracted from the *Actes de la Société Linnéenne de Bordeaux*, and most particularly his third memoir titled *Tableaux synonymiques des Echinides*, vol. IX, 2^e book of the above Actes, of DeBlainville, his article *Zoophytes*, in the *Dictionnaire des sciences naturelles* of Levrault, and his article *Scutelle* in the same dictionary; of Gray, his memoir extracted from the *Annals of Philosophy* titled *An Attempt to divide the Echinida or Sea Eggs into natural Families*; finally my *Prodrome d'une Monographie des Radiaires* in the *Mémoires de la société des sciences naturelles de Neuchâtel*, vol. 1.

I have given colored figures of all the living species whose color seemed to me little or not at all altered. Unfortunately, the number of them is not great.

INTRODUCTION

THE GROUP OF SCUTELLIDS IN GENERAL

The group of Scutellids that is treated in this monograph makes a part of the echinoids that I designated in my Prodrôme under the name of Clypeasteroidea. Its characters are a central mouth while the anus is sub-central and sometimes dorsal, sometimes ventral, and sometimes marginal. Besides these general characters, the genera that I place in this group of Scutellids are distinguished from all other clypeasteroids by a particular physionomy that results from a combination of several constant characters, of which the most remarkable is the extraordinary flattening of the test. This character alone is sufficient to distinguish the Scutellids from all other types of the family of clypeasteroids. But this flat form is found in all species of this group regardless of their structure or size. I do not think that we should envisage it as a simple generic character, as done by Lamarck and DesMoulins. I consider it, on the contrary, as a distinctive character of all the group, the same as I have envisaged the shield-shaped and protruding apical system in the Salenies, as one of the significant characters of all this tribe¹.

The Scutellids have always had the attention of naturalists. We find them figured and mentioned in the oldest works of natural history. The systematic authors of the beginning of the last century have even already divided it into several genera that, although circumscribed in very natural ways, have not however been accepted by modern workers. Klein, whose work appeared in 1734² divided the Scutellids into four genera that he designated under the names of *Mellita*, *Laganum*, *Rotula* and *Arachnoides*. Before Klein, Breynius³ had already described and figured several species of Scutellids under the name of *Echinodiscus*. Rumphius⁴ gave their Dutch name, that recalls in a more-or-less precise way the exterior form of these animals. Van Phelsum⁵ replaced the name *Rotula* of Klein by his genus *Echinotrochus*, but he incorrectly associated it with *Mellita hexapora*. He created in addition the genus *Echinoglycus* that nearly corresponds to the genus *Mellita* of Klein, i.e., it includes the Lobophores, Encopes and true Mellitids. His genus *Echinarachnius* corresponds to the *Arachnoides* of Klein, but as it includes two distinct types, I have kept for one the name of Klein and for the other that of van Phelsum. Finally, it is to van Phelsum that the genus *Echinocyamus* date that includes at the same time the Fibularids and the true Echinocyamus. Davila⁶ divided the Scutellids into two genera, *Placenta* and *Rotula*. The first includes the genera *Mellita*, *Laganum* and *Arachnoides* of Klein. The second corresponds to his genus *Rotula*.

¹ Monographies d'Echinodermes vivans et fossiles, 1^{er} book, containing the Salenies, page 5.

² J. T. Klein. Naturalis dispositio Echinodermatum, in 4^o. Edit. auct. a Nath. God. Leske; Lipsiæ 1778.

³ J. P. Breynii. Dissertatio physica de Polythalamis, Gedani 1732, in-4^o.

⁴ G. E. Rumphii. d'Amboinsche Rariteitskamer. Amsterdam, 1705 Fol.

⁵ Murc. Van Phelsum Brief aan Cornelius Nozemann over de Gewelplekken of Zee-egeln. Rotterdam, 1774.

⁶ Davila. Catalogue systématique, etc. Paris, 1767, in-8^o.

Leske, the commentator of Klein, united all Scutellids, with the exception of the Echinocyamids, into a single genus, under the name of *Echinodiscus* that Breynius had given it. Linnaeus, according to his habit of not taking into account the work of his predecessors, suppressed all three genera and united them with his genus *Echinus* in which he included all echinoids. Lamarck felt the need of sections in the echinoids and established the genus *Scutella* which has been accepted by Cuvier and most modern authors, but which really is nothing other than the genus *Echinodiscus* of Breynius and of Leske because it contains species of nearly all the types of the group Scutellids. Later, Gray has again reintegrated the genera *Lagana*, *Echinodiscus* and *Echinocyamus*, that de Blainville had also maintained in keeping however the name of *Echinodiscus* for the genus *Echinarachnius* and that of *Scutella* for the true Scutellids that Gray left in the genus *Echinodiscus* with the Mellitids and the Rotulids. Ch. DesMoulins, in his work on the echinoids, has not accepted at all this reintegration, but held to the genera *Scutelle* and *Fibulaire* of Lamarck.

Division of the Scutellids.

These numerous oscillations in the limits of the genera of the group are proof of the difficulty of grasping their general character when we have as guide only the form of exterior structure of the test. A glance at the plates that accompany this memoir is sufficient, it is true, to make known that the various species that are figured, although all constructed on the same plan, do not the less form several very distinct types. What is there is in common between an *Encope* and an *Echinocyamus*, between a *Rotula* and a true Scutellid? But these differences in appearance so clear somehow are erased in a way, according to how we go into the details of the species and the most dissimilar types are linked by intermediary species that make setting limits more difficult. We understand, thus, that the authors, moreover very exact, have been led to make very unnatural sections by giving a too exclusive value to a certain exterior character. Others, more circumspect, have preferred to unite all Scutellids into a single genus, such as Leske, Lamarck and Ch. DesMoulins. To reach a more rigorous appreciation of the value of various characters that we have envisaged as generic and of limits in which they can vary. It is important to study their relations with the entire organization of the animal and especially with the principal interior organs, which was all the easier for me since I possess duplicates of specimens belonging to most types. This study made me aware of major differences in the interior structure of species whose external appearance is very similar. I have had to restore in part genera of the old authors and establish in addition several new ones, so that the group of Scutellids, as defined in this monograph, has thirteen genera that are the following: *Rotula* Kl. (Ag.) (*Echinoglycus* van Phels). — *Encope* Ag. — *Lobophora* Ag. — *Amphiope* Ag. — *Scutella* Lam. (Ag.) (*Echinodiscus* Breyn., Gray). — *Echinarachnius* v. Phels. (Ag.) — *Arachnoides* Kl. (Ag.) — *Scutellina* Ag. — *Laganum* (Ag.) — *Echinocyamus* van Phels (*Figularia* Lam.) — *Moulinia* Ag. Each of these genera are distinguished by an ensemble of constant and precise characters, taken essentially from the interior structure combined with the principal traits of the test surface. To leave no doubt about the value of these characters, I have taken care to give comparative figures of the interior of the test of the most similar genera. I have reason to hope that, in this relation at least, the generic sections that I propose will be fully justified, however numerous they may appear at first. The general form, the arrangement of the apical system, the position of the anus, the structure of the masticatory apparatus and the interior cavity of the test are so many

characters whose various combinations give to each genus its particular physiognomy and that should, consequently, serve as guides in the study of the genera and species. I have preferred, in general, to preserve the names of old authors every time I have been able without fear of giving rise to confusion, than introduce new names as is only too true of the moderns who think they have the right to take no account of the works of their predecessors when they do not fit into their system.

Klein already had known very well the generic characters of the Scutellids, although he knew only a small number of species but the manner in which he classed them proves that he had a rather exact knowledge of the detailed organization of these animals. The separation that he established between the species with complete edges that he designated under the name of *Laganum* and those whose test has lunules is not based only on their exterior form. It is also justified by the nature of the internal organs that have a very different arrangement as we shall show below. His genus *Rotula*, defined in a very precise manner, contains the species whose posterior edge is adorned with digitations. So I made it my duty to restore it in the same sense that it had been defined by its author. His genus *Mellita* is less precise. He unites under this name all Scutellids with sinuous edges having two or more openings, i.e., species belong to different types. In circumscribing these genera in a more natural way, I have kept the name of *Mellita* for the species with at least four very narrow ambulacral lunules, a similar lunule in the posterior interambulacral area, but whose apical system has only four gonadal pores. I have in addition established three new genera among the species whose test has openings. These are the genera *Encope*, *Lobophora* and *Amphiope*. The first contains the large species of the type of *Scutella emarginata* having five ambulacral lunules and a large lunule in the posterior interambulacrum. The second is composed of having two elongated lunules in the posterior ambulacral areas, and a masticatory apparatus of a particular structure. The *Amphiope*, finally, have two circular openings instead of elongated lunules in the posterior ambulacral areas. Among the species whose test is complete, I have preserved the name of *Scutella* for those that have the anus on the ventral surface, taking for type the genus *Scutella subrotunda* of Lamarck. I have divided *Echinarachnius* into three genera, preserving the name *Echinarachnius* proper to species of the type *E. parma*. I have separated the small species, such as *E. lenticularis* and *E. nummularius* of the authors, of which I have made a new genus under the name of *Scutellina*. Finally, I have also separated the species known under the old name of *E. placenta* that I see as the type of a separate genus to which I have preserved the name of *Arachnoides*. I have restricted the genus *Laganum* to species with an elongated and sub-pentagonal form and with a complete edge. I have preserved the name *Echinoocyamus* of van Phelsum to species with a pyriform or sub-pentagonal test, having slightly rounded ambulacra and four genital pores very close together. I have completely separated from them the small globular species that Lamarck has incorrectly united with the Echinocyamids and that I think should be associated to the Galerites because of the peculiar structure of the interior of the test. The genus *Runa* that still has only two species, remarkable for the proportions of the ambulacral areas compared to the interambulacral areas, and the genus *Moulinia* that is distinguished by the structure of the surface of the test, are both new. The first of these two genera establishes a transition between the Scutellids with a complete border and those that have indentations.

Let us not forget, however, to note that there is in the Scutellid group, as it is defined here, two large rather separated types. One contains the genera with a circular or elliptical test such as the Rotulids, the Mellitids, the Encopes, the Lobophores, the Amphiope, the true Scutellids, the Echinarchnids, and the Archnoidids. The other includes the genera with a pentagonal or angular

disk, i.e., the Laganids and the Echinocyamids. The last seems at first rather nearer the Clypeasters than the Scutellids, especially their tubercles and spines do not have the varied form and arrangement that characterizes all the circular genera. The form of the mouth recalls more that of Clypeasters, especially in the Echinocyamids. But, on the other hand, there are incontestable transitions from one type to the other in the two genera *Arachnoides* and *Echinarachnius* that have the circular form of Scutellids and the uniform aspect of Laganids. We shall add to this that the interior of the test is constructed in the same manner as in the Scutellids. It is the same arrangement of the intestine, the same compartmentalized structure of the edges of the test and nearly the same structure of the masticatory apparatus. Nevertheless, I have asked myself several times if it is not appropriate to make the Laganids a small separate group, intermediary between the Scutellids and the Clypeasters. Perhaps it will become necessary, when we will have made a comparative study of the soft parts of all the genera. In the meantime, it seems to me that the similarities outweigh the differences, at least as concerns the solid parts, particularly the structure of the interior cavity. Consequently, I have united the Laganids to the Scutellid group. Gray goes even further. He joins even the true Clypeasters and the Cassiduloids to the Scutellid group. But these relations are exaggerated, especially the latter.

General form

The flat form is, as we have said above, a characteristic common to all the Scutellid group. Except for some small species of Echinocyamids, the height is nearly a sixth of the length in most genera. The dorsal surface is in general swollen, with the exception of some species of Laganids and Echinocyamids whose edges are very enlarged. The greatest swelling coincides ordinarily with the apical summit, except in the Encopes and Mellitids where it is in the posterior region. The ventral surface is flat. The periphery of the test is sometimes circular or sub-orbicular (in the Rotulids, the Mellitids, the true Scutellids, the Echinarachnids), sometimes elongated or sub-pentagonal (in the Encopes, the Laganids, the Echinodiscids, etc). In the species with a sub-circular test, it is ordinarily the longitudinal diameter that is greater than the transverse diameter. Sometimes the opposite occurs, see the true Scutellids and some species of Mellitids. Often the posterior edge is more-or-less truncated, while the anterior border is rostrate. This is particularly the case in Laganids and Echinocyamids. Several genera are in addition notable for indentations, lunules and holes of various forms. There are those whose periphery is composed only of digitations, resulting from cuts that indent the disk, e.g., in Rotulids. Ordinarily, the holes affect preferentially the ambulacral areas. Even in the genera whose test is not continuous, we often note in front of the ambulacra, a sinus or indentation that seems to indicate less development in this part of the test than in the inter-ambulacral areas. It is only the Rotulids that make an exception to this rule, in that the indentations are greater in the inter-ambulacral areas than in the ambulacral areas.

Structure of the test.

The test of Scutellids is divided, as those of all echinoids, into ten areas, five ambulacral and five inter-ambulacrals. Each of these areas is composed of two series of principal plates that are often so intimately fused that one can scarcely recognize the sutures that unite them, especially in old individuals. In the young, the articulation is more distinct. The normal number of principal plates is consequently twenty, disregarding the poriferous plates that we shall consider in the section on ambulacra. On the immediate periphery of the mouth opening, we ordinarily count ten plates and sometimes only five instead of twenty. Their form differs completely from that of the plates that compose the rest of the test. Instead of being square, they are wedge-shaped and their arrangement in a circle around the mouth results in a very elegant rosette that I shall designate by the name buccal rosette. This rosette is more-or-less distinct, according to the thickness of the tubercular layer. It has been impossible for me to recognize it in Echinocyamids and in several Laganids. However, I have no doubt that it exists as in the other genera. As for the holes and indentations, DesMoulins has made the very correct observation that far from opening in the plates, they are always the result of a separation and widening of the suture in the ambulacral areas as in the inter-ambulacral areas. It is the same with the anal opening.

When the spines that cover the test of Scutellids are absent (as is the case in most specimens that we see in collections and particularly in fossil species) the entire surface of the test appears to be covered with small tubercles of very homogeneous appearance but, when we examine them with the magnifying glass, show very notable differences. There are some with large distinctively mamelonated and perforated that support the more developed spines that DesMoulins called *spiniferous tubercles*. Beside them, we note many others much smaller, but equally mamelonated, although hardly visible to the naked eye. These are the *miliary tubercles* of Ch. DesMoulins. Fig. 9 of Pl. 2, which represents a portion of the dorsal surface of *Mellita Agusti* Kl. with a magnification of several diameters, will give an idea of this arrangement. On the ventral surface, the arrangement of the tubercles is ordinarily more varied than on the dorsal surface. The large tubercles and notably those of the interambulacral areas are less dense and much more developed. The small ones, on the contrary, are excessively numerous. This marked appearance of the ventral surface is shown in most genera, notably in the Encopes, the Mellitids, the Lobophores and the true Scutellids.

Ambulacra

The ambulacra are of capital importance for the study of Scutellids and all urchins in general because of the numerous variations they undergo according to genus and species and the precise character that they furnish to zoologists in most species and notably in the fossils that do not permit inspection of the interior of the test, the characters taken from these organs are even of the first value.

I shall try here not to enter into a discussion into the nature and function of the ambulacra in Scutellids persuaded that the difficulties that are raised on this subject cannot be resolved until we have studied living animals or at least a series of well-preserved specimens in wine spirits⁷. Consequently, I shall use here only zoological characters.

⁷ From what I have been able to observe on a very well-preserved specimen, although dried, of *Laganum rostratum* Pl. 25, fig. 3, the space between the two rows of pores of the ambulacral petal, is covered inside with a swelling of spongy appearance, composed of vertical lamellae located beside each other, and that communicate with the pores.

The Scutellids have, like most Clypeasteroids, limited ambulacra, i.e., the series of pores, instead of extending in a uniform manner from the mouth to the summit, have a very particular arrangement on the dorsal surface in forming there a rosette composed of five rays that I call *ambulacral petals* because of their petaloid shape. This arrangement of ambulacra is very different from that we see in the Cidarids and even in several groups of the family of Clypeasteroids, such as the Pygasters, the Discoides and up to a certain point in the Galerites. In them, the poriferous zones or ambulacra proper are composed of open pores in the small, separate plates that I designate for this reason by the name of *poriferous plates* and that form one or several continuous rows the entire length of the urchin. It is not the same in Scutellids and the genera with limited ambulacra. These have poriferous plates strictly speaking only on the dorsal surface. Beyond the ambulacral petals, the pores generally disappear or at least do not open in separate plates. This arrangement implies a great inequality in the form and the dimensions of the principal plates of the test. We take for example, *Encope emarginata* figured in Pl. 10. We see there that beyond the petals, the plates of the ambulacral areas are large and nearly square in form. In the interior of the petals, on the contrary, they are very small, much wider than high, forming two rows that articulate in a medial line of the ambulacral area. But instead of prolonging to the interambulacral area, these plates are limited to the internal row of pores and the transversally grooved space whose edge is composed of independent plates having nearly the same width as those of the intermediary space. At first glance, one is naturally led to take the grooves that unite the two rows for the sutures of the poriferous plates. But if one examines them closely, we soon become certain that they are only superficial. I admit that I ignored for a long time the true arrangement of these plates and their mode of articulation. It was in studying the Spatangoids that I found the key to the enigma. I have recognized distinctly the sutures in the intermediary space between the grooves and later I have found them in the same position in Clypeasters. It is more difficult to observe them in the Scutellids because of the very dense tubercles that cover them. However, I do not doubt that they are arranged in the same manner.

This form of ambulacra is common in Echinolampids, Nucleolitids, Clypeus, Clypeasters and, in the family of Spatangoids, to all the genera in which the ambulacra are limited. But a character restricted to the group of Scutellids, and most particularly to the genera *Mellita*, *Encope*, *Lobophora*, *Amphiope* and *Sculella*, is the form that affects the ambulacra of the ventral surface. These are very marked grooves that ramify in all directions in their trajectory from the center to the periphery, and determine thus the numerous and very elegant undulations. If we examine these grooves closely, we find them riddled with a multitude of small pores up to their last ramifications. Various opinions have been given on the function of these small pores. Some authors, in regard their extreme smallness, that makes them even imperceptible in several genera such as the Laganids, the Echinodiscids, and the Echinocyamids, doubt that they provide passage to tube feet. It is therefore important to submit these organs to a close scrutiny. This is what I did in concert with my friend, Valentin. We removed from the test of a specimen of *Laganum Bonani* Kl. preserved in wine spirit some parcels of the epidermis taken from the grooves of the ventral surface. We examined it with the microscope. We effectively recognized a quantity of small, very characteristic tube feet. Fig. 29 of Pl. 22 represent one of these tube feet with an enlargement of 102 times the diameter according to a drawing of Valentin.

However, as it has been demonstrated to me, by analogy to the genus *Echinus* (see the 4th book of these monographs by Valentin) there is a direct communication between the ambulacral pores and the organs of respiration. I have no doubt the juxtaposed lamellae are the skeletons of the gill leaflets of the Scutellae. Examined in isolation under the microscope, they appear to be composed of a very elegantly reticulated calcareous tissue.

It is thus demonstrated by this observation that the ambulacral organs (tube feet or tentacles) exist on the ventral surface as on the dorsal surface. It remains to know now if they are of the same nature. It is this that I have not been able to observe up to now for lack of well-preserved specimens. In any case, the great difference that exists, in terms of dimensions and number between the pores of the dorsal surface and those of the ventral surface, establishes a clear separation between the Scutellids and all the genera with limited ambulacra on one hand and the genera whose poriferous zones are uniform in all their length such as the Galerites, the Pygasters etc. on the other. In all the genera of the Scutellids, and even in nearly all the Clypeasteroids with limited ambulacra, the pores of the internal row of the ambulacral petals are circular and smaller than those of the external row that are in general oblique⁸,

Apical disk

There is in the Scutellids, as in all Clypeasteroids and Spatangoids, opposite the mouth at the top of the disk, a rosette generally angular or star-shaped in form, where the ambulacral petals end that I have designated until now the “appareil oviducal” because the genital pores open around it. However, research that I have done since then on the structure of the test of Scutellids and the discovery that Forbes has just made on *Echinus*, and that I have seen in several species of this genus, of the presence of eyes in the small pores located at the top of ambulacra and generally known under the vague name of “interoviducal or intergenital pores”, and considerations from the structure of the same apparatus in the interior have led me to change the too restricted name of “appareil oviducal” to that of apical rosette that at least is not ambiguous. This rosette is composed of three organs, which are: the madreporite, the genital plates and the ocellar plates. In most genera, these three plates are so intimately articulated with each other that we cannot distinguish any trace of a suture. I was even wondering if the genitals and ocellars were opening in the madreporite itself when I recognized in *Laanum decagonum* a distinct articulation between the various plates of the apical rosette.

The *madreporite* is a more-or-less developed button, but of a different appearance from the rest of the test and that, when we examine it with the magnifying glass, shows a quantity of small pores very similar to the cells of some microscopic small corals. This is without doubt the reason the name of madreporite has been given it. But this cellular structure is not only exterior. In the interior, the top of the test has the form of a very compact star provided with five slender and protruding rays intended to protect the oviduct or spermatic duct that pass under them before reaching the surface. As on the outside, there is not the slightest trace of a suture. During the life

⁸ DesMoulins, in his *premier Mémoire sur les Échinites* (p. 70), gives a detailed description of the ambulacral system of *Enclope* (Scutella) *tetrapora*, in which he demonstrates the existence of ten canals (including one under each half of the five ambulacra), embedded in the calcareous and compartmentalized mass that fills the test. “The roof of each canal, he says, is striated transversely by grooves wider than those outside the ambulacra. These grooves are separated by sharp and denticulated ridges..., the soft parts of the system consist of pink membranes, very thin, fixed in parallel and vertically like so many partitions on the back of each ridge. They communicate by the pores that pierce each groove (the ambulacral pores) with the external dermis of the animal. These membranes are crossed by an infinity of nerves in relief (vessels) and carry the suckers whose remains one sees in the pores.

I have not had the opportunity to observe this arrangement of the membranes, nor their relation with the ridges that separate the grooves of the ventral surface in *E. tetrapora*, but I have encountered a similar structure in the interior of Encopes of several other species.

of the animal, the esophagus is fixed in the middle of this internal apical star, in a small cavity that is open in the direction of the intestine.

The genital pores open sometimes at the end of the rays of the apical disk, sometimes in the intermediary sinus. In the latter case, they are always very close together, e.g., in the Rotulids. The normal number of five genital pores is reduced to four in most genera of Scutellids, e.g., in the Rotulids, the Mellitids, the Lobophores, the Amphiopores, the true Scutellids, the Echinarchnids, the Echinocyamids and in some Laganids. I cannot say if this absence of a fifth pore really depends, as DesMoulins wants, on the absence of the fifth ovary because of the direction of the intestine. In any case, I do not think that we can envisage it with any right as an essential character because when we go to examine the interior rosette, we find the ray of the unpaired interambulacral area is constructed in the same manner as those of the interambulacral pairs except there is no pore. Future anatomical research will teach us if this particularity corresponds to a major difference in organization or not.

The *ocellar pores* will acquire henceforth a great importance if it is true, as I have no doubt, that they also serve in the Scutellids to house the organs of vision. To confirm this, it will be necessary to have available living individuals, which is very difficult in Europe, so we must be content for the moment to draw proof from analogy. I think in general we can accord them a value all the greater as the principal organs are constructed on the same general plan in all the class of Echinoderms. There are never less than five ocellar pores. But sometimes they are so small, that we have difficulty distinguishing them with a magnifying glass. They are invariably located at the top of the ambulacra and penetrate the test like the genital pores.

Spines

The Scutellids have, like all Clypeasteroids, small spines that articulate to the tubercles on the surface of the test. These spines are very variable in form according to the genera and species, and even in individuals of the same species. They have very notable differences according to whether they are from the dorsal surface or the ventral surface. Those of the dorsal surface are in general short and clavellate. Those of the ventral surface are slender and aciculate. Finally, several species of Mellitids and Encopes have a third kind on the periphery of the lunules. They are rather well-developed spines and flat at their end. Alive, they move the animal moves the spines at will in all directions. But in dead individuals, we always find them inclined in the same manner. Those of the ventral surface are directed, in the posterior interambulacral areas, from the edge toward the center and in the ambulacral areas, from the center toward the edge. This arrangement struck me strongly the first time I observed it in *Mellita testudinata*. But later I found it in all the species whose spines were preserved. It is only in the Echinarachnids and the Laganids that seem to be an exception to this result because their spines have no very regular disposition.

When we examine the various spines with the microscope, we are completely astonished to find the same structure as the spines of the true urchins. Instead of being smooth, as we supposed natural, they are strongly striated in the direction of the length. These striations are, in addition, bristling with a number of small spines. (See Pl. 4 a, fig. 7, 11 and 12. Pl. 6 a, fig. 4 and 7; Pl. 10 a, fig. 1 and 2; Pl. 20, fig. 7, 8 and 13, and Pl. 22, fig. 28.)

Color

The color is rarely preserved. It even appears to be transient. I have seen, in my own collections, specimens of *Mellita pentapora* of a bright color fade in a few months. Also, among the specimens that are preserved in collections, most are faded to a point where one could not guess the color in the living state. The predominant color appears to be green and violet, green in the Rotulids, the Mellitids and violet in the Encopes, the Lobophores and the Echinarachnids. I have seen in the Encopes of all shades, from crimson to reddish-brown. Sometimes the color is maintained even when the spines are removed. And even in the specimens that have preserved them only partially, we note the same color in the areas with cilia as those that lack them. Moreover, Scutellids are usually unicolor. If, sometimes, one surface is paler or deeper than the other, this difference is only of shade of one and the same color. I have never encountered a variegated Scutellid.

Mouth

The mouth is central as in all Clypeasteroids, and proportionally smaller than in any other group of this family. Its periphery is ordinarily subcircular or pentagonal and covered during the life of the animal with numerous spines larger than those of the rest of the test that intersect in all directions in a way that often hides the opening. In most genera, we see on the periphery of the mouth, at the end or rather the origin of the ambulacral grooves, small enlargements that protrude into the mouth opening. When examined closely, they have the form of tubes with one or several openings at their end. I envisage these tubes as cavities that contains the buccal gills, that, in any case, must have been very small. When these tubes are missing, as is for example the case in the Laganids, the Echinocyamids and the Echinocyamids and the Echinodiscids, the periphery of the mouth is no less pentagonal. But its form recalls more that of true Clypeasters.

Anal opening

The form and position of the anal opening merits great attention in the study of these animals because of the intimate relation of this organ with the intestine. Also, it gives us in general good generic characters. However, it is necessary not to attribute to it excessive value as some authors have done, placing into different families some otherwise very close species, because in one, the anus is marginal, while in others, it is dorsal or ventral. This would be in my opinion a mistake of wanting to separate the Echinarachnis from other Scutellids because they have a dorsal anus, while the true Scutellids have it on the ventral surface. In the genera that have a notch or lunule in the unpaired interambulacral area, the anus is generally nearer the mouth than in the genera with a complete edge. Its form is sometimes circular, sometimes elliptical, never angular. During the life of the animal, the anal opening is closed by a membrane covered with small calcareous

plates of unequal size, that we sometimes find preserved in dried specimens, e.g., in the *Lagnuam depressum*, figured in Pl. 23, fig. 6.

Interior of the test

The interior of the Scutellids does not have a uniform cavity like the Spatangoids, the Cidarids, and most Clypeasteroids. It is, on the contrary, divided diversely unevenly by walls, pillars and calcareous networks, whose form, structure and arrangement is very variable in the different types of the group would alone be sufficient to justify most of the generic divisions that I accept here⁹. The central space that contains the masticatory apparatus, which I call the *buccal cavity*, is distinct from the *intestinal cavity* that extends all around. Most often, it is true, the wall that separates them is only a membranous wall (in the Rotulids, the Lobophores, the true Scutelles, the Laganids, etc.). But sometimes also, it is a continuous calcareous wall (e.g., in the Encopes), or they are pillars that rise from the interambulacral area, and around which is extended a membrane, e.g., in the Mellitids. As for the horizontal wall that separates the test into two superposed stages, it is only in the Encopes (see the article on the genus Encope) and this is without doubt that having only at his disposal species of this genus that DesMoulins spoke of it as a character common to all the group.

The edges are ordinarily very cavernous in the interior, sometimes they even have a continuous and very complicated network of compartments that penetrate the calcareous substance of the test like a sponge. Other times, and most often, there are winding canals that circulate between the massive vertical pillars, and into which go caecal appendages of the intestinal canal. The genera Scutelline and Echinocyame are remarkable in that the ambulacral areas are separated from the interambulacral areas by protruding calcareous blades that extend from the center to the edge. In contrast, the edges themselves are neither cavernous nor compartmentalized. The main character, which distinguishes the Echinocyamids from the true Fibularids that have been confused until now, consists precisely in these walls that link them to Scutellids, while the Fibularids have neither walls, nor compartments, nor pillars.

The Scutellids have in addition, as all the other Clypeasteroids, five auricles or fixed calcareous supports placed around the buccal opening and destined to facilitate the play of the jaws. They are less developed than in the Cidarids. Their form, their dimensions, and even their arrangement varies more-or-less in the different genera. They are small and very close together when they serve as pivots to the jaws, as is the case in the Lobophores. They are, on the contrary, very developed when they serve as buttresses, as for example in the Laganids.

Masticatory apparatus

This apparatus, ordinarily very developed and mobile, is constructed on the same plan as that of the Clypeasters, of which DesMoulins has given detailed description, accompanied by figures in his *Etudes des Echinites*, with this difference, however, that there are no rotules¹⁰, and that the

⁹ The interior of the test of true Clypeasteroids is constructed in nearly the same manner as in the Scutellids. We distinguish there a quantity of very fine, sharp needles that I have encountered in the Scutellids. DesMoulins is said to have observed very fine ones in a specimen of *Scutella (Encope) emarginata*.

¹⁰ DesMoulins has given the name of rotules to five small pieces alternating with the teeth, and destined, according to him, to facilitate the independent movement to each of the jaws. See DesMoulins, p. 66.

teeth, instead of being fixed vertically at the end of the jaws are, on the contrary, implanted horizontally to the dorsal surface of the latter. The five jaws that make up the masticatory apparatus of the Scutellids are triangular and resemble, like those of the Clypeasters, a very open V or a compass placed horizontally (see Plate 8, fig. 3 and 4 and Plate 6, fig. 7–8.). All have on the dorsal surface, on the median line, a groove in which the teeth are fixed, whose end projects beyond the jaws. The ventral surface is ordinarily enlarged on the median line, and when the teeth pivot on the auricles, as is the case of the Lobophores, we note in addition a small depression that DesMoulins called the boat fossette.

The differences, sometimes very striking, of the jaws in the various genera, are more apparent than real. Briefly, the jaws of the Laganids that are very high, differ from those of the Lobophores, that are very flat, only by the curve of the posterior framework and by the greater development of the vertical lamellae that are bristly above and below, so those that seem thickest are reduced to very thin plates when we remove these lamellae on the edge of their dorsal and ventral surfaces. But as these variations are maintained within constant limits, they offer us excellent generic characters.

Each jaw is composed of two parts that DesMoulins calls *osselets*. They are so intimately united that it is difficult to see the suture. However, I am convinced by examination of the jaws of *Arachnoides placenta* that the two osselets are articulated by a kind of framework, the left osselet having a small ridge that fits into a corresponding groove of the right osselet.

The anterior jaws are smaller than the posteriors, and between them is always the unpaired jaw that is larger. In the living animal, the five jaws are united by the transverse muscle fibers that, in contracting and dilating successively, determine the movement of opening and closing, that close the ends of the teeth and thus causes mastication. In dried specimens, these muscles have ordinarily disappeared. We should not expect to see much more in fossil species. Also, the jaws are seldom adherent to each other. The remainder of the relations of the position of the masticatory apparatus with the other parts of the animal do not vary in the entire order of Echinoidea. Each ray of the rosette corresponds to an ambulacral area, while the five jaws correspond to interambulacral areas. Fig. 6 of Plate 3 gives a correct idea of this arrangement.

It is rare to find the teeth adhering to the jaws, especially when one has made dried specimens. However, I have been able to see them in most genera. They are small blades placed vertically in the median groove of the dorsal surface of the jaws and are ordinarily enameled in all their length except in the Laganids, where they are not except at their end, as in the true Clypeasters. When the jaws are flat (in the Lobophores, the Mellitids), the teeth are nearly horizontally. They are, on the contrary, arched when they are very elevated (in the Rotulids and the Laganids, etc.).

Intestine

It appears that the general form of the intestine does not vary in a sensible manner in the different groups of the family of Clypeasteroids. Charles DesMoulins, in describing and figuring this organ in *Clypeaster Rangianus* DesM. has at the same time made known all the essential particularities of the intestinal canal of Scutellids¹¹. After leaving the masticatory apparatus, the intestinal canal goes to a cavity of the internal apical disk at the top of the dorsal test, between the genital pores. From there, it is directed forward, passing above the right anterior jaw.

¹¹ Charles DesMoulins. Premier mémoire sur les Echinides, avec planches; p. 64. pl. 2.

Arriving near the edge, it turns to the left, goes along the left side, returns by the right side up to the anterior region. From there, folding in upon itself, turns back again and goes to end at the anal opening that is located on the ventral surface of the posterior region. It passes consequently two times on the right side and only one time on the left side. I am sure by attentive examination of the interior of several species, among others a Laganid preserved in wine spirits and in a well-preserved specimen of *Mellita pentapora* that the intestine has along its entire path appendices or lateral processes that will be lodged in the compartments of the calcareous mass. These compartments, the nature of which DesMoulins had doubts, are really pockets of the intestine. This arrangement is seen in an evident manner in fig. 28 of Pl. 22, that represents half of the interior of *Laganum Bonani* seen from the ventral surface. In this species and in all the Laganids in general, these lateral compartments are less numerous in other genera such as the Mellitids, the Encopes and the true Scutellids. But we see very distinctly the way they communicate with the principal canal. It has been impossible, lacking well-preserved specimens, to distinguish exactly the different parts of the intestinal canal. However, I think that the narrow portion of the tube, that extends from the masticatory apparatus to the edge of the intestinal cavity corresponds to the esophagus. The part that extends on the left side, and that is larger, appears to me to be the stomach. Finally, the part that occupies the right side and is folded in on itself appears to me to correspond to the slender intestine. The part that I envisage as corresponding to the stomach is widely wrinkled, at least in the Laganids (Pl. 22, fig. 28 n), while the lateral processes appear to be smooth. It is usually empty in the dried specimens. The two bays of the right side, on the contrary, are constantly filled with debris of organic substances reduced to the state of a strongly triturated paste in which we still distinguish, however, fragments of small corals and small debris of other testacean animals.

Gonads

The gonads up to now have been observed only in the family of Cidarids, where they ordinarily acquire an extraordinary development. DesMoulins himself has made no mention of them in his otherwise very complete description of *Clypeaser Rangianus*. I therefore had to consider as good fortune the possession of a specimen of *Laganum Bonani* preserved in wine spirits, that I have due to the generosity of Valenciennes. To do the best possible, I asked my friend, Professor Valentin, to make anatomical studies. Here is what we have observed regarding the gonads. When we remove the dorsal part of the test, we find a membrane of reticulated appearance and diversely branched that covers all the intestine. As this membrane communicates by elongated tubes with the gonopores located at the top of the test, we could not doubt these tubes were either oviducts or spermatic canals. Unfortunately, the reticulated membrane was not well enough preserved to recognize if it was a male or female organ, because it is probable that, even in the true Echinus, the ovaries and testes are very similar, even in the living individual. The tubes (oviducts or spermatic canals) number five. The membrane itself, although continuous, appears to us to be equally divided into five parts, so that the number five is repeated in the reproductive organs, at least in the genus Lagana. Fig. 11 x of Pl. 22 shows the way these organs are extended on the intestine and the arrangement of three conducting channels, passing over the middle of the jaws to regain the gonopores. I have infinitely regretted not being able to

obtain a fresh specimen of a genus not having four oviducal pores instead of five, to know if the absence of the fifth pore corresponds or not to the absence of the fifth ovary or the fifth testes.

Mode of growth in the Scutellids

It is very difficult to give an account of the manner of growth in the Scutellids. Does it take place by the addition of new plates, or else the original plates only grow on their edges, or these two modes of growth take place simultaneously. There are very different opinions between the naturalists. All, it is true, recognize that the principal plates, first small at a young age, widen on their edges. It suffices moreover to examine attentively the plates in an individual little deteriorated to see that it is composed of successive layers from the interior to the exterior. This often makes them appear swollen in the middle.

We are far from agreeing as well on the question of knowing if new plates are added to the old as is the case in Cidarids. In any case, if a similar addition takes place, I do not think that it can be, as in the latter, around the apical disk because here all parts of the test are too intimately connected to the entire organization of the animal that we could accept such an addition.

But it is true that new perforated plates are produced between the old ambulacral plates, as claimed by Ch. DesMoulins¹². I do not think so for, the reason that, having the opportunity to study comparatively, in different species in a series of specimens of all ages, among others of *Rotula Rumphii* and *Encope Stokesii*, I made sure that the smallest (among which there are some that do not have even half the diameter of the larger) have however the same number of plates as the larger. I am equally convinced, by the study of the interior of the test in this series, that DesMoulins is mistaken in supposing that the intervals between the pillars of the edge finish by being filled with age, because there are not up to now digitations of the Rotulids, of which the interior is not the same in the young and in the old specimens. It is not the same with the notches that, as we shall see in treating the Rotulids, increase and are considerably modified with age.

Relations of the Scutellids with other Clypeasteroids.

A group as numerous as that of the Scutellids should necessarily have points of contact with several other genera of the family. It is in correct appreciation of these affinities that is the principal merit of the naturalist who, according to whether the similarities prevail over the dissimilarities should bring one group closer to or further from another. The Scutellids are linked on one hand to the Galerites by the Echinocyamids, and on the other hand to the true Clypeasteroids by the Laganids¹³. But this resemblance is not a reason to confuse these various genera in the same group with the Scutellids. I agree that by comparing certain species of Echinocyamids with the Fibularids, we may have been tempted to associate them generically as

¹² Ch.. DesMoulins, Etudes sur les Echinides, p. 137.

¹³ Clypeus has only the flat, discoid form of the test of Scutellids, but the particular position of the anus in a deep groove on the dorsal surface and the concave form of the mouth is nearer the Nucleolites. Also, I do not know of any author who has ever associated them to the Scutellids or even placed them near them.

nearly all authors have done. But here again, we let ourselves induce an error by an external resemblance, because by making a comparison of the interior of the test of these animals, I recognize that one (the Echinocyamids) are constructed on the same plan as the Scutellids, while it is not the same of the Fibularids that have neither chambers nor compartments nor pillars.

The true Clypeasters are without contradiction those that have the most analogies with the Scutellids, despite their elevated form that often gives them a completely different appearance. The Laganids and especially the Echinocyamids recall, by their swollen edges and by their often slightly protruding ambulacra, the type of true Clypeasters. Moreover, the position of the intestine is absolutely the same in the two group as DesMoulins has already demonstrated. But beside these resemblances, we find very notable differences in the structure of the interior of the test and notably of the masticatory apparatus. And first, the interior of the Scutellids is not at all bristling with these vertical needles that are so striking in the true Clypeasters. The teeth are not vertical but horizontal, and there is no rotula serving to articulate the jaws as in the Clypeasters. The mouth, finally, that is always pentagonal and very concave in the latter, is flush with the test in the Scutellids. The Echinocyamids and the Laganids of the type of *Laganum Bonani* also have the pentagonal mouth. But there is this difference. It is that the angles of the pentagon correspond to the ambulacrals, while in the Clypeasters, they correspond to the interambulacral areas.

I would have liked to be able to compare the interior of the test and notably the soft parts in several genera of the family of the Clypeasteroids. But the extreme rarity of the species makes this task very difficult, if not impossible.

Geographical distribution of the Scutellids.

The first traces of the Scutellids appear in the upper part of the Cretaceous formation, which contains several species of Echinocyamids, and even a species of true Scutellid, *Sc. Rodgersi* Mort., which is found in the chalk of New Jersey. The terrains of the Jurassic formation have not up to now offered any trace, no more than the lower stages of the Cretaceous formation, such as the Neocomian and the gray green. In contrast, the Tertiary terrains contain a rather considerable number, notably the coarse limestone in the vicinity of Paris and the shell-marl of Touraine.

In comparing the fossil species with the living species, we note between them rather notable differences. The living species are, in general, more rugged in their form than the fossil species. They have lunules, holes and notches, more-or-less varied. It is thus that the genera *Rotula*, *Mellita* and *Encope*, whose test is more rugged, have only living species (with the exception of the genus *Runa*, which is at the border between the types with complete borders and the notched forms and which contains two fossil species of the most recent terrains). The true Scutellids, whose test has no solution of continuity in its periphery are all fossils. The genera *Echinarachnius*, *Echinocyamus* and *Laganum*, whose edge is equally entire, seem more related particularly to the fossil fauna with living fauna because they exist both in the Tertiary terrains and in the present epoch. The genus *Echinocyame* even has representatives in the Cretaceous formation, as we have said above. It is of this genus as in some other types of the family of Cidarids, that are maintained across several formations, while others are replaced from one formation to another by new types. It is thus in the family of Cidarids, the genus of true *Cidaris*, even in the limits to which I have restricted it in my *Description des Echinodermes fossiles de la*

*Suisse*¹⁴, has representatives in the Jurassic formation, in the Cretaceous formation, in the Tertiary terrain and in the present epoch, while the Salenians, for example, are limited to the Cretaceous formation, the Acrosalenians and Hemicidaris to the Jurassic formation¹⁵.

The genera Lobophore and Amphiope form a kind of transition between the true Scutellids, on one hand, the Encopes and the Mellitids, on the other. The first contains only living species. The second (Amphiope) still contains only two species, both fossils.

It is also worthwhile to note that the largest species are those of the present epoch. I do not know that any species of true Scutellids has been reported whose size approaches that of *Encope Valenciennesi*. This superiority of living species is not restricted to the Scutellids. We note a similar progression in other groups of the order Echinites, whose species of more recent origin appear to be more voluminous. It is completely contrary to that of other classes of the animal kingdom, notably in the phylum of vertebrates and that of mollusks that have, in general, smaller dimensions in the present epoch than in older epochs. We shall have occasion to return to this question in treating the other groups, in particular the true Spatangus and the true Echinus.

The living Scutellids inhabit, for the most part, the tropical regions. They appear especially to be frequent in the Pacific Ocean. The seas of the North contain only a few species, among other Echinarachnians, such as *E. parma* and *E. atlanticus* that live off the coast of Canada. The seas of Europe and the Mediterranean have furnished until now only some small Echinocyamids.

¹⁴ Description des Echinodermes fossiles de la Suisse, 2^e Partie, dans les Nouv. Mémoires de la Soc. Hel. des Sc. nat. Vol. IV, p. 54.

¹⁵ I cite these examples in order to prove to the naturalist that in restricting the limits of genera, I am not letting myself be guided by systematic considerations, and that far from subordinating my determinations to the habitation or to the site as some have reproached me. I have always taken for the base of my determinations zoological and anatomical characters. If in proceeding in this manner, I have succeeded in demonstrating that, while demonstrating an incontestable connection between them, the various epochs do not have a more-or-less considerable number of particular types that constitute the general phyionomy, I will have obtained by the study of Echinoderms a result that will only corroborate that which I was already led by my *Recherches sur les poissons fossiles*.

CHAPTER I.

GENUS ROTULA Klein (Ag).

The genus *Rotula*, as we have said above, goes back to Klein who placed there the two species described below. It was not maintained by Leske, who confused the Rotulids with the Laganids under the name *Echinodiscus*. Linné did not even mention the names of Klein and of Leske but was content to place the Rotulids in his genus *Echinus*. Before Klein, Breynius had already described and figured the two species of this genus, but without giving them a specific name. Lamarck and DesMoulins place the Rotules at the head of their genus *Scutelle*, but without generically separating them from other types.

It suffices to have seen a Rotulid to know the generic character, and when we consider the precise way Klein determines his genus *Rotula*, we hardly understand how his successors could confuse it again with species that belong to entirely different types such as the Laganids, the Encopes, the Lobophores, the Echinarachnids, etc. In giving the Rotulids back their rights, I do not think I incur the reproach of multiplying too many genera, as this at least has already been limited in the same manner by the celebrated naturalist of Danzig.

The Rotulids are very flat urchins, circular in form, clearly characterized by the very pronounced digitations at the posterior or anal edge, but whose number and form vary in rather wide limits according to species and even to the individual. Having had the opportunity to compare numerous series of specimens of the two species of Klein, I was convinced that *Scutella radiata* and *Sc. octodactyla* of authors were only varieties of age, one of *R. Rumphii* and the other of *R. Augusti*, and that there really exist only two species in the grand museums of Europe. The mouth is small, circular and placed in the center of the ventral surface. The anus, sometimes circular, sometimes ovoid, is nearer the mouth than the posterior edge. The apical disk is of medium size and the poriferous zones of petals, instead of forming at their end, have on the contrary, a tendency to diverge. Ordinarily the pores are extended in an undulating manner to near the edge. On the ventral surface, the ambulacra are represented by five grooves riddled with a multitude of small pores invisible to the naked eye, but quite distinct with a magnifying glass. These grooves are not branched in a manner as varied as in the Encopes and the Mellitids. Each groove is divided, a short distance from the mouth into two branches so that there is one in each digitation. This arrangement of the grooves together with the uniformity of the tubercles is the cause that the ventral surface of the Rotulids is less rugose than that of most of the other genera.

The apical disk has a very particular structure. The four gonopores are very close together, but instead of being placed at the end of the rays of the madreporite, they are located in the intermediary sinus. There are instead the ocellar pores at the top of the rays. It suffices to compare fig. 7 of Pl. 9 to see this difference. The madreporite itself is very small relative to the

size of the test. Examined with a magnifying glass, it presents a spongy structure common to all Scutellids.

The interior of the test is no less remarkable than its surface. There is no solid partition between the buccal cavity and the intestinal cavity and, as the notches correspond to the interambulacral areas while the ambulacra are less divided, there is reason to think that the intestine is deployed into the bays of the latter and send processes into the compartmentalized mass that fills the interior of the digitations and interior edge of the anterior side (Pl. 4, fig. 2). The internal surface of the dorsal test is nearly smooth because there are only the rays of the apical disk that make only a slight protuberance. The ventral test interiorly has small irregular ridges with spines that recalls in some ways the compartmentalized structure of the Encopes and the Lobophores. The masticatory apparatus is small. The jaws have calcareous lamellae on their two surfaces, but those of the ventral surface are very much higher than those of the dorsal surface, although they do not border the bony lamellae as is, for example, the case in the Mellitids and the Encopes. The groove of the dorsal surface of the jaws, in which the teeth articulate, is very deep. I have not seen the teeth themselves, but to judge by the jaws, they must be very thin and sharp as in all the Scutellids. The auricles are wide, but little protruding. They have a small fossette in the middle that corresponds to a small keel on the ventral surface of the jaws.

I. ROTULA RHUMPHII Klein

Tab. I.

SYN. *Rotula Rumphii* Klein. Nat. Disp. Echinodermatum Ed. Leske, p. 26, §91, Tab. 22, fig. E. F.

Placenta Rotula sp. 2. Klein. Gall. § 91, p. 96, Tab. 12, fig. C.

Echinodiscus dimidia periferia incisionibus aequalibus fere praedita Breyn. Dissert. phys. de Polythal. Schediasma, etc., p. 64, Tab. 7, fig. 3 et 4.

Echinotrochus decem dentatus Van Phelsum, p. 33.

Echinus solaris (de Zonnestraal de Pannekoek) d'Aquet. in Rumph. p. 37 (nota), Tab. 14, fig. 1.

Eclinus orbiculus var. *a* and *b*. L. Gm. p. 3192.

Oursin denté Bosc (Deterv. Tom. 2 1, p. 281).

Oursin solaire (Rotula) Davila, Cat. Tom, I, p. 425, N° 959.

Oursin disque D'Argenv. Zoomorph. Tab. 7, fig. D.

Echinus planus, singularis, etc. Seba. Thés. Tom. III, p. 35. Tab. 15, fig. 15, 16.

Tertia Echinodisci species minuscula Seba. Thes. ibid. p. 35. Tab. 15, fig. 19 et 20.

Echinodiscus dentatus Leske apud Kl. p. 212, Tab. 22. fig. E, F.

Var. minor Leske ibid, p. 212, Tab. 49, fig. 6 et 7.

Scutella dentata Blainv. Dict. sc. t. 48, p. 226. — Zooph. p. 201. — Agass. Prod. Ech. p. 188. — E. Desor. Enc. T. 2, p. 675, N° 1. — Encycl. méth. Pl. 151, fig. 1-4 — Lam. Hist. nat. 3^e Ed. Tom. 3, p. 277, N° 1 — DesMoul. Tabl. syn. p. 220, N° 1.

Scutella semisol DeBl. Dict. sc. nat. Tom. 48, p. 226 — DesMoul. Tabl. syn. p. 220. N° 2.

Scutella radiata DeBl. Zooph. p. 201. — Agass. Prodr. Ech. p. 188. — Lamarck p. 278, N° 1a.

Boccon. Observ. p. 273. — Favan. Zoomor. Tab. 74, fig. C. — Gualtieri, Test. 110, fig. H.
— Valent. Mus. T. 3, p. 177, fig. 2.

We can see by this long list of synonymies that the species in question has had the attention of naturalists many times. We find it figured for the first time in Breynius under the name of *Echinodiscus*, by which this author designated all Scutellids. Klein described it under the name of *Rotula Rumphii*, dedicating it to the celebrated Rumph. Leske and Lamarck, who did not admire the genus *Rotula* placed it, the first, in his genus *Echinodiscus*, the second in his genus *Scutella*. De Blainville made it the type of his division of Demi-soleils. By re-integrating the genus *Rotula* into the same limits that Klein had established, it is natural that I also accept his specific names in preference to those of his successors. And this is why this species figured here is under the name of *Rotula Rumphii*, instead of *Scutella dentata* or *Scutella radiata*.

Before having at my disposal a complete series of individuals of all ages, of which the more important are represented in Pl. 1, I shared the opinion of Blainville who considers the forms that we have since distinguished under the names of *Sc. dentata* and *Sc. radiata* as distinct species. I even cited them as such in my Prodrôme. In fact, the specimen of fig. 1 (*Sc. radiata* of authors) appears at first glance rather different from those of fig. 5 and 8 (*Sc. dentata* of authors). The number of digitations is especially very much less. But if we follow the characters in a series of specimens, we find that it is absolutely not constant. It is thus that the specimen of fig. 5, although smaller than that of fig. 8, has thirteen digitations, while the latter has only eleven. Nevertheless, it will not occur to anyone to make these specimens different species. This proves in addition that there is no fixed rule in the distribution of these digitations, they are not distributed in a uniform manner on the two sides of the same individual. Witness again the specimen in fig. 5, in which the left anterior ambulacrum is separated into two digitations, while the right anterior ambulacrum has only one. In the specimen of fig. 3, the digitations are not extended to the anterior ambulacra. Also, there are only ten in all. In fig. 1, finally, there is only one of the series of posterior interambulacral areas that is separated from the rest of the test. This means we have only eight digitations here. The length of the digitations varies equally within rather large limits. They are more developed in adult individuals than in the young, and those in the middle are longer than those at the edges. It is rather difficult, in the present state of our knowledge, to say if these differences result from the mode of growth or if they are an effect of resorption. I am tempted to accept the latter explanation in preference to the other, because in the more digitated individuals, such as the specimens of fig. 5 and 8, the digitations decrease in length toward the anterior edge. As the latter do not exist in the youngest individuals, we are naturally led to suppose that they are the most recent. In any case, growth is not by the addition of new plates, since their number is nearly the same in all the individuals, whether they are large or small. In *R. Augusti*, the notches are more unequal. Those that correspond to the interambulacral areas are notably larger than those of the ambulacra. It is this that distinguishes our *R. Rumphii* although several specimens have traces of undulations, e.g., the specimen in fig. 5.

The general form of *R. Rumphii* is nearly circular, assuming the intervals between the digitations is filled. In most individuals, the longitudinal diameter is a little larger than the transverse diameter. The top is sensibly swollen and declines in a gradual manner toward the edges, as shown in fig. 7 and 10, that represent the profile of two specimens seen from the posterior surface. The ambulacral star is rather large. The petals are of medium width, of elongated form and always more-or-less swollen. The poriferous zones are sensibly narrower

than the intermediary space. All the petals are extended beyond half the ray that goes from the top to the periphery, but without rounding at their end, as is the case of most other genera. Past this limit, the pores are still visible, but they show more continuity than they have in the petals and are not united by a groove. Fig. 13, which represents the anterior ambulacrum of fig. 8 enlarged, will give an exact idea of his structure. The top of the disk is occupied by the apical disk and is represented enlarged in fig. 12, with the four gonopores that are very close together and the five ocellar pores that are not visible with the naked eye. Seen with a magnifying glass, this apical disk has a finely spongy structure, Fig. 14 represents the posterior interambulacral area seen from the dorsal surface in order to give an exact idea of the arrangement and the relative size of the plates.

The ventral surface has, at first glance, a uniform and tessellated appearance that results from the fact that the sutures of the plates are always very marked, especially in adult individuals (see fig. 6 and 9). Beside these sutures, we see ambulacral grooves that are in general more slender and often scarcely visible to the naked eye. The grooves represent here the ambulacra and, despite their smallness, they have all along their length microscopic pores. The radiate from the mouth to the periphery, dividing at first into two branches, each of which subdivides into two branches that go to the edge without dividing again. Each digitation is thus accompanied by an ambulacral branch. As for the tubercles on the ventral surface, they are nearly as uniform as those on the dorsal surface. We do not find the variety that we encounter in the different species of *Encopes* and *Mellitids*. — The mouth is nearly central. It is small and circular. Fig. 11 represents it to us at a magnification of 1 ½ diameters, that permits recognition of the detailed structure of the ambulacral grooves, and at the end of each groove at the periphery of the mouth, the slightly larger pores that were without doubt destined to receive the buccal gills. The anus is placed nearly halfway between the mouth and the end of the digitations. It is smaller than the mouth and circular in form. Figure 16, which represents the ventral test seen from its internal surface, shows only the five auricles implanted in the interambulacral areas and destined to anchor the jaws. In general, the interior of the test is much more rugged in the interambulacral spaces than in the ambulacrals. There are even small pillars that go toward the center and that are found on both the dorsal surface and ventral surface. Beyond these pillars, the interior cavity has only a network of more-or-less regular compartments that extend to the end of the digitations. Fig. 17 represents the enlarged masticatory apparatus, seen by its ventral surface, the five jaws being united. Fig. 18 is an isolated tooth, slightly enlarged, seen by the ventral surface and showing the laminated structure of its edges. Fig. 19 is the same jaw, seen by its dorsal surface, with the groove in which is fixed the tooth. Fig. 20, finally, represents this same jaw, seen in profile, to show its considerable thickness and the juxtaposition of the calcareous lamellae of its edges. Fig. 17 shows the contours of the masticatory apparatus at natural size.

Among all the specimens I have had the opportunity to examine, I have found none that had kept their spines. The color of the test is in general a deep green. The young individuals however stand out by the generally paler color (see fig. 1, 2, 3, 4). It is probable the spines were the same color as the epidermis. All these specimens that we know of this species come from the west coast of Africa, and particularly from Senegal. Some authors cite the coasts of America as the origin, but I this citation is erroneous. The originals of my figures were sent to me by Michelin.

II. ROTULA AUGUSTI Klein.

Pl. 2. fig. 1–10. pl. 4 a fig. 1–6.

- SYN. *Rotula Augusti* Klein. Edt. Leshe, p. 26. § 90, Pl. 22, fig. A, B, C, D.
Echinodiscus dimidia periferia inaequalibus incisionibus, etc. Breyn. p. 64, Pl. 7. fig. 5 and 6.
Placenta rotula sp. 1 Klein Gall. p. 94, Pl. 12, fig. A. B.
Echinodiscus octies digitatus Leske ibid Kl, p. 209. Pl. 22, fig. A. B.
Echinodiscus octies digitatus Lesc. ibid. p. 211, Pl. 22, fig. C, D.
Oursin à dix doigts Bosc, Déterv. T. 24, p. 281.
Echinodiscus Gualt. Test. Pl. 110, fig. II.
Echinus octodactilos L. Gm. p. 3101.
Echinus alterplanus Seba Ther. III, Pl. 15, fig. 17, 18.
Echinotrochus octodigitatus (Agtvingeterigc Egelschyv) van Phels. p. 33. Gen. 3, sp. 6.
Scutella decadactyla de Bl. Dict. Sc. nat. V. 48, p. 227. — Zooph p. 201. — DesMoul.
Tabl. syn. p. 222. N° 3.
Scutella digitata Lam. Vol. 3. p. 278, N°2. — E. Desl. Enc. Vol. 2, p. 675, N° 2. —
Encycl. méth. Pl. 150, fig. 3–6. — Agass. Prod. Ech. p. 188.
Scutella octodactyla de Bl. Dict. Sc. nat. Vol. 48, p. 227. — Zooph. 201. — Lamarck; Vol.
3, p. 279. — Agass. Prod. Ech. p. 188
Davila, Catal. Vol. I. p. 425, N° 960.
Encycl. (Dict. des Sc.) Pl. 59, fig. 7.
Favanne, Pl. 58, fig. C 2 and C 4.

This species is, like the preceding, rather generally known to naturalists who have also made it two species, without doubt because they have not had the opportunity to study different ages. I would probably have fallen into the same mistake if I had not had the happiness of finding in the collection of my friend, Ch. Stokes, two species of medium size (Pl. 2, figures 4 and 5) that form evidently, the transition between the large specimens known under the name of *Sc. decadactyla* or *digitata* (fig. 1) and the small ones similar to those of fig. 4 a, fig. 1, that de Blainville designated under the name of *Sc. octodactyla*. Not possessing myself an individual of such a small size, I have reproduced (Pl. 4a, fig. 1) the figure of Breynius, that appears to me to be the most characteristic of all that have been published. It suffices to compare this figure with figures 1, 2, 4 and 5 of Pl. 2 to become certain that the three individuals belong very really belong to the same species and the deep notches in the large individuals is only the effect of growth.

The general form of this species is nearly circular. However, the transverse diameter is a little longer than the longitudinal diameter. This is in addition a very flat species. The top especially is less swollen than in *R. Rumphii*. But the essential character of the species resides in the notches and holes of the test. The posterior edge is notched all around like *R. Rumphii*, but with this difference that the notches are much more unequal and the interambulacral areas are always much deeper than those of the ambulacral areas. This difference is produced in individuals of all ages, and we see that in the young specimen of Pl. 4 a fig. 1, where the notches of the ambulacral areas are still very slightly marked, those of the interambulacral areas are already very deep, so that the posterior edge appears here composed of two scallops, each with four short digitations, which makes the number of the latter to eight. From that came the name of *S. octodactyla* that authors gave to it. In the specimen in fig. 5 (Pl. 2), we already count ten and in that of fig. 4,

twelve. In the specimen of fig. 1. the holes of the anterior paired ambulacral areas remain closed. But this circumstance is not a constant character, as we can be assured by comparing the specimen of fig 4 where they are open. We conclude that the form and size of the notches and the lunules cannot be seen as specific characters. They indicate only varieties of age. Another particularity of this species, that is not encountered in the preceding, is the presence of hole a little less elongated than the notches of the posterior interambulacral area and always closed in the interambulacral areas. The petals of the ambulacra are elongated and of average width. They are not closed at their end, and their pores, not connected by a groove, are extended as isolated pairs to the edge of the circumference. The apical disk is limited to a very small space. The gonopores are very close together. They are located in the sinus that forms the madreporiform body at the top of the interambulacral areas. The ocellar pores, five in number, are located at the ends of the rays of the gonadal system, and consequently more distant from each other. Fig. 7, that represents this system enlarged will give an idea of the arrangement of these diverse organs. — When we examine the surface of the test with the naked eye, we see only a fine, very homogenous granulation. But when we examine this granulation at high magnification, we find it composed of spiniferous tubercles, crenelated, mamelonated and perforated, surrounded by a multitude of very small miliary tubers, but also mamelonated as represented in fig. 9, that is taken of the dorsal surface. I have never seen specimens with their spines.

The ventral surface has nearly the same structure as we have described in *R. Rumphii*. The ambulacral grooves are narrow and divide into four branches that extend to the end of the digitations with detaching lateral branches. The buccal rosette that surrounds the mouth is more distinct. It is composed of ten wedge-shaped plates. Those that correspond to the interambulacral areas are sensibly narrower than those that correspond to the ambulacral areas. The mouth itself is small and circular. Examined with a magnifying glass, we see on its periphery, several distinct openings (usually three) that correspond to the branched tubes and are probably destined to provide passage to the buccal gills. Fig. 10 represents this structure of the buccal mouth at a magnification of two times the diameter. The anus is near the mouth than to the edge. It is subcircular, usually a little elongated in the direction of the transverse diameter.

The interior of the test is smooth. Only the edge of the end of the digitations is compartmentalized, as we can see in fig. 2 of Pl. 4 *a*. Fig. 3 of the same plate shows a portion of the internal surface of the ventral test that is more unequal than the dorsal test. Around the buccal opening that is in the middle, are five auricles that are single, rather wide, but little elevated. Fig. 4 and 5 show the masticatory apparatus, at natural size, in one (fig. 4) seen from below, in the other (fig. 4) seen from above. It scarcely differs from that of *R. Rumphii*. However, the calcareous lamellae of the jaws are proportionally less developed than in this latter species. The posterior jaws and notably the unpaired jaw, are sensibly larger than the anterior jaws. The teeth themselves are not preserved. But, to judge by the direction of the grooves intended to hold them, it is probable that they were slightly recurved from top to bottom. Fig. 6 and 6 *a* show the profile of the posterior jaw seen from the front and from the side.

The locality of this species is not known.

CHAPTER II.

GENUS RUNA Agass.

The sailient character of this small genus consists in the form and the proportions of the interambulacral areas, which are sensibly narrower than the ambulacral areas and separated from the latter by more-or-less deep grooves. The ambulacral petals, instead of being closed, widen, on the contrary, at their end. It also appears that there are no transverse grooves between the rows of the poriferous zones. The mouth opening, circular or ellipsoid in form, is placed at the center of the ventral surface. The anus, smaller than the mouth, is located between the buccal opening and the posterior edge.

I know up to now only two species of this genus: *Runa Comptoni*, described below, and *Runa decemfissa* (*Scutella decemfissa* DesM., indicated by Charles DesMoulins in his synonymic tables of the Echinoidea that is in the possession of Jouannet. Both are very small in size and come from Tertiary terrains.

In placing this small genus after the Rotulids, I had only the exterior form to guide me because, having only two specimens of *R. Comptoni*, it was impossible for me to study the interior of the test. It could thus be that, in reality, the Runas are closer to the Laganids and the Echinocyamids than the Rotulids. While waiting for more information, it seems to me that the notches of their edge establish them in some way as a transition between the genera with complete edges and those with notched edges.

I. RUNA COMPTONI Ag.

Pl. II, fig. 11–19.

This small species is subcircular or rather ovoid in form, longer than wide and slightly swollen. The height, equal to nearly two-thirds the length, has a very uniform slope from the top to the edges that are very thick. The interambulacral areas are very narrow. They have only half the width of the ambulacral areas, as we see especially well on the ventral surface where the separation of the areas is very distinct. The poriferous zones of the ambulacra are visible on the dorsal surface only half-way to the border where they disappear in diverging. The notches that separate the ambulacral areas from the interambulacral areas are deep. They extend more than a third of the distance between the edge and the top. The mouth, elliptical in form is located in a depression in the center of the ventral surface. The anus, sensibly smaller than the mouth, is circular and nearer the posterior edge than the buccal opening. I have not been able to recognize the arrangement of the tubercles, the surface of the test being too altered. The apical disk has four gonopores. The ocellar pores, located at the top of the petals, are extremely small.

I have represented at natural size (fig. 11–13 and 14–15) the only two specimens that I possess, and one of which (fig. 14) appears to be a young. Fig. 17–19 represent the individual of fig. 11 enlarged, in order to show the details of the test. The scaly appearance of the ventral surface (fig. 18) comes from the plates of the test being abraded near their articulating edges. This makes them appear protruding in the middle.

This species was discovered in the Tertiary terrain of the vicinity of Palermo by the Marquis of Northampton, president of the Royal Society of London, to whom it is a pleasure to dedicate it.

II. RUNA DECEMFISSA Ag.

Syn. *Scutella decemfissa* DesMoul. Tabl. syn. p. 232.

I know this species only by a sketch for which I must thank DesMoulins and by which I was able to convince myself that it is really different from *R. Comptoni*. Although very small, less than 2.3 mm in length, it is however proportionally more elongated than the species above. The anus is near the mouth and the periphery of the test more flexuous.

This species was discovered by Jouannet in the Tertiary terrain of Terre Nigre near Bordeaux. Ch. DesMoulins has promised to give a detailed description of it.

CHAPTER III.

GENUS MELLITA Klein (Ag.) (¹⁶).

This genus has a kind of middle ground between the Rotulids and the Encopes. While the arrangement of the closed lunules approaches the latter, its flat form and the absence of a gonopore in the unpaired interambulacral area seems, on the contrary, to attach it to the Rotulids. But in addition to these affinities, the Mellitids have several characters of their own and that fully justify the generic section that Klein has already established under the name *Mellita* and that I propose to reinstate by removing the species with two notches that this author confused with the true Mellitids and which I have made my genus *Lobophore*.

The genus *Mellita*, thus circumscribed, contains very flat large species and subcircular in form, longitudinal and transverse diameters being nearly equal. Some species, such as *M. pentapora* and *M. testudinata* are even wider than long, as it also the case for several species of true Scutellids. The lunules sometimes five in number, sometimes six, depending on whether there is one in the unpaired interambulacral area or not. The paired ambulacra always have them, as well as the unpaired interambulacral area. The lunule of this latter is even ordinarily larger. This variation in number and form of the closed lunules constitutes specific characters of which it is necessary to take into account in the study of each species. In general, the lunules of the Mellitids are elongated, slender and nearly always closed, while those of Encopes are rounded, wide and often open at the edges. The ambulacral star is of medium size. The petals are rounded at their end. The apical disk has a porous and finely granular structure. The gonopores, four in number, open at the ends of the madreporae at the top of the interambulacral areas. The five ocellar pores located at the top of the ambulacra are ordinarily too small to be seen with the naked eye. The mouth is slightly subcentral. It is circular in form, but the tubes of the gills that protrude on its periphery usually give it an undulating appearance. The anus, oval or pyriform, nearer the mouth than the lunule of the unpaired interambulacral area, is longer. In general, the space that separates the buccal opening from the anal opening does not exceed the length of the latter. The ventral surface is as rough as the dorsal surface is uniform. The ambulacral grooves branch in their path from the center to the periphery. The tubercles likewise take a very varied arrangement. They are usually very developed in the middle, while they are much denser and nearly microscopic along the groove. This arrangement of the tubercles necessarily affects the arrangement of the spines so that the interambulacral areas have more developed spines than the ambulacral areas. There is in addition a great difference in the form of the spine of the ventral surface and those of the dorsal surface. The latter are short and clavellate. Those of the ventral surface, on the contrary, are slender and pointed. A third kind of spine, flat in form, surrounds the lunules of the dorsal surface. These are larger.

The internal cavity has some very remarkable particularities. The ventral test has, in the interambulacral areas, more-or-less developed pillars that seem to support the dorsal test. Their form is not regular. There are usually two in each area, but often they are fused together in such a way to form only one. A membrane extends around these pillars and thus separates the buccal

¹⁶ This same name of *Mellita* was given later to a genus of hymenopteran insects.

cavity from the intestinal cavity. Although the specimens that I used to study the internal organs were not entirely fresh, I have been able to recognize the form of the intestine and follow it in its path from the mouth up to the anus. In leaving the masticatory apparatus, the intestine goes to attach to the internal apical disk, passes above the right anterior jaw and then curves to the left. At first very slender, it dilates little by little to acquire its greatest width toward the middle of its path. After having passed the left side and sent processes into all the compartmental cavities, it reaches the posterior edge. Here, the walls of the lunule of the unpaired interambulacral area bars passage. It bends inward, passes above the anal opening in crossing a canal formed by the pillars of the unpaired interambulacral area that are bent against the walls of the lunule. From there it is directed to the right side, goes up to the right anterior interambulacral area where it folds on itself to regain the posterior edge and come to the anal opening (see, for the details, fig. 6 of Pl. 3, that represents the interior of *Mellita quinquefora*, seen from above. The masticatory apparatus is composed of five jaws with a very slender framework, but with numerous, very elongated lamellae, especially in the posterior jaws. The teeth are small flat lamellae, enameled and fixed vertically in the groove of the dorsal surface of the jaws. As the latter are not very high, the teeth are only slightly inclined from top to bottom. Each jaw is supported by one of the five auricles that surround the buccal opening.

I know up to now five species of Mellitids, one of which inhabits the west coast of Africa. The others, the east coast of central America. All that have kept the color are all green.

I. MELLITA QUINQUEFORA A. Ag.¹⁷

Pl. 3.

SYN. *Scutella quinquefora* Lam. 3^e Ed. Vol. 3. p. 280. — E. Desl. Enc. Vol. 2, p. 676, N^o 5. — DeB). Dict. Sc. nat. V. 48, p. 223. — DesMoul. Tabl. syn. p. 224, N^o 7.
Scutella pentapora DeBl. Zooph. p. 220. — Agass. Prod. p. 188.

This species figures generally in the collections of Europe under the name of *Scutella quinquefora* that Lamarck gave it. Having one day had the opportunity of comparing a rather numerous series of specimens that had been sent to me from Porto Rico, I perceived that we had confused several species under this name. The specimens from Vera Cruz differed obviously from those of Puerto Rico, and as it is the species from Vera Cruz that were found figured in Leske, I preserved to it the name of *Mellita testudinata* that Klein had given it, in distinguishing the *Mellita quinquefora*, which is the species of Lamarck.

Fig. 1 and 2 represent *Mellita quinquefora* with its natural colors, when the spines are removed. Fig. 3 shows it with its spines by the dorsal surface. Fig. 5 is a sketch of a young individual seen by its ventral surface. A glance at the various figures suffices to make obvious one of the most important characters, the extraordinary width compared to its length. In the specimen of fig. 3, one of the most beautiful and largest that I know, the transverse diameter is 1/2 longer than the longitudinal diameter. We note that the posterior region is always wider than

¹⁷ When I had the attached plates made, I still had not distinguished the genera *Mellita* and *Encope*. This is why the species is figured there under the name of *Encope pentapora* instead of *Mellita quinfora*.

the anterior region. Moreover, the form of the test is generally rather subcircular. The anterior side is sometimes rounded, sometimes truncated. It is the same with the posterior side. As a result, the more-or-less regularity of the periphery of the test cannot be invoked as a specific character. The example in fig. 6 even has a strong notch at the posterior edge in the extension of the lunule of the unpaired interambulacral area. But it is probable this notch is only accidental, perhaps even the result of a break that healed and became covered with spines with time. Fig. 4 represents the profile of this species that, as we see it, is very flat. The greatest swelling corresponds to the posterior region. The lunules are five in number, as the specific name indicates. There is one in each extension of each ambulacrum and one in the unpaired interambulacral area. The unpaired ambulacrum lacks it. All these lunules are narrow and very elongated. That of the interambulacral area is the largest. The ambulacral petals are wide and extend beyond half-way to the border. They show a slight swelling in the middle. The two posterior petal pairs are a little larger than the anteriors, more-or-less truncated at their end and slightly curved inside, without doubt the effect of the unpaired interambulacral area that pushes them back laterally. The space occupied by the small grooves, or the poriferous zone proper, is wider than the intermediary space. Fig. 9 represents a part of an ambulacrum very greatly magnified, where we see that even the space between the grooves has small tubercles very close to each other and arranged in transverse rows. The dorsal surface of the test has a very homogeneous granulation that corresponds to the uniformity of the spines. Only the edges of the lunules have larger tubercles. Also, they have spines much more developed that often nearly close entirely the lunules. The apical disk is small and of a spongy structure. The four gonopores are at the end of the rays of this spongy organ, at the top of the interambulacral areas. The ocellar pores at the top of the ambulacral areas are hardly visible to the naked eye. The ventral surface, as we have said in the section on the genus, has nothing of the uniformity of the dorsal surface. The interambulacral areas there have many more tubercles than the ambulacral areas. They also have sensibly larger spines. This difference in the structure of the ventral surface is reflected even in the colors of the animal, which are always paler in the interambulacral areas than in the ambulacral areas, even with the spines removed, see fig. 2. Fig. 10 represents an enlarged portion of an interambulacral area of the ventral surface. The tubercles there are surrounded by an extremely small granulation that we perceive only with the aid of a strong magnifying glass. The grooves that correspond to the ambulacra are riddled with small pores their entire length, up to the end of the smallest lateral branches. These grooves, very marked in this species, branch in a very irregular manner, so that the frequency of the lateral branches cannot be seen as a specific character. It varies from one individual to another. Often, even the grooves of the same individual can have very notable variations, as is for example the case of the example figured. The grooves of the posterior ambulacra are much more branched than those of the anterior ambulacra. What is more, they even encroach onto unpaired interambulacral area in every direction (fig. 2). The mouth is subcentral, nearer the anterior edge than the posterior edge. It is circular in form and surrounded, in well preserved examples, by a circle of spines that more-or-less hide it. undulating appearance comes from the protrusions made on its periphery by the tubes of the buccal gills that occupy the anterior part of the ambulacral grooves. These tubes are longer in the grooves of the posterior ambulacra than those of the anterior ambulacra because in the latter, the two branches of the groove are united only in the vicinity of the perimeter of the mouth. It is usually closed by an irregular web of calcareous plates.

I have been able to study, in the example of fig. 3, the three kinds of spines that characterize the Mellitids. Those of the dorsal surface are generally small, but of a particular form, with small

swollen masses at their end. Fig. 11 shows them with a very slight enlargement. Those of the ventral surface are longer, cylindrical and tapered. Finally, the spines at the edge of the lunules make the third type. They are shorter than the preceding, but sensibly more massive. Fig. 11 *a* and *c* shown by the flattened surface that has on one side a kind of depression in the form of an elongated spoon. Fig. *d* represents the same spine seen in profile by the thin edge.

The arrangement of all these spines appears subject to constant laws. Those of the dorsal surface are generally inclined toward the periphery with a more-or-less marked tendency to be curved laterally, a disposition that is not visible to the naked eye because of the smallness of the spines, but that can be felt by touch. The spines of the lunules are generally inclined from the edge toward the middle so that they often nearly hide it completely. On the ventral surface, the spines of the posterior paired interambulacral areas are inclined inward, while those of the anterior areas are inclined outward. As the same arrangement is reproduced in nearly all the species whose spines I have observed, I refer to fig. 11, Pl. 4 that represents the ventral surface of *Mellita hexapora* with its spines.

The arrangement of the internal organs is of very great interest. Fig. 6 of Pl. 3 represents the interior of the test, seen from above, the dorsal test being removed. We recognize there very distinctly the form and direction of the intestine that, in leaving the interior of the top of the apical disk, passes above the right anterior jaw and forms the stomach, passes then on the left side, passes then to the right side, goes up toward the anterior edge and returns again backward so that it passes two times on the right side and one time on the left side. The entire mass of the test is in addition filled with compartments that I have found lined with a brownish membrane, absolutely similar to the intestine so that I have no doubt that they are destined to receive appendices from the intestinal canal. The masticatory apparatus occupies the center of the interior cavity. It is separated from the intestinal cavity proper by the pillars that rise from the ventral test in the interambulacral areas. Fig. 8 represents the isolated masticatory apparatus seen by its ventral surface. We note that the two posterior rays of the rosette are sensibly longer than the anteriors. This difference is due only to the ventral lamellae being much longer in the posterior jaw than in the others. It is easy to be convinced of this by attentively studying the isolated jaw. The teeth, whose ends alone are enameled, are fixed by their edge in the groove of the jaws. Fig. 7 represents the central part of the ventral test, after having removed the masticatory rosette. We distinguish there the position and the form of the auricles destined to support the masticatory apparatus. They are wider and have a slight notch in the middle. The mouth, that is in the center, is surrounded by radiating spines. Finally, we also see in the same figure the calcareous pillars that are located, as well as the auricles, in the interambulacral areas. I have already noted above that these pillars vary greatly in form and size according to the individual.

I owe to the kindness of my relative, August Mayor, of New York, a numerous series of individuals of this species that he collected in Puerto Rico. All are of beautiful green color.

II. MELLITA TESTUDINATA Kl.

Pl. 4*a*, fig. 7–9.

SYN. *Mellita testudinata* Klein, Ed. Leske, pag. 25, Pl. 21, fig. C. D. — Ejusd. Maxillæ, p. 36, Pl. 33, fig. *r* and *s*— Klein Gall. § 82, p. 92, pl. 11, fig. C.

Echinodiscus quinques perforatus Leske apud Klein, p. 197, sp. 51.

Echinus orbiculus var. 7 Lin. Syst. nat. 12^e edit. p. 1105.

Echinus pentaporus Lin. Gm. p. 3189.

Echinoglycus quinque canalibus pervius van Phels. Brief over ZeeEgelen, p. 35.

Pain d'épice de là Vcra-Crux Davila. Catal. V. 1, p. 423.

Echinus laganoïdes orbicularis Seba, Thés. Vol. 3. Tab. 15, fig. 9 NS 10.

Scutella quinquefora Encly. méth. V. 149, fig. 3 and 4.

Echinodiscus Gualt. Test. Pl. 110, fig. E.

Muller Délie, nat. I. p. 93. Pl. D. I, fig. 16.

The species in question here has already been described and figured by Klein. As the figures of this author are reproduced in the Encyclopédie méthodique and the figure seems to be the same, I have referred to *M. testudinata* all the synonyms of all authors, citing to *M. quinquefora* only those of authors who have described specimens from the Museum of Paris or at least have seen them. The principal character that distinguishes *M. testudinata* from *M. quinquefora* consists in that the greatest transverse diameter, instead of corresponding to the posterior region, corresponds on the contrary to the anterior region. This difference, although essential and constant, is not apparent at first glance, especially when we are not used to orienting the individuals when studying them. In all the other relations, *M. testudinata* has nearly the same particularities of structure that have been reported in *M. quinquefora* (see the description above). Fig. 10 represents the tubercles of the dorsal surface at a great magnification in order to show their form and the manner in which they are surrounded by smaller tubercles. The spines have the same structure and the same disposition as in *M. quinquefora*. I have figured with the microscope (fig. 7 *a*) on the spines that border the lunules of the dorsal surface in order to show that, despite its smooth appearance, it is bristly with numerous asperities, like the spines of all echinoids in general. The figure represents it by the flat surface.

Klein has given a rather imperfect figure of the jaws. I have not had the opportunity to observe the masticatory apparatus myself, but I do not think that it can be very different from that of *M. quinquefora* that is figured in Pl. 3, fig. 6 and 8.

All the specimens of this species that I have been able to examine until now come from Vera Cruz, where Klein's specimen also originated. I have found they all have a brownish color. But as the spines of the lunules are still green in the specimen figured, it is probable that these animals are green in the living state like *M. pentapora*. The specimens figured are part of the Museum of Paris and were sent to me by Valenciennes.

III. MELLITA HEXAPORA Ag.

Pl. IV, fig. 4–7, and Pl. IVa, fig. 11 and 12.

SYN. *Echinus hexaporus* L. Gm., p. 3189. — Favann. pl. 58, 6g. C 3.

Scutella hexapora DeBl. Zooph. p. 200. — Agass. Prodrome Echin. p. 188.

Scutella sexforis Lam. V. 3, p. 279, N° 4. — E. Desl. Enc. V. 2, p. 676, N° 4. — Encycl. meth. pl. 149, fig. 1 and 2. — DesMoul. Tabl. syn. p. 224, N° 6.
Echinotrochus perforatus {Doorgeboorde Egelschyv) Van Phels. p. 33, N°2.
Echinodiscus sexies perforatus Kesje apud Kl., p. 199, Pl. 50, fig. 3, 4.
Echionanthus Seba Thés. Pl. 15, fig. 7, 8.
Oursin de mer étoile Klein Gall. Suppl. au Cab. de Réaumur, p. 230, 231. Pl. 24, fig. A, B, and 1, 2.
Pain d'epice de la Barbade à six fentes. Davil. Catal. I. p. 423, N° 955.
Müller Deliciae nat. I, p. 93, Pl. D, 1, fig. 17.
Encycl. (Dict. des sc.) Pl. 59, fig. 6.
Knorr, Délie. Pl. D, I, fig. 17.

It is obviously wrong that Lamarck envisaged *Mellita hexapora* and *Mellita quinquefora* as simple varieties of one and the same species. Not only does *M. hexapora* constantly have six lunules, but its form is also completely different. The longitudinal diameter and the transverse diameter are nearly equal. The posterior side is truncated or sub-truncated. The anterior side, on the contrary, is slightly rostrate. The lunules are in general narrow and very elongated. Those of the unpaired interambulacral area are less developed. They are even very small and nearly rudimentary in young individuals (see fig. 7). The test is very flat (Fig. 5). The ambulacral rosette is small proportionally to the diameter of the test (see fig. 4). The petals do not reach even half the distance between the top and the periphery. The poriferous zones have nearly the same width as the intermediary space. The gonopores are far apart. The ocellar pores are too small to be seen with the naked eye. The plates that compose the test are all swollen in the middle, although in a less striking manner in old individuals than in the young. These have at the center of the plates a small more-or-less protruding asperity that is not a tubercle (fig. 7). The interior leaves no trace of the articulation of the plates. We note there only a rough surface, compartmentalized, in the form of protruding lamellae (see fig. 6 that represents the dorsal test seen by its internal surface). The four gonopores open at the end of the bony rays that advance in the interambulacral areas. The ambulacrals show the detailed structure and articulation of the plate of the petals. At the top of them are the ocellar pores that are five in number. Finally, we note also traces of the intestine around the end of the ambulacral petals.

Fig. 11 of Pl. 4 shows the disposition of the spines of the ventral surface, as they have in all the species of this genus. Those of the posterior pairs of the interambulacral areas are bent from outside in. Those of the anterior pairs of interambulacral areas, on the contrary, from inside out in such a way that in from the left posterior ambulacral area to the right anterior interambulacral area, and even from the right posterior interambulacral area to the left anterior ambulacral area, we find the spines inclined in the same direction, with the exception of those that immediately surround the mouth that is circular. The spines of the unpaired interambulacral are inclined laterally toward the lunule. I have figured isolated spines from different parts of the test at very great magnification in order to give an exact idea of their form and structure. Those of fig. 11, *a*, *b*, *c*, are taken from the dorsal surface. They are made remarkable by the clavellate form. The spines of the ventral surface are more cylindrical. Those of fig. 12 *d*, *e* are taken from the ambulacral areas. Those of fig. *a*, *b* are from interambulacral areas. That of fig. *c* from the edge of the mouth. We see only the form varies. The detailed structure is the same in all. Even the spine of fig. 7 *a*, which belongs to *M. testudinata* shows in this regard no difference.

There is every reason to believe that authors have confused several species under the name *M. (Scutella) hexapora*, especially if we consider the very different localities that they assign to it. Leske said that the specimen of the Museum of Réaumur was brought back from the island of Barbados by Hughes. Muller reported it in the Indian Ocean and the northern seas. Davila said it originated on the Coromandel coast and of Vera Cruz. Now, it is not probable that the same species is encountered in countries and climates so different. Among the numerous specimens that I have had the opportunity to examine, there are none whose origin is known. I owe to the kindness of Gray for sending me the specimen with its spines represented in Pl. 4 *a*, fig. 11. Its color is a beautiful olive green. The other species were sent to me by Michelin and by Doctor Mayor of Geneva.

IV. MELLITA SIMILIS AG.

Pl. IV, fig. 1–3.

It is probable that this species has been confused up to now with *M. hexapora* to which it is effectively very close. Its form is subcircular. The posterior side is more-or-less truncated. The anterior side, on the contrary, has a slight tendency to be rostrated. The longitudinal diameter is larger than the transverse diameter. The species is at the same time less flat than the preceding and notably *M. hexapora*. We note that the greatest thickness, instead of corresponding to the summit, is at the anterior region (see Pl. 4, fig. 3). The lunules are six in number but they are less elongated and more irregular than in *M. hexapora*. Finally, although the species is small, the ambulacral star is in general larger than in this last species. The ventral surface is notable for its grooves and very pronounced irregularities, especially at the edge of the lunules that give it a very rough appearance, which *M. hexapora* does not have.

I know only two specimens of this species. Both lack their spines but as they are colorless. I am content to represent in black the specimen that has served as the original of my figures. It is from Puerto Rico, from where it was sent to me by A. Mayor. The second is part of the collection of Michelin.

V. MELLITA LOBATA Ag.

Pl. 4 *a*, fig. 13, and Pl. 16, 4–7.

Although near *Mellita hexapora*, this species has however a quite particular physiognomy that results essentially from the fact that the lunules of the posterior ambulacra are open. This character, although striking, would not be sufficient to constitute a separate species of the genus if all the lunules were not at the same time sensibly wider than in the other species of the genus. The lunule of the unpaired interambulacral area is shorter and narrowest of all. The irregular form of the test is without doubt only accidental. However, it is probable that, even in regular individuals, the longitudinal diameter is larger than the transverse diameter. The petals of the ambulacra are wide and round at their end. The poriferous zones owe much of their width to the

intermediary space. The pores of the apical disk are very distinct. A particularity worth mentioning is that the five ocellar pores are as large as the gonopores. These number four as in all species of the genus.

The ventral surface has nothing in particular in its structure. The ambulacral grooves there are very fine and little marked, as in *M. hexapora*, and we note around the lunules no trace of the pronounced irregularities that are an essential character of *M. similis*. The interior conforms to that of *M. quinquefora*. The masticatory apparatus is composed of jaws of moderate size, bristling with fine calcareous lamellae above and below. Fig. 4 of Pl. 16¹⁸ represents this apparatus seen by the ventral surface, the five jaws being united and showing, on the median line, the small keel that fits into the notch of the auricles. Fig. 7 represents the five disjointed jaws, seen by the dorsal surface, with the median groove, into which will fit the teeth. Fig. 5 and 6 show the profile of one of the jaws from the side (fig. 6) and from behind (fig. 5). I know this species only by the single specimen that is figured here. It is part of the collection of the Museum of Paris and was sent to me by Valenciennes. Its origin is unknown.

¹⁸ It is an error that the jaws of this species have been added to the figures of *Sc. truncata*, instead of being figured in Pl. 4 *a*.

CHAPTER IV.

GENUS ENCOPE.

The Encopes are in general species of large size that, for the most part, are notable for their elegant form and beautiful proportions of all the parts of their test. All have a notch or lunule in the extension of the ambulacral petals and an opening in the unpaired interambulacral area. The form and dimensions of these lunules vary more-or-less in the different species and we note rather great differences even in individuals of one and the same species according to their age. The ambulacral notches, ordinarily very open in the young, tend to close in the old. The mouth is central or subcentral. Its form is circular, but as the tubes destined to be lodged in the buccal gills protrude on its periphery, in most species it takes on an undulating appearance. In individuals that have preserved their spines, the mouth is more-or-less masked by the spines that intersect on its edges. The anus is very near the mouth and placed on the internal edge of the lunule of the unpaired interambulacral area. The ambulacral petals are in general round at the end. When the interambulacral lunule is very large, the posterior petals, which are always the longest, are ordinarily a little repressed laterally; their form is often arced. The spines vary according to position. Those of the dorsal surface are short and clavellate. Those of the ventral surface area are slender and cylindrical.

But all these characters are more-or-less common with Mellitids. Here now are those particular signs we use to distinguish the type of the Encopes. The lunules and the notches are always widened, more-or-less rounded and often very open, while those in the Mellitids are elongated, very slender and generally closed. Moreover, there are five gonopores while the Mellitids have only four. Finally, the color of the Encopes is generally red, violet or brown. That of the Mellitids is, on the contrary, green or olive. To these exterior characters correspond more profoundly differences in the interior of the test. These differences consist essentially in the presence of a continuous compartmentalized wall that separates the buccal cavity from the intestinal cavity and that replaces consequently the calcareous pillars that are found in the Mellitids. To give an exact idea of this disposition, I have represented in Pl. 19 *a*, fig. 7, the interior of *E. micropora*, after removing the ventral test. The buccal cavity, which is at the center, has a pentagonal periphery whose bays correspond to the ambulacral areas. It is in these bays that are lodged the rays of the masticatory apparatus. Leaving the buccal cavity, the esophagus passes above a neck of the median septum (*x*) corresponding to the unpaired ambulacral area, spreads out on the left side (*a*), crosses below the anus as a narrow canal that is found at the origin at the lunules of the unpaired interambulacral area, passes on the right side where it goes up to the left anterior interambulacral area (*b*). There it folds back on itself and goes backwards to the anus in following a canal border on one hand by the wall of the buccal opening and, on the other, by a particular wall (*c*). Reaching again the edge of the posterior lunule, after having made several very pronounced turns, it sinks into the test and goes to end at

the anus (*d*) that opens obliquely from outside to inside. The intestine passes, consequently, as in all Scutellids, twice on the right side and once on the left side. It is very wide on the latter. Finally, what characterizes the Encopes in a very special manner, is the intermediary wall between the two terminal parts of the intestine that is, instead of being membranous as in the other genera, is, on the contrary, calcareous and compartmentalized like the wall that surrounds the buccal cavity. *E. Stokesi* is the sole exception to this rule (see the description of this species). There is, in addition, a separation or a kind of horizontal floor between the buccal cavity and the dorsal test (*o*). It is in this latter cavity that are contained the interior ambulacral organs. The ventral surface of the left posterior petal is seen through a gap of this floor (*s*). The entire mass of the test is much more compartmentalized than in any other genus. The masticatory apparatus is composed of very strong jaws, but otherwise very similar in structure to that of the Mellitids.

The number of known species is eleven, all from the present epoch., Unfortunately, there are several whose origin I could not find, having found most of them in the collections without labels.

I. ENCOPE EMARGINATA Agass.

Pl. 10.

SYN. *Scutella emarginata* Lam. V. 3, p. 279, N° 3. — E. Desl. Enc V, 2, p. 675, N° 3. — Encycl. méth. pl. 150, f. 1, 2. — DeBl. Dict. Sc. nat. V. 48, p. 224. — DeBl. Zooph. p. 201. Agass. Prodr. Echin. p. 188. — DesMoul. Tabl. syn. p. 222, N° 5.

Echinodiscus emarginatus Leske, N° 53, p. 200, pl. 50; f. 5, 6.

Echinus marginatus L. Gm. p. 3189.

Grand Oursin de mer étoile. Kl. Gall. suppl. du Cab. de Réaumur; p. 231, 232, pl. 2, f. A. and pl. 26, f. B.

Echinoglycus frondosus. Van Phelsum, p. 34.

Although very rare in collections, this species has been known, however, for a long time to naturalists. Its form is subcircular in front and more-or-less truncated behind. The transverse and longitudinal diameters have sensibly the same dimensions. The thickness equals nearly a sixth of the length (fig. 3). The entire surface of the test, when it lacks its spines, has a very homogenous granulation, especially on the dorsal surface. The ventral surface is more varied. The tubercles that reach the greatest development in the interambulacral areas, while they are extremely fine in the ambulacral areas. Fig. 6 represents some spiniferous tubercles from the interambulacral areas under a magnification of 1 ½ times the diameter and surrounded by miliary tubercles that fill the space between the largest aureoles. I have indicated, in fig. 1, 2 and 3, the openings of the test by these letters, relating to the positional plan of the animal. The lunule of the unpaired interambulacral area (*p*) is proportionally small. Its edges are not swollen. The five openings of the ambulacral areas are no longer very developed. Those of the posterior ambulacra (*p d* and *p s*) are usually closed near the edge and larger than those of the anterior ambulacra (*a*, *l d* and *l s*). But as there is great variety in the form and size of these openings, we can hardly consider them as specific characters. It is thus that in the specimen figured, the lunule of the right anterior

ambulacrum (*l d*) is closed, while that of the left (*l s*) is open. In the others, the two openings of the right of the right side alone are open. In still others, all are closed. It is the same with the lunule of the unpaired anterior lunule (*a*). It is very open in the specimen figured, while in most of the other specimens I have seen, it is closed. It is always the smallest of the openings. The ambulacral star is very elegant. The posterior petals are longer and at the same time, the narrowest. The anterior pairs are short, wide, and very rounded at the end. Finally, the unpaired anterior petal is generally between the others. The space between the poriferous zones is sensibly wider than the zones themselves in the anterior ambulacra. In the posterior ambulacra, in contrast, this difference is less sensible. The poriferous zones and the intermediary space are nearly equal in width. Fig. 4 represents half the anterior petal enlarged to show the form of the transverse grooves and the way in which they are separated by a row of tubercles. The ambulacral pores can be followed beyond the ambulacral rosette. We note on each of the plates of the test forming the extension of the petals, a pair of pores located sometimes in the middle, sometimes at the edge of the plate. But they are often so small that we have difficulty recognizing them with the naked eye. The apical disk has a pentagonal star whose rays advance in the interambulacral areas, where they end in the gonopores, which number five as in all species of the genus. The ocellar pores located at the top of the ambulacra are sometimes smaller than the gonopores, but however very distinct even with the naked eye. The surface of the apical disk has no tubercular structure like the rest of the test. When examined with a magnifying glass, we find it composed of spongy tissue at the surface of which end a number of small tubes. The ventral surface is very elegantly rugged because of the variety of tubercles and the branching of the grooves (fig. 2). The mouth that is a little pushed forward is small proportionally to the size of the test. We see on the periphery the five small tubes destined to lodge the buccal gills and whose ends, in the form of pads, protrude onto the periphery of the mouth (see fig. 5 that represents the mouth enlarged). The anus, subconical in form, occupies nearly the middle of the space between the internal edge of the interambulacral lunule and the buccal opening. The ambulacral grooves branch in a very variable way and when we examine them with a magnifying glass, we find that not only the main channels but even the smallest lateral canals are studded with microscopic pores. As a result, the pores through which these tubes pass must necessarily be more numerous on the ventral surface than on the dorsal surface.

The attached figures are drawn after the original specimen of Lamarck, the only one that exists in the collection of Paris. I did not know of others. My friend Stokes, of London, had the kindness to send me a whole series that served to complete the description of this species. Several of the specimens have kept a part of their spines. That are small and appear smooth. But when we examine them with a magnifying glass, we find that they are all striated and bristly with spines. Those of the dorsal surface are clavellate. Those of the ventral surface are cylindrical and pointed, nearly like those of *Encope tetrapora* (see Pl. 10 *a*). The color of the surface of the test is yellowish-brown, but this color passes to lilac on the edges of the lunules and the periphery.

The locality of the species is not known exactly. It appears to come from the Philippines.

II. ENCOPE TETRAPORA Ag.

Pl. 10 a, fig. 1–3.

Echinus tetraporus Gm. p. 3190.

Scutella tetrapora DeBl. Zooph. p. 200. — Agass. Prod. Ech. p. 188.

Scutella quadrafora Lam. Vol. III, p. 280. — E. Desl. Enc. Vol. 2, p. 676, N° 6. — Encycl. méth. Pl. 148, fig. 1, 2. — DeBl. Dict. Sc. nat. V. 48, p. 224. — DesMoul. Tabl. syn. p. 224.

Echinndiscus quater perforalus Leske p. 204. Sp. 56.

Echinoglycus oblique incisus (Schyf gescheurde Egel koek met buisen) van Phels. p. 34, N° 5.

Echinanthus spec. 3. Seba Thes. Vol. III, Pl. 15, fig. 5, 6.

Although *Scutella (Encope) tetrapora* is found mentioned in all the works that consider urchins, it is however known only by the figure given by Seba and that has been copied by several authors. I have searched in vain in the collections and the museums of Europe a species that has this name. Not finding any, I have thought I should consider that of my species that closest approaches the figure mentioned above, without guaranteeing with certainty its specific identity. This is a question that we will have to decide when we will have found the original of the author from Holland. Until then, here are the characters that I envisage as *Encope tetrapora*: The form is nearly circular. The greatest width is behind the top. The specimen figured is even a little wider than long. The periphery has slight notches in the extension of the ambulacra. The lunules of the posterior ambulacra are open and of equal width in all their extent. The lunules of the anterior and lateral ambulacra are small, ovoid in form and completely closed. The thickness is rather great, and the dorsal surface has a uniform slope, but very abrupt, on the periphery of the test (fig 3). The mouth is central and circular. The anus is small, ovoid in form and nearer the mouth than the posterior edge (fig. 2). The grooves branch considerably in all directions. The petals are wide, and despite the spines that cover the entire surface of the test, we see that the intermediary space between the poriferous zones is very wide. The specimen figured has kept its color, which is a very deep reddish-brown. The spines are very abundant and variously shaped according to the place they occupy on the test. Those of the dorsal surface are in the form of clubs (fig. 1 a, b). Those of the ventral surface are cylindrical and much longer than those of the dorsal surface, especially in the interambulacral areas (fig. d, c). Examined under the microscope, all have longitudinal striations, finely serrated. The figure figured, the only one I possess, has been sent to me by my friend Stokes. It comes from the Galapagos Islands. Ch. DesMoulin cites the west coast of Africa as the origin of his specimen, where it has been reported by Rang. It remains to be known if it is the same type. I think not because DesMoulins found the figure of Seba more rounded than his specimen.

III. ENCOPE MICROPORA Agass.

Pl. 10 *a*, fig. 4–8 and Pl. 19 *a*, fig. 7.

Very close in many ways to *E. emarginata*, this species differs only by some apparently unimportant characters, but that are no less specific characters since they are invariably found in all the individuals. These characters are: 1° the smallness of the lunule of the unpaired interambulacral area, that recalls the name of *micropora*; 2° the considerable width of the ambulacral petals that are greatly rounded at the end, without however completely closing. The space between the poriferous zones between each petal is notably wider than the zones themselves, especially in the anterior petals; 3° the form of the apical disk that is smaller than in *E. emarginata*. The gonopores are also in general closer together, although placed at the end of the rays of the madreporite. The latter has a spongy aspect as in all species of the Encopes (fig. 6). The ocellar pores are extremely small, but however visible even with the naked eye. The epidermis, finely granular, has, under a strong magnification, two kinds of tubercles that we have found in nearly all the Scutellids. The spiniferous tubercles, that are distinctly perforated and mamelonated, and the miliary tubercles that surround the latter and are very numerous (see fig. 8). In the poriferous zones of the ambulacral petals, the spiniferous tubercles form very regular transverse series (see fig. 7). The ventral surface shows nothing in particular. It has the same disposition of grooves and tubercles as we have described in the preceding species. The buccal opening is small and circular. The anus is pyriform and elongated in the longitudinal direction. The transverse diameter is sensibly equal. The posterior edge is a little more truncated in old specimens than in the young. Fig. 5 represents the profile. The largest thickness is toward the anterior edge.

Fig. 7 of Pl. 19 represents the interior cavity, such as we have described in the article of the genus (see above). The specific difference of this species with *E. emarginata* is confirmed again by the path of the intestinal canal, whose curves are much more numerous, notably on the right side.

I possess several specimens of this species that were given to me by Stokes. But there is none whose origin is known to me. Their color appears to be, in life, a deep brown, judging from some traces that are preserved.

IV. ENCOPE PERSPECTIVA Val.

Pl. 10 *b* fig. 1–5.

This species has the greatest resemblance with *E. micropora*. Its form (fig. 1), its profile (fig. 2), the disposition of the lunules, its apical disk (fig. 5), are nearly identical but I believe different for several reasons: first, the lunule of the unpaired interambulacral area, instead of

being small and elongated, is very large, widened and ovoid; its periphery is marked with tubercles much more developed than those of the rest of the test. This suggests it was edged with corresponding spines. In the second place, the ambulacral petals are narrower than the preceding species, especially the posteriors that are slightly curved by the effect of the lunule that encroaches in some way on their domain. Finally, the poriferous zones nearly equal in width the intermediary space. At the origin of the petals, they are even wider. The anterior petals are sensibly shorter and more rounded than the posteriors. The grooves of the ventral surface branch considerably. The ambulacral areas to which they correspond are covered with tubercles so fine that they give the surface the appearance of velvet. The interambulacral areas have more developed tubercles. The mouth is angular or slightly pentagonal because of the projection of the tubes of the buccal gills (see fig. 3). Fig. 4 represents the form and disposition of the tubercles of the dorsal surface with very great magnification. I know this species only from the figured specimen sent me by Valenciennes under the above name, but without indication of origin. Its color completely tarnished. It is an error that this species is indicated on my plate as established by me. It is Valenciennes who was the first to distinguish it.

V. ENCOPE CYCLOPORA Ag.

Pl. 10 *b*, fig. 6–9.

It is scarcely possible to confuse this species with the preceding. The tendency of its lunules, in particular the lunule of the unpaired interambulacral area, to be rounded, gives a completely particular physiognomy. It is in addition remarkable for its very widened form. It is the only Encope known whose transverse diameter is considerably more than the longitudinal diameter. Its thickness is average. But the most swollen part corresponds exactly to the apical top (fig. 7). The anterior side is narrower than the posterior side. It has a rather pronounced notch in the extension of the lunule of the interambulacral lunule. The lunules of the posterior ambulacra are open, at least in the specimen figured. The ambulacral petals are straight, regular and very uniform. The anteriors are scarcely smaller than the posteriors. The poriferous zones are as wide and even wider than the intermediary space. The apical disk protrudes slightly. The five gonopores are very distinct and located at the end of the rays of the madreporite. The ocellar pores are equally distinct, even by the naked eye. The madreporite itself is composed of an agglomeration of very dense capillary tubes (fig. 8). Finally, a last particularity of this species consists of the absence of distinct miliary tubercles. We see only spiniferous tubercles that, examined with great magnification, have the form and disposition indicated in fig. 9.

The ventral surface is very rough, the grooves there are more branched than in any other species. But the lateral branches are short and wide, with the exception of the last that extends around the lunules. The mouth is of average size. The anus, pyriform in form, is located on the internal edge of the lunules of the interambulacral area. The specimen figure, the only one I know, was sent to me by Michelin. Its origin is unknown. Its color is entirely faded.

VI. ENCOPE OBLONGA Ag.

Pl. 9.

This species is more elongated than any other Encope. It would form a regular oval if the posterior side were slightly truncated. The height is proportional to the other dimensions. But the most elevated point, instead of being before or at the center, is moved behind and the apical top is even a little depressed (fig. 2). The ambulacral lunules, like the lunule of the interambulacral area, are very large, especially the posterior, and have considerably swollen edges. All are contiguous at the end of the petals of which they are a kind of extension. The ambulacra themselves do not differ in form or dimensions from those of *E. emarginata*. Fig. 4 represents half of the left anterior petal at a magnification of two times the diameter in order to show the detailed structure of this part of the test. We see by this figure that the poriferous zones have small tubercles between transverse grooves absolutely like the rest of the surface. The internal pores are round, while the external ones appear sensibly elongated. The apical disk is notable for the extraordinary protrusion of its rays. The posterior ray is truncated and therefore sensibly smaller than the others (fig. 7). The gonopores are located in the interior of the rays. The ocellar pores occupy the top of the ambulacrals in the reentrant corners of the madreporite.

The grooves of the ventral surface are of average width, but their branches are less marked than in the other species, although we always distinguish the ambulacral pores when we examine them with a magnifying glass. The mouth shows nothing particular. It is as usual sub-central forward and allows the ends of the teeth to be seen. Fig. 5 represents the periphery of the mouth enlarged, showing an extraordinary number of microscopic pores, plus five slightly larger pores located at the end of the small tubes that, without doubt contain the buccal gills. The anus is very near the mouth, which is explained by the size of the lunule of the interambulacral area. Professor Pictet sent this curious species to me. Its origin unfortunately is not known. The sole specimen that I have seen is the one I figured. It is in the Museum of Geneva.

VII. ENCOPE VALENCIENNESII Ag.

Pl. 7 and 8.

It is the largest species of the family of Scutellids and one of the largest urchins known. But few collections have specimens of it. I have found no descriptions or figures of it. It is thanks to my friend, Valenciennes that I received the specimen figured that makes part of the Muséum d'Histoire naturelle de Paris. It gives me great pleasure to dedicate this beautiful species to him.

The elegant form of *E. Valenciennesii* is due to the beautiful proportions of all parts of the test. The ambulacral notches, as well as the lunule of the interambulacral area, are proportional to the dimensions of the test. However, there are rather marked differences in their dimensions and

in their form. The notches of the posterior ambulacra are larger than those of the anterior ambulacra. The smallest is the one that corresponds to the anterior ambulacra (*a*). These five notches, which I have indicated by letters relative to the plan of the animal, have nearly the same form and are all contiguous at the end of the ambulacra. Although none of them are closed, we note however that they tend to narrow at the edge of the test. Consequently, I do not think that we can envisage as a specific character that case where one or the other of these notches are closed. The lunule of the interambulacral area is large and elongated in form. Its edges are scalloped and form a rather marked swelling above the surface of the test, as can be seen especially well in fig. 2 of plate 7 that represents the profile seen from behind. The contour of the test is nearly circular. However, the longitudinal diameter is a little larger than the transverse diameter. The height is greater than in the other species. It equals a sixth of the length and decreases gradually toward the edges in a way that the dorsal surface is very evenly convex (see fig. 2 of Pl. 8 that represents the reduced profile seen from the side). The anterior and lateral petals are wider, shorter and more rounded than the posteriors. Also, the space between the poriferous zones is narrower than the zones themselves. Finally, as the lunule of the unpaired ambulacra is very large, the posterior lunules are moved laterally and have a rather marked curve. The contours of the apical disk are not very precise. In contrast, the pores are more distinct. The ocellar pores are very visible and as developed as the gonopores. Examined with a magnifying glass, the madreporite has the same spongy appearance that we have reported in the preceding species. But there is this particularity. It is that it extends more forward in the interambulacral area. The gonopores, although very far from the center still open in this spongy surface. The dorsal surface has very homogeneous spiniferous tubercles, each in the middle of a small depression and circled by miliary tubercles that can be seen only at great magnification. Fig 3 of Pl. 7 represents some of the tubercles enlarged. Figure 4, a portion of the poriferous zone of a petal, taken at its end and showing the intervals of the grooves with tubercles as well as the rest of the surface.

The ventral surface (Pl. 8) has the same variety of tubercles that we have already reported in *E. emarginata*. Those of the interambulacral areas being always larger than those of the ambulacral areas. But this that always merits being noticed is the depth and width of the grooves and the manner in which they branch in all directions. The smallest branch still shows, up to the end, pores very visible with the magnifying glass. The buccal opening is circular, nearer the anterior border than the posterior border. The anus is at the origin of the interambulacral lunule and separated from the buccal opening by a space that corresponds to a ninth of the length. It is oval in form as in all *Encopes*.

The masticatory apparatus has the structure usual to this organ in all *Encopes*, but it is worth noting that despite the larger size of this species, its jaws are less developed than those of *E. emarginata*. As usual, the unpaired posterior jaw is more developed than the paired jaws. Its wings especially are more elongated. Fig. 3 of Pl. 8 represents the five disjointed jaws, seen from above and showing in a very distinct way the juxtaposition of their perpendicular lamellae. The protruding keels in the median line are the teeth that are fixed in the corresponding groove of the fusion of the two demi-jaws. Fig. 4 represents the same jaws seen by the ventral surface with the median swelling that corresponds to the notch of the top of the auricles. Fig. 5 represents the unpaired jaw seen in profile.

The spines are not preserved in the specimen figured. But I have found them on some specimens of Stokes in the British Museum. They are cylindrical with a large swollen ring above the articulating surface. Their size is related to the size of the tubercles. Also, on the ventral

surface, those of the interambulacral areas are much more developed than those of the ambulacral areas. Those of the dorsal surface are very small and in the form of clubs. This species comes from Martinique.

VIII, ENCOPE SUBCLAUSA Ag. ⁽¹⁹⁾

Pl. 5.

We cannot ignore the great resemblance that exists between this Encope and *E. Valenciennesii* that we just described. The sole striking difference at first glance is that the posterior notches are closed. Now, noting that in general the notches tend to close with age, it is scarcely possible to identify these two species, since *E. Valenciennesii*, despite its larger dimensions, has all the ambulacral notches widely open. But, on the other hand, we have also seen that there are numerous exceptions to this rule and the form of the notches can vary considerably in the same species. I cannot confirm in a positive manner that *E. subclausa* is really a distinct species, although I have noted a few other particularities that I am going to indicate. First, the lunule of the unpaired ambulacrum is proportionally narrower than that of *E. Valenciennesii*. The grooves of the ventral surface are shallower and narrower, the secondary branches especially are less apparent. Finally, the edges of the test are sharper and become thinner more quickly. In all other relations, our species does not differ in anything from *E. Valenciennesii*. Its general form is sensibly the same. The buccal and anal openings show no difference. No more than the apical disk that is conspicuous by its very distinct gonopores and ocelli. Finally, the ambulacra have the same form. The spines that cover the test prevent perceiving the details.

This species was sent to me by Professor Pictet. The specimen figured comes from Brazil. It is found in the Museum of Geneva.

IX. ENCOPE GRANDIS Ag.

Pl. 6.

This species is constructed on the same plan as *E. Valenciennesii* and anyone who sees only a figure of the ventral surface or dorsal surface, can scarcely help from taking this species for a young of this species, considering that the principal character that distinguishes it consists in the

¹⁹ When I began my work on the Scutellids, I took this species for the *Scutella tetrapora* of the authors and I figured in 1839, on the plate cited under the name of *Encope tetrapora*. But having later the opportunity to examine the figured specimen later, Pl. 10, fig. 1–3, I have found more relations with the figure of Seba than as *Scutella tetrapora* cited by all the authors than with the species that I designate here under the name of *Encope subclausa* so that the name of *Encope tetrapora*, which is at the bottom of Pl. 5, will have to be changed to *Encope subclausa*, which relates to the shape of the notches.

thickness of the edge, that is more considerable than in any other species of the genus (see fig. 3, 4, 5 and 6 that represents the profile). The ambulacral star has the same proportions as in the preceding species. The posterior petals are sensibly longer than the anteriors and slightly bent from outside to inside. The notches of the periphery are shallower and widely open. Those that correspond to the anterior ambulacra are larger than those that correspond to the anteriors and notably to the unpaired ambulacrum. The lunule of the unpaired interambulacral area is wide and oval in form. Its edges are very swollen and form a kind of crest on the dorsal surface. The ventral surface, represented in fig. 2, has the same details of the structure that we have recognized in the preceding species.

Fig. 4 and 5 show the interior of the test seen in profile, the specimen being cut in the middle in the longitudinal direction. The buccal cavity occupies the center. It is separated from the intestinal cavity by the compartmentalized wall that is interrupted only in the front to give passage to the intestine. A horizontal wall separates likewise the ambulacral apparatus from the buccal and intestinal cavities. I have indicated by letters the different cavities as they appear in the profiles above: *t* is the buccal cavity; *o* and *p* are the atria; *a*, the anus; *n*, the cavity occupied by the first bay of the intestine; *h*, the opening that crosses the intestinal canal in passing from the left side to the right side; *e*, *c*, *l*, *i*, *gh*, *d*, holes passing over the ambulacra in the cavities occupied by the ambulacral tubes when they are retracted; *m* and *q* two of these cavities opening longitudinally (*m*), and in cross section (*q*); *k* and *f* openings going into the cavity of the interambulacral areas. Fig. 6 is a cross section of the right side. *s* is the opening by which the intestinal canal leaves the buccal cavity to enter the calcareous network of periphery of the test; *q* is the canal that encloses the internal bay of the right side of the intestinal canal.

I have represented three jaws by their different surfaces in order to give an exact idea of their form. Fig. 7, 8 and 9 show the profile, fig. 7', 8' and 9' by their ventral surface and fig. 7'', 8'' and 9'' by their dorsal surface. The teeth proper are lost. They were fixed in the groove that is on the dorsal surface and that corresponds to the suture of the two demi-pyramids of the jaw.

This specimen was sent to me by Michelin. It probably came from the Antilles.

X. ENCOPE MICHELINI Ag.

Pl. 6 *a*, fig. 9 and 10.

This is a very massive species, sensibly longer than wide, with thick edges. But what distinguishes it in a completely particular way is that the greatest height, instead of being at the apical top, is considerably pushed backward so that the posterior side has a very considerable slope, while the anterior side is very gradual as shown in fig. 10, that represents the profile. The posterior edge is truncate and even slightly notched in the middle of the unpaired interambulacral area. The apical disk is large. The petals are rounded at the end. The posteriors are slenderer than the anteriors and the poriferous zones sensibly wider than the intermediary space. The notches of the ambulacral areas are very open, of moderate width and very uniform. However, the posteriors are a little deeper than the anteriors. Both show no tendency to close at the edge. The lunule of the posterior interambulacral area is small and narrow. Its edges are slightly swollen at the upper edge. The apical disk is a regular pentagon whose five corners are occupied by the

gonopores. The ventral surface is completely flat. Its grooves are shallow, but diversely branched. The mouth is central. Its periphery is scalloped from the projection of the branchial tube feet. It is to Michelin that I owe this beautiful species. Its origin is unfortunately not known. I have dedicated it to the tireless paleontologist who sent it to me.

XI. ENCOPE STOKESII Ag.

Pl. 6 *a*, fig. 1–8.

We often encounter, at the limit of genera, species that by a combination of their characters, seem to evade zoological determination. *E. Stokesii* is in this class. Its physiognomy is completely that of the Encopes, but if we open the interior, we are completely astonished to find the structure of Mellitids. Instead of the calcareous wall that separates the buccal cavity from the intestinal cavity, and that extends over the right flank, between the folds of the slender intestine, we have here some calcareous pillars that rise from the interambulacral areas, absolutely like those that we described in *M. pentapora* (Pl. 3, fig. 6 and 7). I have wanted to assure myself that this particular character exists in all the specimens. I have found it the same in the adults as in the young, so there can be no doubt about its real value. If, on the other hand, we consider that *E. Stokesii* has all the external characters of the Encopes, the general form, the size of the ambulacral star, the rounded form and often open lunules and finally the five gonopores so that, for those who did not know the interior structure, there could be no doubt about the genus to which this species should be referred. If, I say, we take into account all these circumstances, we must agree it is nearly impossible, in the present state of our knowledge of the anatomy of these animals, to make a definitive judgement. I have no intention of deciding the question now. There is a single exterior character that, although secondary, seems to betray a greater affinity with the Mellitids. It is the color that is green, as in the Mellitids. While all the Encopes, whose color has been preserved, are brown, violet or lilac.

Considered in itself and as a species, *E. Stokesii* is noted for its circular form in young individuals and more-or-less truncated posterior in the adults. The transverse diameter and the longitudinal diameter are nearly equal. The highest point corresponds to the apical top. The dorsal surface has a uniform slope toward the edges (see fig. 3). The ambulacral petals are wide and rounded at their end, but do not reach the edge of the notches. The lunules of the unpaired ambulacral area is oval in form and very near the edge. The mouth is at the center of the ventral surface, surrounded by a decagonal buccal rosette (fig. 2). When the spines are preserved, as is the case for most of the specimens that I possess, the mouth is hidden by the spines on its periphery. The anus is pyriform, located halfway between the mouth and the posterior edge. The grooves of the ventral surface are very marked, even in the specimens covered with their spines. They bifurcate one or several times before reaching the edge.

I have represented specimens of different ages to show better the modifications that occur as these animals grow. I have been able to assure myself, in comparing about twenty specimens of different size that, in this species at least, the notches of the ambulacral areas, instead of widening with age, tend, on the contrary to close at the edge. In fact, they are very open in the small specimen in fig. 1. In the specimens in fig. 2, 5 and 8, they already show a very pronounced tendency to close. Finally, in the specimen in fig. 6, the anterior notches are completely closed, and the posteriors are only very little open at the edge.

The spines vary in form according to their location. Those of fig. 4, taken from the dorsal surface are notable for their essentially clavellate form. Those of fig. 7 are from the ventral surface. They are distinguished by their cylindrical and pointed form. Fig. *c'* represents a part of

the spine 7 *c* at two times magnification, showing the form and disposition of the fine serrations which make the longitudinal striations bristly. All these spines have a very distinct articulating surface, separated by very marked ring or circular swelling.

Fig. 8 shows the interior cavity with the calcareous pillars that we reported above. Around these pillars is extended the intestinal canal that is here represented in the dried state. This makes it appear narrow. I am assured myself by examination of the cavity of other individuals that the part in the left side is sensibly wider than in fig. 8.

The masticatory apparatus is far from being massive. The framework of the jaws especially is very thin and the vertical lamellae very delicate. The ventral surface has a small keel that fits into a groove at the top of the auricles. The latter are small and close together. This species appears to be very common on the west coasts of tropical America. My friend Stokes had the kindness to send to me a considerable series of specimens coming from the Galapagos Islands. Their color is ash-green, a little deeper in old individuals than in the young. The naturalists of Bouite, Eydoux and Souleyet, have given to the Muséum d'histoire naturelle de Paris several specimens coming from Guayaquil, colored lilac but lacking their spines.

CHAPTER V.

GENUS LOBOPHORA Agass.

This genus is distinguished by several first-class characters, both exterior and interior. It contains in general very flat species, having a rounded anterior edge, while the posterior edge is truncated and cut by two more-or-less deep notches or lunules corresponding to the posterior ambulacral areas. The presence of these two notches, without being an essential character, suffices however, in the present state of our knowledge, to distinguish the Lobophores from all the other genera of Scutellids. The ambulacral star is small proportionally to the dimensions of the test. The petals rarely reach halfway of the ray between the edge and the top. The apical disk shows the same spongy structure that is found in all Scutellids. The very distinct gonopores are four in number and open at the end of the rays of this rosette. The ocellar pores are ordinarily very distinct. The ventral surface is completely flat, and especially less branched than in the preceding genera, but equally riddled with microscopic pores. The mouth is central. The anus is circular and more-or-less near the posterior edge, without however being marginal.

The interior cavity is noted by the absence of a wall and pillars between the masticatory apparatus and the intestinal canal. In contrast, there is, all around the intestine, a network of very developed calcareous compartments that occupy more than half the cavity of the test and that appear destined to contain the appendices of the intestinal canal. The intestine itself is very slender. Its path is the same as in the preceding genera, i.e., it passes one time on the left side and two times on the right side. The sole particularity that distinguishes the Lobophores in this respect, is that before moving back toward the anus, the intestine folds back on the side into a rather deep caecum corresponding to the right anterior interambulacral area (see Pl. 13, fig. 6).

The masticatory apparatus has a completely remarkable structure. The jaws are extremely flat because the vertical lamellae that they have on the dorsal and ventral surfaces are very little developed. But what constitutes the most remarkable character is that the auricles destined to hold the jaws in place do not form at all an enclosure around the latter as is the case with the Mellitids, the Encopes and especially the Laganids, but articulate, on the contrary in a depression that is in the middle of the ventral surface of the jaws, in nearly the same manner as in the true Clypeasters. This depression that is represented in fig. 5 of Pl. 14, in fig. 7 of Pl. 12, and in fig. 4 of Pl. 13 has been designated by DesMoulins, in Clypeasters, under the name of *fossette naviculaiare* (boat-like depression). The teeth themselves are very thin enameled blades, implanted on the field of the groove of the dorsal surface of the jaws, which they do not fill the entire length.

The spines are more uniform than in the preceding genera. However, this is still a difference between those of the ventral surface and those of the dorsal surface. The latter are slightly swollen at their end. Those of the ventral surface, on the contrary, are slender and cylindrical. I have not seen up to now, only a single species that has preserved its color, which is *L. bifissa*, which is a beautiful violet color.

The species known to this day are four in number, all belonging to the present epoch. Unfortunately, there is some confusion in the synonymy owing to the bad habit of authors of citing synonyms without consulting the works and of copying their figures from older figures instead of taking original specimens for types.

I. LOBOPHORA BIFORA Agass.

Pl. 12.

SYN. *Scutella bifora* Lam. Vol. 3, p. 281, N° 7. — Agass. Prodr. Ech. p. 188.

Echinus biformis L. Gm. p. 3188 (pro parte).

Echinoglycus irregularis (Onregelmatige Egelkoek;) Van Phels. p. 35, N° 15, (pro parte).

Echinodiscus Knorr Delic. nat. V. 1. p. 92, Pl. D 1 fig. 1. — (pro parte).

Scutella bilincarifora DesMoul. Tabl. syn. p. 226, N° 11.

The species that I designate under this name is not found figured by any author. I would not have thought of keeping it in preference to the next one that was formerly used, the name so generally received now of *S. bifora*, if I had not acquired at the Museum of Paris the certainty that Lamarck considered it as the type of his *Scutella bifora*, the name under which he confused however as simple varieties, several very distinct species. The form of *L. bifora* is irregular. The anterior side is rounded and sensibly narrower than the posterior side that is truncated and has a slight indentation in the extension of the anal opening. The greatest thickness is not exactly at the center, but forward of the apical disk (fig. 3). The lunules are very oblique, elongated, and narrower in the middle than at the end. The ambulacral rosette is very unequal, the posterior petals being sensibly longer than the anteriors. These latter are in addition atrophied and, instead of being rounded at the end, appear truncated. We are very naturally led to attribute this to the encroachment of the lunules. However, it is necessary to note that the anterior petals that have no lunules in their extension also not perfectly rounded. Figure 6 represents a portion of a poriferous zone with a magnification of several diameters to show that even the intermediary space between the transverse grooves has small tubercles like the rest of the surface. Fig. 5 represents the ventral surface of an ambulacral petal with a lower magnification. We see there first the two regular rows of pores and, moreover, in the intermediary space between the two poriferous zones, two other less regular rows whose function remains unknown to me.

The ventral surface has a much more variable aspect than in the other species. First, the ambulacral grooves are wider and more distinct, without however being branched. Each groove has only a single principal branch that goes to the interambulacral area. Moreover, the interambulacral areas are distinguished from the ambulacral areas by a very different granulation, made of very dense spiniferous tubercles that are not surrounded by miliary tubercles (see fig. 11). In the ambulacral areas, on the contrary, the spiniferous tubercles are smaller and arise from the middle of a depression surrounded by very apparent miliary tubercles, nearly like those seen in fig. 10, which represents a portion of the magnified dorsal surface. Finally, the ambulacral grooves are accompanied along their entire length by an apparently smooth and velvet-like band. But examination with the magnifying glass shows it is also composed of extremely fine and numerous tubercles. This diversity in form and dimensions of the tubercles implies without doubt similar differences in the structure of the spines. It is only to be regretted, all the more, that these were not preserved.

The mouth is nearly central, very small and lobed in shape by the projections the tubes of the buccal gills make on its periphery. Fig. 4 represents this part of the test magnified 1 ½ diameters to see its detailed structure. The buccal rosette is composed of five large, lobed plates corresponding to the interambulacral areas and of five other extremely thin plates corresponding to the grooves of the ambulacral areas. The grooves have microscopic pores that here are less numerous than in the preceding genera. The anus is very small and circular in form. It is located in front of an indentation of the posterior edge.

The interior is remarkable for the compact structure of the compartments that especially fill the edges that, when examined in profile, resemble a forest of bony pillars. The jaws are extremely thin as we see in fig. 9, that represents the profile of an isolated jaw. I have indicated by the letters *a*, *l*, *p* the anterior, lateral, and posterior position of the jaw in figures 7 and 8. One (fig. 8) represents the masticatory apparatus seen from its dorsal surface, the jaws being united. We distinguish very well in the middle of each jaw a small groove in which are fixed the teeth that have been lost. In Fig. 7, which represents the masticatory apparatus by its ventral surface, the jaws are disarticulated. We note on each side of it a small depression that is the navicular depression. The auricles that correspond to these depressions are very small.

DesMoulins, having had the kindness of sending me a sketch of his *Scutella bilinearifora*, was even able to confirm with certainty that his species is indeed the form that Lamarck made the type of his *Sc. bifora*. The specimens that I have had the opportunity to examine were sent to me by Valenciennes and by Chavannes, but without indication of origin. One of these species was tarnished brown-olive on the ventral surface. DesMoulins reported that his came from the coasts of Cafrerie.

II. LOBOPHORA TRUNCATA Ag.

Pl. 11, fig. 11–16.

SYN. *Scutella bifora* var. 2. Lam. V. 3, p. 281. — E. Desl. Enc. V. 2, p. 676. — DeBl. Dict. sc. nat. V. 48, p. 223. — DesMoul. Tabl. syn. p. 226. — Encycl. méth. Pl. 147, fig. 7 and 8.

Scutella biforis DeBl. Zooph. p. 200.

Echinus biforis L. Gm. p. 3188.

Mellita laevis Klein Edt. Leske p. 25, Pl. 21, fig. A, B. — Klein Gall, § 81, p. 90, Pl. 11, fig. B.

Echinodiscus biperforatus Leske apud Kl. p. 196.

Echinodiscus Mull. Del. natur. I, p. 92, Pl. D I. fig. 15,

Pain d'épice à deux fentes Davila Catal. V. 1, p. 423, N° 955.

This species appears to have been the oldest known to authors. Klein had already given a figure under the name of *Mellita laevis*. Later, Leske changed the name to *Echinodiscus biperforatus* and included in the same species *L. bifora* that we just described. Lamarck, instead of separating these two species, saw them as two varieties and added to them a third, that is my *Amphiope bioculata*). DesMouslins, the first to make these diverse types three distinct species that he designated under the name of *Scutella bilinearifora* (my *L. bifora*), *Sc. bioculata* (my

Amphiope bioculata) and *Sc. bifora* (the species that is in question here). Not having thought it necessary to preserve the specific name of Klein, who included two distinct species, I could be asked why I did not maintain that of DesMouslins. I have already responded to this question in the description of the preceding species, recalling that it is the latter that Lamarck envisaged as the type of his *Scutella bifora*. So, I was forced to give to the species that concerns us a new name. I call it *truncata* because of the truncated form of its posterior edge that is nearly straight.

Although this species is very close to the preceding, we can however distinguish it very easily by the completely different form of its lunules that, instead of being slender and elongated as in *L. bifora*, are sensibly shorter and wider. Moreover, the ambulacral rosette has a completely different structure. The petals are not atrophied outside but are rounded, on the contrary, at their end and are separated from the lunules by a rather considerable space. Finally, the poriferous zones are narrower and the intermediary transverse grooves do not extend from one row to the other as in *L. bifora*, but are, on the contrary, very limited (see fig. 15 of Pl. 11 that represents a portion of the magnified ambulacrum). The ventral surface shows no remarkable peculiarity, but only the ambulacral grooves branch a little more in *L. bifora*. The smooth band that borders the grooves is in contrast less pronounced. The apical disk is represented magnified in fig. 14. We recognize there very distinctly the location of the gonopores at the top of the interambulacral area and those of the ocellar pores at the top of the ambulacra. Fig. 13 represents the profile of the test that is very regular. The jaws have the same structure as those of *L. bifora*, but they are proportionally a little smaller.

The origin of this species is unknown. The specimen figured is part of the Museum of Paris.

III LOBOPHORA BIFISSA Ag.

Pl. 13, fig. 2–6 and Pl. 14, fig. 1 and 2.

SYN. *Scutella bifissa* Lam. Vol. 3, p. 281, N° 8. — E. Desl. Enc. Vol. 2, p. 676, N° 8. — DeBl. Dict. sc. nat. V. 48, p. 224. — DesMoul. var. A. Tabl. syn. p. 226, N° 12. — Encycl.métab. Pl. 152, fig. 1 and 2.

Scutella inaurita {pro parte) DeBl. Zooph. p. 200. — Agass. Prod. Ech. p. 188.

Echinus inauritus var. a. L. Gm. p. 3199.

Echinoglycus inauritus (Ongeoorde Stomphart) van Phels. p. 34, N° 2.

Echinodiscus inauritus Leske apud Klein, p. 202.

Echinus planus (Groote Pannekoek) Rumph. p. 37, Pl. 14, fig. F.

Placenta laganum majus Rumphii Klein Gall. § 85, p. 92.

Oursin double-entaille Bosc Deter. V. 24, p. 281.

Echinanthus Seba Thes. Pl. 15, fig. 1 and 2.

The determination of this species presented the greatest difficulties to me because of the contradictory information of the authors. Van Phelsum and later Leske already distinguished two species in the type of Lobophores with two open notches, one having the truncated posterior edge (*inauritus*), the other have projecting extensions (*auratus*). Leske refers to the first fig. 3 and 4 of Pl. 15 of the work of Séba as well as the figure of Rumphii (Pl. 14 F) but makes the

remark that he hardly finds the differences sufficient. Lamarck and DesMoulins saw them only as varieties of one and the same species, that they designated under the name of *Scutella bifissa*.

The species that I describe here under the specific name of Lamarck corresponds to his variety *a* and to fig 3 of Pl. 15 of the work of Séba. It is true that the posterior lobe intermediate between the two notches is a little less protruding. But, in contrast, its edge is truncated and more-or-less curved. Now as this character is precisely that which van Phelsum indicated as the most significant, I have referred to this species all the synonyms that have referred to the figure above mentioned by Séba and to that of Pl. 152 of the *Encyclopédie méthodique* that is only a reduced copy.

In general form, *L. bifissa* perfectly resembles a hoe. The anterior side is rounded and sensibly narrower than the posterior side, especially in old individuals. It is the flattest species of all the genera, and perhaps of all the group of Scutellids. In old specimens, such as that of Pl. 13, fig. 2, the thickness equals nearly an eleventh of the length. The notches located in the extension of the posterior ambulacral areas are of moderate width at their origin but widen sensibly toward the periphery. The ambulacral rosette is small proportionally to the size of the test. The posterior petals are, as in all the Lobophores, shorter than the anterior. Their length is equal to that of the notches, and the intermediary space has nearly the same dimensions. The apical disk is small. The gonopores, four in number, are at the end of its rays. The ocellar pores are hardly visible. The articulation of the plates is very distinct, particularly in young specimens (Pl. 14, fig. 1 and 2). The spines are very small, especially on the dorsal surface. The specimen of Pl. 13, fig. 2, is covered with them in one half while the other half shows the granular appearance of tubercles. The spines of the ventral surface are more developed, notably in the interambulacral areas. Instead of being swollen at their end, they are slender and cylindrical throughout their width.

The ventral surface is more uniform than in the two preceding species. The ambulacral grooves there are less pronounced, but more branched, at least in old specimens. The tubercles, although of uniform appearance, are however different according to their location. They are much more developed in the interambulacral areas than in the ambulacral areas. This difference is reflected in the spines. The mouth is in the center of the ventral surface. Its periphery is circular. The rosette that surrounds it is very distinct and composed of five rhomboidal plates. But when we examine it closely, we recognize five other very narrow plates, corresponding to the ambulacral grooves so that there are really ten as in all Scutellids. The anus is located at the top of the origin of the notches, i.e., a little nearer the posterior edge than the mouth. It is very small and circular in form. The color is a very bright violet in young specimens. In the old, it seems to pass to a red brown. We note that on the ventral surface, the spines are more brightly colored in the interambulacral areas than in the ambulacral areas.

The interior is in large part filled with the compartmentalized network. As a result, there is very little space for the masticatory apparatus and for the intestine. Also, the latter is reduced to a very narrow gut. Fig. 6 of Pl. 13 represents its path on the right side. After going up to the top of the right anterior interambulacral area, it enters into a deep bay where it folds back onto itself to go back to the anal opening. This bay is strongly bent to the right, while that in the follow species is less curved. Fig. 4 and 5 of Pl. 13 represents the masticatory apparatus of an individual of the same size as that of Pl. 14, fig. 1. It is seen by its ventral surface in fig. 4 and by its dorsal surface in fig. 5. In the latter, we see the teeth in place. Fig. 3 represents the ventral test seen by its internal surface; the masticatory apparatus being removed. We recognize there the five auricles on which articulate the jaws.

The specimens of Pl. 14, fig. 1 and 2 were sent to me by Valenciennes. It comes from the Red Sea, from where it was sent to the Museum of Paris by Roux. The specimen of Pl. 13, fig. 2 was sent by Pictet from Geneva. Its origin is not known. In the grand work on Egypt, Savigny has given a figure of this species that perfectly conforms to the specimen that I have represented Pl. 14 and likewise coming from the Red Sea.

IV. LOBOPHORA AURITA Ag.

Pl. 13, fig. 1 and Pl. 14, fig. 3–7.

SYN. *Scutella aurita* DeBl. Zooph. p. 200; — Agass. Prod. Ech. p. 188.

Scutella bifissa var. 2. Lam. Vol. 3, p. 282. — Encycl. méth. Pl. 151, fig. 5, 6. — DesMoul.
var. C. Tabl. syn. p. 228.

Echinoglycus auritus (Goorde Stromphart) Van Phels. p. 34.

Echinus auritus L. Gm. p. 3189.

Echinodiscus auritus Leske apud Klein, p. 202.

Echinanthus maximus Séba Thés. 3. Pl. 15, fig. 1, 2.

Favanne Pl. 58, fig. C, 1.

It is not without some hesitation that I refer this species to the *Scutella aurita* of authors. The specimen figured, the only one that I know, does not have an intact posterior edge so that I cannot affirm with complete certainty that it really had auricular extensions. One circumstance however makes me suppose that this extension existed. It is the thickness of the test that is chipped and more considerable in this area (the corner of the notches) than elsewhere. In any case, this specimen belongs to a different species than the preceding as we are going to see. And first of all, its periphery is not the same. The anterior side especially is wider and much more uniformly rounded. The ambulacral petals are most extended. The notches, instead of widening toward the periphery, have on the contrary a tendency to narrow. Finally, the anus is placed sensibly behind the origin of the notches and consequently nearer the posterior edge. Fig. 3 of Pl. 14 represents the dorsal surface that shows distinctly the articulation of the plates of the test, the form of the ambulacral petals and the arrangement of the gonopores, that are four in number and very apparent. The five ocellar pores, located at the top of the petals, are hardly perceptible to the naked eye. The ventral surface has no character particular to this species except that the difference between the tubercles of the interambulacral areas and the ambulacral areas is more striking than in *L. bifissa*. The grooves there are little marked.

Fig. 1 of Pl. 13 represents the interior cavity, the ventral test being removed. The ambulacral petals there are seen as clearly as on the external surface. We see the gonopores open into the four protruding bony ridges that extend into the interambulacral areas. The ridge corresponding to the unpaired interambulacral area differs from the others only in that it lacks a

gonopore. Beside the unpaired anterior ambulacrum, we see the sinus in which the intestine is recurved on itself to reach the anus. Fig. 5 and 6 of Pl. 14 represent the masticatory apparatus, seen from below (fig. 5) and above (fig. 6). The letters *a*, *l*, *p* indicate, as in *L. bifora*, the relative position of the jaws. In fig. 5, we distinguish very well at the surface of each jaw, the boat-like depressions. They correspond to the five auricles that we see projecting from the interambulacral areas in fig. 4 that represents the ventral test seen by its internal surface. The jaws are very large, but not thick. Fig. 7 shows one in profile with the tooth fixed vertically on the surface.

The specimen figured was addressed to the Museum of Neuchâtel by Guebhard, Prussian consul in Alexandria. It comes from the Red Sea.

CHAPTER VI.

GENUS AMPHIOPE Ag.

The species that I place in this genus have the greatest relations with the Lobophores. However, I have thought it necessary to separate them because of the form of their lunules that are rounded instead of being elongated as in the Lobophores. This particular form determines an arrangement completely different of the plates of the posterior ambulacral areas that, instead of forming regular rows on each side of the lunule, are disposed in a circle around them. (Compare fig. 1 and 6 of Pl. 11 with fig. 11 of the same plate). Except for that, the Lobophores are very regular Urchins, strongly flattened, with a generally circular periphery. The ambulacral petals, wide and short, rounded at their end, rarely pass mid-edge. The gonopores are four in number and located at the top of the rays of the madreporite. The ocellar pores are in their usual place at the origin of the petals. The ventral surface is flat. The grooves that indicate the ambulacra divide at a short distance from the mouth into two branches that detach a more-or-less considerable number of lateral branches in their path toward the periphery. The mouth is central. Its circular periphery is made irregular by the projections of the five brachial tubes. The buccal rosette is pentagonal in appearance, but examined closer, we see ten plates there as in Lobophores. The anus is on the ventral surface and very near the posterior edge. It is small and circular.

I still know only two species of this genus. Both are fossils of Tertiary terrains.

I. AMPHIOPE BIOCULATA Ag.

Pl. 11, fig. 1–5.

SYN. *Scutella bioculata* DesMoul. Tabl. syu. p. 232, N° 23.

Sc. bifora Lam. var. c, Vol. 3, p. 282. — E. Desl. Encycl. Vol. 2, p. 676, N° 7. — Encycl. méth. Pl. 147, fig. 5–6. — Desmar. in Al. Brong. Tbéor. des terr. Tabl. N° 5, p. 12.

Dict. sc. nat. V. 54.

Amphiope bioculata Ag. Calai, syst. Ectyp. Mus. Neoc. p. 6.

This species has a nearly circular and moderately flat form. Its periphery has no notches, but slight concavities in front of the ambulacral pairs. The longitudinal diameter nearly equals the transverse diameter. The posterior side is truncated. The lunules are nearly circular. They occupy the intermediary space between the edge and the end of the posterior petals and around them. The plates of the test are arranged in a circle (fig. 1). The ambulacral petals are short, but wide and rounded at the end. Fig. 4 represents the apical disk at the end of the ambulacra at a weak magnification. We distinguish there the four gonopores at the top of the corners of the madreporite that correspond to the paired interambulacral areas. The unpaired interambulacral area lacks them. The grooves of the ventral surface have numerous branches in which we distinguish, with the aid of a strong magnifying glass, rows of microscopic pores. Near the

mouth, where they are still individual, these grooves are deeper and have slight ridges that are without doubt the tubes in which are lodged the buccal gills. Fig. 5 represents the buccal rosette will give a quite clear idea of this arrangement of the branchial tubes around the mouth. The anus is inframarginal, but it does not determine any notch in the posterior edge.

Amphiope bioculata comes for the Tertiary terrain of France. DesMoulins cites Bordeaux as the locality, and Sure near Bollène, Department of Vaucluse. One of the specimens that I examined were sent to me by Deshayes, the other by Michelin. They come from Touraine.

II. AMPHIOPE PERSPICILLATA Ag.

Pl. 11, fig. 6–10.

SYN. Catal. syst. Ectyp. Mus. Neoc.p. 6.

This species is one of the flattest of the family of Scutellids. It is not more 2 mm in thickness while its length and width are nearly five cm. The anterior side is sensibly narrower than the posterior side. The latter, instead of being truncated as in *A. bioculata*, is on the contrary rounded and even slightly rostrate. The two sinuses that correspond to the posterior ambulacral pairs are very marked. The lunules have a subcircular form and are of the same size as in the preceding species. We note also around them the same arrangement of plates in a circle. The ambulacra are smaller and especially narrower than those of *A. bioculata*. The end is also less rounded. Fig. 9 represents that apical disk at the top of the ambulacra. On the ventral surface, we distinguish clearly the ambulacral grooves, and at the origin of the latter, near the mouth, the brachial tube with their opening as shows fig. 10, which represents the buccal rosette. The anus, substantially distant from the edge, is nearly a fourth of the distance between it and the mouth.

The specimen figured was sent to me by Michelin. It comes from the Tertiary terrain of Rennes.

CHAPTER VII.

GENUS SCUTELLA Lam. (Ag).

After having removed from the genus of the Scutellids as characterized by Lamarck, on one hand the species lacking notches, lunules, digitations, etc. of which we have made the genera *Rotula*, *Runa*, *Mellita*, *Encope*, *Lobophora* and *Amphiope*, and on the other hand, the species having the anus marginal, such as *Echinarachnius*, *Arachnioides*, *Scutellines*, as well as the species near the true Clypeasters, such as *Laganum*, *Echinocyamus* and *Moulinia*, there remains as true Scutellids only the species with a complete edge that have converging ambulacra and the anus on the ventral surface.

The Scutellids thus limited are Urchins of large size, ordinarily very flat and having a very gradual slope from the top to the edge. Most of the species are wider than long. Their periphery is generally irregular. The anterior side is generally sensibly narrower than the posterior side. The top of the test coincides with the apical disk. The ambulacral petals are more-or-less developed according to species. Their relative length and width constitute the principal specific characters of the species. The apical disk usually is a quite regular pentagon. There are only four gonopores. The ocellar pores, less distinct than the latter, are however recognizable in all well-preserved specimens. The madreporite is composed of an agglomeration of capillary tubes as in the preceding genera. The ventral surface is less uniform than the dorsal surface. The grooves especially branch considerably. The mouth is composed of ten wedge-shaped plates of which the largest corresponds to the ambulacral areas. It would be more circular except for the branchial tubes whose ends protrude on its periphery. The anus is small, more-or-less near the posterior end, but never entirely marginal.

The interior of the Scutellids recalls in many ways the interior cavity of the Lobophores. There is neither pillars, nor calcareous wall destined to separate the intestine from the masticatory organ. But the free cavity in the middle is very small. In contrast, the edges have only a labyrinth of calcareous pillars, between which are without doubt lodged, during the life of the animal, the appendices of the intestinal canal. The masticatory apparatus is in general very solid. The jaws are strong, bristling with the very tall calcareous lamellae, set in a massive frame.

I know only fossil species of this genus. With the exception of a single one, *Sc. Rogersi*, which is from the Cretaceous, they all belong to different stages of the Tertiary formation, from the coarse limestone in the vicinity of Paris to the deposits of Touraine.

I. SCUTELLA SUBROTUNDA Lam.

Pl. 17.

SYN. *Scutella subrotunda* Lam. Vol. III, p. 284, N° 14. — DeFr. Dict. sc. nat. V. 48, p. 230. — DeBl. Zooph. p. 201.— DesMoul. Tabl. syn. p. 232.— Bronn Lethaea p. 138. —Ag. Cat. syst. Ectyp. Mus. Neoc. p. 6.

Nothing was easier than determining this species when it was the only known Scutellid having an inframarginal anus, the entire edge and the five constricted ambulacra at their end. But after we had recognized in the numerous specimens confused under the name of *S. subrotunda*, constant variations, the diagnostic characters indicated by Lamarck¹ became insufficient as specific characters and could no longer be applied to this genus. It was now necessary to distinguish *S. subrotunda* from its congeners, to enter into a detailed examination of its test and look at all the particularities of its structure. The species to which I keep the name *Sc. rotunda* is that which Lamarck designated, and of which Valenciennes has shown me specimens at the Museum of Paris still having the label written in the hand of Lamarck. It is subcircular in form, slightly irregular on its periphery because of the sinuosities that correspond to the middle of the ambulacral areas. The posterior side is truncated and separated from the rest of the test by the two sinuses of the posterior ambulacral pair areas. The transverse diameter is a little larger than the longitudinal diameter.

The height of the test is hardly equal to a sixth of the length and a seventh of the width. The edges are thin without being as sharp as in *Sc. truncata*. The entire surface of the test is covered with a homogenous granulation, composed of spiniferous tubercles emerging from the middle of a hexagonal area surrounded by some of miliary tubercles. Fig. 11 represents some tubercles from the ventral surface at a magnification of several diameters. Those of the dorsal surface are smaller. I conclude from this that the spines become more developed on the ventral surface than on the dorsal surface. The disposition of the plates can often be recognized by this granulation, especially in specimens whose surface is a little abraded. We can see by my figures that the plates are proportionally much narrower on the dorsal surface than on the ventral surface. Around the buccal rosette that is formed of prismatic pieces arranged in rays, they often even take an elongated, more-or-less irregular form.

The ambulacral star is very regular and does not protrude above the test. Because of the convergence of the poriferous zones, the petals are rounded at their end, but without completely closing. The posteriors are hardly several millimeters longer than the anteriors. The intermediary space between the two poriferous zones is a little narrower than these zones themselves. The pores of the externals are elongated, while those of the internal rows are small and round. The grooves that connect them are directed obliquely, from inside to outside. The gonopores, that number four, are very distinct and located at the end of the corners of the pentagon. The ocellar pores, much smaller, are at the origin of the petals in the sinus of the apical pentagon (fig. 6). The ventral surface is flat. The ambulacral grooves there are quite deep, but irregularly branched. The mouth is central, small and irregular. The buccal rosette is large and very recognizable in this species. There is not a suture that we can distinguish perfectly (fig. 2). The anus is

¹ *Scutella orbicularis*, dorso convexiuscula; ambulacris quinque subovalis, apice coarctatis; ano infra marginem.

inframarginal, small and very near the notch of the posterior edge that is very pronounced in this species.

The interior of the test has on its edges a very complicated labyrinth of pillars, compartments and canals (fig. 4, 5), so that the central cavity is very restrained. And if we consider the dental apparatus (fig. 7) that occupies a good part of it, it is necessary to accept that there remains little space for the soft parts of the animal. Fig. 4 shows in its left edge and fig. 5 in its right edge, the canal that crosses the posterior end of the intestine. The test itself is of moderate thickness. Near the mouth, it is even very thin.

The masticatory apparatus is admirably preserved in the specimen figured. Fig. 7 shows it from above, the five jaws being joined. In fig. 8, the same organ is seen from below, the five jaws being separated. As in the preceding genera, the anterior jaws (*a a*) are smaller and more symmetrical than the laterals (*l. l.*), of which one of the branches is sensibly longer than the other. The unpaired jaw is the most developed of all (*p*). Fig. 10 represents this latter in profile, showing its thickness that is rather considerable. Fig. 9 represents it opposite, to show its irregular form and the height of the calcareous lamellae that are spiny.

This species appears to be particular to the Tertiary terrain of Bordeaux. At least I have no knowledge of specimens coming from another locality. The specimen figured is part of the beautiful collection of Deshayes. The specimen figured by de Grateloup (Pl. 1, fig. 3) is most similar to *S. subrotunda*, to the point that it difficult to distinguish them if the author did not say expressly that the anus is sensibly nearer the center. This suggests to me that it is *Sc. propinqua*.

II. SCUTELLA TRUNCATA Val.

Pl. 16, fig. 1, 2, 3, 8, 9, 10 and Pl. 19, fig. 3–6.

SYN. *Scutella truncata* Val. Explic. des Planches de l'Encycl. méth. Tabl. 146, fig. 45.

Scutella intégræ DeBl. Dict. sc. nat. V. 48, p. 225. — Zooph. p. 201 — Ag. Prod. p. 188.

Scutella latissima DesMoul. Tabl. syn. p. 228 (pro parte).

This species is remarkable for its swollen form and by its very thin edge. The ambulacral star is large. The ambulacra are wide, very rounded at the end because of the convergence of the poriferous zones. The periphery of the test, with the exception of the two sinuses corresponding to the posterior ambulacra, have only very slight irregularities. The mouth is central. Its sinuous periphery is riddled with an immense number of small pores in the ambulacral areas (fig. 10). The grooves of the ventral surface are shallow. Each groove is divided into two branches that give off one or two lateral branches. The buccal rosette shows the same disposition as in *Sc. subrotunda*. The plates that compose it are ten in number. There is, consequently, one per area. The anus is located a quarter of the distance between the edge and the center. The posterior edge has no deep notch that characterizes *Sc. subrotunda*. We see only a slight indentation. The entire surface of the test is covered with very dense tubercles that extend even between the irregular grooves of the poriferous zones (fig. 8). By examining them at high magnification, we recognize there very distinct spiniferous tubercles, surrounded by extremely small miliary tubercles (fig. 9).

The masticatory apparatus (Pl. 19, fig. 3)² does not differ sensibly from that of *Sc. subrotunda*. It is worth noting that the vertical lamellae are also well preserved in a fossil species. Fig. 3 represents this apparatus seen from below, showing the five connected jaws and in the middle of each of them a small ridge following a small hollow intended for meshing with the auricles. In fig. 4, the jaws are disarticulated, and we see on the median line the groove in which are fixed the teeth. I have before me several specimens of this species. That which is figured here was originally from Anjou and made part of the collection of Deshayes. The Museum of Paris has one no less perfect from the deposits of Touraine. Ch. DesMoulins reported wrongly the plate cited from the Encyl. method. to his *Sc. latissimi*, that is a true Clypeaster.

III. SCUTELLA PROPINQUA Ag.

Pl. 16, fig. 11–16.

By its general form, this species is sensibly near *Sc. truncata* and *subrotunda*. But it differs from them by several characters that we are going to indicate. First, the ambulacral star is proportionally much smaller (fig. 11). The ambulacral petals are found at their end. Moreover, the space between the poriferous zones is sensibly wider than the zones themselves. The transverse diameter of the test is larger than the longitudinal diameter. The edge is entire and has no sinus as those that correspond to the posterior ambulacral pairs. The anal edge itself has only a very slight indentation, much different from the deep notch that characterizes *Sc. rotunda*. The anus is even more distance from the edge than in *Sc. truncata*. It is a third of the distance between the edge and the mouth. The mouth is of medium size. The buccal rosette that surrounds it is small and the ten plates that compose it do not appear to be as elongated as in the preceding species.

The entire surface of the test is covered with a granulation, very homogeneous in appearance, that occupies even the intermediary spaces between the transverse grooves of the petals (fig. 15), but that, examined at high magnification, has distinctly mamelonated spiniferous tubercles surrounded by some miliary tubercles (fig. 16). Fig. 14 represents the magnified apical disk showing the capillary tubes with which it is riddled.

This species is found in the deposits of Touraine. The specimen figured comes from Saint-George in Anjou. It was sent to me by Dr. Mayor of Geneva.

IV. SCUTELLA BRONGNIARTI Ag.

Pl. 15, fig. 1–3.

² The lithographer has figured by error the masticatory apparatus of *Mellita lobata* instead of that of *Sc. truncata* in Pl. 16, which has forced me to report in Pl. 10 the true masticatory apparatus of *Sc. truncata*

This species is of medium size, very flat and with very thin edges. The transverse diameter exceeds by only a few millimeters the longitudinal diameter. The height scarcely equals a sixth of the length. The periphery of the test is slightly sinuous, but the two posterior sinuses are very marked in a way that the posterior side appears sensibly rostrate. The ambulacral petals are of medium size and nearly closed at the end. The space between the poriferous zones is wider than the zones themselves. On the ventral surface, the grooves are shallow and little branched. The mouth is small. The anus is very near the edge without however being marginal.

Seen from above, this species is more similar to *Sc. propinqua*. But it differs from it however by its flatter form and by the position of the anus that is more marginal. I know only this specimen. It comes from the Tertiary terrain of Grignon where I found it myself.

V. SCUTELLA FAUJASII DeFr.

Pl. 15, fig. 4–6.

SYN. *Sc. Faujasii* DeFr. Dict. sc. nat. V. 48, p. 230. — DeBl. Zooph. p. 201. — DesMoul. Tabl. syn. p. 244, N° 27.

An essential character of this species, and that is striking at first glance, is the thickness of the edge compared to the not very considerable height of the test. The posterior sinuses are very pronounced so that the anal edge forms a kind of very marked rostrum, narrower than in the preceding species. The ambulacral petals are elliptical in form, rounded at their end. The grooves of the ventral surface are very deep and very sinuous. The anus is located a nearly one third of the distance between the edge and the center, nearly as in *Sc. truncata*. The test is very thick, as I have been able to judge by some fractures of the edge and by the buccal cavity. Its appearance is also in general more massive than those of most other species. I know only very few specimens of this species. Those that are figured here come from the Tertiary terrain of the Department of Sarthe. They were sent to me by Eudes-Deslonchamps. *Sc. Faujasii* of de Grateloup (Mém. sur les Oursins foss. Tab. I, fig. 2) is *Sc. truncata* of Valenciennes, although his variety *b* (Pl. 1, fig. 3) is probably *Sc. propinqua*. Ag.

VL SCUTELLA STRIATULA M. de Sr.

Pl. 18, fig. 1–5.

SYN. *Scutella striatula* M. de Sr. Géogr. p. 156. — DesMoul. Tabl. syn. p. 234.
Scutella subrotunda Grat. Tabl. 1, fig. 1.

Marcel de Serres is the first who has distinguished this species. It is in fact very different from all its congeners by its subconical form (fig. 3), by its strongly irregular periphery and by a narrow and very deep notch on the posterior edge. The ambulacral petals are very rounded at the end and smaller than in other species, because they rarely reach mid-edge. The poriferous zones are a little wider than the intermediary space. Fig. 5 represents the end of a petal at low magnification showing the form of the pores that are elongated in the external row, small and circular in the internal row. Finally, the grooves that join the two rows instead of being oblique or irregular, are transverse to the end of the petals. Fig. 4 shows the disposition of the tubercles at the same magnification as in fig. 5. The ventral surface is flat. The mouth is surrounded by a very elegant decagonal rosette. The grooves are shallow and little branched. The anus is submarginal and nearly contiguous with the notch of the posterior end. De Grateloup, who has incorrectly referred it to *Sc. subrotunda*, cited it in the yellow deposits and in the superficial bed of the deposits of St. Paul near Dax, at Mainot, at Mandillot, noting that it was never encountered in the blue deposits.

This species is found in the Tertiary terrain of southern Europe. The specimen figured was sent to me by Brongniart.

VII. SCUTELLA PRODUCTA Ag.

Pl. 18, fig. 6–10.

At first glance, this species has the same physiognomy as *Sc. striatula* figured on the same plate. But it suffices to see the details of the test to be convinced that it differs completely. One of the most conspicuous characters consists of the very rostrated form of its posterior edge. Its periphery is very irregular. Its thickness is medium. But instead of being subconical, it is rounded and slightly depressed at the top (fig. 8). The ambulacral star is medium in size. The petals are very rounded at their end. They rarely pass mid-edge. The poriferous zones, first very narrow at their origin, widen considerably toward their end where they are sensibly wider than the intermediary space. Fig. 10 represents the end of a large petal, where we can see that the grooves connecting the two rows of pores, instead of being transverse as in the preceding species, are on the contrary oblique. The ventral surface shows some traces of the buccal rosette surrounding the mouth. The branchial tubes there are a little more distinct. The grooves appear to be inconspicuous and little branched. The anus is located a third of the distance between the posterior edge and the mouth, consequently, much less marginal than in *Sc. striatula*.

I have several specimens of this species that I received through the kindness of Valenciennes and DeFranc. They come from the vicinity of Saumur.

VIII. SCUTELLA PAULENSIS Ag.

Pl. 19, fig. 8–10.

This species is the most common in the collections, where it ordinarily goes under the name of *Sc. subrotunda*. It is in fact very close to the latter. Its form is subcircular, strongly widened in back so that the transverse diameter is sensibly larger than the longitudinal diameter. Its thickness is not great (fig. 10). Its edges are thin without also being sharp as in *Sc. truncata*. The ambulacral petals are of medium size, very rounded at their end. The poriferous zones are wider than the intermediary space. The mouth is small and central. The anus is inframarginal, but we do not note on the posterior edge the notch characteristic of *Sc. subrotunda*. The periphery of the test is slightly undulated. The sinuses of the posterior ambulacra themselves are inconspicuous.

As all the specimens that I have seen of this species come from the Upper Tertiary terrain of St. Paul-Three Château near Dax, I give it the name of *Sc. paulensis*, which recalls its origin. The original of my figures were sent to me by Doctor Mayor of Geneva.

IX. SCUTELLA STELLATA Ag.

Pl. 19, fig. 1, 2

The extraordinary thickness of the test constitutes the essential character of this species. Although I know it only by the rather defective specimen represented in Pl. 19, fig. 1 and 2, I am not afraid of being accused of being reckless for having distinguished it from all the other Scutellids. The dorsal surface in particular is remarkable for its extreme thickness that, as we see it in profile in fig. 2, is equal to half the height. The edges thin abruptly. The ambulacra are very wide, especially toward their end where they become nearly completely rounded. The grooves of the ventral surface are shallow, although wide.

The original of my figure is part of the beautiful collection of Deshayes and comes from the deposits of Touraine.

X. SCUTELLA SUBTETRAGONA Grat.

Pl. 19, fig. 7.

SYN. *Scutella subtetrгона* Grat. Mém. sur les Ours. foss. p. 87, Pl. 1, Fig. 4. — DesMoul. Tabl. syn. p. 234.

This species, discovered by Grateloup in the yellow deposits of the vicinity of Dax, is known only by the description and the figure that this naturalist has given in his *Mémoire sur les Oursim fossiles des environs de Dax* and that I reproduce in the plate above. It is sufficient to glance at this figure to know the distinctive character of this species, which consists of its extreme width that is nearly a third more than the length. The periphery of the test is very irregular, nearly quadrilateral, because of the very deep notches corresponding to the ambulacral pairs. The

posterior edge is also marked with a slight notch. The ambulacral petals are small, narrow and lanceolate. DesMoulins reports that the specimen of Grateloup is the only one that is known up to now. The anus is not visible.

XL Scutella Smithiana Ag.

Pl. 19 *a*, fig. 5 and 6.

This species in Molassic terrains is until now the only one that has been reported. Although the specimen that I possess is very imperfect, I have however thought it necessary to figure because I have every reason to believe it constitutes a separate species, very near *Sc. subrotunda* and that, being entire, appears to have had rather considerable dimensions as we can judge by the attached figure, which represents a specimen whose anterior edge is in large part removed. A character that distinguishes it from the aforementioned species is the proportionally wider width of the ambulacral petals that, although rounded at their end, are not closed entirely. I have not been able to succeed in cleaning the ventral surface so that the position of the anus remains unknown to me. The profile (fig. 6) shows that it is a very flat species. The original was sent to me by Smith of Jordanhill. It comes from the Molasses in the vicinity of Lisbon. It is until now the only specimen known.

XII SCUTELLA ROGERSI Mort.

Pl. 19 *a*, fig. 1–4.

SYN. *Scutella Rogersi* Morton, Synops. des foss. de la Craie des Etats-Unis. — DesMoulins.

Tabl. syn. p. 236.

Lagana Rogersi Ag. Catal. syst. Ectypt. Mus. Neoc. p. 6.

This species, described and figured by Morton in his work on the Craie des Etats-Unis appears very special to the Chalk of America. At least, I do not know anyone who has reported it until now in the Cretaceous terrains of Europe. It is no less remarkable for its zoological characters than for its deposits because it has characters of several genera at the same time. It is linked to *Echinarachnius* by its circular form and by the arrangement of its grooves, to *Laganes* by its swollen edge, to true Scutelles by the form of its ambulacra that are rounded at the end and the position of its anal opening. According to the preponderant value we place on one of these characters, we place it in one or the other of these genera. But the definitive place can be assigned to it only when we have learned the structure of the internal cavity. Perhaps then we should make it the type of a new genus. Until then, it appears to me that it is a genus of the true Scutellids that it approaches most. In fact, if we make an abstraction of its circular form and the

presence of five gonopores instead of four, it has all the essential characters of the latter: the rounded form of the ambulacral peals, the position of the anus, which is in the middle of the intermediary space between the mouth and the posterior edge, the grooves of the ventral surface, which are branched as in the true Scutellids, and the presence of branchial tubes around the mouth.

In any case, these characters are more than sufficient for the specific distinction of the species. Here is how we can characterize it: it is a Scutellid of circular form, medium thickness, with very swollen edge and showing moreover, between the latter and the top, a rather marked circular depression as in the Laganids of the type *L. Bonani*³. The petals extend a little beyond mid-edge. They are very rounded at their end without however completely closing. The poriferous zones are sensibly wider than the intermediary space. The apical disk is small. We recognize distinctly there five gonopores at the end of the rays of the madreporite. There are likewise five very small ocellar pores. The anus, smaller than the mouth, is equally circular and occupies the middle of the space between the latter and the posterior border. The ambulacral grooves of ventral surface branch several times in their path. The test is thick as in the true Scutellids. Its entire surface is covered with tubercles that are very homogeneous in appearance, similar to those of the Scutellids. This makes me presume that the spines were of the same nature.

The specimen that has served as type for this description is part of the collection of the Museum of Lausanne and was sent to me by Professor Chavannes. It comes from the Chalk of Alabama in North America.

ADDITIONAL OBSERVATIONS ON THE SCUTELLIDS

Charles DesMoulins mentions in his *Tableaux synonymiques* two fossil species of the Tertiary terrain of Blaye that are unknown to me, *Scutella marginalis* DesMoulins that he says exists in two varieties, and *Scutella polygona* DesMoulins. It is possible they are true Scutellids. In this case they are perhaps either duplicating species with one or another species described above, or they are Laganids similar to *Lag. Reflexum* Ag. and *Lag. tenuissimum* Ag. figured in Pl. 26. I also do not know the *Scutella gibbercula* of Marcel de Serres that comes from the Tertiary terrain of Cadenet, Department of Vaucluse, and that DesMoulin says he saw a specimen in the collection of Requier. We hope that DesMoulins will not be slow to publish the description and that he will complete this monographic study of the Scutellids.

As for the descriptions and figures of old authors that we generally cite in the synonymy of *Scutella subrotunda*, they do not appear to be precise enough to be able to be referred with certainty to this species instead of another that is close to it. The figures usually represent only the dorsal surface, and the descriptions do not concern the details of the structure that make up specific differences. The species figured by Scilla under the name of *Echinus Melitensis*⁴ is very

³ This particularity had led me previously to place *Sc. Rogersi* in the genus Laganum. Catal. syst. Ectyp. Mus. Neoc. p. 6.

⁴ Scilla from Corp. niarinis, Pl. 8, fig. 1–3.

near, it is true, to our *Sc. subrotunda*. However, its form is more rounded and its location in the Tertiary terrains of Malta suggests to me that it is a separate species. It is the same for that which Leske describes under the name of *Echinodiscus subrotundus* and that he gives a figure printed in the work of Cl. Andreae⁵. As this figure is made after a specimen coming from the island of Malta, it is probable that it represents the same species. The figure of Parkinson⁶ is more precise. But as the author does not indicate the position of the anus, it is impossible to say with certainty if this is *Sc. subrotunda* or *S. propinqua*, or to *Sc. paulensis* that it must be referred. It is perhaps this later that it is closest. The author said it came from Italy. It would be just as risky to refer it to *Sc. subrotunda* instead of another species, *Echinus subrotunda* of Linnaeus, as well as the figure of Valentin⁷

⁵ Andreae, Briefe aus der Schweiz nach Hannover geschrieben, in dem Jahre 1763. Zurich und Winterthur, 1776. Pl. 5, fig. f, g.

⁶ Parkinson, Organic Remains, etc. Pl. 3, fig. 2.

⁷ Valentin, Musei Museorum, 1714. Pl. 3, fig. 7 h.

CHAPTER VII.

GENUS ECHINARACHNIUS v. Phels.

The genus Echinarachnius dates back in origin to van Phelsum from whom Leske borrowed it, who replaced it with the genus Arachnoides of Klein. But Klein cited only one species in his genus Arachnoides, *A. placenta*, that is the large Echinodiscus of Breynius. And it is only quite recently that Gray reinstated the genus Echinarachnius to group around this first species and other species that are more-or-less distinct from it. Having recognized very marked generic differences between *A. placenta* and the species of the type of *E. parma*, I have preserved to the first the old name of *Arachnoides* that Klein had given it and reduced the genus Echinarachnius to those of the type of *E. parma*.

Circumscribed in these limits, the genus Echinarachnius sensibly approaches the true Scutellids, from which it differs however by its more circular form, by its more open ambulacral petals, and especially the marginal position of the anal opening. Without giving to the latter character a value as great as done by most authors, I think however that it should be taken into consideration in the delimitation of genera, especially when it coincides with other constant characters and that it thus contributes to give a particular physiognomy to a whole series of species.

The known species until now are four in number, of which three are living and one is fossil. They are in general Urchins with a massive test, circular in form and with narrow edges. The ambulacral star is distinct. The petals are very wide and extend beyond half-way, but they are not closed at their end. The apical disk is hardly distinguished from the rest of the test. There are only four gonopores. The ocellar pores are five in number. On the ventral surface, the ambulacra are indicated by very distinct groove that extends up to the periphery, usually giving off two lateral branches. The mouth is central, circular and of medium size. The buccal rosette is decagonal as in the true Scutellids. The surface of the test is covered with a very uniform granulation composed of spiniferous tubercles around which are grouped some miliary tubercles. There is little difference in this regard between the dorsal surface and the ventral surface except that, on the latter, the spiniferous tubercles are a little more developed and spaced than on the dorsal surface. This difference is reflected in the spines. Those of the dorsal surface are shorter, very dense and swollen at their end. Those of the ventral surface are longer, cylindrical and tapered. Both are distinctly striated when examined with a microscope. The species that I have been able to observe the color are either deep violet shading to brown, like *E. parma*, or a lilac-pink like *E. atlanticus*.

The interior cavity has nearly the same structure as those of the true Scutellids. There is neither a wall nor calcareous pillars between the masticatory apparatus and the intestine. In contrast, the edge has a very complicated labyrinth of canals circulating between numerous calcareous pillars. The masticatory apparatus is composed of very high jaws. Also, the teeth themselves are directed nearly vertical from top to bottom. The auricles against which the jaws lean have a small very distinct notch in the middle. I have not seen the teeth proper so I cannot say if they are enameled for their entire length or only at their end.

I. ECHINARACHNIUS PARMA Gray.

Pl. 20, fig. 7–18.

SYN. *Echinarachnius parma* Gray. Attempt on Ecb. p. 6. — Ag. Prodr. p. 188.

Echinodiscus parma JeB. Zooph. p. 199.

Scutella parma Lam. p. 284, N° 13 — E. Del. V. 2, p. 677. N° 13. — DeBl. Dict. sc. nat. V. 48, p. 226.

This species is of subcircular form, more-or-less rostrate behind, notably in the old specimens and with a medium thickness, having a uniform slope toward the end that is very thick. The top corresponds to the apical disc. The ambulacral petals, open and even slightly flared at the end, extend beyond mid-edge. The poriferous zones do not have even half the width of the intermediary space. Beyond their end, we still see ambulacral pores extending in isolated pairs up to the periphery of the test. The ventral surface is nearly as uniform as the dorsal surface. The grooves there are very marked. Each groove gives off two principal branches near the periphery of the test and several other smaller, less marked branches and, for this reason, are not visible on specimens having their spines (fig. 13). The surface of the test is covered with an extremely dense granulation, especially on the dorsal surface. Fig. 14 represents a portion of the end of one of the ambulacral petals, at a magnification of $1\frac{1}{2}$ diameters, showing the arrangement of the spiniferous tubercles and the manner in which they are surrounded by miliary tubercles. We see there likewise the ambulacral pores become less and less regular to the end of the petals as the distance that separates them is greater. The tubercles of the ventral surface are less numerous and more developed. To these differences correspond similar differences in the form and arrangement of the spines. Those of the dorsal surface are short and very dense. Their end is rather truncated and swollen (fig. 1 *a b c*). Those of the ventral surface are pointed, cylindrical and considerably longer than those of the dorsal surface (fig. 8 *a b*, and fig. 13, *a b c*). Examined under the microscope, some are ridged and bristly with fine teeth on the ridges. The articular surface alone is smooth.

The masticatory apparatus is composed of very strong jaws, bristly with strong high lamellae. Also, each jaw taken separately is very thick as we see in fig. 17 that we represented in profile. Fig. 18 is a jaw seen by the ventral surface showing in the middle the small ridge that fits on the auricle. Fig. 16 shows the same jaw seen by its dorsal surface. We note there the median groove in which is fixed the tooth. Fig. 18 finally represents again the same jaw seen by its posterior surface. By an oversight by the designer, it is found here upside down, so that the arcs of the frame, instead of being directed upward are directed downward.

I have represented several ages of this species in the attached plate. Fig. 9 is a young individual entirely circular, on which we distinguish perfectly the articulation of the plates of the test, without doubt because the epidermis has not yet attained all its thickness. Fig. 10 is an individual a little older, in which the rostrum of the posterior edge is already sensibly marked. Fig. 7 and 8 show an individual of medium size, covered with its spines. Finally, fig. 12 and 13

represent two adult individuals, one (fig. 13), with its spines, seen by the ventral surface, the other lacking spines (fig. 12) and very distinctly rostrate.

Echinarachnius parma lives on the coasts of Canada, where it is abundant. Some of the originals of my figures was brought to this country by Lyell, brother of the celebrated English geologist.

II. ECHINARACHNIUS RUMPHII Ag

Pl. 20, fig. 1–6.

SYN. *Echinarachnius Rumphii* Ag. Prodr. p. 188.

Echinodiscus Rumphii DeBl. Zooph. p. 199.

Scutella Rumphii DeBl. Dict. sc. Nat. V. 18, p. 226.

Echinus planus Rumph. Pl. 14 G.

de Blainville was the first to distinguish this species from the preceding, under the name of *Echinodiscus Rumphii*. Later, this difference was contested. However, as it lives on the coast of Amboine, from where it was collected by Rumph, while the other comes from Canada, we are entitled to conclude *a priori* that they are specifically distinct. I do not know the origin of the specimen that I figure here under the name of *E. Rumphii* and it is by relying on the description of de Blainville with which it agree in all points that I have distinguished the Canadian species. It appears to me that it differs from it by the more arced form of the ambulacra, the higher position of the anal opening, and in that the posterior edge, instead of being rounded or slightly rostrate, is more-or-less truncated. In all other relations, the two species are perfectly identical. The mouth is central, surrounded by a decagonal buccal rosette. The ambulacral grooves are very distinct and riddled with a multitude of small pores. We note likewise on the periphery of the mouth the opening of brachial tubes (see fig. 4, the mouth magnified). Fig. 5 represents the apical disk likewise magnified with its four gonopores located at the top of the interambulacral areas. At the end of the corners of the madreporite, which has a granular surface, in the middle of which we distinguish very fine tubes. Fig. 6 finally shows the arrangement of the tubercles under very high magnification. We see that the spiniferous tubercles are very developed and distinctly mamelonated and perforated. It is incorrect that in Pl. 20, fig. 7 and 8 are attributed to this species. They belong to *Echi. Parma*.

The original of my figures is part of the collection of the Museum of Neuchâtel. de Blainville cited two specimens in the collection of the Prince of Eslingen.

III. ECHINARACHNIUS ATLANTICUS Gray.

Pl. 21, fig. 32–34.

This species was established by J. E. Gray according to a series of specimens deposited at the British Museum. It has a test proportionally less massive than the others. The height hardly equals a sixth of the width. Its form is nearly circular. However, the transverse diameter is greater than the longitudinal diameter. The posterior edge has a slight sinus in the middle of the unpaired interambulacral area. A second character consists of the form of the ambulacral petals that, instead of being very open as in the preceding species, have on the contrary a very pronounced tendency to be rounded at their end without however closing entirely. The poriferous zones of the petals are sensibly narrower than the intermediary space. The apical disk has four gonopores and five ocellar pores. Both are scarcely visible to the naked eye. The mouth is in the center of the ventral surface. It is circular and surrounded by a rosette composed of ten wedge-shaped plates. Those that correspond to the interambulacral areas are larger than those of the ambulacral areas. The ambulacral grooves are little marked. Also, we see no trace of them when the test is covered with its spines. They bifurcate only two times in their path from the center to the circumference. The anus is entirely marginal and located in the notch of the posterior edge. Having only one individual of this species that I owe to the kindness of Gray, I have represented half with its spines to give an exact idea of its structure. There are several specimens in the British Museum that have a beautiful pinkish color shading to lilac that come from the coasts of Newfoundland.

IV. ECHINARACHNIUS INCISIS Ag.

Pl. 21, fig. 29–31.

SYN. *Scutella incisa* Defr. Dict. sc. Nat. V. 48, p. 231. - DesMoul. Tabl. syn. p. 234. N° :52.

Up until now, this is the only known fossil species of Echinaster. Although small, it is near in many aspects to *E. parma*. Its form is circular, its thickness equal to nearly a fifth of its length. Its edge is swollen (fig 30). The mouth, located in the center of the ventral surface, is small and circular. But what distinguishes it from all its congeners, is the position of its anal opening that is very small and turned toward the ventral surface (fig. 31), below the notch of the posterior edge. The ambulacral petals are very open at their end as in all the species of this genus.

This species was described under the name of *Scutella incisa* by DeFrance who collected it in the coarse chalk of Hauteville. The specimen figured was sent to me by Deshayes and with which I made the design after a specimen from Museum of Paris coming from the same locality. I have seen other specimens in the collection of DeFrance. So that there can be no doubt of the fossil with the synonymy that I give of it.

CHAPTER IX.

GENUS ARACHNOIDES Klein.

Klein, in establishing his genus *Arachnoides*, placed there only one species that had already been figured previously by Breynius under the name of *Echinodiscus* and that Linnaeus called later *Echinus placenta*. As this species is still today the only known of the genus, it suffices to describe it by reporting at the same time its generic characters.

I. ARACHNOIDES PLACENTA Ag.

Pl. 21, fig. 35–42.

SYN. *Arachnoïdes* Klein, éd. Leske, p. 26, § 94, Pl. 20, fig. A, B. — Klein Gall, p. 98, Pl. 11, fig. A.

Scutella placenta Lam., p. 283 — E. Desl., Encycl. V. 2, p. 677. — DeBl. Dict. sc. nat. V. 48, p. 225. — Encycl. méth. Pl. 143, fig. 11 and 12. — DesMoul. Tabl. syn. p. 228, N° 15.

Echinarachnius placenta Gray Attempt on Ech. p. 6. — Flem. Brit. An. p. 479. — Ag. Prod. p. 188. — Forbes. History of British starfishes. p. 178.

Echinodiscus placenta DeBl. Zooh. p. 199.

Echinus placenta Linn. 12° edit. p. 1105. — Bosc Délerv. V. 24, p. 281.

Echinodiseus maximus etc., Breyn. Sched. p. 64, Pl. 7, fig. 8.

Echinarachnius Leske, ap. Klein, p. 218, Pl. 20, fig. A, B.

Echinarachnius (Egelspinneweb) van Phels. p. 38.

Arachnoïdes Davila, Cat. Vol. 1, p. 424, N° 958.

Gualt. Test. Pl. 110, fig. G.

Scutella porpita Expl. Enc. méth. Pl. 152, fig. 3 and 4. — Ag. Prod. p. 188. (very young specimen).

We recognize this species at first glance by its lenticular form, its very thin edges, its subconical profile and its supra-marginal anus. I shared for a long time the opinion of naturalists who saw it as congeneric with true *Echinarachnius* that we just described in the previous chapter. But a deeper study of the details of its organization has taught me the differences that distinguish them are too deep that we can refuse to see there two independent types. In fact, if *A. placenta* is attached to *Echinarachnius* by its circular form, its open petals that are even flared at the end, and

by the position of the anal opening that is nearly marginal. It is separated by other characters perhaps much more important. First, the grooves of the ventral surface are not of the same nature. They do not branch in their path from the edge to the circumference and, despite all my efforts, I could not discover the least trace of microscopic pores. It is a smooth and depressed band that continues likewise on the dorsal surface up to the apical disk. In the second place, the structure of the test is very different. Instead of being massive as in most *Echinarachnius*, it is on the contrary very thin and covered with a very particular granulation, remarkable especially by the variable arrangement of the tubercles. In the ambulacral areas, the spiniferous tubercles form regular oblique series, separated by small lines apparently continuous (fig. 39), but that, examined under higher magnification (fig. 39 *a*), is composed of miliary tubercles formed in the same way as the spiniferous tubercles, i.e., mamelonated and perforated, although of extreme fineness. This arrangement of the tubercles is the same on the ventral surface, although less apparent to the naked eye. The tubercles of the interambulacral areas are far from having this regularity. They are distributed without apparent order on the surface of the test, and the tubercles are surrounded by miliary tubercles as in the preceding genera. However, we note that these latter (the miliary tubercles) are proportionally less numerous (fig. 37 *a*).

A third character that distinguishes this species of *Echinarachnius*, is the presence of five gonopores, while there are only four in the latter. These pores occupy their usual place at the top of the interambulacral areas. The ocellar pores number five and are nearly as large as the gonopores. They are located at the top of the ambulacral petals and form with the latter a regular circle around the madreporite that is composed, as usual, of an agglomeration of small capillary tubes invisible to the naked eye but very distinct with a magnifying glass (fig. 41).

The ambulacra have a very particular form. They resemble elongated triangles constricted in the middle of the sides. As they widen considerably in a way to nearly take on the contours of the interambulacral areas of other genera. It has happened that they were confused with the latter and claimed that the anus opened into an ambulacrum. (see fig. 39 that represents a magnified petal). The poriferous zones maintain themselves as continuous only up to half the width of the test. After this limit, the pores exist only as isolated pairs that we can follow to the circumference. The transverse groove that connects the two rows of pores of the same zone are very marked. The pores themselves are round and very uniform.

The structure of the interior also justifies in several ways the distinction that we have established between this genus and *Echinarachnius*. Except for the calcareous networks or pillars in the edges, we note on the internal surface of the test other asperities than the auricles. But they are of a very particular form because they end in two small beads separated by a very deep notch. The masticatory apparatus is as slender as that of *Echinarachnius* is massive. The jaws have a very open compass (fig. 41 *a, b*). their frame is very thin, bristly with fine calcareous lamellae on the edges (see fig. 42 *c* and *d* that represent the profile of a jaw seen from behind and from the side). There is in addition, on the upper surface of the jaws, a rather projecting ridge that rises on each side of the tooth groove (fig. 42 *b, c, d*). The interior surface has bristles only of very small lamellae.

This is to my knowledge the only species where the articulation of the two demi-pyramids on the median line are distinct. They even disarticulate very easily. It is then easy to be convinced that the right demi-pyramid is provided with a small longitudinal ridge articulated in a small groove corresponding to the left demi-pyramid.

The mouth is central and circular, surrounded by an indistinct buccal rosette, but that appears composed of ten plates, of which those that correspond to the ambulacral areas are narrower (fig.

36). I have represented (fig. 40) the periphery of the mouth magnified 1 ½ diameters to show that the grooves that come here and end at the mouth really are lacking in microscopic pores. In the specimen that has served as the model for fig. 40, we see some spines of the edges of the interambulacral area converge toward the center of the mouth, nearly as in Asteroids. Another particularity is that the enclosure of the buccal rosette is no difference between the tubercles of the ambulacral areas and those of the interambulacral areas. They resume their respective disposition only outside the rosette. The anus, as we said above, is supra-marginal, circular and appears to be pierced from back to front.

The spines are very fine. But it does not appear that they differ much in their structure from those of other genera. Examined with the microscope, they bristle with strongly toothed ridges. Those of the dorsal surface are clavellate. Those of the ventral surface are more-or-less cylindrical. Forbes has given an enlarged figure in his *Histoire des Echinodermes anglaise*, page 181.

Scutella Porpita of authors is certainly a young *Arachnoides Placenta*. I confirmed this by comparing specimens of the Museum of Paris. It demonstrated to me that the fossil species that Ch. DesMoulins reported in his *Tableaux synonymiques* under the name of *Cassidulus Porpita* that I do not recognize, could not have as synonyms the citations relative to *Scutella Porpita* of authors that DesMoulins referred to it. It is impossible for me to think that DesMoulins has taken a young *Arachnoides Placenta* for a species of the genus *Cassidulus*.

It is by error that we have thought this species originated from the Southern Ocean. It actually inhabits the seas of the North. Forbes at least confirms that the specimen that he describes and figures in his work was collected by Professor Jameson at the island of Toulah, one of the Shetland Islands. But it was an error that he confused it with the species from Canada from the collection of Lyell that is *Echinarachnius parma*, as we have said above in treating this species.

The originals of my figures were sent to me by Valenciennes and J. E. Gray.

CHAPTER X.

GENUS SCUTELLINA (Ag).

At first glance, the species of this genus do not seem to differ much from Echinarachnius, with which it shares the most striking characters such as the circular or subcircular form, marginal or submarginal anus and disjointed ambulacral petals. Also, I placed them among the Echinarachnius before I had studied their interior structure. To justify the establishment of a new genus, I am going to indicate the particular characters presented to me by the interior cavity. When I open a Scutellinid, I am astonished to encounter, instead of the calcareous networks that form the continuous network on the interior periphery of the test of Echinarachnius and most of the other genera. A series of lamellae or vertical walls radiating from the center to the periphery and separating ambulacral areas from the interambulacral areas. Around the mouth, these walls do not rise to the dorsal test so it is probable that the intestine passes over it to extend successively into the bays of the interambulacral area between the walls. The masticatory apparatus has also a structure difference from that of Echinarachnius. The jaws, instead of being short and high as in the latter, are on the contrary very low and very elongated (Pl. 21, fig. 14 *a b c*). The frame is horizontal and the lamellae that make their edges bristly are hardly sensible. To these particularities of internal structure are joined exterior characters no less important, although little apparent. And first, there are no visible grooves on the ventral surface. Or if they exist, they are never branched like those of Echinarachnius. Moreover, the pores of the poriferous zone of the petals are not connected by transverse grooves. If we take into account all these characters, we shall find that the Scutellinids are much closer to the Echinocyamids than Echinarachnius or any other genus. They even differ from the first only by a single essential character, the marginal location of the anus, to which it is necessary to add the circular or subcircular form of the test, while the form of Echinocyamids is generally sub-pentagonal or pyriform.

The Scutellinids are Urchins of small size and are very flat. We know until now only fossils that all come from Tertiary terrains. Often the surface of the test has a fenestrated appearance, a kind of regular mosaic resulting from the corrosion of the middle of the plate while the edges are intact, so that each plate has the appearance of a tile surrounded by a frame.

I. SCUTELLINA NUMMULARIA Ag.

Pl. 21, fig. 8–14.

SYN. *Scutella nummularia*. Defr. Dict. sc. nat. V. 48, p. 231. — DeBl. Zooph. p. 202. — Lam.

Vol. III, p. 287, N° 20 — Ag. Prodr. p. 188. — DesMoul. Tabl. syn. p. 236, N° 34.

Echinarachnius nummularia Ag. Cat. syst. Ectyp. Mus. Neoc. p. 6.

I take this species for type of the genus *Scutellina* because it is very frequent in the collections of Tertiary fossils. We recognize it easily with the perfectly circular form except a small notch at the posterior edge into which opens the anus. It is a very flat species with a rather swollen edge. The ambulacral petals are large, rounded in the form of a lobe, but however open at their end. They extend to beyond mid-edge. The poriferous zones are much narrower than the intermediary space. Their pores are not joined by a transverse groove, or if they are, they are hardly visible. The apical disk has the form of a small, slight protruding button. Examined with a magnifying glass, we recognize very well the four gonopores. As far the ocellar pores. I have not been able to discover them, but I have no doubt they exist, having seen them in other species. The mouth is circular. The ventral surface is completely flat. It is only in the perfectly preserved specimens that we note some traces of the groove that are straight and non-branched as in all species of this genus. The anus is completely marginal so that we see neither the dorsal surface nor the ventral surface. It is in addition very small and corresponds, as I said above, to the notch of the posterior edge.

Fig. 11, 12, and 13 represent a very extraordinary specimen that has only four ambulacra. I thought at first it was a separate species but having encountered since several similar anomalies in other genera, I see this case as a monstrosity by default. As this specimen has moreover all the characters of *Sc. nummularis* and that it came from the same locality and even the same terrain, I do not think it reckless to associate it to this species. Its sub-quadrangular form comes without doubt from the same cause. Fig. 14 represents the jaw of this species seen by different faces. Fig. *a* at natural size. Fig. *b* shows the dorsal surface at a magnification of two diameters so that we see very well the median groove in which is fixed the tooth. Fig. *c* shows the ventral surface at the same magnification. Fig. *d* is seen from the anterior surface and fig. *e* from profile. We see by this figure that what characterizes these jaws is their elongated form, comparatively to the low height.

This species is frequent in the Tertiary terrain of Grignon. It is also found, according to DesMoulins, at Blaye (Department of Gironde).

OBSERVATION.

The anomalies that this species offers us an example are not very rare in echinoderms.

In an unedited work on the analogy that exists between the solid parts of Urchins and those of Asteroids, work that I presented several years ago to the Société des Sciences Naturelles de Neuchâtel, I sought to demonstrate that each Asteroid ray corresponds to an ambulacral area of an Urchin plus the two adjacent interambulacral demi-areas, so that the large plates that border the rays of some Asteroids correspond to interambulacral plates of Urchins. This analogy was fully confirmed by the anomalies that I have observed in Urchins. Because in the deviations in the typical number of areas, it is always an ambulacral area and two adjacent interambulacral demi-areas that are missing as is the case of *Scutellina nummularis* mentioned above and as I also observed in a *Discoidea cylindrica* from the collection of Michelin in a *Cidaris coronata* from the Museum of Carlsruhe⁸. Or there is a supernumerary ambulacral area, accompanied by two interambulacral demi-areas, interposed between the unpaired ambulacral area and the anterior right or left pair. I saw an anomaly of this kind in a Galerite from the Museum of Paris.

⁸ H. de Meyer, who has published a figure of this fossil unfortunately has represented it upside down.

H. de Meyer has figured and described this case⁹. The discovery made by Forbes of the eyes of Urchins likewise confirms this analogy between Urchins and Asteroids. We know by Ehrenberg that they are found in the terminal plates of rays. As soon as I learned that they had been observed in Urchins, I assumed they had to be at the top of the ambulacral areas, and this is fact in the pore of the plates that we have called up until now *interoviduales* and that I call *ocellar plates* where they are found and where I have seen them in several species. The anomalies observed in Crinoids will also contribute without doubt to comparisons between these animals and the other Echinoderms.

II. SCUTELLINA LENTICULARIS Ag.

Pl. 21, fig. 20–23.

SYN. *Scutella lenticularis* Defr. Dict. sc. nat. Vol. 48, p. 230. — Lam. Vol. III, p. 282, N° 9. — E. Desl. Enc, Vol. 2, p. 677. — DeBl. Zooph. p. 202. — DesMoul. Tabl. syn. p. 234, N° 33.

Echinarachnius lenticularis Gray. Att. on Echi. p. 6. — Ag. Prodr. p. 188.

As in the preceding, this species was first described by DeFrance under the name *Scutella lenticularis*. Its circumference is elliptical. Its dorsal surface is not equally sloping. The sides are on the contrary bent backwards, which gives it a gibbous appearance. The ventral surface is slightly concave. The ambulacral grooves are straight and have the form of depressed channels. The anus is marginal or slightly infra-marginal because it is not visible from above but in part from below. The ambulacral petals extend to mid-edge but are not closed at the end. The tubercles are not visible to the naked eye, but when we examine them with the magnifying glass, we find them arranged in the same manner as in other genera. The spiniferous tubercles are surrounded by much smaller tubercles but having the same form and structure. Fig. 20 represents the apical top under weak magnification to show the disposition of the four gonopores. Fig. 23 shows the radiating walls that I spoke of in the article on the genus. They divide the test into ten, nearly regular triangles. Around the mouth are the five auricles that are rather wide and against which the jaws rest. The latter are not known to me in this species. I doubt however that they differ much from *Sc. nummularis*.

There are numerous specimens of this species in the various collections of Tertiary fossils that I have examined. Most come from the coarse limestone of Grignon. DesMoulins also reported them from the Tertiary terrain of Blaye (Department of Gironde) and Antibes (Department of Var).

III. SCUTELLINA PLACENTULA Mer.

Pl. 21, fig. 1–7.

⁹ Act. Nov. Acad. Cæs. Leop. Carol. nat. Cur. vol. 18, p. 1.

SYN. *Cassidulus placentula* Mérian, Mus. of Basel.

This species is one of the smallest of the whole family. I have never encountered an Urchin smaller than that of fig. 1 that is scarcely one millimeter in diameter. Its form is circular or rather sub-oval and very flat. The anus is supra-marginal. The ventral surface is slightly concave. The circular mouth is located in the center. As for the details of the structure of the test, they are scarcely to be seen except with a magnifying glass. I have also added figures of the natural size. Fig. 6 and 7 represent an individual at a magnification of 1 1/2 diameters. We see by these figures that the surface of the test is covered with a very homogeneous granulation. But that which constitutes a conspicuous feature of the species is the form of the ambulacral petals that are very narrow, so that the poriferous zones are as wide as the intermediary space.

This species comes from the Tertiary terrain of Chaumont. I have found several specimens in the Museum of Basel. It is thanks to the kindness of my friend Mérian who sent me the originals of my figures.

IV. SCUTELLINA SUPERA Ag.

Pl. 21, fig. 15-19.

The dorsal position of the anus in this species could raise doubts about its generic position, if it did not recall be the details of its structure the real type of the Scutellines and if we did not have intermediaries between it and the species with a completely marginal anus, the *Sc. placentula* that, as we just saw above, also has a dorsal anus, but nearer the border. Its periphery is pyriform, the anterior side is much narrower than the posterior side. The dorsal surface has a kind of bilateral slope as in *Sc. lenticularis* and the ventral surface is concave. The mouth, located in the center of the ventral surface, is circular and proportionally much bigger than in the other species. The ambulacral petals are of medium size, but do not close at their end. The poriferous zones are very narrow and lack transverse grooves. There remains the dorsal position of the anus, to which an allusion is made in the specific name, sufficient alone to distinguish this species from all its congeners.

This is perhaps the *Cassidulus Hayesianus* of DesMoulins that is known to me only by the simple citation of this author, pag. 246 of his *Tabl. Synonymiques*.

It comes from the coarse limestone of Girgnon. I have known only one specimen that was deposited in the Museum of Neuchâtel by Auguste de Montmollin.

V. SCUTELLINA OBOVATA Ag.

Pl. 21, fig. 24-28.

The principal character of this species resides in its ovoid form. I first saw it as a simple variety of *Sc. nummularia*, but the constancy of its form made me change my opinion, and I think that it really constitutes a particular species. It is, moreover, much smaller than the latter. The anus is completely marginal. The mouth is large and central. The ambulacral petals are very open at their end. But the poriferous zones are narrower. We note no trace of transverse grooves between their pores. The apical disc is remarkable in that the gonopores are very far apart. There are four of them as in all Scutellids.

This species is frequent in the Tertiary terrain of Grignon, where we find it with *Sc. nummularia*. It could be that it was the *Scutella elliptica* of DesMolins, cited in the *Tabl. synonym.*, pag. 236, but it still is not described and figured anywhere, although DesMoulin says it is common in the Tertiary terrain of Paris. If this were so, it will be necessary to change the name of *Scutellina obovata* to that of *Scutellina elliptica* DesMoul.

CHAPTER XI.

GENUS LAGANUM Klein.

At first glance, the Laganids have more resemblance to the true Clypesters and notably to those flat species such as *Clypeaster placunarius*, *C. latissimus*, *C. scutiformis*, etc., than with the Scutellids. Their pentagonal or subpentagonal form contrasts especially with the rounded form of the latter. However, this difference is more apparent than real, because it suffices to look at the interior organization of these animals to be convinced that they are constructed on the same plan. Singularly, it is the genus *Rotula*, which has the least exterior resemblance with the Laganids, that is closest by its interior structure.

The genus *Laganum* has had the same fate at most other genera of the order of Echinites, i.e., that it has been circumscribed in the most varied way. Klein, who established it, places there the most diverse species, preoccupied with the idea that essential character of the Echinoids was the position of the anus. It is this fact that made him place his genus *Laganum* in the true Scutellids. Leske paid no more attention to this genus than to the others and combined the Laganids of Klein with his genus *Echinodiscus*. Lamarck and Desmoulins removed it from the Scutellids. It was DeBlainville who united again the Laganids in a particular genus, but instead of preserving the name *Laganum* of Klein, he called it *Lagana*.

I place in the genus *Laganum* the species with a sub-pentagonal or ovoid form having the posterior edge truncate or sub-truncate and the anterior edge sometimes rounded or less angular. The longitudinal diameter ordinarily is much greater than the transverse diameter. Although the height is not very considerable, the edge is generally swollen. In contrast, the dorsal surface is only flatter, and in several species whose top is scarcely more elevated than the edges, there is a sensible depression in all the space between the top and the borders.

The ambulacral rosette is large. The petals are more-or-less closed at their end. I know no species in which they pass half the ray length between the top and the edge. The mouth is central, circular, and proportionally larger than in the preceding genera. The anus, sometimes circular, sometimes elongated, oscillates between the posterior edge and the mouth without being ever completely marginal. The ambulacral grooves do not bifurcate in their path are rarely visible beyond mid-edge, although they are riddled with microscopic pores. The interambulacral areas are narrower than the ambulacral areas, especially on the ventral surface where they are reduced, in most species, to a very narrow band that we can follow from the center to the circumference. The surface of the test has a very homogeneous granulation that differs completely from that we have seen in the preceding genera in that the spiniferous tubercles there are less serrated and less numerous, while the miliary tubercles there are extremely abundant. Those of the ventral surface scarcely differ in general from those of the dorsal surface except by their greater dimensions. This no longer any sensible difference between those of the ambulacral areas and those of the

interambulacral areas. The same uniformity occurs in the spines. However, those of the ventral surface are in general a little longer and a little slenderer than those of the dorsal surface.

As I noted above, it is in the interior that I have taken the most important characters for the classification of this genus. It is especially in the study of the masticatory apparatus that I have been led to place the Laganids in the Scutellids, instead of seeing them as a separate group. In fact, although the jaws of the Laganids are distinguished by the massive appearance, they conform in the same way as those of the preceding genera. I.e., the teeth are articulated in the groove of the dorsal surface of the jaws and if at times they appear to be sloping and nearly vertical, it is only the effect of the excessive development of the ventral lamellae. What is important to note is that they are never fixed in a vertical groove at the end of the jaws as occurs in true Clypeasteroids. But a character common with the latter is that only the end of the teeth is enameled. There is no trace of walls or pillars between the masticatory apparatus and the intestinal canal. These two organs are separated only by a membrane. In general, the interior of the test is less compartmentalized than in the preceding genera. There is little more than the edges of the cavity that has a labyrinth of calcareous pillars. From this I conclude that the appendices of the intestinal canal are less numerous than in the species that have a very compartmentalized interior cavity. The path of the intestinal canal is the same as in the other Scutellids, as we can see by fig. 9 of Pl. 25 that represents the interior cavity of *Laganum rostratum* seen from below. The intestine leaves the central cavity in passing above the right anterior jaw. From there, it goes to the left side in the form of the stomach, passes on the right side where it goes up to the top of the right anterior jaw and turns back again towards the anus, in going around a very solid tendonous wall. The structure and the relative position of the different interior organs are indicated by the concordant letters in figures 25, 27 and 28 of Pl. 22. *n* is the intestine that is folded on the right and left sides; *r* (fig. 27) represents the esophagus that is narrower and marked with tighter folds; *s, s* (fig. 28) are the appendices of the intestine in communication with the latter; *x x* (fig. 25 and 27) are the ovaries extended onto the intestine; *k* (fig. 29 is, according to Valentin, a part of the ventral gills; *t* (fig. 25 and 27) is the end of the rays of the masticatory apparatus. Fig. 29, finally, represents one of the suckers of the ventral grooves of the same species at a magnification of 102 diameters).

There is a point in the organization of the Laganids that has grave difficulties. It is the variety that prevails in the number of gonopores, one part of the species invariably has five, while others have only four. I have sought in vain to attach this fact to some other constant character of organization. But not having recognized in the interior structure of the genital system any difference between the species that have four pores and those that have five, I have had to give up temporarily to divide them. Later, naturalists will return without doubt to these differences and perhaps separate the species of the type of *Laganum Peronii* (that generally have four very separated gonopores) and those of the type of *L. Bonani* that have five that are close together) and making in addition *L. rostratum* the type of a genus distinct from that of *L. Bonani*, etc., by its four gonopores and its form that is narrow posteriorly. In waiting for more complete information that comparative anatomy of diverse animals will not fail to provide us with time, I shall content myself to unite these various types under the heading of the genus *Laganum* that thus has 14 species, of which 12 are living and 2 are fossils.

I. LAGANUM BONANI Klein.

Pl. 23, fig. 8–12, and Pl. 22, fig. 25–29.

SYN. *Laganum Bonani* Klein, p. 25, § 84, Pl. 22, fig. a, b.

Laganum minus Bonani Klein, p. 25, § 84, Pl. 22, fig. c.

Lagana minor Gray Att. on Ech. p. 6.

Clypeaster laganum Lam. V. III, p. 291, N° 5. — E. Desl. Encycl. V. 2, p. 199, N° 5.

Scutella laganum DeBl. Dict. sc. nat. V. 48, p. 228. — DesMoul. Tabl. syn. p. 230.

Lagana laganum DeBl. Zooph. p. 196.

Echinodiscus laganum Leske ap. Klein, p. 204, Pl. 22, fig. c.

Echinus laganum. L. Gm. p. 3190.

Echinus planus (Zeereal) Rumph. p. 36, 37, Pl. 14, fig. E.

Echinodiscus Gualt. Pl. 110, fig. c.

Seba Thes. Pl. 15, fig. 25, 26.

The name of *Lag. Bonani* was given to this species by Klein, and as it is the oldest, I have thought it necessary to preserve it in its integrity in preference to names of subsequent authors. The form of this species is pentagonal. The posterior edge is truncated and sometimes even slightly reentrant. The anterior edge is protruding. The longitudinal diameter exceeds the transverse diameter. The greatest width is usually anterior to the top and corresponds to a line drawn from the end of one the anterior ambulacral pairs to the end of the other. The thickness is not great, but the edge is very swollen, also the top is scarcely raised above the latter (fig. 10). There is moreover between the top it borders a very sensible depression. The ambulacral star is very large. The petals, lanceolate in form, extend beyond the mid-edge without completely closing, although they narrow considerably at their end. The apical disk occupies only a very small space at the top of the ambulacra. The gonopores, scarcely visible to the naked eye, are five in number and very close to each other. The ocellar pores are still smaller and difficult to discover, even with a magnifying glass. On the ventral surface, the ambulacral grooves are very pronounced. They extend beyond the mid-edge, but without branching (fig. (9)). Examined with the magnifying glass, they are shown riddled with microscopic pores, especially near the mouth. We note in addition in the middle of the interambulacral area (fig. 9), but only in young individuals, a kind of inconspicuous band that results from the tubercles here being less dense than on the rest of the surface. The mouth is distinctly sub-pentagonal. In no specimen have I been able to see the buccal rosette, but I suppose it must exist nonetheless. The anus is in the middle of the space between the posterior border and the mouth. Its periphery is distinctly oval. Only the edge turned toward the mouth is slightly depressed, as if the anal opening had been obliquely pierced from front to back. The tubercles are numerous and dense. Those of the ventral surface have the same disposition as those of the dorsal surface but they are a little more developed.

The spines are very homogeneous in appearance. We can scarcely distinguish on the dorsal surface the ambulacra and sometimes some small black patches on the interambulacral areas. But when we examine the spines from different parts of the test with a strong magnifying glass or a

microscope, we recognize there the same difference sections that we have reported in most of the preceding genera. Those of the dorsal surface are slender and end in a bead at their end (Pl. 22, fig. 27 *a, b*). Those of the ventral surface are longer and pointed (fig. 28, *c, d*). Seen at strong magnification, the toothed ridges can be seen distinctly, with which they are bristly for their entire length (fig. *c*). Finally, there are still the spines around the mouth. These are the largest. But they are less regular and especially less straight than the preceding (fig. 28 *a b*). All these spines have at their base a small articulating facette, surmounted on a protruding and crenelated ring.

I have represented in Pl. 22, fig. 26, a jaw of *L. Bonani* seen by the different surfaces. Fig. *a* shows the ventral surface and the way the lateral calcareous lamellae are united in bundles. Fig. *b* represents the dorsal surface with the median groove in which is lodged the tooth. Fig. *c* shows the profile and the relative proportions of the lamellar blades and of the frame or massive plate. Fig. *d*, finally, is the tooth seen from behind, showing the two arcs of the frame and the manner in which the lamellae adhere there. We see by this figure that the ventral lamellae are much longer and stronger than the dorsals.

Fig. 25, 27 and 28 of Pl. 22 represent the anatomical details that we have described in the article on the genus and in the generalities.

This species is common in the collections, where they are usually under the name of doughnut Clypeaster or Scutella (*Clypeaster*, *Scutella* or *Laganum*), without doubt because of its very flat form. There are numerous specimens preserved in wine spirits in the Museum of Paris. Most have been reported from the Southern Ocean by Quoy and Gaimard. There are several from New Guinea. The originals of my figures come from Vanicoro.

It is evidently wrong that Leske confused this species with *Sc. orbicularis* that is quite distinct. In contrast, the small variety of *Laganum Bonani minus* of Klein does not appear to me to differ specifically.

II. LAGANUM DEPRESSUM Less.

Pl. 23, fig. 1–7.

This species is near in several respects to the preceding, among others by its sub-pentagonal form and by the depression that occurs around the top. But, on the other hand, it is much flatter and the anterior side is proportionally very wide while the posterior side is sensibly narrowed. The periphery of the test is in addition more angular, notably in old specimens. But what especially distinguishes it from *L. Bonani* is the form of the anus that, instead of being longitudinal, is on the contrary elongated transversely as is shown in fig. 6, which represents this organ under low magnification. The anus is in addition sensibly nearer the posterior edge. The ambulacral petals are wide, but strongly narrow at their end without, however, completely closing. The grooves that connect the rows of pores are very marked. The apical disk is small and the gonopores scarcely visible. The spiniferous tubercles are not as dense as in most other species, notably on the ventral surface. Also, the spines are not very abundant there. In contrast, the miliary tubercles and the small spines that depend on them are very abundant. The mouth is small and central. Fig 7 shows it magnified, to see the form and disposition of the tubercles and the brachial tubes that radiate around the periphery. The ambulacral grooves are not visible to

the edge. The ambulacral rosette, slightly indicated in the specimen of fig. 2, is composed of ten plates. Those that correspond to the ambulacral areas are sensibly wider than those of the interambulacral areas. The articulation of the plates is in general much more distinct than in *L. Bonani* because the epidermis is less thick. Therefore, it is a more elegant species. Fig. 4 and 5 represent a very large specimen covered with its spines. Fig. 3 is a small specimen covered with spines on half its surface and showing on the other half the structure of the different parts of the test. Fig. 1 and 2 represent an individual of medium size, proportionally a little wider than the others.

The interior cavity is not different from that of *L. Bonani* in any way except that it is less elevated. The masticatory apparatus is very strong and maintained in place by very high auricles against which the jaws lean. The very arched teeth are enameled only at their end.

This species comes from Bouron Island where it was collected by Lesson and Garnot who have deposited it in the Muséum d'histoire naturelle de Paris, under the name *Lagana depressa*.

III. LAGANUM ELLIPTICUM Ag.

Pl. 23, fig. 13–15.

The elliptical form of this species recalls the Laganids with four gonopores of the type of *Lag. orbiculare*, but its detailed structure approaches *Lag. Bonani*. It has like it a very swollen edge and a very marked depression between the edge and the top. Also, the latter has only a very slight protrusion above the edge (fig. 15). The ambulacral petals are nearly completely rounded at their end. The poriferous zones, although narrower than the intermediary space that they circumscribe, widen from the top to the periphery. The gonopores number five and are small, as in the preceding species. The ocellar pores are not visible. The ventral surface is slightly concave. The mouth is located nearly at the center. Its pentagonal form is scarcely sensible. The ambulacral grooves that surround it are visible only for a rather short distance. In contrast, the bands of the interambulacral areas go to the edge. The anal opening is elongated transversely, as in *L. depressum* and nearer the posterior edge than the mouth. The tubercles on the surface of the test are of the same nature on the ventral surface. On the dorsal surface, the spiniferous tubercles are in a very marked depression, especially on the ventral surface that gives it a very rugose appearance.

I have succeeded in extracting a jaw that is the specimen figured. It has nearly the same structure as the jaws of *Lag. Bonani* figured in Pl. 22, fig. 20.

This specimen was sent to me by Stokes. Its origin is unknown.

IV. LAGANUM DECAGONUM Less.

Pl. 23, fig. 16–20.

This species is known only by a single specimen from Waigiou Island by Lesson and Garnot. It is remarkable by its very flat form, subconical at the top and its nearly circular periphery so that we could easily take it for an Arachnoid, if it also did have all the other characters of the Laganids of the type of *Lag Bonani*. The ambulacral petals in conform in the say way as in the latter species. They are narrow, lanceolate, and scarcely extend beyond mid-edge. Their poriferous zones are narrowed and do not equal even half of the intermediary space. The edge of the test is slightly swollen on the periphery, but in a more sensible way anteriorly than laterally (fig. 18). The apical disk shows with the magnifying glass some very distinct traces of the sutures that leave no doubt that the gonopores and ocellar pores do not open in particular plates. The madreporite has tubercles like the rest of the surface. The gonopores, five in number, are very distinct. The ocellar pores, in contrast, are not visible (fig. 20). The mouth is at the center of the ventral surface, where it is surrounded by five small grooves that, seen under high magnification, appears bordered by an infinity of microscopic pores. The articulation of the plates is quite distinct, and we see in fig. 17 that the interambulacral areas are narrower than on the dorsal surface because they are not even half the width of the ambulacral areas. The anus, sensibly nearer the posterior border, is small, circular in form, and seems pierced from outside to the inside. The test is covered with a very homogeneous granulation, but remarkable in that the spiniferous tubercles are less numerous than in the above species and surrounded by a considerable number of miliary tubercles as we can see in fig. 16 *a*, that represents a portion of the dorsal surface at a high magnification.

The original shows vestiges of a beautiful red color that is especially preserved vividly on the articulations of the dorsal surface.

V. LAGANUM TENUISSIMUM Ag.

Pl. 26, fig. 4-6.

SYN. *Lagana tenuissima* Ag. Cat. Ectyp. Mus. Neoc. p. 6.

The name of this species indicates its principal character, which consists in its extreme flatness (fig. 5). The edges are however slightly swollen, especially anteriorly, so that the intermediary space between the edge and the top forms a sensibly depressed zone. The general form of the test of the test is ovoid. The posterior side is truncated. The ambulacral petals extend to the edge without closing at the end. The poriferous zones equal in width nearly half the intermediary space. The apical disk is not preserved enough to perceive exactly the number of gonopores. But I think there are five as in the preceding species. The articulation of the plates is quite distinct, and I have been able to assure myself that, as in all the Laganids, the interambulacral areas are narrower than the ambulacrals, notably on the ventral surface. The mouth is central and circular. The anus has the same form, but it is small and located on the posterior edge.

This species comes from the Tertiary terrain of Blaye. The original of my figures was sent to me by Michelin.

VI. LAGANUM REFLEXUM. Ag.

Pl. 26, fig. 1–3.

This species differs from *Laganum tenuissimum* by its more considerable thickness and by the extraordinary swelling of its edges, particular the anterior edge (fig. 2). The dorsal surface is consequently marked by a wide depression that goes all around the top. The periphery of the test is ovoid, the posterior side is truncated, the anterior side is narrower than the posterior side. The ambulacral petals are very elongated. They nearly reach the edge of the test and are very open at the end. The mouth is circular and central. The anus is small and near the posterior edge.

The specimen figured is the only one I know of this species. Like the preceding, it comes from the Tertiary terrains of Blaye and was sent to me by Valenciennes.

My *Laganum tenuissimum* and *reflexum* probably correspond to the *Scutella marginalis* and *polygona* of Ch. DesMoulins, which also come from Blaye. But as the latter is neither described nor figured, I have not been able to assure myself. If it is so, I shall be the first to regret the useless multiplication of synonyms.

VII. LAGANUM TONGANENSE Quoy and Gaim.

Pl. 26, fig. 7-19.

This species is in some way in the middle between the species of the type of *Lag. Bonani* and those of *Lag. Lesueuri* described below. It has the large size and the angular form of the latter, while its irregular profile, resulting from a more-or-less marked depression between the top and the edge (fig. 9) and the presence of five very small gonopores, brings it near *Lag. Bonani*. Fig. 8 and 10 represent two varieties of this species, one elongated and ovoid (fig. 10), the other wide, angular and short (fig. 8). Fig. 7 is a young individual covered with its spines. The ambulacral petals are lanceolate and in generally irregular. Their poriferous zones, much narrower than the intermediary space, are not joined at their end. The anterior petal is in general slenderer than the others. The surface of the test is covered with a very homogeneous granulations that, examined at a high magnification, shows large spiniferous tubercles depressed on their periphery, distinctly mamelonated and perforated at their top and surrounded by a quantity of miliary tubercles (fig. 13). The tubercular apical disk has the same appearance, and we recognize there some traces of sutures. The gonopores are small and five in number. The ocellar pores are not visible at the

surface (fig. 12). The arrangement of the plates is always distinct when the spines are removed, and we recognize in their disposition the same relations that we have reported in the other species, i.e., that on the dorsal surface, the plates of the interambulacral areas are much narrower, although higher, than those of the ambulacral areas (fig. 8). On the ventral surface, they are still less developed. Also, the interambulacral areas there are reduced to five very narrow bands that radiate from the center to the periphery (fig. 7). The mouth is central and circular, surrounded by five ambulacral grooves visible up to mid-edge. In the specimens covered with their spines, the mouth is closed by their spines of a particular kind, implanted all around the periphery and converging toward the center (fig. 7). The anus is large and circular, located nearly halfway from the mouth to the edge. The interior cavity does not have asperities except at the edges, where we note pillars and calcareous networks, as in all the species of the genus. Fig. 10 shows the internal surface of the dorsal test, where we distinguish very well the articulation of the plates of the petals and, at the center, the five genital pores opening into small ridges. The unpaired interambulacral area is marked by a wide groove corresponding to the anal opening. Fig. 11 shows the internal surface of the ventral test raised in fig. 10. We see there the mouth surrounded by the five auricles that are raised in the form of large, arced pillars that will hold the masticatory apparatus in place. The latter is constructed on the same plan as that of the Laganids in general. I.e., it is composed of very high jaws numerous calcareous lamellae on both their dorsal surface and their ventral surface as we can see in fig. 17 and 18, that represent an isolated jaw in profile (fig. 18) and from behind (fig. 17). Fig. 16 is the same jaw seen by its dorsal surface with the groove destined to receive the tooth. Fig. 14 and 15, finally, show the masticatory apparatus as represented when the five jaws (whose position is indicated by the letters) are connected. Fig. 14 represents the ventral surface; fig. 15, the dorsal surface with the circle formed by the juxtaposition of the arcs showing the massive frame of each jaw.

The spines that cover the surface of the test, although uniform in appearance, are very varied in their form when we examine them with the microscope. I have figured (fig. 19), at the same magnification, spines taken from different parts of the test to give an idea of their proportions: *a* is a spine from the dorsal surface; *b* is the spine of a spiniferous tubercle from the ventral surface; *c* is the spine of a miliary tubercle; *cl*, finally, is one of the spines that surrounds the periphery of the mouth. As usual, these latter are more developed but also more irregular than the other spines of the ventral surface. It is worth noting that those of the dorsal surface (fig. 19 *a*) are not clavellate to the end.

This species was reported from Tonga by Quoy and Gaimard, which they deposited in the Museum of Paris under the name of *Lagana tonganensis*. It is an error that it is inscribed under my name on the plate.

VIII. LAGANUM LESUEURI Val.

Pl. 24, fig. 3–6.

This is the largest species of the genus. It reaches 14 cm in length and 13 cm in width. The height is not great. It does not even reach 2.5 cm in the largest specimens. The edge is not swollen as in the species of the type of *Lag. Bonani*, and for the same reason, there is no depression between the latter and the top. The periphery of the test is polygonal. We note a kind

of truncation in front of each ambulacrum so that, if we wanted to rigorously specify the contours of the test, we would find that it is decagonal. These ambulacral truncations are always smaller than the part that corresponds to interambulacral areas. Contrary to the preceding species, the anterior side is sensibly wider than the posterior side. The ambulacral petals are remarkable for their narrowness compared to the size of the test. They are all the same and, instead of being rounded, they are truncated at their end. The intermediary space between the poriferous zones is wider than the zones themselves. The gonopores are very apparent, but they number four only, located at the end of the rays of the madreporite that takes the form of a star with five very pronounced rays and notched at their end (see the apical disk in fig. 6). It has been impossible for me to perceive the ocellar holes. However, I have no doubt that they exist in the sinus of the madreporite at the top of the ambulacra. The ventral surface is completely flat. The mouth is central and circular. On the periphery are the branchial tubes that have at their end several more-or-less distinct openings (see fig. 5 that represents the mouth magnified). The buccal rosette is not very distinct (see fig. 5, that represent the mouth magnified). The buccal rosette is not very distinct. As for the ambulacral grooves, they are very marked near the center and riddled with a quantity of microscopic pores, but they disappear toward the edge. The interambulacral areas on the ventral surface are extremely narrow where they are in the form of indistinctly limited bands. It is in one of these bands that the anus is found, that is very near the border. Its form is circular, but it seems pierced obliquely from outside to inside. A very uniform granulation covers all the surface of the test. The spiniferous tubercles, a little larger on the ventral surface than on the dorsal surface, are in the middle of a very pronounced depression. The intermediary space has a quantity of miliary tubercles. The spines, like those that articulate with the spiniferous tubercles, are very slender. But, examined with the magnifying glass, that show distinct ridges (fig. 3 *b*), and if we observe them at high magnification, we find that these ridges are bristly with small, very pointed teeth (fig. 3 *c*).

The interior cavity has neither walls nor pillars. The network of compartments exists only in the edges, where it is however more varied than in *Lag. Bonani*. The internal apical disk has the form of a star composed of five rays that extend into the interambulacral areas and into the ends of which open the gonopores. The ridge that corresponds to the interambulacral area differs from the others only in that it is a little stronger and that it has no gonopore. Otherwise, its form and structure are the same.

This species was reported by Péron and Lesueur from their voyage to southern lands and by Plée from Guadaloupe. I know of no other specimens than those of the Museum of Paris. Valenciennes was the first to recognize the specific characters that distinguish *Laganum tonganense*.

As I have said above, when we have deeper knowledge of its anatomical relations, this species will probably have to form the type of a separate genus, to which will be included *Laganum elongatum* and *rostratum* and perhaps also *L. tonganense*.

IX. LAGANUM ELONGATUM Ag.

Pl. 24, fig. 1, 2.

This species has absolutely the same physiognomy as *L. lesueuri*, from which it differs only by a single essential characteristic, the position of the anus that, instead of corresponding to the narrowest side, is on the contrary on the widest side or, in other terms, the posterior side that, in the preceding species, is very narrow, is here widened. Except for that, we find in it all the principal characters of *L. Lesueuri*. Its form is sub-decagonal, although a little less angular. The height nearly equals 1/6 of the length. The petals are elongated, but with a rather pronounced tendency to close at their end. The apical disk has five very clear rays and notched at their end, near the place where the gonopores open. The tubercles of the surface of the test are the same on the dorsal surface and the ventral surface. They also occur in the intermediary spaces between the transverse grooves of the poriferous zones, where they are disposed in regular rows (fig. 1 a).

The ventral surface is completely flat. The interambulacral areas there are indicated by very narrow zones that we can follow to the periphery. The ambulacral grooves scarcely extend beyond mid-edge. The mouth is circular and central. On its periphery, we see the openings of the small branchial tubes (fig. 2). The anus is nearly as large as the mouth and also circular.

I still know only one specimen of this species that Stokes sent me. Its origin unfortunately is unknown.

X. LAGANUM ROSTRATUM Ag.

Pl. 25.

This species belongs to the type of *L. Lesueuri*. It is very elongated and oval. The posterior side is narrower than the anterior side. The periphery of the test does not have the angular form that characterizes the species mentioned above, although we still note the slight truncations in the extension of the ambulacral areas, especially the posteriors. But a particular character of this species consists of the slope of the dorsal surface (see the profile in fig. 3). The edge is thick without being swollen. The ambulacral petals, narrow and lanceolate, do not close at their end. The intermediary space between the poriferous zones has twice the width of the zones themselves. The apical disk is rather wide and when we examine it closely, we recognize there the same spongy structure that characterizes most of the Scutellids. The gonopores, four in number, are very apparent. One of them, that of the right posterior interambulacral area, is even double in one of my specimens. I have not been able to recognize traces of the ocellar pores that appear to be hidden under the epidermis (see fig. 4, which represents the apical disk and two petals magnified).

The ventral surface is completely flat. The mouth is central and circular. It is surrounded by a circle of small spines very stiff and distinctly striated in the direction of their length. The ambulacral grooves are very marked and, as usual, they contain a quantity of small pores. The interambulacral areas form a narrow band rather distinctly limited. They have a brighter tint than the rest of the test in the specimens that have preserved their color. The anus is very near the edge. Its periphery has small spines in the depression of the anal opening and that, by their dimensions, are intermediary between those of the spiniferous tubercles and the miliary tubercles. It is the only species that has shown me such a disposition of spines around the anus. The entire surface of the test has a very uniform granulation, but remarkable in that the

spiniferous tubercles are less dense than in most other Laganids. We do not note in this regard any sensible difference between the dorsal surface and the ventral surface.

The interior, which I have represented in fig. 5, the lower test being removed, has given me valuable information on several obscure points on the organization of Scutellids. I have found there, in addition to the relative position of the principal organs that we have described in the article on the genus, the ambulacral petals interiorly with a kind of spongy tissue that appears to be soft in the living animal and that I think are true gills because they are composed of leaves that end at the external row of pores, exactly as in the true Echinus. These gills do not extend beyond the end of the petals. So that there is every reason to presume that they constitute a different organ than those that depend on the suckers of the ventral surface. The masticatory apparatus is remarkable for its massive appearance. The jaws are very high because of the extraordinary development of the lamellar blades of the ventral surface. The frame itself, and particularly the arcs are very strong and, seen from above, they form with the dorsal surface of the masticatory apparatus a very massive circle when the five jaws are united (fig. 7). Fig. 8, 9 and 10 represent an isolated jaw of natural size, seen from above in fig. 9, in profile in fig. 10 and from behind in fig. 8. These two last figures give an idea of the extraordinary height of the jaws and the arrangement of the calcareous lamellae. The teeth are fixed in the groove of the dorsal surface of the jaws. But as they are very high, it results instead of their being horizontal, as in species with flat jaws, they are oblique and very arched to reach the mouth. Most are enameled only at their end, as in the true Clypeasters. The masticatory apparatus is maintained in place by five strong auricles that, instead of serving to pivot the jaws, as is the case in the Lobophorids, form on the contrary powerful buttresses that keep them in place. These auricles are always located in the interambulacral areas as we see in fig 6 that represents the internal surface of the ventral test with the mouth in the middle.

The color of this species is brownish shading to purple. It comes from New Zealand. I have specimens from DesHayes and Michelin.

XI. LAGANUM ORBICULARE Ag.

Pl. 22, fig. 16–20.

SYN. *Echinodiscus orbicularis* Leske p. 208, Pl. 45, fig. 6, 7.

Echinodiscus circinatus etc. Breyn. Sched, p. 64, Pl. 7, fig. 1,2. — Gualt. Pl. 1 10, fig. B.

Laganum Schynvoetii Klein, p. 25.

Echinus planus (Zeeschelling) Rumph. p. 37.

Echinus orbiculus L. Syst. nat. XII, p. 1105, N° 17, d.

Echinus orbicularis L. Gm. p. 3191.

Boccon Obs. p. 269, fig. 2, 3.

Encycl. méth. Pl. 147, fig. 1, 2.

I envisage this species as the type of the division of Laganids with four gonopores. It is without doubt the same that is found figured in Breynius and in Leske and that from there has passed into all the works dealing with Echinoderms. Its form is circular. The posterior side is

slightly rostrate. It is in addition very flat. The edge is swollen and separated from the top by a wide depression (fig. 18). The petals extend beyond mid-edge. They are of medium width and in a tapering point. The grooves of the poriferous zones take a direction more and more oblique toward the end of the petals. The entire surface is covered with very distinct spiniferous tubercles, widely spaced, that extend equally on the interambulacral area, the ambulacral areas and the apical disk. The four gonopores are located at the top in interambulacral areas that are here much narrower than the ambulacral areas (fig. 19). When we examine the tubercles under great magnification, we find them distinctly mamelonated, perforated and surrounded by a multitude of miliary tubercles that appear to be made in the same way (fig. 16 *a*). The anus is circular, located a third of the way between the edge and the mouth. It has the appearance of being pierced obliquely from behind forward. I have not been able to observe the mouth because of lack of complete specimens, but it is probable that it was the same as in the following species, if it is permissible to judge by analogy of adjacent parts. Fig. 20 represents the apical disk seen by the internal surface at the same magnification as fig. 19. We distinguish there very well the four rows of plates that compose the ambulacral petals and, in the center, a very marked depression bordered by a wrinkled bead to which the esophagus was attached. The edges of the test show, on the interior, calcareous pilars and a kind of labyrinth or network in which are lodged without doubt the appendices of the intestine, as occurs in *L. Bonani*.

The specimen comes from the Museum of Neuchâtel. Its origin is unknown to me. I have not referred this species to *Scutella orbicularis* of Lamarck, which is *Lagana orbicularis* of de Blainville because the specimen of the Museum of Paris, which serves for the descriptions, is a very different species of *Echinodiscus orbicularis* of Leske in question here. I describe below the species of Lamarck under the name of *Laganum Peronii*.

XII. LAGANUM MARGINALE Ag.

Pl. 22, fig. 11–15.

This species is very near *Lag. obiculare*. It could even be that it is a variety. However, here is why I tend to think it differs from it specifically. Although as flat and perhaps even flatter than the latter, its edge is proportionally more swollen. The depression of the space between the top and the edge is more pronounced. The ambulacral petals are wider and more in relief. Finally, the gonopores are larger (compare fig. 14 and 19). As for the general form, it is ovoid like that of *Lag. orbiculare*. The ventral surface is flat or nearly so. The anus is small and circular. I have not been able to observe the mouth. Instead, I represent (fig. 15) the internal surface of the apical disk that shows absolutely the same disposition as that of *Lag. orbiculare*, except that the ambulacral petals are a little wider at their top. The surface of the test is covered with the same spiniferous and miliary tubercles that characterize all the Laganids and which fig. 11 represents the structure at very high magnification. In addition to these tubercles, the swollen border of the test has a quantity of small vitreous bodies of which I am unable to recognize the nature. They are as numerous as the spiniferous tubercles and nearly the same size when examined under the magnifying glass. Fig. 116 shows them mixed with the miliary tubercles.

I know only a single specimen of this species that was sent to me by Michelin. Its origin is unknown.

XIII. LAGANUM STELLATUM Ag.

Pl. 22, fig. 7–10.

The form of this species is widely ovoid. Its height is greater than that of the preceding species. In contrast, the intermediary depression between the top and the edge is scarcely sensible (fig. 9). The edge is thick. The ambulacral petals are wide, lanceolate, and what makes a character particular to this species is that they do not converge toward the top so that the gonopores located at the top are necessarily far apart (fig. 7). The poriferous zones are narrow, and the transverse grooves uniting the pores of the two rows are scarcely visible. The ventral surface is slightly depressed. We recognize there traces of the five bands or ambulacral grooves directed toward the mouth that is at the center of the depression. The anus is smaller than the mouth and circular in form. The spiniferous tubercles conform as in the other species but the miliary tubercles that surround them are less numerous. (fig. 7 *a*). Being successful in extracting some jaws from one of my specimens, I have been able to assure myself that the masticatory apparatus is constructed, in this species, in the same manner as in the species of the type of *Laganum Bonani*. The jaws are very high and have abundant calcareous lamellae as we can see in fig. 20 *c* and *d* that represent the profile of a jaw, seen laterally in *c* and from behind in *d*. Fig. 10 *a* represents the ventral surface and fig. 10 *b* the dorsal surface of the masticatory apparatus, the five jaws being united. I have not seen the teeth, but we can judge from the height of the jaws and by the form of the grooves that would hold them that they are very arced.

I must thank my friend Stokes for several specimens of this species coming from New South Wales.

XIV. LAGANUM PERONII Ag.

Pl. 22, fig. 21–24.

SYN. *Scutella orbicularis* Lam. Vol. III, p. 282, N° 10. —E. Desl. Enc. V. 2, p. 677, N° 10. —

DeBl. Dict. sc. nat. V. 48, p. 228. — DcsMoul. Tabl. syn. p. 232.

Lagana orbicularis DeBl. Zooph. p. 196.

Echinodiscus orbicularis DeBl. Zooph. p. 199.

It was wrong that Lamarck, DeBlainville and DesMoulins referred this species to *Laganum orbicularis*. It suffices to compare fig. 16 and 21 of Pl. 22, that represents these two species by the dorsal surface to be convinced of their great specific difference. *Laganum Peronii* is much more elevated (fig. 23), scarcely curved between the top and the edge, and its periphery, instead of

being circular, is sub-pentagonal. The ambulacral petals extend nearly to the edge and are more rounded than tapered at their end. The poriferous zones are narrow and the transverse grooves strongly oblique. Finally, a last character of *Lag. Peronii*, that alone suffices to distinguish this species from all its congeners, is the considerable distance between the gonopores that are nearly as distant from the top as from the edge. The entire surface of the test is covered with a homogeneous granulation composed of spiniferous tubercles surrounded by a prodigious quantity of miliary tubercles (fig. 21 *a*). The edges of the test are distinguished in addition by a quantity of vitreous granules that we reported in *Lag. marginale*. The ventral surface is moderately depressed. The mouth, located in the center of the latter, is sub-pentagonal and when we examine it with the magnifying glass, we find that the ambulacral grooves around its periphery although very little marked, are however riddled with a quantity of small pores. We note in addition, on the immediate periphery of the mouth, at the end of each groove, two pores a little more marked that are without doubt the openings of the branchial tubes. The anus is small, circular, and located a third of the distance between the posterior edge and the mouth.

I named this species after the illustrious naturalist voyager who collected it in the southern seas. My figures are made after the same specimen of Peron that is deposited in the Museum of Paris and that was sent to me by Valenciennes.

ADDITIONAL REMARKS ON THE LAGANIDS, THE SCUTELLINIDS AND THE ECHINARACHNIDS.

The indecision that has prevailed in most authors regarding the limits assigned to the genus *Laganum* has resulted in referral to it of species that must be excluded now that the characters are better determined.

It is thus that the *Lagana* or *Scutella ovalis* of authors, which is also the *Scutella reticulata* DeBl, and to which the Encyclopédie méthodique contains a figure Pl. 144, fig. 5 and 6, should be removed from the genus *Laganum* to take its place in the genus of the true *Clypeaster*.

My *Lagana profunda*, (Catal. syst. Ectypor. Mus. Neoc. p. 6, fossile des Alpes suisses), is also a true *Clypeaster*).

Later, we shall have the opportunity to note again the several species referred to the genera *Laganum* and *Fibularia* should now take their place among *Echinocamus*. Such are *Lagana occitana* and *Fibularia altavilensis*, *obtusa*, *sicula*, *pyriformis*, etc.

The *Laguna Scillæ* of Klein is a true Scutellid that we find mentioned p. 87.

As for *Laganum Rumphii* of Klein, DesMoulins has referred it to his *Scutella bifissa* that is my *Lobophora bifissa*. But I do not know what his *Laganum Plotii* could be.

Several species that I have referred to the genus *Echinarachnius* in my Prodrome and in my catalog of molds of echinoderms should also be separated from this genus now that it is otherwise circumscribed. Such are *Echinarachnius nummularis* and *lenticularis* that enter the genus *Scutellina*. *Echinarachnius Parma* that reverted with Klein to the type of the genus *Arachnoides*, and *Echinarachnius placunarius* and *latissimus* (referred by de Blainville to the genus *Echinodiscus*), which are true *Clypeaster*. It is the same with *Scutella clypeastriformis* DeBl, which is returned later to *Clypeaster scutiformis* of Lamarck. To note in passing, I will remark that *Clypeaster placunarius* Lamarck is at the same time *Scutella ambigena* Lamarck. I assured myself of this at the Museum of Paris by inspection of original specimens of Lamarck. Finally, Professor Bronn assures us that *Scutella gibbosa* and *pyramidalis* of Risso are also true *Clypeaster*.

CHAPTER XII.

GENUS ECHINOCYAMUS v. Phels.

This genus, although very old, is however one whose study has given me the greatest difficulties. Van Phelsum, who established it, placed there fourteen species to which he assigned as the principal character, according to Leske, of having the anus on the ventral surface and near the mouth. Lamarck circumscribed this genus in nearly the same manner¹⁰. But instead of preserving the original name of Echinocyamus, he changed it to *Fibularia*. In the genus thus limited are two very different types, as we are going to see. Goldfuss, in his great work on the petrifications of Germany, even associated them with a third by confusing them with the Echinoneans. de Blainville again integrated the genus Echinocyamus and took for type *Echinocyamus pusillus* described below. But on the other hand, he confused the Fibularians and several species of true Echinocyamids in the same genus with the Echinoneans and the Galerites, which was a grave error. This confusion, which I could not entirely avoid in my Prodrôme for lack of sufficient material has two principal causes. In the first place, the rarity of these animals that collectors have without doubt despised because of their smallness and their lack of characteristics and in the second, the still greater rarity of the work of van Phelsum. Lacking the original, I have been obliged to content myself with the extract that Leske gave in his edition of Klein. Although the descriptions of the species there are imprecise, I have however been able to recognize there the two types mentioned above: the globulose species, or Fibularians, and the flat species, or the true Echinocyamids. The first appears to be the more numerous in the work of van Phelsum.

I have already insisted in the introduction on the profound differences that distinguish these two genera apparently so close. While the interior cavity of Fibularids is completely plain and has no other asperities than the five auricles that support the jaws, the interior of the test of the Echinocyamids has calcareous walls that radiate from the center to the periphery and thus divide the cavity into ten sections corresponding to the ambulacral and interambulacral areas. It is absolutely the same structure that we have recognized in the Scutellines. This particular structure necessarily implicates a disposition of the interior organs, and notably the intestinal canal, very different from that it must be in the Fibularids. As for the Echinoneans, which Goldfuss confused with the latter, DesMoulins has already noted that this association of species so different must be rejected immediately. In my Prodrôme, I had already likewise separated them.

Circumscribed in the limits that we have assigned them here, the genus Echinocyame thus holds to the Scutellines on one hand by the walled structure of the interior of the test and to the Fibularians by its exterior appearance, the form of its ambulacral petals and by the position of the anus that is more-or-less near the mouth. On the other hand, the same characters that bring it close to one of these genera, separate it from the other. It differs, consequently from the

¹⁰ Corpus subglobosum, obovatum aut orbiculare, margine nullo vel rotundato ; spinis minimis, Ambulacra quinque, brevia, agusta, circumscripta. Os inferum, centrale; ano ori vicino vel mediano intra os et margini.

Scutellinids by the position of the anus on the ventral surface and from the Fibularids by the walled structure of its interior cavity. As the latter character is connected to the basic organization of these animals, the differences should be more profound between the Echinocyamids and the Fibularians. Consequently, I have not only separated the Fibularians as a genus, but I think even that they must be removed from the group of Scutellids and referred to another group because I see that they are even closer to the type of Galerites and especially the Echinoneans than to the group of Scutellids.

An important character of Echinocyamids consists of their oval form swollen on the edges. The petals are not limited in a very distinct way and, in this regard, the genus forms in some way the transition between the Clypeasteroids with limited ambulacra and those with continuous ambulacra. The poriferous zones are very close together, but the pores are not joined by transverse grooves, or, if these grooves exist, they are so small that they cease in any way to be an important character. There is only *E. occitanus* in which they are very distinct. The entire surface of the test is covered with spiniferous tubercles, ordinarily very developed relatively to the size of these urchins and surrounded by miliary tubercles. This same granulation extends also on the apical disk so that it is rather difficult to recognize if it were not ordinarily a little more protruding than the rest of the test. The gonopores are four in number and ordinarily very small. The ocellar pores are generally imperceptible. The spines are quite developed on the entire surface of the test. Those of the ventral surface are as usual cylindrical and longer than those of the dorsal surface. They are truncated and slightly swollen at the end.

The masticatory apparatus is composed of very high jaws, nearly like those of Laganids, so that their teeth, to reach the mouth, necessarily be very arced.

The species I describe here are eleven in number. Two are of the present epoch, seven come from Tertiary terrains, and two, *Echinocyamus alpinus* and *Echinoc. occitanus*, from the Cretaceous period. This latter, which is the largest of all the genus, will return perhaps one day as the type of a different genus (see below the description of the species).

The synonymy of the species of this genus is very difficult to establish. It has been impossible for me to find in the collections the originals of the descriptions of most of the authors. Even those species of Lamarck and de Blainville are not found in the Museum of Paris, and the brevity of their descriptions does not permit rigorous determinations. Also, of the eleven species described below, there is only one that I think I can relate to synonyms of van Phelsum and Leske. It seems preferable to me to pass in complete silence all the doubtful citations and to keep descriptions to species that I possess myself. I shall add in the form of an appendix at the end of this chapter the most important indications that I have collected in the various works that treat these small animals.

I. ECHINOCYAMUS PUSILLUS Flem.

Pl. 27, fig. 1–8.

SYN. *Echinocyamus pusillus* Flem. Brit. anim. p. 481. — Ed. Forbes Hist. of br. Starfish. p. 175.

Spatangus pusillus Miller Zool. dan. p. 18, Pl. 91, fig. 5, 6.

Echinus minutis L. Gm. p. 3194.

Echinocyamus minutus DeBl. Zooph. p. 195.

This species seems to attach in a direct manner by its swollen form, the Fibularids to the Echinocyamids. It is important consequently to study first the interior to be assured if this transition really exists and, in the contrary case, to know to which of the two genera it is necessary to refer it. Now, it suffices to glance at fig. 6 and 7, which represents the interior, to be convinced it is really an Echinocyamid, because it is only the species of this genus that have similar walls. The Fibularids as we just said in the article on the genus, do not have asperities other than the auricles in the interior.

E. pusillus is a small species of ovoid or pyriform form, very high comparatively to its volume (fig. 3). The dorsal surface is uniformly swollen, and the most protruding point corresponds to the apical disk. The ventral surface is slightly concave. The mouth, circular in form, occupies the center. The anus, located halfway between the mouth and the posterior edge, is very small (fig. 4). To give a more exact idea of the structure of this small urchin, I have added to the figures of natural size, figures 2, 5, 7 and 8 that are seen at a magnification of two diameters. A particularity of this species consists in the proportionally very considerable size of the spiniferous tubercles (fig. 2 and 5). The ambulacral petals are scarcely sensible, even under magnification. However, we note that they take a more-or-less arced form, but without rounding at their end. I thought also to remark that the pores of the poriferous zones are not joined by transverse grooves. Fig. 8 represents a specimen with its spines. Seen with the naked eye, these spines appear to be very uniform over all the surface. but in examining them with the microscope, we find between them some very notable differences in form. Those of the ventral surface (fig. 8 *a*) are cylindrical, pointed and much longer than those of the dorsal surface (fig. 8 *b*), that have scarcely half the length of the preceding are swollen at their end. But some of them have the same structure, i.e., they have longitudinal ridges bristly with fine spines. Fig. 7 is a magnification of fig. 6, after a specimen a little larger than that of fig. 1. We distinctly recognize there the ten ridges that radiate from the center to the periphery and separate the ambulacral areas from the interambulacral areas. The auricles also are very distinct. They correspond to the interambulacral areas that are here, as in the Laganids, sensibly narrower than the ambulacral areas. Since the printing of the attached plates, I have had the occasion to also observe the masticatory apparatus. It is composed of five very high jaws, nearly like those of *Echinocyamus pyriformis* represented in fig. 24 of the same plate. A natural consequence of this considerable height of the jaws is that the teeth are very arced.

This species is common on the coast of England. The originals of my figures were sent to me by Ed. Forbes. They come from the coasts of the Island of Man and from the bay of Edinburgh. Fleming has sent me a specimen from the Shetland Islands. It is said to be very widespread in Europe. But it would be important to review these indications with specimens in

hand, in order not to confuse under the same name individuals that could belong to distinct species

II. ECHINOCYAMUS SUFFOLCIENSIS Ag.

Pl. 27, fig. 9–13.

SYN. *Fibularia suffolciensis* Aq. Prodr. p. 188. — DesMoul. Tabl. syn. p. 244.

Close in many respects to *E. pusillus*, this small species differs however in its more depressed and wider form (fig. 11) that makes it nearly circular while *E. pusillus* is more ovoid. As for the details of the structure of the test, they are sensibly the same in the two species as seen in the magnified designs of fig. 10 and 13 compared to those of fig. 2 and 5. The ambulacral petals are indistinct, but we note however that they are not rounded at the end. The mouth is much larger than the anus and located in the center of the ventral surface that is slightly depressed. The tubercles that cover the surface of the test are very developed without however being as large as those in *E. pusillus*.

This species has been found in the Red Crag of England at Sutton in Suffolk. I have seen numerous specimens in the collection of Wood, who possesses in addition others of this genus still undescribed also coming from the Crag. The specimens were sent to me by Woodward Jr. It has a deep brown tint, as many fossils from this locality. This color is due to the ferruginous parts of this land.

III. ECHINOCYAMUS ANGULOSUS Leske.

Pl. 27, fig. 14–18.

SYN. *Echinocyamus angulosus* Leske ap. Kl. p. 215.

Fibularia angulosa DeBl. Dict. sc. nat. V. 16, p. 512. — E. Desl. Enc. V. 2, p. 390.
DesMoul. Tabl. syn. p. 236. — Lam. V. 3, p. 301.

The form of this species is sometimes sub-pentagonal, sometimes more-or-less oval. The anterior side is a little narrower than the posterior side that is in addition truncated or sub-truncated behind. The height is average. The dorsal surface is moderately swollen. The edges are thick. The ventral surface is ordinarily a little depressed and it is at the center that the mouth is located. The ambulacral petals show no tendency to be rounded at their end. They are scarcely arced at their origin near the apical disk. The interambulacral areas, whose sutures are distinguished very well on the ventral surface (fig. 16), are very narrow, because they have scarcely a quarter of the width of the ambulacral areas. Fig. 17 and 18 represent the interior of this species with its divergent walls that does not allow me to doubt that it is not an

Echinocyamus. Fig. 17 shows the internal surface of the dorsal test; fig. 18, the internal surface of the ventral test with the five auricles that surround the mouth.

This species inhabits the coasts of Ireland. I collected the specimen figured with several other small marine snails in the interior of a Murex in Belfast Bay. I refer it to *Echinocyamus angulosus* of Leske because it appears to me to correspond best to the description given by this author. The naturalists who have the work of van Phelsum will decide if my species is really identical with that of the author from Holland.

IV. ECHINOCYAMUS PYRIFORMIS Ag.

Pl. 27, fig. 19–24.

SYN. *Fibularia pyriiformis* Ag. Catal. syst. Ectyp. Mus. Neoc. p. 6.

Although fossil, this species resembles so strongly *E. angulosus*, that it has been impossible for me at the beginning to distinguish it specifically. It is true that its form is in general less angular and more pyriform, and that in most of the specimens, the anterior side is scarcely half the width of the posterior side. But this difference could not by itself constitute in my thinking a specific character since I had recognized incontestable transitions between these diverse forms. It was after examining the interior of the two species that I recognized they really were distinct. The principal difference consists in the thickness of the test that is quite considerable in *E. pyriiformis* while the test of *E. angulosus* is extremely thin.

The surface has a very homogeneous granulation and although the species is larger than *E. pusillus*, the spiniferous tubercles are however sensibly smaller. The ambulacral petals, at first very distinct near the apical disk, are insensibly lost toward the edge and we note no tendency to be closed. The gonopores are four in number, small and close together. The ocellar pores are not visible, without doubt because of their extreme smallness. Fig. 24 represents the masticatory apparatus of the difference surfaces, in *a* by the ventral surface; in *b*, by the dorsal surface, the five jaws being united. The posterior jaw is to be noted by its extreme width that is nearly twice that of the other jaws. The other figures represent the profile of this same jaw, seen from the side in *d*, from behind in *e* and from in front in *c*.

This species is very common in the Tertiary terrain of Grignon. I think that it is the *Scutella inflata* of DeFrance, but I dare not affirm this, not having seen an original specimen of this species. If it is so, the name of *Echinocyamus pyriiformis* must be replaced by that of *Echinocyamus inflatus*.

V. ECHINOCYAMUS ALTAVILLENSIS Ag.

Pl. 27, fig. 25–28.

SYB. *Scutella altavillensis* DeFr. Dict. sc. nat. V. 48, p. 231. — DeBl. Zooph. p. 202. — Ag. Prod. p. 188. — DesMoul. Tabl. syn. p. 234. - Lam. V. 3, p. 286.
Fibularia altavillensis Cat. syst. Ect. Mus. Neoc. p. 6.

The form of this species is in general circular. The posterior side is truncated, the anterior side sometimes rounded, sometimes rostrate. The dorsal surface is flat and slightly inclined from front to back, so that the highest is at the anterior edge (fig. 27). The ambulacral petals are a little swollen near the apical disk and arced at their origin but they do not close at their end. The gonopores are four in number, located at the top of the interambulacral areas in a small depression, in the middle of which the madreporite is elevated in the form of a small, slightly protruding button. The mouth is circular and located in a small depression in the center of the ventral surface. The anus is extremely small (fig. 28).

This species is found in the Tertiary terrain of Hauteville, where it was collected by DeFrance who described it under the name of *Scutella altavillensis*.

VI. ECHINOCYAMUS OBTUSUS Ag.

Pl. 27, fig. 29–32.

SYN. *Fibularia obtusa* Ag. Cat. syst. Ect. Mus. Neoc. p. 6.

At first glance, this species appears to differ from *E. altavillensis* only by its more elongated and more ovoid form. However, it is another character that is particular to it and that, in opinion, is more important than the general form. It is that the ambulacral petals, instead of being arced, are straight for their entire length and disappear near the edge without curving either outside or inside. This character arises in a very distinct way from the comparison of fig. 30 with the fig. magnified of the preceding species (fig. 26). The ventral surface is slightly concave, the mouth is circular, like the anus that is located halfway between the mouth and the posterior edge. The dorsal surface has the same uniform slope that we reported in the previous species, so that the culminating point is at the anterior edge (fig. 31). The petals also are slightly protruding.

It is probable that this species has been confused more than once with *E. altavillensis* that is found with it in the same localities. The original of my figures comes from the Tertiary terrain of Hauteville. It was sent to me by Michelin.

VI. ECHINOCYAMUS SICULUS Ag.

Pl. 27, fig. 33–36.

SYN. *Fibularia sicula* Ag. Cat. syst. Ect. Mus. Neoc. p. 6.

It could be that this species is only a variety of *E. pyriformis* described above. However, as I know by experience how easy it is to be mistaken in the identification of species, especially Tertiary species, I thought it necessary to separate provisionally the Sicilian Tertiary species that concerns us here from the Grignon terrain because, instead of being pyriform, it is oval, slightly rostrate anteriorly, truncated behind, and that the difference in width between the anterior side and the posterior side is not as great as in the preceding species. As for the ambulacral petals, they are extremely slender. The poriferous zone shows no trace of transverse grooves, nor any tendency to converge at the end.

This species comes from the Tertiary terrain of Sicily. The original of my figure was sent to me by Deshayes.

VIII. ECHINOCYAMUS ANNONII Mer.

Pl. 27, Fig. 37–40.

SYN. *Fibularia Annonii* Merian Catal. manusc. from the Museum of Basel.

Knorr II, 2, p. 180, Pl. E, II, Fig. 8.

This species has already been described and figured by Knorr, and I have even reason to think that the original of this author is the same that has served for my figures. It is distinguished from all its congeners by its circular form that seems to attach it directly to the Scutellinids. But it is none the less a true Echinocyamus since the anus is on the ventral surface. Another character that is proper to it and that is not sufficiently indicated in fig. 38 is that the ambulacral petals are more protruding than in any other species of this genus. Moreover, they are very wide, distinctly round and have a very marked tendency to arc at their end without closing. We note also between the poriferous zones distinct traces of transverse grooves. The apical disc has four very distinct gonopores. The ocellar pores are not visible. The most elevated point is at the center of the dorsal surface and has consequently a uniform slope in all directions. The mouth is central, small, and circular. The anus, still smaller, is located between the posterior edge and the mouth.

This species comes from the Pisolitic terrain of Verona. All the specimens that I have seen and that were sent to me by Mérian have a reddish tint, as all the fossils of this ferruginous terrain. They are deposited in the Museum of Basil and were once part of the collection of Annone that Knorr illustrated.

IX. *Echinocyamus alpinus* Ag.

Pl. 27, fig. 41–43.

SYN. *Fibularia alpina* Ag. Descr. des Ech. foss. de la Suisse, 1^{re} part. p. 74, Pl. 12, fig. 1–3.

This species that I have described and figured in my *Description des Echinodermes fossils de la Suisse* under the name of *Fibularia alpina*, is to be noted by its regularly oval form and by the

position of the anus that is very near the posterior edge. The dorsal surface is very swollen. The ventral surface is slightly concave. The mouth that occupies the center is circular. But what make this species especially interesting is its deposit. I know of only two species that make part of the Museum of Bern. They were collected in the Swiss Alps Chain, at Burgenberg, near Stanz (canton of Underwalten) in a kind of black fossilifeous conglomerate belonging to the Cretaceous terrain and containing a quantity of crushed fossils, among others a large nummulite.

X. ECHINOOCYAMUS AMBIGUUS Ag.

Pl. 27, fig. 44–47.

SYN. *Scutella ambigua* Expl. of Pl. 153 of the Encycl. méth. fig. 4.

The prominent character of this species, of which the Encyclopédie méthodique has given a good figure, is easy to grasp. It consists of an extraordinary thickness of the edge (fig. 46). In contrast, the dorsal surface is completely flat. The ambulacral petals are distinctly arced but are not closed at their end. Fig. 45 represents the origin of the petals at a magnification of several diameters. We see by this figure that the poriferous zones have extreme narrowness compared to the intermediary space. This character, joined to the absence of transverse grooves, serves to distinguish our species from *E. occitanus* described below. The ventral surface has a rather marked central depression in which the mouth is located. The anus is in the middle of the space between the latter and the posterior edge.

Mérian sent me very good specimens of this species, coming from Alençon. The Museum of Paris also has several well-preserved specimens.

I have every reason to think that this species is synonymous with the *Scutella hispana* of DeFrance, whose identity however I have not been able to confirm, lacking the original specimens.

XI. ECHINOCYAMUS OCCITANUS Ag.

Pl. 27, fig. 48–58.

SYN. *Scutella occitana* DeFr. Dict. sc. nat. Vol. 48, p. 231. — DeBl. Zooph. p. 202.— Ag. Prodr. p. 188.

Lagana occitana Ag. Cat. syst. Ectyp. Mus. Neoc. p. 6.

It is very easy to take the change in this species and confuse it with Laganids of the type of *Lag. Bonani* because of its swollen border and its long ambulacral petals that nearly reach the circumference of the test. I myself fell into this error and it was only after I opened a specimen that I assured myself that it really belonged to the genus Echinocyanus because the radiating lamellae that separated the ambulacral areas from the interambulacral areas are as distinct as they could possibly be. But these lamellae have a peculiarity of structure that is not found in the other

species. Instead of being united, they are bristly with lateral lamellae or numerous processes that appear like spines adherent to the walls (fig. 53). These spines are not seen on the dorsal test because the walls do not reach its edges. The auricles surround the circumference of the mouth, but they are proportionally much narrower than in the small species that we have described above, such as *A. pusillus*, *angulosus* and *pyriformis*.

The general form of *E. occitanus* is circular, slightly truncated behind, as shown in fig. 48 and 49 that represent two individuals of different ages. The dorsal surface is nearly flat. Also, the edge is very thick (fig. 50). The ambulacral petals are remarkable for their extraordinary length. They nearly reach the edge of the test but without closing at the end. This last particularity is very important because it is the principal character that distinguishes exteriorly this species from the Laganids. Second, the pores of the poriferous zones are united by very distinct oblique transverse rows. Now, we have seen by the preceding descriptions that these grooves do not meet in the other species of Echinocyamids, or at least they are very rudimentary. The gonopores are four in number as usual. The ocellar pores are rarely recognizable. The ventral surface is slightly depressed. The mouth, sub-pentagonal in form, is in the center. The anus is circular and located in the middle of the space between the posterior edge and the mouth. The interambulacral areas are much narrower than the ambulacral areas, notably on the ventral surface where they are ordinarily indicated by five bands that radiate from the center to the periphery and in one of which opens the anus (fig. 51). The entire surface is covered with very uniform tubercles on all sides.

The masticatory apparatus is remarkable for its extraordinary height (see fig. 56, 57 and 58, that represent the different surfaces of one of the jaws, seen in profile in fig. 57, from behind in fig. 58, from in front in fig. 56). This height is the result of the extraordinary development of the calcareous blades that surround the frame of the jaw. Fig. 54 represents the masticatory apparatus seen from below, the five jaws being united. Fig. 55 represents it seen from above.

This species appears to be common in the Upper Chalk. The originals of my figures were sent to me by Alcide d'Orbigny who collected them at Royen, Department of Gironde.

ADDITIONAL REMARKS ON THE ECHINOCYAMES.

There can be no doubt about the generic affinities of the species figured and described by Goldfuss as belong to the genus *Echinoneus*.

Echinoneus scutalis Munst. (Goldf. Pl. 42, fig. 11), from the Tertiary marine sandstone of Blinde, is a true Echinocyamid very close to my *Echinocyamus altavillensis* and *obtusius*. However, as I do not possess an authentic specimen, I did not believe I could comment on the relations of these species. I do not know what motives led DesMoulins to unite as synonyms *Echinocyamus scutalis*, *ambiguous* and *occitanus*.

The *Echinoneus placenta* of Goldfuss (Pl. 42, fig. 12) of the Cretaceous limestone of the mountain of St. Pierre of Maestricht is a true Echinocyamid very close to my *Echinocyamus pyriformis*. It appears to differ only by its more angular form.

Echinoneus ovatus Münster. (Goldf. Pl. 42, fig. 10) from the Tertiary sandy marls of Astrupp near Osnabrück and from Wilhelmshöhe near Cassel is likewise a true Echinocyamid, near to my *Echinocyamus suffolciensis*, but constituting evidently a particular species that I have not yet seen in nature.

Echinoneus subglobosus (Goldf. (Pl. 42, fig. 9) is a true Fibulairid.

Fibularia Francii of DesMoulins, from the Tertiary terrain of Paris, to which gives as synonym *Scutella inflata* DeFr., is very probably my *Echinocyamus pyriformis*.

I do not know what the *Fibularia australis*, *affinnis* and *subcaudata* of DesMoulins could be.

Scutella fibularis Lam., to which Dujardin has given as a synonym in the second edition of Animaux sans vertèbres *Echinoneus ovatus* Munst. and *Scutella hispana* DeFr., is very probably a true Echinocyaamid. It is very possible that it a double use with either of the species that I have described. But it will be difficult to be sure, the originals of Lamarck not being found in the collections in Paris.

The numerous species reported by van Phelsum to his genus *Echinocyamus* appear to belong in large part to the genus *Fibularia*. Such are at least his *Echinocyamus nucleus*, *lathyrus* and *craniolaris*.

As for *Fibularia tarentina* Lam., a living species from the Mediterranean, I think that it is a true Echinocyaamid, although I have not been able to assure myself with authentic specimens. It is the same for *Fibularia trigona* Lam. and *Fibularia inaequalis* de Blainville. The *Fibularia ovulum* of Lamarck is very probably a synonym of *Echinocyamus pusillus*.

The undetermined Echinocyamus, mentioned in my table on the geographical distribution of the species as inhabiting the Mediterranean, is a very small species, near *Echinocyamus pusillus*. Desor collected several specimens some years ago in the interior of a Spatangue coming from the coasts of Sicily. Unfortunately, these specimens have been lost so that I cannot give a description.

CHAPTER XIII.

GENUS MOULINIA Ag.

This small genus constitutes a type completely particular and very different from all the genera that we have treated up to now, but that however approaches in several regards the Echinocyamids and the Scutellids. I have dedicated it to Ch. DesMoulins whose works on the Echinoderms have so powerfully contributed to the advancement of our knowledge on this class of Rayonnes. I still know only a single species, that is

MOULINIA CASSIDULINA Ag.

Pl. 22, fig. 1–6.

SYN. *Scutella cassidulina* DesMoul. Tabl. syn. p. 232.

The most striking character of this urchin is the presence of deep grooves between the different rows of plates so that the test is divided exteriorly into twenty very marked sections so that the edge is strongly irregular. The transverse sutures are likewise indicated by small grooves, that however are less deep than the sutures of the rays. These sutures or depressions would not be the result of an alteration because the tubercles and the epidermis would have disappeared. Now, far from that, both are perfectly preserved. The tubercles especially are very protruding and very distinct. The ambulacral petals strongly diverge at their end. The pores are not united by transverse grooves nor do they open in particular plates as is the case in most other genera. But they are pierced in the same plates of the ambulacral area, absolutely like the plates of the Galerites, with this difference that they are limited to the dorsal surface. We could therefore wonder if this species really belongs to the group of Scutellids and if it would not be better to report it with the Fibularids in the group of Galeritidss. It is incontestable that the affinity is great between these two genera. If I decide to associate it with the group of Scutellids, it is in regard to its very flat form that recalls particularly the Scutellines. The mouth is central and circular. The anus, located halfway between the edge and the mouth, is likewise circular and of average size. I have not had the opportunity to observe the interior of the test nor the masticatory apparatus.

The species in question is circular in form, a little longer than wide, very flat with thin borders, undulated and rounded. Fig. 1, 2 and 3 represent it at natural size by the dorsal, ventral and profile surfaces. To better bring out the details of the test, I have represented these same figures at a magnification of two diameters in fig. 4, 5 and 6.

Figure 4 shows a portion of the surface at a still much greater magnification to give an idea of the disposition of the spiniferous tubercles that are distinctly mamelonated, perforated and surrounded by a circle of miliary tubercles that appear to be made in the same manner. But a particular character that is found in no other genus of the group of Scutellids, not even in the Echinocyamids, is that instead of being surrounded by a smooth areole, the tubercles rise immediately from the test, which makes them appear so protruding. I have not been able to

observe the apical disk. But I have no doubt that it has some particular character that permits establishing in a more complete manner the natural affinities of this genus.

I know this species only by a single specimen, for which I owe the kindness of DesMoulins. It comes from the coasts of Martinique, where this species was discovered by Rang.

TABLE OF THE GEOLOGICAL AND GEOGRAPHIC DISTRIBUTION OF THE GROUP OF SCUTELLIS.

1). Species of the Cretaceous epoch.

Scutella Rogersi Mort.	White chalk	North America
Echinocyamus alpius Ag.	Alpine chalk	Stanz, canton of Unterwalden.
Echinocyamus occitanus Ag.	Superior chalk	Royan (Depart. of Gironde).

2). Species of the Tertiary epoch.

Scutella Brogniarti Ag.	Coarse limestone	Grognon
Scutella Smithiana Ag.	Molasses	Lisbon
Scutella subrotunda Lam.	Tertiary terrain	Bordeaux
Scutella Faujasii LaFr.	Tertiary terrain	Department of Sarthe
Scutella producta Ag.	Tertiary terrain	Saumur
Scutella truncata Val.	Faluns	Anjou, Touraine
Scutella propinqua Ag.	Faluns	Touraine
Scutella striatula M. de Ser.	Faluns	St. Paul, near Dax
Scutella paulensis Ag.	Faluns	St. Paul, near Dax
Scutella stellata Ag.	Faluns	Touraine
Scutella subtetragona Grat.	Faluns	Dax
Echinocyamus pyriformis Ag.	Coarse limestone	Grignon
Echinocyamus altavillensis Ag.	Coarse limestone	Hauteville
Echinocyamus obtusus Ag.	Coarse limestone	Hauteville
Echinocyamus ambiguus Ag.	Coarse limestone	Alençon
Echinocyamus siculus Ag.	Tertiary terrain	Sicily
Echinocyamus suffolciensis Ag.	Crag	England
Echinocyamus Annonii Mer.	Pisolithic terrain	(Chalk?) Verona
Scutellina nummularia Ag.	Coarse limestone	Grignon
Scutellina lenticularis Ag.	Coarse limestone	Grignon, Blaye
Scutellina Placentula Mer.	Coarse limestone	Chaumont
Scutellina supera Ag.	Coarse limestone	Grignon
Scutellina obovata Ag.	Coarse limestone	Grignon
Echinarachnius incisus Ag.	Coarse limestone	Hauteville
Laganum tenissimum Ag.	Coarse limestone	Blaye
Laganum reflexum Ag.	Coarse limestone	Blaye
Amphiope bioculata Ag.	Faluns	Touraine, Bordeaux
Amphiope perspicillata Ag.	Faluns	Rennes
Runa decemfissa Ag.	Tertiary terrain	Bordeaux
Runa Comptoni Ag.	Tertiary terrain	Palermo

3). Living species

a). From northern seas, the sea of the north, and the Atlantic Ocean, up to 45°

Echinarachnius Parma Gr.	Canada
Echinarachnius atlanticus Gr.	Newfoundland
Arachnoides Placenta Ag.	Foulah (Shetland Islands)
Echinocyamus pusillus Flem,	Irish seas, coasts of Scotland
Echinocyamus angulosus Leske	Coast of Ireland

b). *From the Mediterranean.*

Echinocyamus (undetermined species).

c). *Caribbean Sea, Gulf of Mexico, coasts of Brazil and west coast of Africa.*

Rotula Rumphii Kl.	Senegal
Mellita quinquefora Ag.	Puerto Rico
Mellita testudinata Kl.	Vera Cruz
Mellita hexapora Ag.	Antilles? (DesMoulins)
Mellita similis Ag.	Puerto Rico
Encope Valenciennesii Ag.	Martinique
Encope subclausa Ag.	Coasts of Brazil
Encope grandis Ag.	Martinique
Laganum Lesueurii Ag.	Guadeloupe
Moulinia casidulina Ag.	Martinique

d). *Indian Ocean, Red Sea, Persian Gulf and the Bay of Bengal.*

Encope emarginata Ag.	Reunion Island or Philippines
Lobophora bifora Ag.	Coasts of Cafrerie
Lobophora bifissa Ag.	Red Sea
Lobophora aurita Ag.	Red Sea

e). *Sunda Islands, Australia and Polynesia.*

Laganum Bononi Kl.	New Guinea, Vanikoro
Laganum depressum Less.	Bourou Island
Laganum decagonum Less.	Waigiou Island
Laganum tonganensa Q. and G.	Tonga Island
Laganum stellatum Ag.	New South Wales
Laganum rostratum Ag.	New Zealand
Laganum Peronii Ag.	Southern seas.

f). *West coast of tropical America and the Galapagos Islands.*

Encope tetrapora Ag.	Galapagos Islands (west coast of Africa, DesMoulins)
Encope Stokesii Ag.	Guyaquil and the Galapagos Islands

g). *Species of still unknown origin*

Rotula Augusti Kl.
Mellita lobata Ag.
Encope micropora Ag.
Encope perspectiva Val.
Encope cyclopora Ag.
Encope oblonga Ag.
Encope Michilini Ag.
Lobophora truncata Ag.
Echinarachnius Rumphii Ag., (Amboine?)
Laganum elliptica Ag.
Laganum elongatum Ag.
Laganum orbiculare Ag.
Laganum marginale Ag.

These tables show that from their first appearance, the Scutellids have inhabited the new as well as the old world, but that they have been much more numerous during the Tertiary period than now. As for the living species, all differ specifically, and even most generically from fossil species. It is curious that the *Echinarachnius*, the *Arachnoides* and the *Echinocyamus*, which are closest to the fossils, inhabit only the seas of the North, while the Mellitids and the Moulinids characterize the Caribbean and the Gulf of Mexico, the Rotulids, the west coast of Africa, and the Lobophores, the Indian Ocean. The Encopes and the Laganids are distributed in all the tropical seas, the Encopes especially on the eastern and western coasts of America and the Laganids in the large Ocean.

The total number of Scutellids that are known to me now is 73, of which 33 are fossils and 40 living.

CONSPECTUS GENERUM ET SPECIERUM SCUTELLARUM.

CHARACTER GENTIS SCUTELLARUM E FAMILIA CLYPEASTEROÏDEORUM.

Testa depressa, circularis vel ovata. Os centrale, rotundatum vrl subangulatum. Anus inferus vel marginalis. Ambulacra petaloïdea.

I. Genus **ROTULA** Klein. Discus orbicularis, margine posteriore digitatus; petala ambulacrorum magna, elongata, aperta. Quatuor foramina genitalia in sulcis corporis madreporiformis sita. Os médium, anus inferus; sulci ambulacrales inferiores dichotomi, vix ramosi.

1. *Rotula Rumphii* Klein (Pl. 1). Disco convexiusculo, petalis angustis, elongatis, apertis; digitis numerosis, cylindricis.

2. *Rotula Augusti* Klein (Pl. 2, fig. 1–10 and Pl. 4, fig. 1–6). Disco depresso; petalis latioribus, arcuatis, apertis; digitis dichotomis depressis.

II. Genus **RUNA** Agass. Testa ovata; areae interambulacrales angustae, incisuris marginalibus sejunctæ; petala angusta, divergentia.

1. *Runa Comptoni* [Pl. 2, fig. 11–19] Agass. Testa lata, ovata; ore medio, magno, elliptico; ano parvo, margini posteriori propinquiore.

2. *Runa decemfissa* Agass. Testa elongata, margine flexuoso, ano ori propinquiore.

III. Genus **MELLITA** Klein. Discus suborbicularis; petala lata, arcuata, subclausa. Foramina genitalia quatuor in angulis corporis madreporiformis. Lunulae elongatae in areis ambulacralibus et in area interambulacrali posteriori. Os parvum, médium, sinuosum. Anus pyriformis ori proximus. Sulci ambulacrales inferiores ramosissimi.

1. *Mellita quinquefora* (Pl. 3) Agass. Disco suborbiculari postice latissimo, lunulis quinque; petalis latis, arcuatis, subclausis. Ore sinuoso; ano magno pyriformi; sulcis ambulacralibus inferioribus latis, ramosissimis.

2. *Mellita testudinata* Klein (Pl. 4 a, fig. 7–9). Disco suborbiculari, antice latissimo; lunulis quinque; petalis latis, subclausis.

3. *Mellita hexapora* Agass. (Pl. 4, fig. 4–7, Pl. 4 a, fig. 11–12). Disco suborbiculari valde depresso; lunulis sex, angustis; lunula areae posterions imparis angustissima; petalis parvis, clausis; basi subæquali.

4) *Mellita similis* Agass. (Pl. 4, fig. 1–3). Disco suborbiculari vel subquingulari, lunulis sex; basi undulata; sulcis ambulacralibus valde ramosis.

5. *Mellita lobata* Agass. (Pl. 4 a, fig. 13, and Pl. 16, fig. 4–7). Disco suborbiculari, lunulis sex; lunulis ambulacralibus posticis apertis; petalis brevibus, ovatis, subclausis; poris genitalibus ocellaribusque vere distinctis.

IV. Genus **ENCOPE** Agass. Discus magnus orbicularis, vel ovatus. Aperturæ vel lunulae sex. Petala magna, clausa vel subclausa. Pori génitales quinque, in angulis corporis madreporiformis. Os centrale, sinuosum. Anus elongatus, ori proximus. Sulci ambulacrales inferiores ramosissimi.

1. *Encope emarginata* Agass. (Pl. 10). Disco suborbiculari, postice truncato; petalis ambulacralibus magnis, latis, subclausis; lunulis ambulacralibus clausis vel subclausis; lunula areae

interambulacralis elongata,

2. *Encope tetrapora* Agass. (Pl. 10 a, fig. 1–3). Disco orbiculari; lunulis ambulacralibus posticis angustis, apertis; petalis latis, ovatis, subclausis.

3. *Encope micropora* Agass. (Pl. 10 a, fig. 4–8, Pl. 19 a, fig. 7). Disco orbiculari; lunulis ambulacralibus clausis; lunula postica minima; petalis latissimis, ovatis, subclausis.

4. *Encope perspectiva* Val. (Pl. 106, fig. 1–5). Disco orbiculari; lunulis ambulacralibus laevis, ovatis; lunula postica maxima, ovata; petalis anticis brevioribus, ovatis.

5. *Encope cyclopora* Agass. (Pl. 10 b, fig. 6–9). Disco subcirculari, postice latissimo; lunulis ambulacralibus posticis apertis, anticis ovatis, clausis; lunula postica magna subcirculari; petalis elongatis; angulis corporis madreporiformis prominentibus; basi plana; sulcis ambulacralibus ramosissimis.

6. *Encope oblonga* Agass. (Pl. 9). Disco elliptico; lunulis ovatis, clausis, margine superiori incrassatis; lunula postica maxima; petalis posticis elongatis, anticis brevioribus, latis; angulis corporis madreporiformis prominentibus.

7. *Encope Valenciennesii* Agass. (Pl. 7 and 8). Disco maximo convexiusculo; sinibus ambulacralibus latis, apertis; lunula postica elongata, margine superiore incrassata; petalis posticis elongatis, leviter incurvis, anticis latis, ovatis.

8. *Encope subclausa* Agass. (Pl. 5). Disco subovato; aperturis antice subclausis; lunula postica elongata, margine superiori leviter incrassata.

10. *Encope Michelini* Agass. (Pl. 6 a, fig. 9–10). Disco subovato, postice truncato, in parte posteriore altiore; sinibus ambulacralibus apertis; lunula postica parva, angusta.

9. *Encope grandis* Agass. (Pl. 6). Disco subovalis, postice emarginato margine crassissimo; sinibus ambulacralibus latis, apertis; lunula postica elliptica, magna.

11. *Encope Stokesii* Agass. (Pl. 6 a, fig. 1–8). Disco orbiculari convexiusculo; sinibus in prima ætate apertis, in adultis subclausis; petalis subovatis latis. Differt ab aliis speciebus pariete intestinum sejungente nullo.

V. Genus **LOBOPHORA** Agass. Discus suborbicularis, duabus incisuris vel lunulis in margine posteriore. Petala breviora, convergentia. Foramina genitalia quatuor, in angulis corporis madreporiformis. Os medium, sinuosum. Anus parvus, margini propinquior quam ori. Sulci ambulacrales inferiores ramosi.

1. *Lobophora bifora* Agass. (Pl. 12). Disco sinuoso, postice valde dilatato, lunulis angustis elongatis; petalis latis, brevibus, truncatis.

2. *Lobophora truncata* Agass. (Pl. 11, fig. 11–16). Disco sinuoso postice truncato; lunulis longatis; petalis brevibus, ovatis, clausis.

3. *Lobophora bifissa* Agass. (Pl. 13, fig. 2–6 and Pl. 14, fig. 12). Disco depressissimo, valde dilatato; incisuris posticis duabus; petalis latis, ovatis, clausis.

4. *Lobophora aurita* Agass. (Pl. 13, fig. 1 and Pl. 14, fig. 3–7). Disco sinuoso, incisuris angustis, elongatis. Petalis subovatis, clausis.

VI. Genus **AMPHIOPE** Agass. Discus valde depressus; lunulis duabus rotundatis, posticis; petala ambulacralia lata, subovata, clausa, foramina genitalia quatuor. Os parvum; anus margini postico propinquus.

1. *Amphiope bioculata* Agass. (Pl. 11, fig. 1–5). Disco suborbiculari, postice truncato; lunulis subcircularibus; petalis latis, ovatis, subclausis. Ano margini proximo; sulcis ambulacralibus ramosissimis.

2. *Amphiope perspicillata* Agass. (Pl. 11, fig. 6–10). Disco valde depresso, postice subrostrato; lunulis subcircularibus; petalis subovatis, acutis.

VII. Genus **Scutella** Lam. (Ag). Discus orbicularis, margine integro. Petala ambulacralia subovata, subclausa. Foramina genitalia quatuor. Sulci ambulacrales inferiores ramosi. Os médium sinuosum. Anus margini postico proximus.

1. *Scutella subrotunda* Lam. (Pl. 17). Disco suborbiculari, valde dilatato, margine postico subrostrato, truncato, in medio inciso; petalis elongatis, subclausis; sulcis ambulacralibus inferioribus ramosissimis; ano infra marginem.

2. *Scutella truncata* Val. (Pl. 16, fig. 1, 2, 3, 8, 9). Disco inflato; margine tenuissimo postice subrostrato, truncato; petalis latis, ovatis, clausis; ano a margine remoto.

3. *Scutella propinqua* Agass. (Pl. 16, fig. 11–16). Disco convexiusculo, postice truncato, rostrato; petalis ovatis; ano a margine valde remoto.

4. *Scutella Brongniarti* Agass. (Pl. 15, fig. 1–3). Disco subcirculari; margine postico lato, truncato, subrostrato; petalis latis, ovatis, clausis; ano margini postico propinquiore.

5. *Scutella Faujasii* DeFr. (Pl. 15, fig. 4–6). Disco dilatato; margine crassissimo, postice angusto, rostrato, truncato; petalis latis; ano a margine remoto.

6. *Scutella striatula* M. de Sr. (Pl. 18, fig. 1–5). Disco tenui, subconico, postice rostrato, inciso; petalis parvis, ovatis; ano infra incisionem marginalem posticam.

7. *Scutella producta* Agass. (Pl. 18, fig. 6–10). Disco convexiusculo, postice valde rostrato; petalis ovatis; ano a margine remoto.

8. *Scutella paulensis* Agass. (Pl. 19, fig. 8–10). Disco convexiusculo, valde dilatato, postice truncato, non inciso; petalis elongatis, subclausis; ano infra marginem.

9. *Scutella stellata* Agass. (Pl. 19, fig. 1–2). Disco convexiusculo; petalis magnis, latis, ovatis; testa crassissima.

10. *Scutella subtetragona* Grat. (Pl. 19, fig. 7). Disco valde sinuoso, subquinquangulato, postice truncato, inciso; petalis parvis.

11. *Scutella Smithiana* Agass. (Pl. 19 a, fig. 5). Disco tenui, dilatato; petalis latis, ovatis, clausis.

12. *Scutella Rogersi* Mort. (Pl. 19 a, fig. 1–4). Disco orbiculari, superne undato, margine crassissimo; petalis ovatis, non clausis; ano inter os et marginem medio.

VIII. Genus **ECHINARACHNIUS** v. Phels. Discus orbicularis, convexiusculus, margine integro; Petala lata, aperta. Foramina genitalia quatuor. Basis plana. Anus marginalis. Os circulare, medium. Sulci ambulacrales inferiores trifurcati.

1. *Echinarachnius parma* Gray (Pl. 20, fig. 7–18). Disco orbiculari, margine crasso, postice subtruncato; petalis latis, valde apertis; ano marginali.

2. *Echinarachnius Rumphii* Agass. (Pl. 20, fig. 1–6). Disco subovali, margine crasso; ano submarginali; petalis latis, valde apertis.

3. *Echinarachnius atlanticus* Gray (Pl. 21, fig. 32–34). Disco circulari, margine tenui; petalis subovalis, convergentibus, non clausis; ano marginali.

4. *Echinarachnius incisus* Agass. (Pl. 21, fig. 29–31). Disco circulari; testa subconical; ano sub margine; petalis subovatis, valde apertis.

IX. Genus **ARACHNOIDES** Klein. Discus circularis. Anus supra marginem. Petala valde aperta. Foramina genitalia quinque. Basis plana. Os rotundatum. Sulci ambulacrales inferiores simplices, recti.

Arachnoides Placenta Agass. (Pl. 21, fig. 35–42. Testa subconica, margine tenuissimo; areis ambulacralibus multo majoribus quam areæ interambulacrales, tuberculis per series obliquas dispositis; ano supra marginem.

X. Genus **SCUTELLINA** Ag. Discus orbicularis vel ovatus; intus parietibus radiantibus præditus. Anus marginalis vel supramarginalis. Petala aperta, poris non conjunctis. Os rotundatum.

1. *Scutellina nummularia* Ag. (Pl. 21, fig. 8–14). Disco orbiculari, valde depresso; basi plana; petalis apertis, leviter convergentibus; ano marginali.

2. *Scutellina lenticularis* Ag. (Pl. 21, fig. 20–23). Disco ovato, convexiusculo; basi concava; ano marginali.

3. *Scutellina placentula* Mer. (Pl. 21, fig. 1–7). Disco ovato, minimo, depresso; ano supramarginali.

4. *Scutellina supera* Ag. (Pl. 21, fig. 15–19). Disco ovato, convexiusculo, antice angustiore, ano supra marginem; basi concava; ore magno, rotundato.

5. *Scutellina obovata* Ag. (Pl. 21, fig. 24–28). Disco ovato, depresso; ano marginali.

XI Genus **LAGANUM** Klein. Discus elongatus, subcircularis vel angulosus, margine tumido vel inflato. Basis plana. Os rotundatum. Anus infra marginem. Petala elongata, lanceolata. Foramina genitalia quatuor vel quinque.

1. *Laganum Bonani* Klein (Pl. 23, fig. 8–12 and Pl. 22, fig. 25–29). Disco subquingulato, depresso, margine valde inflato; petalis elongatis, lanceolatis, subclausis; foraminibus genitalibus quinque; ano longitudinali, inter os et marginem medio; sulcis ambulacralibus inferioribus ad dimidiam peripheriam productis.

2. *Laganum depressum* Less. (Pl. 23, fig. 1–7). Disco subdecagonali, postice truncato, antice dilatato, margine inflato; petalis elongatis, lanceolatis, subclausis; foraminibus genitalibus quinque; ano transverso, margini postico propinquiore.

3. *Laganum ellipticum* Ag. (Pl. 23, fig. 13–15). Disco ovato, depresso, margine tumido; petalis elongatis, subclausis; foraminibus genitalibus quinque; ano transverso, margini postico propinquiore.

4. *Laganum decagonum* Less. (Pl. 23, fig. 16–20). Disco convexiusculo, subcirculari, subangulato; testa tenuissima, margine leviter inflato; petalis angustis, subclausis; foraminibus genitalibus quinque; ano margini postico proximo.

5. *Laganum tenuissimum* Ag. (Pl. 26, fig. 4–6). Disco ovato, postice truncato; testa tenuissima, margine antice inflato; petalis elongatis, postice apertis; ano postico.

6. *Laganum reflexum* Ag. (Pl. 26, fig. 1–3). Disco ovato, postice truncato, margine antico reflexo maxime tumido; petalis longis apertis; ano postico.

7. *Laganum tonganense* Quoy and Gaim. (Pl. 26, fig. 7–19). Disco convexiusculo, subovato vel subangulato, postice truncato, margine tumido; petalis elongatis, apertis, irregularibus; foraminibus genitalibus quinque; ano magno inter os et marginem posticum medio.

8. *Laganum Lesueuri* Val. (Pl. 24, fig. 3–6). Disco convexiusculo, decagonali, anticedilatato; petalis elongatis, apertis; foraminibus genitalibus quatuor; ano magno, margini postico propinquiore.

9. *Laganum elongatum* Ag. Ag. (Pl. 24, fig. 1–2). Disco ovato, subangulato; antice rostrato, truncato; petalis convexiusculis; foraminibus genitalibus quatuor; ano magno, margini postico propinquiore.

10. *Laganum rostratum* Ag. (Pl. 25). Disco convexiusculo, ovato, postice rostrato, margine crasso, non inflato; petalis elongatis, apertis; foraminibus genitalibus quatuor; ano margini postico proximo.

11. *Laganum orbiculare* Ag. (Pl. 22, fig. 16–20). Disco orbiculari, postice subrostrato, margine inflato; petalis lanceolatis, acutis, clausis; foraminibus genitalibus quatuor; ano postico.

12. *Laganum marginale* Ag. (Pl. 22, fig. 11–15). Disco ovato, tenuissimo, convexiusculo, margine inflato; petalis lanceolatis acutis; foraminibus genitalibus quatuor.

13. *Laganum stellatum* Ag. (Pl. 22, fig. 7–10). Disco convexo, ovato; petalis acutis; foraminibus genitalibus quatuor, distantibus.

14. *Laganum Peronii* Ag. (Pl. 22, fig. 21–24). Disco alto, subcirculari, postice truncato; petalis ovatis; foraminibus genitalibus quatuor, maxime distantibus.

XII. Genus **ECHINOCYAMUS** v. Phel. Discus ovatus, depressus, intus parietibus radiantibus præditus. Petala aperta, recta vel ovata. Foramina genitalia quatuor. Basis plana vel concava. Os rotundatum, centrale. Anus infra marginem.

1. *Echinocyamus pusillus* Flem. (Pl. 27, fig. 1–8). Disco ovato, inflato, tuberculis maximis; ano inter os et marginem posticum medio.

2. *Echinocyamus suffolciensis* Ag. (Pl. 27, fig. 9–13). Disco ovato, depresso; tuberculis magnis.

3. *Echinocyamus angulosus* Lcske (Pl. 27, fig. 14–18). Disco ovato, subinflato; petalis angustis, apertis; testa tenui.

4. *Echinocyamus pyriformis* Ag. (Pl. 27, fig. 19–24). Disco ovato, subinflato, antice subacuto, postice dilatato; petalis angustis, apertis; testa crassiore.

5. *Echinocyamus altavillensis* Ag. (Pl. 27, fig. 25–28). Disco circulari, depresso; petalis ovatis, apertis.

6. *Echinocyamus obtusus* Ag. (Pl. 27, fig. 29–32). Disco ovato, depresso; petalis rectis, apertis.

7. *Echinocyamus sculus* Ag. (Pl. 27, fig. 33–36). Disco ovato, subinflato, antice subacuto, postice dilatato; petalis apertis, rectis.

8. *Echinocyamus Annonii* Mer. (Pl. 27, fig. 37–40). Disco orbiculari; petalis ovatis, convexiusculis, apertis.

9. *Echinocyamus alpinus* Ag. (Pl. 27, fig. 41–43). Disco ovali, inflato; ano margini postico propinquiore.

10. *Echinocyamus ambiguus* Ag. (Pl. 27, fig. 44–47). Disco ovato, depresso, margine crassissimo; petalis ovatis vel subovatis, apertis.

11. *Echinocyamus occitanus* Ag. (Pl. 27, fig. 48–58). Disco depresso, subcirculari, postice truncato, margine crasso; petalis magnis, apertis, sulcis transversis conjunctis; ano inter os et marginem posticum medio.

XIII. Genus **MOULINIA** Ag. Discus ovatus, depressus, extus sulcis radiantibus inter areas præditus. Anus inferus, inter os et marginem médius. Petala ambulacralia aperta, sulcis transversis non conjunctis.

Moulinia cassidulina Ag. (Pl. 22, fig. 1–6). Disco ovato, convexiusculo, sulcis radiantibus profundis; margine undato; tuberculis prominentibus.

Diekmann. ad nat in Lap. del.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-10. ROTULA AUGUSTI Klein.
Fig. 11-19. RUNA COMPTONI Ag.

Lichmann in lap.

Lith. de Nicolet à Neuchâtel / Suisse.

A. Thes. del. et sculp.

Lith. Sc. Nisbet & Haycraft [C. Swann]

Fig. 1-3. MELLITA SIMILIS Ag. Fig. 4-7. MEL. HEXAPORA Ag.

Diekmann ad. nat. in Lap.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-6. ROTULA AUGUSTI Klein. = Fig. 7-10. MELLITA TESTUDINATA Klein.
Fig. 11-12. MELLITA HEXAPORA Ag. = Fig. 13. MELLITA LOBATA Ag.

A. Hez sculp.

Lith. de Nicolet à Neuchâtel (Suisse)

A. Thes. sculp.

Delav. del.

Lith. de Miesler & Neuchatel (Strass.)

ENCOPE GRANDIS Ag.

Diekmann. ad. nat. in Lap. del.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-8. ENCOPE STOKESII AG. Fig. 9-10. ENCOPE MICHELINI AG.

Dielasma in 1827

Encope oblonga Ag.

ENCOPE OBLONGA Ag.

A. Thez sculp.

Delav. del.

Lith. de Nicolet à Neuchâtel (Suisse)

ENCOPE EMARGINATA Ag.

Fig. 1-3. ENCOPE TETRAPORA Ag. = Fig. 4-5. ENCOPE MICROPORA Ag.

Diekmann ad. nat. in Lap. del.

Lith. de Nicolet et Jeanjaquet Neuchâtel.

Fig. 1-5. ENCOPE PERSPECTIVA Ag. 4 Fig. 6-9. ENCOPE CYCLOPORA Ag.

Dickmann del.

Lith de Nicoler à Neuchâtel.

Fig. 1-5. AMPHIOPE BIOCULATA A. G. - Fig. 6-10. AMP. PERSPICILLATA A. G.

Fig. 11-16. LOBOPHORA TRUNCATA A. G.

Diekmann ad. nat. in liq.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

LOBOPHORA BIFORA Ag.

Lith. de Nicolet et Jenujaquet à Neuchâtel.

A. Sourel ad nat. in lap.

Fig. 1. LOBOPHORA AURITA Ag. Fig. 2-6. LOBOPHORA BIFISSA Ag.

Lith. de Nicolet à Neuchâtel.

A. Sommel ad nat. in lap.

Fig. 1-2 LOBOPHORA BIFISSA Ag. = Fig. 3-7. LOBOPHORA AURITA Ag.

A. Thes. Sculp.

Wallinger del.

Imp. de Nicolet & Neuchâtel (Genève)

Dickmann in lap.

Lith. de Nicolet à Neuchâtel (Suisse)

Fig. 1-10. SCUTELLA TRUNCATA Val. Fig. 11-16. SCUT. PROPINQUA Ag.

Lith. de Nicolet à Neuchâtel (Suisse)

Dickmann in lap.

SCUTELLA SUBROTUNDA Lamk.

Lith. de Nicolet Neuchâtel.

A. Sonrel ad nat. in lap.

Fig. 1-5 SCUTELLA STRIATULA M.Sr. = *Fig. 6-10* SCUT. PRODUCTA Ag.

Dickmann in Lap.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 12. SCUTELLA STELLATA Ag. Fig. 3-6. SCUTELLA TRUNCATA Val.
Fig. 1. SCUTELLA SUBTETRAGONA G. Fig. 8-10. SCUTELLA PAULIENSIS Ag.

Diekmann. ad nat. in Lasp.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 14. SCUTELLA ROGERSI Morc. Fig. 56. SCUT. SMITHIANA Ag. Fig. 7. ENCOPE MICROPORA Ag.

Diekmann ad. nat. in Lap. del.

Lith. de Nicolet et Jeanjapuet à Neuchâtel.

Fig. 1-8. ECHINARACHNIUS RUMPHII AG.*Fig. 9-18.* ECH. PARMA GRAY.

Diekmann ad nat. in Lap. del.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-7 SCUTELLINA PLACENTULA Mer. *Fig. 8-14* Sc. NUMMULARIS Ag.
Fig. 15-19 Sc. SUPERA Ag. *Fig. 20-23* Sc. LENTICULARIS Ag.
Fig. 24-28 Sc. OBOVATA Ag. *Fig. 29-31* ECHINARACHINIUS INCISUS Ag.
Fig. 32-34 Ech. ATLANTICUS Gray. *Fig. 35-42* ARACHINOIDES PLACENTA Ag.

Diekmann ad nat. in Lap. del.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-6. MOULINIA CASSIDULINA Ag. Fig. 7-10. LAGANUM STELLATUM Ag.
 Fig. 11-15. LAGANUM MARGINALE Ag. Fig. 16-20. LAGANUM ORBICULARE Leske.
 Fig. 21-24. LAGANUM PERONII Ag. Fig. 25-29. LAGANUM BONANI Klein.

A. Senzel ad nat.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

Fig. 1-7. LAGANUM DEPRESSUM Less. *Fig. 8-12. LAG. BONANI* Klein.
Fig. 13-15. LAG. ELLIPTICUM Ag. *Fig. 16-20. LAG. DECAGONUM* Less.

Th. Let. 2. n. 1.

Lith. de Nicolet et Jeannet à Neuchâtel.

Fig. 1 et 2. *LAGANUM ELONGATUM* Ag. - Fig. 3-6. *LAG. LESUEURII* Val.

A. Sonrel ad nat.

Lith. de Nicolet et Jeanjaquet à Neuchâtel.

LAGANUM ROSTRATUM Ag.

Diekmann ad nat. in lap. del.

Lith. de Nicolet et Jeanyquet à Neuchâtel.

Fig. 1-3 LAGANUM REFLEXUM Ag. *Fig. 4-6* LAG. TENUISSIMUM Ag. *Fig. 7-19* LAG. TONGANENSE O. et G.

Diekmann ad nat. in lap. del.

Lith. de Nicolet et Jeayquet à Neuchâtel.

Figs 1-8. ECHINOCYAMUS PUSILLUS Flem. = *Fig. 9-13. E. SUFFOLCIENSIS* Ag.
Fig. 14-18. E. ANGULOSUS Leske. *Fig. 19-24. E. PYRIFORMIS* Ag. = *Fig. 25-28. E. ALTAWILLENSIS* Ag.
Fig. 29-32. E. OBTUSUS Ag. = *Fig. 33-36. E. SICULUS* Ag. = *Fig. 37-40. E. D'ANNONII* Meriam.
Fig. 41-43. E. ALPINUS Ag. = *Fig. 44-47. E. AMBIGUUS* Ag. *Fig. 48-58. E. OCCITANUS* Ag.