1839

**Monographies d'Échinodermes Vivans et Fossils. Échinites.
Famille des Cidarides. Premiere Monographie. Des Salénies: A
translation of *Monographies d'Échinodermes vivans et fossiles.
Échinites. Famille des Cidarides. Premiere Monographie. Des
Salénies***

Louis Agassiz

John Lawrence
University of South Florida, lawr@usf.edu

J. C. Fletcher

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Translator's notes:

In his Preface, Agassiz stated his plan was for “Monographies d'Echinodermes vivans et fossils” to publish successively small monographs, each including a natural group, as they became available. These were ultimately to include the entire phylum of echinoderms. Agassiz prepared two (Salenies and Scutellids). He asked Desor, who was working with him, to prepare two (Galerites, Dysaster). He invited a friend, Valentin, an eminent physiologist at the University of Bern, to prepare a work on the anatomy of Echinus. These were the only five monographs published, the last by Desor in 1842.

Agassiz, L. 1839. Echinites. Famille des cidarides. 1. Monographie. Des salénies.

Agassiz, L. 1841. Echinites. Famille des clypeasteroides. 2. Monographie. Des scutelles,

Valentin, G. 1841. Anatomie des echinodermes. 1. Monographie. Anatomie du genre Echinus,

Desor, E. 1842. Echinites. Famille des clypeasteroides. 3. Monographie. Des galerites,

Desor, E. 1842. Echinites. Famille des clypeasteroides. 4. Monographie. des Dysaster.

The year of publication of the first monograph has been cited as 1838. This year is on the cover of the monograph. This publication year has been questioned. The year of printing, as indicated on the cover, is not necessarily the year of publication. Agassiz gave the date of his writing the Preface to the first monograph as 22 December, 1838. In their published list of books available for purchase, two book sellers gave 1839 as the year of publication. Buecher, Landkarten &c. in Leipzig listed it in books published from July to December, 1839. Bent's Monthly Literary Advertiser in London listed it as published in September, 1839. I thank M. Reich (pers. comm.) for calling my attention to these references. It seems probable 1839 is the year of publication.

I have changed some of Agassiz's anatomical terms:

appareil oviducal to apical disk. Agassiz changed his term for the structure to “apical rosette” in his subsequent monograph on Scutellids. He noted he used the term “appareil oviducal” in the monograph on Salenies because the genital pores open around it.

plaques ovariiales to genital plates.

plaques interovariales to intergenital plates.

ouverture inférieure to mouth.

I thank Mike Reich, Andreas Kroh, Chris Mah and Richard Turner for helpful comments on the Monographies.

I thank Michel Jangoux for help with some difficult terms.

MONOGRAPHIES D'ÉCHINODERMES

VIVANS ET FOSSILES.

PAR

LOUIS AGASSIZ,

DOCT. EN PHIL., MÉD. ET CHIR., DOCT. EN DROIT H. C. DES UNIV. D'ÉDIMBOURG ET DE DUBLIN; MEMBRE DES SOC. ROY. DE LONDRES ET D'ÉDIMBOURG, DES ACAD. ROY. DES SCIENCES DE STOCKHOLM ET DE TURIN, DE L'AC. IMP. LÉOP. CÉS. DES CUR. DE LA NAT., DE LA SOC. IMP. DES NAT. DE MOSCOU, DE LA SOC. PHILOM. DE PARIS, DES AC. DE PHILADELPHIE ET DU VAL D'ARNO, DU LYCÉE DE NEW-YORK, DE L'INSTITUT DE BRISTOL, DE LA SOC. PHILOS. ET LITT. DE LEEDS, DE LA SOC. GÉOL. DE FRANCE, DE L'ASSOC. BRITT. POUR L'AVANCEMENT DES SCIENCES, DES SOC. HELVÉT. ET GERMAN. DES SC. NAT. ET MÉD., DE LA SOC. DES ANTIQ. DU NORD À COPENHAGUE, DE CELLE DES SC. PHYS., CHIM., ARTS AGRIC. ET INDUSTR. DE FRANCE, DES SOC. D'HIST. NAT. DE BERLIN, FRANCFORT, PRAGUE, HEIDELBERG, STRASBOURG, SILÉSIE, HALLE, PRIBOURG, ZÜRICH, HALE, ETC.; PROFESSEUR D'HISTOIRE NATURELLE À NEUCHÂTEL.

NEUCHÂTEL EN SUISSE,

AUX FRAIS DE L'AUTEUR.

—
1858.

TO

VALENCIENNES

PROFESSOR OF ZOOLOGY AT THE JARDIN DES PLANTES

AND

PAUL DESHAYES,

PROFESSOR OF CONCHILIOLOGY, AT PARIS

*Editor's testimonial, of recognition and friendship of
the Author.*

PREFACE

The nature of the general results to which the study of fossil fish led me, the certainty that I have acquired by the changes that this class has undergone over all the geological formations, presents a kind of progressive transformations, announcing an order of higher things, accomplished in the present period with the appearance of man, the desire to learn about the diverse trends that are shown in the other branches of the animal kingdom, and finally the always more pressing need to encompass with a glance the relations that exist between all living beings in their appearance on the earth. All these considerations have engaged me to investigations on several classes of animals that I had occupied myself less until now.

The class of echinoderms appeared first to me to merit particular attention. The strength of the test for most species, to which it is necessary to attribute the often very perfect preservation of the numerous remains of these animals in all the layers of the surface of our globe gave in advance certainty that I could examine the characters of these animals in the most extended scale at the same time that the complicated nature of these strong envelopes promised numerous many terms of comparison and consequently the possibility of a study more complete and more significant in their organization than would be offered by the examination of molluscan shells. Another circumstance appeared to me at first to facilitate research in this class and lead more promptly to certain results was the comparatively smaller number of known species. However, I soon found I was singularly mistaken because a comparison of species coming from different locations and that had been considered identical after determinations made for the most part from figures or even according to simple descriptions, I became certain that not only were these species frequently different, but still more that they even belonged sometimes to different genera. The necessity of a careful review of the entire class was then apparent to me and I made every effort to obtain the necessary material for a direct comparison of all the species described or reported by authors. It appeared likewise essential to go back to the first sources to establish synonymy in an authentic way and to avoid the too frequent duplication in the works of pure compilation and also as fatal to the progress of science as the enumeration of all the nominal species whose existence is often based on superficial indications or bad descriptions applicable to several species at the same time, or on the inadequate care we generally take in comparing old works.

To order more surely attain my goal, and to avoid as much as possible the diverse source of errors that I just described, I went to Paris shortly after the publication of my *Prodrome d'une Monographie des Radiaires ou Echinodermes* (inserted in 1^{er} vol. des *Mémoires de la Soc. des sc. nat. de Neuchâtel* 1836), to study in detail the collection of echinoderms of the Museum, the largest that exists in Europe. Encouraged in my research by the kind friendship of Valenciennes who was kind enough to put the entire collection at my disposal, I examined the different species one by one that I determined for the most part and among which I distinguished a large number new as well as several entirely new genera. I especially found the originals of nearly all the species of Lamarck, bearing still for the most part the labels in his hand. A large number of species described by de Blainville, in the new *Dictionnaire des sciences naturelles*, are likewise found with the label in the hand of the author. Thanks to the zealous perseverance of Valenciennes, this class of radiates is now in the process of arrangement in the galleries of the Museum, so that those who want to

make an in-depth study will find all the desirable facilities. The specimens are mounted in a very ingenuous and clear manner to indicate the characters of the species. Brongniart has likewise sent to me, with his usual kindness, the fossil species that he has described or indicated in his different works. I also must recognize to DeFrance the knowledge of all the fossil species he has described. The examination of these original collections was all the more valuable to me as it is to the works of these authors that the more recent works on echinoderms refer. And before having seen the original of their descriptions, I could still have grave doubts of the identity of their species with those that were later described by Gray, Goldfuss, the Count of Münster and Ch. DesMoulins.

In addition to these original species, I have encountered in these collections, a large number of new species that have been placed at my disposal with the same liberality. But it is to DesHayes in particular that I have received the largest number of new species, especially fossils. It is scarcely to be believed that his collection alone contains more than one hundred species of echinoids that are still not mentioned in any of the numerous works that treat the history of echinoderms. Driven by this noble confidence that characterizes the naturalists whose sole goal is to promote the progress of science, DesHayes has had the goodness to send me his entire collection and authorized me to keep it as long it was necessary for my work. I have found the same eagerness to place at my disposal all that could be of some interest for my publication, by most French geologists and naturalists who had collections. Elie de Beaumont has sent me several very interesting Alpine species; Voltz, different urchins of the Neocomian of Bourgogne and the south of France; Milne-Edward, some species from Italy and Egypt; Alcide d'Orbigny, superb urchins from the Cretaceous and some living species of South America; he has in addition a remarkable collection of crinoids. Michelin has sent me the most interesting of his magnificent collection of living and fossil echinoids containing species of diverse localities and different terrains. I have seen in de Verneuil a very beautiful collection of crinoids, especially from Mountain-Limestone; Dutressier, from Besançon, has sent me a rather large number of fossil cidarids with the spines nearly intact, Leymeric some diademids from the Triassic period from Caen, and Deslongchamps, from Caen, a very beautiful collection of species coming from the terrains of Normandy. Previously, I have examined in London the species of the British Museum described by König in his *Icones sectiles*, and by Gray in his different notices; those of the collection of Stockes, which is very rich in living species, and a part of those of the Geological Society, collected in all the English terrains. At Brighton, I have seen those of the collection of Mantell, coming for the most part from Cretaceous terrain. At Bristol, I have examined the magnificent collection of crinoids of Miller that are found in the Museum of this city, and the species that Cumberland has discovered. Several new species from the collection of Sir Philipp Egerton, and those of the Museum of Scarborough, had equally a great interest. But I have been especially delighted to find in the Museum of Cambridge the species figured in Ag. Scilla. In Switzerland, Studer has placed at my disposal the magnificent collection of fossil species from the Museum of Berne; those of the Museum of Soleure were sent to me by Hugli, those of Bâle by Mérian. During the meeting of the Soc. géol. de France at Porrentru, I have examined most of the species mentioned by Thurmann. Finally, Gressley has given me all the new species that he has discovered in exploring the Swiss Jura including important observations on their deposits and in particular their association with other fossils, a circumstance well worthy of the attention of geologists and on which he was the first to insist in a precise manner how it would contribute to clarifying the history of the terrestrial globe.

Already the *systematic tables of the Echinites* of DesMoulins have been the greatest help to me, as a summary of our knowledge of this order of the class, at the time of their publication. I appreciate all the more this work that I knew myself of the difficulties without number that it

presents when, on my side, I prepared similar table for my own particular use. I am happy to be able to dispense with, in large part, publishing the details and to be able to confine myself to pointing out the difference that I find between his synonymy and that I have established.

If I have mentioned all the facilities that have been offered to me for my work, it is not at all to make a parade. It is, on the contrary, a sentiment of justice that has determined me to give public homage to the liberality of all those who have contributed to place me in a position to give to my work an extension that would never have been possible if I had been reduced to work on only the material possessed by the Museum of Neuchâtel. I have in addition the conviction that it is only in faithfully indicating all the sources I have used, in giving to each what is right, in trying never to usurp a priority that is not justly merited, in not aiming at a supreme tyranny in science that we can deserve from our contemporaries a confidence without which the most important scientific works lose their authority, and that the only position of a scholar in the world would not know how to give it or keep it. And then, there are so rarely favorable circumstances of our making in which we can find ourselves, it would be ridiculous to want to glorify ourselves.

To complete the inspection of original collections, it still remains for me to see or review more carefully, the species described by Goldfuss, those of the Count of Münster, those of Ch. DesMoulins and Grateloup, those of Philipps, Risso, Marcel de Serres, and those of Rømer. As soon as my occupations permit me, I shall hasten to finish this part of the task that I imposed on myself, as much as possible the natural history of this class. The relations that I have with most of these scholars give me the certainty I shall find with them the same facilities that I have already encountered in the course of my research.

Allow me to add still some words on the plan of this work. My intention is to describe and represent all the new or little-known species, and even those that have been poorly figured up to now. But not being able, in the very interest of this work, to use the regular mode of publication and in order to publish first the parts of my research in which the newest material and information is most complete, I shall publish successively small monographs, each including a natural group and thus forming wholes, whose order of succession becomes rather indifferent. They will be linked in the last analysis by general considerations that will terminate this work. These monographs, whose extent will be proportional to their content, will appear at irregular times. This is, I think, the only way that an author who must publish in parts can follow, without incurring continual reproach for negligence and slowness, often so little merited. In this way, this work will be envisaged, in some way during all the duration of its publication, as a journal or a review destined for the study of the entire class of echinoderms. I shall be happy to use all the new facts that individuals want to send me. The new species, which have not been mentioned at all in the chapter on the genus, will be described in supplements that will accompany the monographs each time they appear.

Desiring all naturalists to have the ability to verify the correctness of my statements and directly evaluate the value of the characters that I assign to my new genera and new species that I distinguish, I had plaster molds made of them when the condition of the specimens permitted it. I offer these collections to the museums that desire them in the hope of obtaining in exchange new material for my work.

In order not to prolong indefinitely this publication and to complete rather the descriptive details, I have associated to my work one of my friends, Desor, who has made, under my direction, a very deep study of echinoderms, and who is already in charge of carefully editing my notes and the direction of the artists occupied with drawing the considerable material that I now have before me.

Neuchâtel, 22 December 1838.

L. AGASSIZ

ÉCHINITES.

FAMILLE DES CIDARIDES.

Première Monographie.

DES SALÉNIES.

SOME OBSERVATIONS ON THE SALENIES IN GENERAL.

As, since Linnaeus, we began to subdivide the urchins into several genera, we have recognized the necessity of restricting the generic characters to the particularities of organization to which we had at first attached little importance. Nevertheless, the number of genera that we accept now into the family of true urchins, is still not great. However, the organic differences that exist between the species that we left in the genus *Echinus*, often have a generic value as great as the characters according to which we have distinguished the genera up to now, namely the genera *Cidaris*, *Diadema*, *Arbacia* (Gray) or *Echinocidaris* (DesMoulins), *Salenia*, *Echinometra* and *Echinus*. In fact, it especially because of the structure of their ambulacra composed, as in *Cidaris*, of only two pairs of pores that we have detached *Arbacia* and *Salenia* from the genus *Echinus*. And the large ambulacral tubercles of *Cidaris* have served to distinguish them from diademids. Now, if we examine carefully the species placed in each of these genera, we will be struck by the differences they present. We shall find very great difficulty to introduce there a large number of unpublished species whose examination, far from suggesting uniting already established genera, rather makes felt the need of creating new ones with narrower limits that permit grouping more naturally the species according to their closest affinities. It is especially the study of fossil species that makes felt the need for multiplying the genera. As we know them better, we perceive that they do not fit well with the living species to which we are used to associate them. E.g., *Cidaris crenularis*, placed successively into the genera *Cidaris* and *Diadema*, is the type of a particular genus I shall call *Hemicidaris*, whose spines are so bizarre that often they have been seen as polyps. I know now about ten unpublished species of this genus. Another equally new genus, near *Hemicidaris*, is *Glymnocidaris*, characterized by the nearly complete absence of large tubercles on the dorsal surface of the test. In the collections of Paris, I have recognized a new genus, near *Cidaris*, that I shall call *Acrocidaris*, whose spines are equally known to me. They resemble those of *Echinometra mammillata*. Other generic types near *Cidaris* seem indicated by the spines that we confuse under the name *Cidaris glandifera*, and that I know five or six distinct species of the Jurassic and Cretaceous terrains. The spines of which we made *Cidaris Schmidelii*, also appear to refer to a particular genus. It is the same for an unpublished species of the Lower Oolitic, whose spines end in wide spatuliform blades. In summary, the number of species of *Cidaris*, in the broadest sense of the genus that I know now and that I have examined in the field, is at least triple reported by the authors.

As far as the *diademids*, it is evident to me that the Jurassic and Cretaceous fossils that have been reported to this genus, differ generically from living diademids, both in the structure of the test and by the nature of their spines. I have thought it necessary, consequently, to refer these latter to the genus *Astropyga* established by Gray. But I did not stop there. I have even been led to accept several generic sections in the fossils, in separating from the true diademids three new genera, *Tetragramma*, *Acropeltis* and *Pedina*. The first is characterized by the presence of four rows of principal tubercles on the inter-ambulacral areas, the second by a very particular apical disc, similar to that of the Salenies, and the third by its general flat form and arrangement of its ambulacra.

The species with non-perforated tubercles, that we had up to now confused with the diademids, can no longer remain united with this genus, whatever the similarity of their forms. I have made several distinct genera of it: the genus *Cyphosoma*, with single ambulacra with two rows of

principal tubercles on the ambulacral and inter-ambulacral areas; the genus *Cælopleurus*, whose ambulacral areas are spiny, the inter-ambulacral areas, on the contrary, lack tubercles in all the dorsal surface of the test, and the genera *Echinopsis*, *Codiopsis* and *Terina*. Despite these restrictions, there still remains to me in the true diademas, five times as many species that have not been described until now.

The living *Arbacia* differ generically from the Jurassic species that I have placed in this genus. The number of species has also doubled since the publication of my Prodrôme.

But it is in the group of *Salenia* that I have made the most additions, because the number has been quintupled. I have recognized three new genera that were confused in this division.

I shall not extend further my indications on additions that the class of echinoderms is at the point of receiving. I shall content myself only with noting on this occasion how our knowledge in paleontology is still incomplete, because in a class where so much has been done since Lamarck, and on which has appeared work so remarkable, a few visits to existing collections have furnished me such a mass of new material, and how the scientific results presented up to now will probably undergo modifications. We want to consider, now, only Salenies and the genera close to it. I am going to indicate the general characters of this group. I shall go later in great detail on the genera *Echinometra* and *Echinus* proper, as they also must be divided into several genera. But the enumeration of them would take me beyond my present goal.

The SALENIES, such as Gray has characterized them (Proceed. of the Zool. Soc. 1835, p. 58), and as I consider them here, are urchins with ambulacral areas narrower than the inter-ambulacrals, having only one large imperforated tubercle on each coronal plate and whose genital and inter-genital plates, fused in a way that they cannot easily be separated, form a protruding disk crossed by the anal system whose opening is sometimes central, sometimes anterior and sometimes posterior. In carefully examining this group, however, I have recognized notable differences in the structure of the apical disc. And how a peculiarity worth noting, this apparatus is preserved in all the specimens that are barely recognizable to the point that, when it is a matter of determining an urchin that combines all the characters of Salenies, but when it lacks the apical disc, we can without fear of making a mistake relate it to other genera. I thought I had to attach a particular importance to this part of the test and divide the group of Salenies into four following genera according to the modifications they present. These are: 1° the genus *Salenia* proper, 2° the genus *Goniopygus*, 3° the genus *Peltastes* and 4° the genus *Gonioporus*, all of which occur particularly in Cretaceous terrain, since up to now no species has been found in older terrains or in the more recent ones. Goldfuss in truth also cites his *Cidarites scutiger* in the Jurassic formation, but this report requires confirmation.

As Salenies are generally of small size, and their characters difficult to see with the naked eye, I have been careful to represent the different parts of the test enlarged beside the figures of natural size. Each species is seen in profile and by the dorsal and ventral surfaces. The enlarged parts are, for each species, an ambulacral and an inter-ambulacral area of the test, the apical disc and a tubercle seen in profile.

CHAPTER I.

GENUS SALENIA Gray (Ag.)

The genus *Salenia*, restricted to the limits that I assign it now, is characterized by an unpaired plate located in the middle of the apical disc, which I shall call the suranal plate and that, according to its position vis-à-vis the anal opening, always makes the anus eccentric, projecting it sometimes forward, sometimes backward. This suranal plate is ordinarily the same size as the genital plates and forms with them, as with the five inter-genital ones, a circular disk diversely notched on its periphery. The plates themselves have truncated or serrated or lobed edges that constitute very important specific differences. When the suranal plate is located forward of the anus, the three posterior genital plates are ordinarily a little larger than the two anteriors. On the contrary, when it is behind and approaches the posterior inter-ambulacral area, there are the four pairs of genital plates that are the largest. The inter-ambulacral plates are very wide, composed of a small number of plates in the middle of which is raised a wide cone, surrounded by a smooth zone that is edged with other small tubercles. This cone is surmounted with an articulating mamelon at the top of which there is no foraminiform impression as in the species of the tribe of *Cidaris*. The constriction that separates the articulating mamelon from the base of the tubercular cone is marked by radiating impressions that, according to the observation that de Buch has made for the *Cidaris*, serves to fix the rods and regularize their movements. Up to now, I have not had the opportunity to observe the rods of any species of *Salenia*. The ambulacral areas have two rows of principal tubercles, separated sometimes by small, more-or-less granulose tubercles, but in general closer together than in the genus *Diadema*. They are edged on each side by a double row of pores arranged by single oblique pairs, and very close to the small tubercles of the ambulacral plates. The number of these pairs of pores is constantly considerably more, often triple that of the tubercles. The opening of the buccal apparatus is always smaller than the disk formed by the apical disc, although in different proportion. In broken specimens of various species, I have been able to note that the test of *Salenia* is very thick, proportionally to their size, and that the supports to which the buccal apparatus is fixed are very short. All the species that I know are of small size, some being scarcely a third of an inch, others a half inch in diameter. All come from Cretaceous terrains, from the Neocomian terrain up to the white chalk inclusively. According to the position of the anus, I have divided this genus into two sections: the first includes the species where the anus is anterior, the second those where it is posterior.

I. Salénies having the anal opening in front.

I. SALENIA PERSONATA Ag. Pl. 1. fig. 1–8.

Cidaris personata Defrance, Msc.

Its form is orbicular, with a very flat ventral surface, fig. 2 and 3. The buccal opening is smaller than the apical disc and slightly re-entrant. Its periphery is circular although with small notches placed equidistance from each other so that the edge of the ambulacral areas and that of the inter-ambulacral areas have nearly the same extent. Only the latter is straight while the edge of the ambulacral areas is characterized by a smaller median serration that corresponds to the junction of two rows of tubercles, fig. 3 and 7. The apical disc fills nearly half the dorsal surface of the test. The plates that compose it are smooth, but as they articulate in sinuous lines and are depressed where the join, the entire apparatus has a very rugged aspect that has given the species the name of *personata*. The genital plates differ essentially from the inter-genital plates by their dimensions and their structure. These are wide, trilobed shields, pierced by a small hole in the middle. The inter-genital plates are sensibly smaller and elongated in the direction of the transverse diameter. Finally, the suranal plate takes a very particular form. It resembles a wide crescent embracing all the posterior half of the anal opening that it makes protrude even more than the anterior part. It is bordered by the base of two front genital plates. The anal opening itself is oval in the direction of the transverse diameter of the animal, fig. 1 and 6.

The ambulacral areas, although very narrow, to the point of not leaving any free space for the small tubercles between the two rows of principal tubercles, are however wider in the ventral part than in the dorsal part of the disk and converge in a slightly sinuous line from the base to the top. They make two rows of single tubercles, rather small, against which abuts, on each side, a line of double pores, arranged in oblique pairs, like the tubercles, fig. 5. In the inter-ambulacral areas, that are very wide, are two rows of four large, conical tubercles, of which the most protruding occupies the middle of the ambitus. Their base is perfectly smooth, but the top has a rather pronounced constriction, with small articulating crenulations all around the mamelon that ends the cone, fig. 8. Around each large tubercle, grouped in a circle outside a smooth and rather wide zone, are small tubercles similar to those of the ambulacra, fig. 2 and 4.

The label of the specimens, which I owe to the kindness of Defrance, indicates the origin as Minorca, and as the gray-green deposit. Valenciennes has sent me a specimen from the Museum having the same indications. I have others thanks to DesHayes. Their origin is not known.

II. SALENIA SCRIPTA Ag. Pl. 1, fig. 9–16.

We can consider this species as intermediary between *S. personata* and *petalifera*. Its essential character consists of the structure of the apical disc, fig. 9 and 14 and, in particular, in the manner in which the different plates are fused together. The sutures are fine lines, crossed themselves by the perpendicular depressions that pass from edges of one plate to those of the adjacent plates. They are especially apparent in the sutures the unite the large suranal plate to the three posterior

genital plates. The genital plates are all pieced by a small hole in the middle. But they differ from each other in form and size according to their position. Those of the posterior side resemble the large shields in the form of irregular heptagons, wider at their internal edge than at their external edge, while those of the anterior side take up to a certain point, the form of a crescent. They are reduced by the periphery of the anus that is subcentral and carried forward. The suranal plate that forms the immediate edge of the anal opening on the posterior side, is very thick and very protruding. It differs from the genital plates by its larger dimensions and by its more concave base. The inter-genital plates overlap somewhat the genital plates. They are irregularly lozenge-shaped and finely serrated at their external edge. The anal opening is oval, elongated in the direction of the transverse diameter. The peristome is not very large, fig. 11. On its periphery, at the corners of the ambulacral areas, are rather deep crenelations placed nearly equidistance from each other. But the edge of the ambulacral areas differs from the edge of the inter-ambulacral areas in that it has a small, secondary crenelation corresponding to the union of two rows of tubercles, while the latter is nearly straight, fig. 11 and 15. The ambulacral areas are very narrow and their tubercles very small. However, here and there, are still some small tubercular granulations between the two rows of tubercles. The inter-ambulacral areas are wide, fig. 10, that are remarkable for their articular mamelon that is proportionally very small, fig. 16. Around each large tubercle is also, as in most species of this genus, a circle of smaller mamelonated tubercles. Others, even smaller, occur between these circles and form a rather wide sinuous zone between the rows or large tubercles. The only perfect specimen that I know of this species is part of the collection of the Museum of Paris and was sent to me by Valenciennes. Its origin is unknown.

III. SALENIA PETALIFERA Ag. Pl. 1. fig. 17–24.

Echinus petaliferus DesM. (Defrancc, Dict. Sc. nat. vol. 37, p. 10
DesM. Echin. p. 304.

The arrangement of the apical disc, that sensibly stands out from the dorsal surface of the test, and the rather considerable number of small tubercles between the two rows of tubercles of the ambulacral areas, constitute the most salient character of this species, fig. 18 and 21. Its circular form, very flat on the ventral side, is near *S. scripta* and *S. geometrica*. The peristome is rather large and re-entrant. The notches of its periphery are wide and deep. The edge of the ambulacral areas between two crenelations is as large, if not larger than that of the inter-ambulacral areas. The difference consists of this, it is that the latter is protruding while that of the ambulacral areas is notched, fig 19 and 23. The ambulacral areas form a slightly sinuous band, composed of two rows of principal tubercles that converge in coming closer from the base to the top. But they are however sufficiently far apart, especially towards the ventral surface, to permit the insertion of two other rows of small tubercles. The pores are arranged in oblique pairs in two very close lines that abut on each side the tubercular band, fig. 18 and 21. As far as it has been possible for me to be assured on fossil tests, I think I have recognized that there is scarcely one pair per plate in the ambulacral area. The inter-ambulacral areas are wide and have two rows of approximately five rather steep tubercles surmounted by a rather large mamelon that surrounds, below the neck of the tubercle, very small articulating grooves, fig. 20 and 24. The largest tubercles are located above the most

swollen part of the test. Below, they decrease sensibly as they approach the peristome. Each principal tubercle is surrounded by a complete circle of small tubercles lacking a mamelon and rather similar to the tubercles of the ambulacral areas. Other tubercular granulations, still smaller, fill the space between these circles and thus form several sinuous lines from bottom to top, fig. 18 and 20.

The apical disc is nearly circular and very raised. It occupies nearly a third of the dorsal surface of the test. The five genital plates of a more-or-less regular form according to their position before or behind the anal opening, are each pierced by a small hole in the middle. The inter-genital plates are smaller, in the form of elongated triangles and wavy on their external edge. The suranal plate, finally, has the form of an irregular crescent, located between the posterior genital plates and the anal opening of which it forms the immediate border that is very protruding. All these plates are smooth and united by very distinct sutures on which appear from here and there small sunken pits that give the plates a slightly cut and marbled appearance. The periphery of the entire system has a slightly undulating line, resulting from the fact that the genital and inter-genital plates do not overlap each other. The anal opening is subcentral, tilting toward the anterior side, fig. 17 and 22. The test, in general, has a medium thickness. Its structure is very elegant and very delicate. Among the specimens I have at my disposal, two have been sent to me by DesHayes, one by Defrance and two by Brongniart, of which one comes from Cape La Hève and the other from Longleat.

IV. SALENIA GEOMETRICA Ag. Pl. 1. fig. 25–32.

It is the largest species of this genus known to the present. Its elevated form, nearly spheroidal, slightly flattened on the dorsal and ventral surface, narrows in the ambulacral areas and the rectilinear sutures of the apical disc (that prompted me to give it the name above), serves always to distinguish it at first glance from most of its congeners. The peristome is smaller than the apical disc. Its ambitus is circular, although slightly notched between the ambulacral areas and the inter-ambulacral areas. As in *S. personata*, the edge of these latter is nearly straight, while those of the ambulacral areas have a slight inflexion correspond to the point of junction of the two rows of tubercles. It is worth mentioning that despite the great difference in width of the ambulacral and inter-ambulacral areas, the notches that separate them on the periphery of the buccal opening are equidistant, fig. 27 and 31.

The ambulacral areas, very narrow and slightly sinuous, have two rows of tubercles so close together that there remains no free space between them for small tubercles. There are scarcely any very small ones near the peristome. The pores form on each side of the ambulacral area a double row parallel to the rows of tubercles, fig. 26 and 29. The inter-ambulacral areas, equally wide on the anal side and the buccal side, are formed of a small number of large plates, each with a very protruding tubercle surrounded by a circle of smaller tubercles. The larger tubercles are located above the middle of the ambitus. All, without exception, are raised in the middle of a wide smooth zone and are with a very apparent mamelon, although comparatively small to the width at the base, fig. 28 and 32. The small articulating crenulations of the mamelon are seen very well below the neck of the tubercles. Finally, the space between the two rows of large tubercles is sprinkled as in the preceding species but in considerably fewer number, with very small granulations that have been mistakenly omitted from the drawing.

The genital and inter-genital plates and the suranal plate are equally smooth. The anal opening is subcentral, slightly protruding and bordered in its posterior half by the large suranal plate that occupies the center of the dorsal disk. The latter is hexagonal in form with a concave base. The genital plates are irregularly hexagonal, elongated and narrowed outside, with a small hole in the middle. Their exterior edge is truncated and rounded. But it does not overlap the edge of the inter-genital plates, which makes the apical disk circular and rather regular. The inter-genital plates are irregular triangles in form. Their largest side is turned outside and is slightly undulated. The sutures that unite all these plates are straight lines interrupted here and there by small angular impressions, fig. 25 and 30. D'Orbigny had the kindness to send me several very well-preserved specimens of this species, coming from the lower beds of chalk of Saintes, near Charente in the Department of Charente-Interieur. Another, no less perfect, was sent to me by DesHayes.

V. *SALENIA SCUTIGERA* Gray. Pl. 2, fig. 1–8.

Cidarites scutiger. Münster. (Goldf. Pl. 49. fig. 4 *a* and 4 *b*.)

I thought it was necessary to refer this species from the genus *Cidaris*, where the Count of Münster had placed it, to the genus *Salenia*, because it has no perforated tubercles. Gray, and after him DesMoulins had confused it with *S. petalifera* (*Echinus petaliferus* DesM.), but it has several particularities of structure that sufficiently distinguishes it for it to be considered as specifically different. It is, among others, the narrowness of the ambulacral areas and the disposition of the plates composing the apical disc, fig. 1. 2 and 6.

I have seen several specimens of this species, of which two found by Coulon in the yellow rocks (middle stage of the Neocomian terrain), at Roc near Neuchâtel, and two coming from the gray-green of England, of which one was sent me by Brongniart and the other by Defrance. It has also been reported in several other localities, but I doubt all are specifically identical with my species, notably those that Goldfuss says were found in the Jurassic terrain. On the other hand, the figure published by this author from the specimen of the Count of Münster coming from the gray-green of Kehlheim does not appear to me to differ from it.

The periphery of the peristome is circular, slightly crenelated at the border of the ambulacral areas whose edge exceeds the edge of the inter-ambulacral areas, fig. 3 and 7. The pores are arranged in single pairs on each side of the ambulacral area and converge, like it, uniformly to the top, fig. 2 and 5. The inter-ambulacral areas, fig. 4, are sprinkled with a mass of tubercles, of which two rows of very large, with a smooth base and with a top constricted and folded below the constriction, fig. 8. A very dense circle of small tubercles surrounds the large ones. The space between these circles is filled with even smaller tubercles that are equally numerous on all the surface of the disk.

The apical disc, fig. 1 and 6, perfectly preserved in the specimen from the English gray-green that I owe to the kindness of Defrance, is much larger than the peristome. Its periphery is slightly sinuous. The genital plates are large, rounded at their external edge, strongly crenelated at the internal edge and each pierced with a hole. The inter-genital plates are smaller and elongated transversely. The genital plates articulate with each other and with the larger suranal plate that forms the immediate posterior edge of the anus, by the straight line marked with small sunken

points. The anal opening is circular, moved forward and slightly raised at its edges. All the apical disc plates are smooth.

VI. SALENIA GIBBA Ag. Pl. 2. fig. 9–16.

This species stands out from all its congeners by the very strong projection of the apical disc, fig. 10, which gives it a nearly conical form from bottom to top. The ambulacral areas, as in *S. geometrica*, is distinguished by their extreme narrowness to the point that there is not even space for the smallest granulations between the two rows of tubercles. These are not larger than the secondary tubercles that border the large tubercles of the inter-ambulacral areas, fig. 10 and 13. The inter-ambulacral areas, fig. 10 and 12, are proportionally as wide as the ambulacrals are narrow. The larger tubercles, to the number of four or five in each row, each surrounded by a very pronounced circle of small tubercles, is surmounted with a very apparent articulating mamelon, fig. 16.

The peristome has small notches on its periphery that make a nearly equilateral polygon, fig. 11 and 15.

By the structure of the apical disc, fig. 14, this species closely resembles *S. personata* and *S. petalifera*. Only the depressions on the suture lines are deeper here. The genital plates have, up to some extent, the form of a grape leaf, while the inter-genital plates are rather triangular. The suranal plate is proportionally very wide, so that the anal opening is considerably moved forward. This circumstance, joined to the elevation of the entire apparatus, determines this irregular hunchbacked appearance that has given the species its name. The specimens I have before me have been sent to me, one by Michelin and the other by d'Orbigny, who found them in the gray-green of Aix Island at the mouth of the Charente.

VII. SALENIA TRIGONATA Ag. Pl. 2, fig. 17–24.

The structure of the apical disc and the size of the inter-ambulacral areas, which is considerably more than in the other species, fig. 22 and 20, constitute the distinctive characters of *S. trigonata*, that otherwise is rather near, by its general appearance, to *S. personata*. Its form is spherical with a rather considerable flattening of the ventral side, fig. 18. The peristome is circular, smaller than the apical disc and slightly notched on its periphery, so that the edges of the ambulacral and inter-ambulacral areas are nearly equal, fig. 23. The ambulacral areas have, as in *S. personata*, two rows of small tubercles, close enough to each other that there remains no space between them for smaller tubercles, fig. 18 and 21. The pores are arranged in single pairs on each side of the ambulacral areas, fig. 21. The inter-ambulacral areas, as we just saw, are remarkable by their large tubercles. The smooth zone that surrounds their base is very large, and the top of the cone, fig. 24, forms a strong articulating areole surrounded by radiating folds that can be seen especially well when the mamelon that surmounts them is removed. A circle of six to seven small tubercles surrounds the smooth zone at the base of the large tubercles and some still smaller granulations, and frequently, especially near the buccal opening, fill the space between the different circles, fig. 20. The apical disk, fig. 17 and 22, is nearly circular, the corners of the inter-genital plates only slightly

overlapping the genital plates. Their sutures are marked here and there by small, rather deep triangular depressions. The genital plates are generally larger than the inter-genital plates, in particular those of the posterior edge that have the form of a fleurs de lis, while the anteriors appear atrophied and are nearly triangular. The inter-genital plates are in the form of isosceles triangles having a straight base and turned toward the ambulacra. Finally, the suranal plate, in form of an irregular crescent, forms on the posterior side of the immediate edge of the anal opening, that is found thus moved forward on the side of the unpaired ambulacrum. This plate produces radiating ridges that extend onto the adjacent genital plates and form, with the other transverse ridges, triangles more marked in young specimens than in the old where they are hardly visible. The anal opening itself is insensibly elongated in the direction of the transverse diameter. Its edges are enlarged and protruding. The specimens I have had at my disposal come from the vicinity of Tours. They make part of the collection of Michelin.

II. Salénies having the anal opening in back

VIII. SALENIA STELLULATA Ag. Pl. 2, fig. 25–32.

The apical disc attains considerable development in this species. It occupies more than half of the dorsal surface of the test and presents a marbled appearance that makes it very apparent although it is only slightly protruding, fig. 30. The general form of the test is circular, greatly flattened ventrally, slightly depressed above, fig. 26. The ambulacral areas have two rows of small tubercles that come closer together as they approach the buccal system or the anal system. The ambulacral pores are arranged in single oblique pairs on each side of the tubercles, fig. 26 and 29. The inter-ambulacral areas are very wide and have two rows of large conical tubercles with a smooth base, but often grooved with small radiating, articulating folds around the constriction. There are in addition, around each large tubercle, a circle of small tubercles nearly the same size as those of the ambulacral areas, fig. 28 and 32. But as the apical disc occupies a larger part of the dorsal surface of the test, and neither one nor the other hardly exceeds the middle of the ambitus, it results that, seen from above, this species appears to have fewer tubercles than most of its congeners.

The peristome is circular. Its periphery has crenulations similar to those we have reported in all the preceding species, fig. 27 and 31. The anal opening is nearly circular, subcentral, moved backwards by the suranal plate that articulates with the two anterior genital plates, thus forming on this side the edge of the opening that is more raised than the posterior side. The genital and inter-genital plates are deeply serrated on their entire periphery. This particularity determines the marbled and star-shape of these plates, which makes it easy to recognize the species and that gave it its name. The anterior genital plates are larger than the posteriors. All are pierced with a hole in the middle. The inter-genitals are in the form of irregular triangles. The surface of both is smooth, fig. 25 and 30.

The prettiest specimen that I have seen of this species belongs to Cél. Nicolet, who found it in the Neocomian terrain in the vicinity of Cahaux-de-Fonds. Another specimen was sent to me by Defrance. It comes from the gray-green of Wiltshire.

IX. SALENIA AREOLATA Ag. Pl. 3, fig. 1–8.

Form circular, flat on the ventral side, less depressed on the dorsal side, fig. 2. The peristome, fig. 3 and 7, is less large than the apical disc. However, the difference between their relative dimensions is considerably less than in *S. stellata*. Its periphery has crenelations at the point of contact of the inter-ambulacral areas with the ambulacral areas. And, as usual, the space between two crenelations is always larger than in front of the ambulacral areas than in front of the inter-ambulacral areas, although these are much wider in all the rest of the periphery. The apical disc scarcely differs in general form from that of *S. stellata*. The genital and inter-genital plates have at their points of meeting, small depressions that give the entire system an unequal and rugged appearance, and to the genital plates in particular, a form rather similar to an oak leaf. The inter-genitals are small and rather regularly triangular. The suranal plate has the form of an irregular crescent. The anal opening is strongly elongated in the direction of the transverse diameter. Its anterior edge is more protruding the posterior edge, fig. 1 and 6.

The ambulacral areas have two single rows of tubercles of average size, proportionally larger than in *S. stellata*, especially on the ventral surface of the test. The pores are arranged in two rows on each side of the ambulacral area that they follow its entire extent, fig. 5. The inter-ambulacral areas are very wide and ornamented with two rows of four to five more-or-less large tubercles, from the plates that surround the peristome up to those that form before the apical disc, each surrounded by a circle of smaller tubercles nearly the same dimension as those of the ambulacral areas, fig. 2 and 4. Their articulating mamelon, fig. 8, is proportionally larger than in *S. stellata*. As in all true Salenies, these large tubercles are smooth at their base and constricted at their top that is surrounded by a circle of small radiating folds. The small tubercles, located in a circle around the large one, being more numerous in the middle of the inter-ambulacral area than on the side of the ambulacrals, there results a kind of double sinuous line in the middle of the two rows of large tubercles.

Up to now, this species has still been encountered only in the Neocomian terrain. Coulon found a specimen in the yellow rock of Roc and DuBois, a second in the marl pit of Hauterive, near Neuchâtel.

At the moment the genera *Salenia* and *Arbacia*, established by Gray and for which DesMoulins claimed priority, the latter raised doubts, in his studies on echinoids, pag. 207, on the date of my *Prodrome d'une Monographie des Radiaires ou Echinodermes*, read at the Société des Sciences naturelles de Neuchâtel on 10 February 1834, printed during the winter of 1835 and published in July 1836. It is based on what I introduced in enumeration of species published by Gray in 1835, printed in the Proceedings of the Zoological Society of London in April (not in October as DesMoulins thought) and that I consequently could not know in 1834. It is no less true, however, that I knew the genera of Gray since 1831, this scholar having the kindness of sending

me the characters to me before the publication of his notes. As it is not here for me a question of priority, but of rendering justice to the author of the genera of *Salenia* and *Arbacia*, I have been able to show that in preserving the names of Gray I follow the generally accepted rule, without giving any harm to DesMoulins. His names cannot be preserved in this case because his work appeared in August, 1835, i.e., later than that of Gray. It is no less true, however, that DesMoulins has established well these groups at a time when he could not have known of the work of Gray. In indicating how, on my side, I have known it earlier, I have simply the intention of exonerating myself from the reproaches that this nearness of dates seems to reflect on me. Accidents that I have just reported between Gray and DesMoulins, are reproduced for several genera that I have established or modified in the same sense as DesMoulins. Not attaching a great importance to the question of this genus, and not to abuse the priority of reading of my memoir in 1834. I shall limit myself to preserving my nomenclature when it seems preferable to that of DesMoulins. I shall do it all the more willingly because the tables of this scholar have the great advantage over my Prodrôme of giving a complete and generally very well-done synonymy of all the species known until now.

In my Prodrôme, etc., I have cited under the name of *Salenia hemisphærica* and *Salenia Hoffmanni*, two species that I have thought to refer to this genus, according to the characters given them by Rømer. Not having had the opportunity of seeing the original of these species, I have abstained from mentioning them in this monograph, for fear of confusing in the same genus different but close types, as are, e.g., the genera *Cyphosoma*, *Acropelti* and *Salenia*. The very fact that these species come from Jurassic terrains, make me doubt if they are true Salenies. Because, as I said p. 5 and 7, all the species that I possess and whose origin is known belong to the Cretaceous terrain.

At the time of going to press, I received a shipment of fossils from Rømer, among which is found a specimen of his *Cidarites Hoffmanni*, the *Salenia Hoffmanni* of my Prodrôme, which is a very nice species of my genus *Hemicidaritis*, of which I shall give a detailed description in my monograph of this group. There remains thus no doubt that my *Salenia hemisphærica*, the *Cidarites hemisphærica* of Rømer, that I hope to receive before publishing the monograph of *Hemicidaritis*, in which I think it must take place, judging from the great resemblance to *Cidarites Hoffmanni*.

CHAPTER II.

GENUS GONIOPYGUS Ag.

I include in this genus all the species of the family of Salenies whose apical disc lacks the suranal plate that, in the three other genera, places the anal opening sometimes in front, sometimes behind, depending on whether it is placed behind or in front of its opening. The genital plates are not fused along their entire length to the inter-genital plates. As a result, the apical disc has constantly a more-or-less distinct decagonal rosette. The anal opening is central sometimes circular, sometimes angular according to the species. Sometimes it is triangular, square or pentagonal, and we see other more-or-less distinct small plates emerge from the interior of the corners. The dimensions of the species of this genus have notable variations, from *G. major* that reaches a diameter of a one and a quarter of an inch in its large diameter and beyond up to *G. intricatus* that has scarcely only one quarter of an inch in its greatest diameter (see tab. 3 and 4). The general structure of the test is nearly the same as in the true Salenies. The pores are arranged in single pairs. As a result, the ambulacra strictly speaking are very narrow. The inter-ambulacral areas are much less tubercular than in the other genera of this family. In the dorsal part of the test, the coronal plates often have only a single large tubercle without accessory granulations. Finally, a last character particular to this genus and that alone is sufficient to distinguish it from the three others is the absence of radiating grooves on the tubercles of the inter-ambulacral areas. We know up to now two kinds of spines of *Goniopygus*, both coming from Neocomian terrain and that I think can be referred to with fair certainty to *G. peltatus* and *intricatus*, to which they are usually associated. In general, all the *Goniopygus* whose origin is known belong to Cretaceous terrain. To my knowledge, there are no species, neither in the older terrains, nor in the more recent terrains. In the present creation, we do not encounter any type that is near it, even distantly.

I. GONIOPYGUS PELTATUS Ag. Pl. 1, fig. 9–18.

Salenia peltata Agass. Mém. de la Soc. des sc. nat. de Neuchâtel, vol. I.
Echinus peltatus DesM. Echin., p. 304.

Up to the present, this species has been found in the Cretaceous terrain of the Neuchâtelois Jura (Neocomian terrain) where it is rather frequent. Its form is circular, strongly flattened below and sensibly depressed above, fig. 10. The peristome is proportionally larger than in any other species. It occupies nearly two thirds of the ventral surface of the disk, fig. 11. Its periphery is regularly notched at the point of contact of the ambulacral areas with the inter-ambulacral areas. The space between two notches (the total number is ten since there are five ambulacral areas and five inter-ambulacrals) is always smaller at the end of inter-ambulacral areas than at the edge of the ambulacral areas, fig. 11 and 15. In general, the latter taper little or not at all as they approach the peristome, while the contrary occurs with the inter-ambulacrals. It is these, that by widening, produce the enlargement of the test.

The apical disc is star-shaped and much smaller than the interior opening, fig. 9. The plates that compose them are smooth with their surface notched at the edge. We note very distinctly the sutures that unite them. The genital plates, in the form of a grape leaf and pierced by a hole in the middle, all fused together to form the immediate edge of the anal opening. The inter-genital plates are smaller, truncated at the exterior edge, rounded at their internal edge. The genital plate of the odd inter-ambulacral area is, as in most of the species, a little larger than the others. The ambulacral areas, composed of two single rows of tubercles stand out strongly from the surface of the test and narrows sensibly toward the apical disc, fig. 10 and 13. Although rather separated, especially toward the middle of the ambitus, we do not note, however, smaller tubercles between the two rows. The pores are arranged in oblique pairs on each side of the ambulacral areas. The inter-ambulacral areas have two rows of six to seven large tubercles surmounted with a strong articular mamelon, fig. 12 and 13. The small tubercles that ordinarily cover all the space between the large tubercles, are here very rare. One notes some very small ones on the ventral surface, fig. 11.

RODS. We would not doubt that the rods that habitually accompany the specimens of this species, discovered by DuBois of Montpéroux, are not true spines. These rods are eminently claviform, strongly striated longitudinally in the upper part, smooth in the lower part up a third of the height, fig. 18. They lack, in addition, what we commonly call the head of the spine, i.e., the ring-shaped swelling that, in the rods of *Cidaris*, follows the articular facet. This is a simple small cavity, fig. 17, lacking the teeth like the neck of the collar of the tubercle with which it must have articulated. This figure is the projection of a rod, seen from below. All the rods have nearly the same dimensions, approximately half an inch in length and two or three lines of diameter in the most enlarged part.

II. GONIOPYGUS INTRICATUS Ag. Pl. 3, fig. 19–28.

This is the smallest species that I know of the entire group of Salenies and even of the entire family of cidarids. By its form and by its structure, it greatly approaches *G. peltatus*. But, on the other hand, it is more tubercular and the dimensions of the apical disc are proportionally larger, fig. 19 and 24. The ambulacral areas, fig. 20 and 23, are rather wide, without the two rows of tubercles that we see there being separated by smaller tubercles. The inter-ambulacral areas, fig. 20 and 22, have two rows of perfectly smooth large tubercles that become especially protruding in the middle of the ambitus, fig. 26. The pores, arranged in single pairs the length of the areas, are so small that we can hardly see them. The peristome, fig. 21 and 25, is very large and notched in its periphery. It occupies more than half the very ventral surface of the test.

The anal opening is small, tuberculated and placed in the middle of the apical disc that is, itself, very large although little apparent because they slightly project above the test. The genital plates form large, elongated lobes, serrated on their edges and pierced with a small hole, while the inter-genitals are in the form of rather regular triangles, fig. 19 and 24.

RODS, fig. 27 and 28. The rods of this species were discovered simultaneously with those of *G. peltatus*, in the yellow stone (Middle Neocomian) of Merdasson, by DuBois of Montpéroux. They differ from the latter by their smaller size and the absence of folds in the upper part. The entire rod is more uniform with a very slight narrowing near its base that, as in *G. peltatus*, lacks the annular swelling and the crenulations of its articulating facet. Fig. 27 is the projection of the rod, seen from below.

III. GONIOPYGUS MENARDI Ag. Pl. 3, fig. 29–36.

ECHINUS MENARDI DesM. (Defrance, Dict. sc. nat., vol. 37, p. 101.)

Its form is circular, flat on the ventral surface, a little depressed on the dorsal surface. The longitudinal and transverse diameters are nearly twice the vertical diameter. The peristome, fig. 31 and 35, is central, rather large, larger even than the apical disc, so that it occupies the greater part of the ventral surface. Its periphery, although circular, has small notches that correspond to the sutures of the ambulacral and inter-ambulacral bands. As a result, it is a decagon whose largest sides are at the edge of the ambulacral areas and the smallest in front of the inter-ambulacrals. In addition to these notches at the point of contact of the ambulacral and inter-ambulacral areas, we note other smaller ones in the middle of the edge of the ambulacral area, there where the two rows of tubercles meet. Although hardly visible, their presence is constant.

The apical disc, fig. 29 and 34, composed of entirely smooth and strongly fused plates form a slightly prominent rosette above the test. The genital plates are in the form of elongated heptagons having their most protruding corner turned outside. They are all of equal size. The inter-genital plates are half the size, pentagonal, having, to the inverse of the genitals, the largest size turned outside so as to overlap considerably the top of the ambulacrals. The same side is in addition slightly concave, while the other sides of the polygon articulate by straight lines with the genitals. Finally, the anal opening merits very particular attention because of its triangular form. At the beginning, I was disposed to attribute it to a fracture, but having encountered it since in a number of specimens, I can no longer doubt that this is a particular character of this species.

The ambulacral areas, fig. 30 and 33, have two rows of tubercles that, although rather far apart, notably toward the peristome and in the middle of the ambitus, are however not separated by small tubercles. The pores are very apparent, arranged in single, oblique rows, contiguous with the tubercles of the ambulacral area and converging at the peristome and top without narrowing much. The inter-ambulacral areas, fig. 30 and 32, are wide, with two rows of large tubercles with a smooth base and surrounded, on the lower half of the test only, by a circle of smaller tubercles. The most protruding large tubercles occupy the middle of the ambitus. The articulating mamelon that forms the top is very large and very apparent, fig. 36. I have before me several specimens of this species one belonging to Defrance, the other to Brongniart. d'Orbigny has sent me others much larger, coming from the gray-green of the mouth of the Charente, that I refer to the same species although the apical disc is nearly the same size, despite the difference in size. I think they are simple varieties.

IV. GONIOPYGUS HETEROPYGUS Ag. Pl. 4, fig. 1–8.

It is difficult, at first glance, not to confuse this species with *G. Menardi*. However, there are some differences of organization that requires separating them specifically. There is, among others, the form of the anal opening that, instead of being triangular as in *G. Menardi*, is square. The ambulacral areas are also more protruding and the tubercles proportionally larger, fig. 3 and 5. The

apical disc has nearly the same dimensions as the peristome. the genital plates are all of equal size. Their form is that of an elongated pentagon, have its narrowest corner turned outside. Their base, which forms the immediate edge of the anal opening, is strongly concave. It is from the middle of this concavity that rise the small plates or tubercles that are particular to most of the species of this genus. The base of the plate of the odd inter-ambulacral area alone is straight. Consequently, there is no small additional plate, which reduces the number of the latter to four. The inter-genital plates are pentagonal, as in *G. Menardi*, and insert by their top between the genital plates. Their base has a slight enlargement in the middle. All the plates are perfectly smooth and the sutures that unite them are indicated by straight lines, fig. 1 and 6.

The two rows of ambulacral tubercles are too tight for there to be smaller tubercles between them, fig. 2 and 5. The tubercles of the inter-ambulacral areas are very protruding, smooth and constricted in the middle of the cone so as to form a very large articulating mamelon, fig. 8. The small tubercles that accompany them exist only on the ventral part of the test and up to the vicinity of the ambitus, fig. 3 and 4. The ambulacral pores are arranged in oblique pairs in two single rows on each side of the ambulacrum. The only perfect specimen of this species that I have encountered was sent to me by DesHayes. It comes from the vicinity of Tours.

V. GONIOPYGUS GLOBOSIS Ag. Pl. 4. fig. 9–16.

The dimensions of this species are considerable, its transverse diameter being approximately an inch by a half inch and more in height. Its form is circular, flattened below and slightly depressed above, fig. 9 and 10.

The peristome of this species is of extraordinary size, occupying at least half of the ventral surface. The notches of the periphery are rather deep and the spaces between two crenulations are always smaller at the edge of the inter-ambulacral areas than at the edge of the ambulacral areas, provided we do not count the slight depression in the middle of the latter, fig. 11 and 16.

The apical disc, smaller than the peristome, is composed, as in all the species of this genus, of five genital plates of pentagonal form, having their narrowest corner turned outside, and five inter-genitals likewise pentagonal or rather sub-pentagonal, wider than long, and inserted at their top between the genitals. The genitals overlap the inter-genitals very little. But the latter, because of small size, do not reach the anal opening. It is triangular, bordered only by the genitals that have for this purpose alternatively a straight base and a concave base. In front of each of the three plates with a concave base, we see in the interior of the anal opening, a kind of small plate or peculiar tubercle that seems to arise from below the principal plates. All the plates are smooth or very slightly rugose. They articulate by straight or approximately straight lines, fig. 9 and 15.

The ambulacral areas are remarkable for their width. They have two single rows of tubercles that narrow slightly toward their top where they have a rounded end. Although these two rows of tubercles are rather far apart, we do not see however smaller tubercles between them. The ambulacral pores are very apparent, arranged in single oblique rows on each side of the ambulacral area, fig 10 and 13. The inter-ambulacral areas have two rows of large tubercles, smooth at their base and surmounted by a large articular mamelon, fig. 14. Around each of these large tubercles, we see a more-or-less complete circle of small tubercles that are especially visible in the middle of the ambitus, there where are also the largest tubercles. I have only seen them on a well-preserved

specimens of this species. It comes from Aix Island (Department of Charente-Inférieure) and was sent to me by Alex. Brongniart under the name *Echinus Menardi*.

VI. GONIOPYGUS MAJOR. Ag. Pl. 4, fig. 17–22.

This is the largest species that I know in the group of Salenies. By its general form and by the arrangement of its tubercles, it is near some types of *Cidaris*. But an attentive examination of the structure of its test, the apical disc, and especially the tubercles that are not perforated nor surrounded by articulating grooves, will always make it recognized for what it really is, i.e., a *Goniopygus*. I have seen up to now only one well-preserved specimen coming from the Lower Chalk of the port of Barques at the mouth of the Charente, that d'Orbigny has very kindly sent to me. This species is distinguished from *G. globosus* by its more conical shape, fig. 18. Its oral-anal diameter is nearly half the greatest diameter, which is an inch and a half. The peristome is not preserved well enough to be described in detail. We can scarcely determine its central position. Its circular periphery and its diameter, which is nearly a third of the greatest diameter of the test. Its periphery appears to have some slight notches that correspond to the sutures of the ambulacral and inter-ambulacral areas, fig. 19.

The apical disc forms a decagonal rosette around the anal opening, as in *G. globosus*, but with the difference that the genital plates are notably more tapering and sensibly overlap the inter-genitals. All the genitals have nearly the same form. They are pentagonal, very elongated at their top and concave at their base. Their edges are not perfectly straight, but all nearly equal in length, without sutural crenulations and entirely smooth. The inter-genitals are likewise pentagonal, but much wider than high and slightly enlarged at the external edge, which overlaps considerably the top of the ambulacrals, above which it is found placed like a hat with two horns. Their top is embedded between the sides of the genitals. The sutures that unite these two systems of plates are indicated by slightly depressed lines. The surface of all these plates is only very slightly granular, if not entirely smooth. The anal opening is pentagonal. In front of the concave base of each genital plate is produced another small plate of the same nature as those that we have reported in *G. globosus*. It is worth noting that in this species they number five, while there are only three in the preceding, fig. 17 and 22.

The very apparent ambulacral areas are nearly half the width of the inter-ambulacral areas. Their two rows of tubercles, rather far apart at the origin, come closer together in approaching the top. The tubercles themselves are very protruding, especially in the middle of the ambitus and the ventral part of the test where they nearly reach the same size as those of the inter-ambulacral areas. What especially merits noting is that, just like the latter, they are constricted toward their top and end in an articulating mamelon. Smaller tubercles occur between the two principal rows on the ventral surface of the test. Ambulacral pores are very distinct and located alternating in two nearly parallel lines. Each pair of tubercles correspond on each side to three pairs of pores, fig. 17, 18 and 21.

The inter-ambulacral areas are composed of very distinct plates, very large in the middle of the periphery and surrounded by perfectly distinct and very prominent tubercular granulations. Each of these plates produces a very conical tubercle, surrounded by a wide, smooth zone and having a little flat articulating mamelon that is separated from the tubercle only by a slight constriction without radiating folds, fig. 17, 18 and 20.

The spines are not known.

CHAPTER III.

GENUS PELTASTES Ag.

The very peculiar form of the apical disc in several species of the group of Salenies led me to elevate them to the dignity of genus that I call *Peltastes* because of the resemblance of this system with a shield. The genital plates extend in elongated lobes on a considerable portion of the inter-ambulacral areas, edged on each side by inter-genital plates to which they are fused for their entire length in a way that, instead of a star with ten rays, we have here a simple pentagonal rosette. In addition to the five genital plates and the five inter-genitals, there is, as in the true Salenies, a suranal plate located between the genitals on the anterior side and the anal opening, so that the latter is pushed back as in *S. areolata* and *S. stellulata*.

The known species of this genus are of small size, but with a very elegant structure. The peristome is constantly smaller than the apical disc. The ambulacral areas, although very narrow compared to the inter-ambulacral areas, are however very apparent. The poriferous zones, or the ambulacra strictly speaking, are very narrow, and although it is very difficult to recognize the pores in the specimens I possess of the genus, I am led to think that they are generally arranged in single pairs as in all the family of Salenies. Finally, the inter-ambulacral areas are remarkable for their very protruding tubercles that are raised in steep cones in the middle of a smooth zone. They are surmounted, as in all Salenies in general, by a non-perforated articulating mamelon that surrounds. below the constriction, a circle of small radiating folds.

I. PELTASTES PULCHELLUS Ag. Pl. 5, fig. 1-8.

Ch. DesMoulins cites this species in his synonymic tables, p. 302, under the name *Echinus acanthoides*. At least I think that his *Echinus acanthoides* is nearer my *Peltaster pulchellus* than to *P. marginalis*. Not having seen the original of DesMoulins, I cannot state this positively. Its form is circular, strongly flattened on the ventral surface and slightly depressed on the dorsal surface so that the vertical diameter equals nearly half the transverse diameter, fig. 1 and 2. The peristome, of medium size, is sensibly reentrant and its periphery has small crenulations as in most Salenies. But with this difference that here the edge of the ambulacral area is more protruding and narrower than that of the inter-ambulacral areas, fig. 3 and 7. The ambulacral areas have two rows of small rather protruding tubercles, that sensibly come closer together from the base to the top. The intermediary space has scattered, scarcely visible small tubercular granulations. The pores appear arranged in single pairs on each side along the length of the ambulacral area, fig. 5. The inter-ambulacral areas are very wide and especially remarkable in that they are covered, over all the dorsal surface of the disk, with small, uniform tubercles. The large tubercles scarcely go beyond the middle of the ambitus. The latter increase in size from the edge of the peristome up to half the height of the test, where they are distinguished by steepness of the cone, fig. 1 and 8. All rise from

the middle of a smooth zone that borders a circle of small tubercles located equidistant from each other. The top of the cone ends in an articulating mamelon remarkable for its smallness and surrounded by a circle of very small radiating folds that we scarcely distinguish except with a magnifying glass, fig. 4 and 8.

The apical disc is only slightly protruding above the dorsal surface of the test. But, in contrast, its structure is rather complicated and often difficult to recognize because of the transverse hatching that intersects with the suture lines, especially since these are usually very fine and even sometimes imperceptible to the naked eye. The genital plates are very elongated, crenelated at their external edge and considerably larger than the inter-genitals that are inserted in the form of very narrow crescents between the intervals of their tops. The suranal plate, that pushes the anal opening backward, is sub-pentagonal with a concave base. We see on the sutures that unite it with the anterior inter-genitals the same transverse hatching as between the genitals and the inter-genitals. Its dimensions are not very great. All the plates are perfectly smooth and the rough aspect of the entire system absolutely comes from the hatching that I just described, fig. 1 and 6.

I have seen two perfectly preserved specimens of this species coming from the Department of Var. One was sent to me by Studer and the other by DesHayes.

II. PELTASTES MARGINALIS Ag. Pl. 5, fig. 9–16.

Very near *P. pulchellus* by its form and by its structure. However, with attentive study, we are not slow to recognize incontestable specific differences. First, the apical disc is proportionally much larger, the genital plates are wider, less constricted in the middle, and their external edge forms an obtuse corner instead of being serrated as in *P. pulchellus*. In contrast, the inter-genital plates are smaller and more arched, and the hatchings that we noted on the sutures that unite them to the genital plates and these to the suranal plate are less deep and more regular. Instead of transverse grooves, these are small pits placed equidistance from each other. The anal opening is elongated in the direction of the transverse diameter and its anterior edge formed by the internal side of the suranal plate is very raised. This suranal plate is rather regularly pentagonal, with the exception of its base that is concave, fig. 9 and 14.

The peristome is strongly reentrant, and we note that the crenelations of its periphery are arranged in the same manner as in the preceding species, i.e., that the edge of the ambulacral area is more protruding and narrower than that of the inter-ambulacra, fig. 11 and 15.

The ambulacral areas have two rows of tubercles between which are, on all the lower part, very small granulations. The pores are arranged in single pairs on each side of the ambulacral areas, fig. 13.

The inter-ambulacral areas are wide and with very large tubercles that, however, do not pass the middle of the ambitus. The dorsal surface of the test is uniformly covered with small granulations. The large tubercles are as usual smooth at their base and surrounded by a circle of smaller, single tubercles. The articulating mamelon that crowns their top, as well as the radiating folds below, are more apparent than in the preceding species, fig. 10, 12 and 13. The space between the principal rows also has scattered small granulations as on the dorsal surface. In general, we see them appear everywhere the large tubercles or the apical disc have left some free space.

This species was sent to me by Michelin. It comes from Caussols, Department of Var.

CHAPTER IV

GENUS GONIOPHORIS Ag.

This genus, very near true *Salenies*, is distinguished, like the two preceding, essentially by the form of the apical disc. The structure of this system is in fact very bizarre. At first glance, we are tempted to think that it is composed only of inter-genital plates. And it is only with careful examination that we see that the steep and protruding ridges are not sutures, these being scarcely visible to the naked eye. In addition to the genital and inter-genital plates, there is also a large suranal plate that, located as in the *Peltastes* and the *Salenies* of the second division, between the anterior genital and the anal opening, pushing the latter behind. The form of the entire system is that of a regular pentagon, whose protruding corners are formed by the inter-genital plates.

I still know only two species of this genus. Both are noted by the elevation of their test, which is the result of the extraordinary height of the inter-ambulacral plates proportionally to their number, which is scarcely four to five in a row. The ambulacrals or poriferous zones are little apparent, formed of two rows of pores arranged in single pairs in a way that there are nearly as many pairs of pores as there are tubercles on the ambulacral areas. The latter are extremely narrow. The inter-ambulacrals, on the contrary, are very wide, filled with two rows or principal tubercles that are elevated in the middle of a wide, smooth zone edged with a circle of smaller tubercles. The peristome is medium in size and crenelated on the periphery.

I. GONIOPHORUS LUNULATUS. Ag. Pl. 5, fig. 17–24.

This pretty little species is nearly as high as wide with a slight flattening of the ventral surface, fig. 179. The peristome is very small. Nevertheless, we distinguish very well the small crenelations on its periphery that are placed equidistance from each other in a way that the edges of the ambulacral and inter-ambulacra areas are nearly equal if sometimes we disregard another small indentation in the middle of the edge of each ambulacral area, fig. 19 and 23.

The ambulacral areas are remarkable for their narrowness and the smallness of their tubercles. From the base to the top, there is no free space for the smallest tubercles between the two principal rows. The pores are arranged in oblique pairs on the sides of the ambulacral area that uniformly converge toward the top, fig. 18 and 21.

The inter-ambulacral areas are very wide, filled with two rows of principal tubercles, the largest of which is in the middle of the ambitus. But they abruptly decrease in size as they approach the peristome or the anal system. Each of these tubercles has a wide, smooth zone at its base. In addition, it is surrounded by a circle of smaller tubercles. These are even more apparent than in most other species. The articulating mamelon that ends the cone is remarkable for its size. The radiating folds around the constriction are equally very apparent, fig. 20 and 24.

The apical disc occupies a third of the dorsal surface of the test. The lines of suture between the various plates of which it is composed are so fine that often we can scarcely recognize them, all the more as we are naturally led to confuse them with the ridges that are more pronounced in this species than in any other. However, if we attentively examine it, we shall find that the anterior genital plates are rather regularly pentagonal and that the two posteriors that touch immediately the anal open are alone compressed and elongated. This is due only to the position of the suranal plate that, in inserting between the two anterior genital plates and the anal opening, pushes the latter back and thereby narrows the two posterior genitals. The suranal plate itself is in the form of an elongated pentagon enclosing nearly half the anal opening. The inter-genital plates are small triangles with a convex base and rounded top that is inserted between the genitals, thus forming the corners of the pentagonal genital, fig. 17 and 22.

The ridges of the apical disc are crossed in all directions with the sutures of the plates. They are, in general, more apparent in front than in back of the anal opening. They form here three nearly equal triangles. The edges of the entire system as well as the edges of the anal opening are very protruding. I still know only a single well-preserved specimen of this species. It comes from Cape la Hève and was sent to me by LeSueur.

II. GONIOPHORUS APICULATUS. Ag. Pl. 5, fig. 25–32.

It is very easy, at first sight, to confuse this species with the preceding, with which it is very close. But, on the other hand, it differs in several ways. Thus, the apical disc, although arranged in the same manner as in *G. lunulatus*, has however much less protruding ridges. This could be explained by a difference in age, because the specimen that I have before me is nearly twice as large as the *G. lunulatus* figured. Now, we cannot reasonably accept that they were attenuated by age, fig. 25 and 30. It is the same with the tubercles that are less protruding and smaller. In addition, the anal opening is less central, larger, more elongated, and its edges are sharper. The peristome is circular and crenelated nearly as in the preceding species, fig. 27 and 31.

The ambulacral areas are narrow and little prominent, composed of two single rows of small tubercles without intermediate granulations. On each side are two single rows of small pores arranged by oblique pairs, fig. 26 and 29.

The inter-ambulacral areas are wide, with two rows of strong tubercles, of which those in the middle of the ambitus are much larger than those that surround the buccal opening. The smooth zone, that occupies the largest part of each plate rises in the form of a cone flatter than in *G. lunulatus*. The articulating mamelon that is surmounts it is equally smaller, strongly constricted and surrounded at the base of the constriction by a rosette of small, radiated folds, fig. 28 and 32. The form and arrangement of the apical disc are absolutely the same as in *G. lunulatus*, except its edges are a little straighter and more protruding. It is the same with the ridges that leave from the hole of each genital, going in all directions. This results in triangle that we could so easily take for the sutures of the plates. The posterior genitals are considerably attenuated by the anal open that leans sensibly to this side, which also makes the ridges completely disappear. The suranal plate is proportionally narrower and more elongated. Its form is an irregular pentagon with a concave base, fig. 25 and 30.

It is thanks to my friend Valenciennes, who has kindly sent me all the echinoderm species of the collection of the Museum that I did not possess the originals myself, that I could give the description of this species.

CONSPECTUS GENERUM ET SPECIERUM SALENIARUM.

Character gentis Saleniarum e familia Cidaridum. Ambulacra simplicia, iuterambulacris angustiora; tubercula majora non perforata; discus ovarialis prominulus, assulis firmis, intime conjunctis.

I. Genus **SALENIA** Gray. Ag. Discus ovarialis circularis, plus minusve emarginatus, assulis ovarialibus et interovarialibus quinque, assula undecima, supraanali, anlica, vel postica: tubercula collo crenulato,

α. Species ano antico.

1. *Salenia personata* Ag. Disco ovariali inæquo, suturis assularum depressis; zonis ambulacralibus angustis; tuberculis majoribus (¹).

2. *Salenia scripta* Ag. Suturis assularum disci ovarialis transverse insectis; ano prominulo; tuberculis minimis; zonis ambulacralibus angustissimis.

3. *Salenia petalifera* Ag. Disco ovariali æquo, angulis assularum depressis, zonis ambulacralibus amplioribus; apertura inferiore magna, margine alte inciso.

4. *Salenia geometrica* Ag. Orbicularis; disco ovariali æquo, suturis assularum linearibus.

5. *Salenia scutigera* Gray. Ag. Disco ovariali subpiano, margine aperturæ analis tumido, prominulo; tuberculis minoribus.

6. *Salenia gibba* Ag. Disco ovariali conico, angulis assularum truncatis, depressis.

7. *Salenia trigonata* Ag. Disco ovariali costulis triangulos conferentibus prædito.

β. Species ano postico.

8. *Salenia stellata* Ag. Depressa, disco ovariali amplissimo, assulis in margine crenulatis.

9. *Salenia areolata* Ag. Depressa; disco ovariali inæquo, assulis in margine depressis; zonis ambulacralibus angustissimis.

II. Genus **GONIOPYGUS** Ag. Discus ovarialis stellatus, assulis ovarialibus et interovarialibus quinque, supraanali déficiente. Tubercula collo lævi.

1. *Goniopygus peltatus* Ag. Facie inferiore plana, apertura maxima; assulis ovarialibus acuminatis; margine aperturæ analis subpentagonali. Spinis clavatis, sulcatis.

2. *Goniopygus intricatus* Ag. Depressus, minimus; apertura inferiore magna; assulis ovarialibus margine crenulatis. Spinis obtusis, lævibus.

3. *Goniopygus Menardi* Ag. Disco ovariali assularura margine lineari. Margine aperturæ analis trigonato.

4. *Goniopygus hcteropygus* Ag. Margine aperturæ analis quadrato inæquo.

5. *Goniopygus globosus* Ag. Suborbicularis; apertura inferiore magna; ano trigonato.

6. *Goniopygus major* Ag. Subconicus; disco ovariali minore; assulis ovarialibus valde acuminatis. Apertura anali pentagonali.

¹ In going through the plates of this monograph since it has appeared, I have noticed that in some specimens of the 1st plate, the large tubercles appear perforated. This grave error, corrected in the proof, was reproduced in part in the printing. It appeared important to report this effort that I would have corrected by suppressing the proofs if I had known before the stones were erased.

III. Genus **PELTASTES** Ag. Discus ovarialis pentangulatus; assulis ovarialibus prominentibus, assulas interovariales emarginatas amplexantibus. Assula supraanali antica.

1. *Peltastes pulchellus* Ag. Disco ovariali minore, assulis margine crenulatis, ovarialibus apice fissis ; tuberculis parvis, maxime prominentibus.

2. *Peltastes marginalis* Ag. Disco ovariali majore, assulis in angulis depressis, ovarialibus in apice integris.

IV. Genus **Goniophorus** Ag. Discus ovarialis marginibus rectis, pentangulatus, costatus, assulis interovarialibus prominentibus, angulos referentibus.

1. *Goniophorus lunulatus* Ag. Costis disci ovarialis crassis; apertura inferiore minima.

2. *Goniophorus apiculatus* Ag. Globosus; disco ovariali majore, costis tenuioribus.

Species omnes simili modo a facie superiore, laterali et inferiore delineatæ sunt. Partes auctæ sunt: discus ovarialis, tuberculum spiniferum, apertura inferior, zona interambulacralis et ambulacralis.

Mandato jam typis hoc opusculo et amicis doctissimis proposito, clariss. Bronn speciem novam e gente Salenianim mecum communicavit, quæ eo magis interest mea, quod probet non solam Saleniam scutigeram in Germania occurrere. Ad genus Goniopygorum pertinet; alias accuratam ejus descriptionem cum figuris in lucem proferam. Ad Goniopygum Menardi proxime accedit; a quo tamen differt assulis disci ovarialis acutioribus, et inde disco in margine valde serrato. Apertura analis transversim ovata. *Goniopygus Bronnii* dicendus. E stratis cretaceo-margaceis Westphaliæ.

Nicolet in lap. sculpt.

Lith. de Nicolet à Neuchâtel (Suisse)

Fig. 1-8. SALENIA PERSONATA Ag. - Fig. 9-16. SAL. SCRIPTA Ag.
Fig. 17-24. SAL. PETALIFERA Ag. - Fig. 25-32. SAL. GEOMETRICA Ag.

Nicolet in lap.

Walker del.

Lith de Nicolet à Neuchâtel.

Fig. 1-8. *SALÉNIA SCUTIGERA* Ag. = Fig. 9-16. *SAL. GIBBA* Ag.
 Fig. 17-24. *SAL. TRIGONATA* Ag. = Fig. 25-32. *SAL. STELLULATA* Ag.

Nicolet in lap.

Wallinger del.

Lith. de Nicolet à Neuchâtel.

Fig. 1-8. SALENIA ARAEOLATA Ag.

Fig. 9-18. CONIOPYGUS PENTATUS Ag. - Fig. 19-28. CON. INTRICATUS Ag.

Fig. 29-36. CON. MENARDI Ag.

Nicollet sculp.

Wallinger del.

Lith. de Nicollet à Neuchâtel

Fig. 1-8. GONIOPYGUS HETEROPYGUS Ag. - Fig. 9-16. GON. GLOBOSUS Ag.
 Fig. 17-22. GON. MAJOR Ag.

Nicolet in lep. scrup.

Lith. de Nicolet & Neuchâtel.

Fig. 1-8. PELTASTES PULCHELLUS Ag. = Fig. 9-16. PELT. MARGINALIS Ag.
 Fig. 17-24. GONIOPHORUS LUNULATUS Ag. = Fig. 25-32. GON. APICULATUS Ag.