THE DANISH INGOLF-EXPEDITION.

VOLUME IV.

1.

ECHINOIDEA.

(PART I.)

BY

TH. MORTENSEN.

WITH 21 PLATES AND 12 FIGURES IN THE TEXT.

TRANSLATED BY TORBEN LUNDBECK.

COPENHAGEN.
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I.

By

Th. Mortensen.

The present work forms the first part of a planned revision comprising all the arctic Echinoderms, excepting the Holothurioidea. The basis of the work is formed by the rich material of the Ingolf-Expedition together with the large collections of arctic Echinoderms found at our Zoological Museum from earlier expeditions. To the arctic fauna all the species are referred which are found in the Norwegian Sea, the Greenland Sea, the Denmark Strait, and at the coast of West-Greenland, as also in the White Sea and the Polar Sea with the Bering Strait. Of forms that are only found south of the large ridge between Greenland and Iceland, and between Iceland and the Faröe Islands, only such as have been taken by the Ingolf-Expedition, have been included in the work.

During the examination of the material the absolute necessity of taking into consideration also other more or less nearly related forms soon made itself felt. By and by I became aware of the fact that the classification hitherto used with regard to the families treated of here, was quite erroneous, and so I have sought to include into the examination as many forms as possible in order to be able to give the new classification that had to be made, so broad a base as possible. Inspector G. M. R. Levinsen placed the whole rich collection of Echinoids of the museum at my disposal with the greatest readiness; but as far from all species and genera are represented in this collection, I have applied to several foreign naturalists, and have everywhere been met with the most obliging kindness and friendliness, so that I have been enabled to examine almost all known genera and species comprised in the groups treated of here.

The following gentlemen have sent me Echinoids on loan or in exchange: Dr. Appellöf (the Museum of Bergen), Prof. F. Jeffr. Bell (British Museum), Prof. E. v. Beneden (Liège), Prof. Collett (Christiania), Prof. Döderlein (Strassburg), Conservator J. Grieg (the Museum of Bergen), Prof. Koehler (Lyons), Prof. P. de Loriol (Genève), Prof. E. v. Marenzeller (Vienna), Geh.rath, Prof. E. v. Martens (Berlin), Geh.rath, Prof. K. Mobius (Berlin), Prof. Monticelli (Naples), Prof. P. Pallary (Oran), Prof. G. Pfeffer (Hamburg), Prof. R. Rathbun (U. S. National Museum), Prof.

d'Arcy Thompson (Dundee). By this present I beg to offer my sincerest thanks to all these gentlemen. Finally I had occasion for a short stay at the British Museum in August 1901. By the genial friendliness of Prof. Bell I was enabled to examine a great many forms, especially original specimens from the Challenger-Expedition. It will appear throughout my work, that this stay has been of material importance to me, and my best thanks are due to Prof. Bell for his liberality. Still I have to thank Dr. F. A. Bather (British Museum) for his excellent assistance in several literary questions.

Copenhagen, January 1902.

The Author.

«Loin d'être nuisible aux vrais progrès de la science, cette multiplication des genres, lorsqu'ils sont établis sur des caractères précis, ne saurait avoir d'autre effet que de rapprocher de plus en plus les espèces, que leurs caractères naturels lient le plus étroitement. C'est là le grand avantage des petits genres, et cet avantage est surtout sensible dans les familles, dont toutes les espèces se ressemblent par leur aspect extérieur et par l'ensemble de leurs caractères.

L. Agassiz.

On generic and specific Characters in the Echinoids.

Everybody who has studied Echinoids, will have felt a considerable difficulty in recognising many of the genera, at all events of the regular Echinoids. Such was, at any rate, my case at the commencement of my researches. I studied the excellent collection of these animals found in our museum, and found it to be more and more hopeless. A great many genera were exhibited, as: *Echinus*, *Psammechinus*, *Toxopneustes*, *Hipponoë*, *Boletia*, *Psilechinus*, *Lytechinus*, *Loxechinus*, etc.; but it seemed to be impossible to discover the characters on which they were established, whether the naked tests, or specimens that had kept the spines, were examined. And the literature did not contribute very much to clear up the question. To be sure, some of these names (— as it will be seen, partly unjustly —) appeared to be synonyms; but nevertheless the other genera were not much better characterized. We learned through long descriptions that the spines were thick or thin, few and scattered, or many and closely packed; that the tubercles might be small or large, and that they might be placed in more or less regular series, etc. — altogether things easily enough seen, but so relative, that it was impossible to get any any firm hold. It was almost enough to drive one to despair.

Still a faint hope was left. Might not the difficulty be in the literature, and the animals themselves in reality be less intractable? A profound and careful attempt at penetrating into the mysteries of the relationship of the Echinoids was planned, and the plan was the simple, but clear one: to let literature alone for the present, while the animals were studied thoroughly. Everything had to be examined that might in any way be supposed to show systematic characters: the test, the spines, the tube-feet, the pedicellariæ, the spicules, the sphæridiæ, etc. The beginning was to be made with the *Echinus*-species. This choice seemed to be the best one, as these species have hitherto been especially notorious for their difficulty, and a very rich material of them is found in the museum of Copenhagen. The result was excellent. The animals proved to be very tractable, the species to be very well characterized (with a few exceptions). The difficulties arise from the literature containing numberless bad descriptions. And what a confusion is reigning in the literature with regard to the names. Almost every species must drag along with it a lot of synonyms, not only specific synonyms, but also generic ones. Several species have by and by been referred to a whole series of different genera, to end at last as a separate genus, as badly characterized as most of the other genera. To name only one instance: The genuine *Psammechinus*-species: *variegatus* (Lamk.) and *semituberculatus* (Val.) have by and by been referred to the following genera: *Echinus*, *Lytechinus*, *Schizechinus*, *Toxopneustes*, but only rarely, in recent times not at all, to the genus to which they decidedly belong. On the other hand the following extraneous species have been referred to *Psammechinus*: *Echinus norvegicus*, *magellanicus*, *miliaris*, *microtuberculatus*, *angulosus*, *Strongylocentrotus Gaimardi*, *intermedius*, *Sphærechinus pulcherrimus*, *Evechinus chloroticus*, *Echinostrephus molare*. — This instance may be taken as a significant illustration of the generic descriptions. Or should it be necessary also to recall the genera of Cidarids?

That under such circumstances erroneous determinations have been frequent, is not to be wondered at. I have had occasion to substantiate several (far too many!) cases, and such cases too where the greatest authorities have been responsible for the determination. We ought therefore to be very cautious in using the existing statements with regard to the geographical distribution of these forms.

The characters that have hitherto chiefly been used for the distinguishing between the genera and species, are the following: the pores, the spines, the tubercles, the mouth-slits, the lining of the buccal membrane with larger or smaller plates, and the calycinal area. All these structures may give excellent characters, and, of course, they are always to be taken into consideration. But most frequently they are so relative, that it is exceedingly difficult or impossible by means of these structures to decide whether a specimen in hand belongs to one species or another. Such is especially the case when the question is of the position of the tubercles; it may be simply irritating to read the descriptions of these in different species that are to be compared, and often the result falls very short of the exertion to get a clear view of the descriptions. To this may be added that the number, size, and position of the tubercles vary very much with age. With regard to the pores, their number and mutual position is no absolutely reliable character either. That in species with many pairs of pores their number increases with age is a well-known fact. The young *Strongylocentrotus drobachiensis* has only three pairs of pores (Lovén 250); «*Strongylocentrotus*» *lividus* has only 3 pairs of pores in the lower ambulacral plates; *Echinostrephus* has 2—4 pairs of pores, oftenest 3 pairs etc.

By these researches the pedicellariæ and spicules proved to be of very great systematic importance; they give the most excellent characters we may want. To be sure, this fact is no new discovery. It has long been known that these organs and structures were more or less differently constructed in the different species and genera; much has been written about this fact, and a great many figures have been published. But nevertheless the fact has never been fully utilised.

The history of the pedicellariæ is highly interesting; scarcely many zoological objects will be able to vie with these organs with regard to the number of interpretations. From parasites to embryos, and even to vertebrates, and back again to parasites their history passes, until they are generally acknowledged to be what they really are: organs forming integral parts of the animal. v. Uexküll has given an excellent account of their history (406), and so there is no reason to give it here again. I shall only here note a few less important treatises, not mentioned by v. Uexküll, viz. by Duncan (130), Groom (175), and Stewart (381). A little note by Troschel (Verhandl. d. naturhist. Vereins d. preuss. Rheinl. u. Westphalen. 1870 p. 137) is also to be mentioned for the sake of completeness; it contains nothing new.

The histological structure of the pedicellariæ has of late years been very carefully studied, especially by Foettinger (155), Hamann (184), Sladen (366), Prouho (327), and v. Uexküll (406). The most interesting ones in this respect are the globiferous pedicellariæ, which have proved to be poison-apparatus of a very peculiar and complicated structure with sensitive cilia, poison-glands etc. Only a single point seems hitherto not to have been fully understood, viz. how the poison gland opens through the large tooth at the end of each of the three valves forming the skeleton of the head of the pedicellaria. Perrier[1]) thinks that in some there is a large »lacune mediane» in the end-tooth, in others he finds two terminal teeth beside each other. The latter fact is also stated by Valentin[2]) with regard to *Strongylocentrotus* »*lividus*. Sladen (366, p. 105) describes the end-tooth as »channelled and presenting the appearance of two or more lateral lamellæ merged together to form the tip or tooth-like fang». Stewart alone seems to have seen the fact correctly; he says (381, p. 910) of the globiferous pedicellariæ in *Echinostrephus*: »The jaw terminates in a long, deeply grooved fang; the groove, which is almost converted into a canal by the meeting of its margins, opening at a point near, but never at the tip on the external or distal surface». But this correct description seems to have been overlooked. Neither seems the most recent author on this subject, v. Uexküll, to have understood the structure correctly, although he is not much mistaken. He says (op. cit. p. 364): »Die Verdickung (the upper end of the blade where the end-tooth issues) weisst jederseits eine längliche Öffnung auf, von der aus je ein Canal ins Innere tritt. Die beiden Canäle vereinigen sich in der Mittellinie zum unpaaren Giftcanal, der bis nahe an die Spitze des Endhakens läuft um hier dorsal zu münden. Der Endhaken zeigt am äussersten Ende noch eine aufgesetzte feinste Spitze». According to this description v. Uexküll seems to think that the poison-canal runs quite inside the tooth, which would thus be tubular.

An essential reason why the authors have not hitherto succeeded in reaching the correct understanding, is no doubt that *Sphærechinus granularis* has especially been used as the subject of examination, and in this species the structure of the tooth is only to be seen with some difficulty. If, on the other hand, an *Echinus* or a *Psammechinus* is used, the structure is easily seen, and when first it is understood, it is also easily seen that the pedicellariæ of *Sphærechinus* are in reality constructed in the same way. — When the fang is viewed from above, the poison-canal is seen to be an open groove on the upper surface of the fang (Pl. XVII, Fig. 15), the whole reminding of the poison-fangs in the opistoglypha. As mentioned by v. Uexküll, the canal runs out a little before the point; to speak of »eine aufgesetzte Spitze» is misleading. (In the Cidaridæ the structure of the globiferous pedicellariæ is quite different, as described below.)

As far as I know there is in literature next to no more exact accounts of the development of the pedicellariæ of the Echinoids[3]). Only Prouho (327) gives some excellent figures of the first stages of development, but only of the histology; the development of the calcareous skeleton is not mentioned. Agassiz, in the »Challenger»-Echinoidea (8) Pl. II, Fig. 16, gives some figures of developmental stages of pedicellariæ in *Goniocidaris canaliculata*; but only the outer contour is given, and mention is made neither of the histology nor of the calcareous skeleton. No further direct observations seem to be found. — Generally, the small pedicellariæ have been regarded as developmental

[1]) Recherches sur les Pédicellaires et les Ambulacres des Astéries et des Oursins. Ann. Sc. Nat. 5. Sér. XII—XIII. 1869—70.
[2]) Anatomie du genre Echinus. (Agassiz: Monographies d'Echinodermes.) 1842.
[3]) On the development of the pedicellariæ in Asteroidea Agassiz gives some informations. (Rev. of Echini IV.)

stages of the large ones of the same kind. Duvernoy[1]) even thinks all the different kinds of pedicellariæ to be developmental stages of a single, definitive form, pedic. tridens. Valentin (Op. cit. p. 49) writes of the triphyllous pedicellariæ: «Je n'ai pu m'assurer si ce sont des pédicellaires d'une espèce particulière, ou s'ils ne sont que le jeune âge des pédicellaires ophicephales», and Agassiz, in «Rev. of. Ech.» p. 665, says: «in *Echinometra* there is no doubt these trifoliate pedicellariæ are only the younger stages of the tridactyle forms». Scarcely any student of these forms will now-a-days suppose one form of pedicellariæ to be a developmental stage of the other. On the other hand it must be admitted that at a first glance the small pedicellariæ might appear to be developmental stages of the larger ones of the same kind. A little reflection, however, will immediately show the improbability of this supposition; what re-arrangements were to take place in the calcareous mass to make a small fully formed pedicellaria become a large one! — Pedicellariæ are not rarely found that seem either to be only half-formed, or half-decomposed. The possibility that they might be somewhat decomposed, because the preserving fluid had become acid, has to the dismissed at once, — if this were the case the lime would be corroded everywhere, and not only the outer edge be decomposed. Döderlein (116) has seen and figured such half-formed pedicellariæ of *Stereocidaris grandis* and «*Leiocidaris*» *verticillata*, and regards them as a separate kind. «Es scheint noch eine vierte Form von Pedicellarien bei den Cidariden zu geben, von der ich aber bisher nur einige isolierte Klappen gesehen habe, die sich auf Präparaten ganz vereinzelt neben den anderen Formen fanden. Diese «korbförmigen» Klappen zeigen eine sehr weite, bauchige Kammer, die am oberen Theil in einer sehr grossen Öffnung mündet; diese Öffnung zeigt einfache dünne und etwas gekerbte Ränder; von Zähnelung u. dgl. ist keine Spur vorhanden. Solche Pedicellarien erreichen bei *C. grandis* die Grösse und die äussere Gestalt der dickköpfigen Form, sie sind dagegen sehr klein bei *L. verticillata*; bei anderen Arten kenne ich sie nicht, auch ihren Standort konnte ich nicht entdecken» (op. cit. p. 33). For a long time I had no clear understanding myself how to interpret this form, until I found some specimens of *Phormosoma placenta* possessing such structures in large numbers and in different sizes, and then there was no doubt that they are developmental stages of pedicellariæ. On Pl. XII, figs. 15, 24, 30, 38 the development of a triphyllous pedicellaria is given. The part first formed is the basal part of the three valves and the stalk (its upper end); they seem to appear contemporaneously. From the basal part then the blade grows up, and new calcareous particles being constantly added all round, it grows in breadth and height; the apophysis is early formed. The figures give, better than a long description, an idea of the way in which the growth takes place. Where a distinct margin is formed the growth is completed. The margin is first formed below when the definitive breadth has been reached, and is then continued towards the upper end. A large pedicellaria is begun with a broad base, a little one with a narrow base. No growth takes place when a coherent margin has been formed all round the valve. — On Pl. XII, figs. 4—5 is shown a developmental stage of a large tridentate pedicellaria. — I have found such stages of development in most of the species I have examined.

Already Duvernoy (op. cit.) and W. B. Herapath[2]) lay stress upon the fact that the pedi-

[1]) Mémoire sur l'analogie de composition et sur quelques points de l'organisation des Echinodermes. Mém. de l'Inst. de France. XX. 1849. p. 611.

[2]) On the Pedicellariæ of the Echinodermata. Quart. Journ. micr. Sc. (N. S.) V. 1865. p. 175—84. Pls. IV—V.

cellariæ of the Echinoids give good specific characters. Stewart, Koehler, Döderlein, Wyv. Thomson, a. o., but especially Perrier and Agassiz have later described pedicellariæ of a great many different Echinoids, and have shown that here an immense richness in forms is found, and that they give characters with regard as well to families, as to genera and species. Nevertheless the pedicellariæ have only a few times (in Wyv. Thomson's classical work on the »Porcupine»-Echinoids (395) and Döderleins as excellent work on the Cidarids (116)) been treated as being of importance in the systematic works; generally they have only been mentioned as a matter of small importance beside the description proper, and often no attention at all has been paid to them. Rarely all the different forms of pedicellariæ in a species are described, and still less in all species of the same genus; of one species an ophicephalous and a tridentate pedicellaria is figured, of another a valve of a globiferous one, of a third perhaps none at all, etc. In this way, of course, we shall never get a clear understanding of the systematic characters which may be found in these small organs. The pedicellariæ in effect give absolutely excellent systematic characters, sometimes only specific characters, sometimes also generic ones.

The use of the pedicellariæ in classification is attended with great advantages; they do not change their form with age, but are in the newly metamorphosed Echinoid of the same form as in the grown one, only somewhat smaller in the small specimens. It is therefore (oftenest) possible, by means of the pedicellariæ, easily to determine quite small Echinoids with absolute certainty — at all events as to genus. Another advantage is that it is not necessary to remove the spines in order to get a view of the tubercles, the specimens have not to be destroyed for the sake of determination.

It may, perhaps, seem unreasonable to lay so much stress, as is done here, on so minute features as the pedicellariæ — to use them for the characterizing of as well species as genera and families. But when it proves to be a real fact that these minute features give excellent, constant characters, it may be taken to be reasonable to use them without regard to their being small or large. Surely any student of Echinoids will also feel it as a great advantage not to be obliged to be contented with all these relativities, as the length and number of the spines, the size of the tubercles, the form of the test etc. To all these things, of course, regard must always be paid, and so has also been done here, as far as the material has permitted. But the pedicellariæ are, at least, as important. I can completely subscribe the expressions of Stewart (381 p. 912): »It seems to me most desirable that minute, and even apparently trivial, features should be given in the descriptions of species, and that when this is more done, we may find affinities between forms, we should otherwise not suspect, and be enabled by the examination of even an ambulacral tube or pedicellaria etc. to determine a species without the denudation of portions of the corona, which is sometimes not desirable».

The supposition by Stewart that by an examination of the pedicellariæ etc. we might find a closer relation between forms not otherwise regarded as related, has been amply justified by these researches, even to so high a degree that the classification hitherto used proves to be quite a failure (with regard to the groups treated of here). A good proof of the correctness of the new classification given here, which has been found especially by the examination of the pedicellariæ, is found in the fact that forms with the same kind of pedicellariæ also agree in other important respects. To be sure, the material has not been sufficient for a thorough examination of all characters with regard to some groups (especially the Cidarids), but I think that from the results found elsewhere we shall be justified in supposing that it will appear everywhere to be a fact that forms with the same kind of pedicellariæ in reality belong to the same natural group.

It is a serious drawback that the pedicellariæ cannot be used in the classification of the fossil Echinoids. Groom (175), to be sure, has described the pedicellariæ of *Pelanechinus corallinus* in a very well preserved state, and it will, no doubt, also be possible to find them in well-preserved specimens of other fossil Echinoids; of course, however, it will always be a rare thing — generally we have here to be content with the tests (and the spines). These structures also often give excellent characters, but they are far from being always reliable. The former great incertainty in the determination of the recent forms of regular Echinoids (and I think it is not much better with regard to the irregular ones) may be taken to imply that there cannot be any great certainty in the classification of the fossil forms either.

As is well known, no less than four different kinds of pedicellariæ are found in an *Echinus*, viz. globiferous pedicellariæ, tridentate, ophicephalous, and triphyllous ones. Of these forms the triphyllous and ophicephalous ones have only very little systematic importance; they are very much alike in almost all Echini. The tridentate ones give often excellent specific characters; the globiferous ones are generally very much alike in related species, but show very characteristic differences in the different genera. Especially the latter form shows many peculiarities. The structure of the blade is highly different; it may be open or shut, the margins having coalesced on the inside; there may be many or few teeth along the edge, placed symmetrically or unsymmetrically, or teeth may be quite wanting. On the other hand no forms are known with more than one end-tooth[1]). When Perrier (op. cit.) says that the globiferous pedicellariæ in the Echinometrids end in two hooks, one placed a little above the other, this statement is not quite correct. There is also here only one end-tooth, with the mentioned open canal on the upper side; the other one that is placed below the former, is a lateral tooth with no poison-canal, homologous with the lateral teeth of the pedicellariæ in *Echinus*. Here thus is only one unpaired lateral tooth. In *Sphærechinus*, *Strongylocentrotus* etc. no lateral teeth are found at all, only a little obliquity is seen towards the end of the blade, a little process on one side, perhaps a reminiscence of the unpaired lateral tooth in the Echinometrids. — Some *(Strongylocentrotus)* have a long, muscular neck between the stalk and the head; in most forms the head is placed directly on the end of the stalk. Even the structure of the stalk is very different, in some forms it is a perforated tube, in others some thin calcareous threads, irregularly connected by short cross-beams, or it may even be a single thin calcareous thread. Some forms have large mucous glands on the stalk. In the Cidarids the stalk is very peculiar, with an upper thin part and a lower thick one; at the transition between the two parts a limb of projecting calcareous ridges is often seen.

The mentioned four different kinds of pedicellariæ are found in the old families *Echinidæ* and *Echinometradæ*. In the Echinothurids globiferous pedicellariæ are only found in a single genus *(Hapatosoma)*; they are highly peculiar (Pl. XIII, Figs. 20, 24, 25), obviously very primitive. The calcareous skeleton consists of three simple rods lying between the three (mucous?) glands, each

[1]) Comp. however, the description of the globiferous pedicellariæ in *Stomopneustes*.

of which ends in a fine pore at the end. The rods reach only half-way, the whole thing is coalesced to the very point; there are no muscles between the basal parts of the valves. In another genus *(Aræosoma)* a singular kind of pedicellariæ are found, the tetradactyle, with four peculiar, very elegantly formed valves. Also in other Echinoids a four-valved pedicellaria may now and then be found, but only as an abnormity. Ophicephalous pedicellariæ[1] are among the Echinothuridæ found in only a single genus *(Tromikosoma)*; on the other hand, triphyllous and tridentate pedicellariæ are found in all of them, and especially the tridentate ones show a great variety of forms, and are of great systematic importance. In the Cidarids are found tridentate pedicellariæ, and another kind occuring in a large and a small form, of substantially the same structure. They seem to be poison-apparatus as the globiferous pedicellariæ of the Echinidæ; but they are of a quite different structure, the gland being here placed inside the blade, quite surrounded by the calcareous skeleton, while in the Echinidæ it is situated on the outside of the blade. On the inside of the blade, somewhat below the point, there is a larger or smaller opening («the mouth») in the calcareous skeleton, filled with large cells, richly provided with cilia (sensitive hairs?). The efferent duct of the secretion of the gland passes up through the end-tooth, and opens on its surface. How these structures are arranged in forms with no end-tooth is unknown. The inner opening is of great systematic importance, while the glandular opening itself scarcely is of any importance in this respect. Perrier (op. cit.) gives these pedicellariæ a special name «Pedicellaires armées». After the discovery of the above described form of globiferous pedicellariæ in the Echinothurids[2] there seems to be sufficient reason to take these pedicellariæ in the Cidarids to be homologous with the globiferous pedicellariæ of the Echinoids, as has also been done by Stewart (379) and Prouho (327), so that there is no cause to keep the name given to them by Perrier. There is still less reason to keep the name «Ped. inermes» for the tridentate pedicellariæ of the Cidarids; there can be no doubt but that they correspond to the tridentate pedicellariæ of the other Echinoids (Prouho (327), Koehler (217)). Hamann (184) regards the small pedicellariæ as «a subspecies of the tridactylous ones». Now it has to be admitted that sometimes it may be rather difficult to distinguish between these latter and small tridentate pedicellariæ; but generally they are very easily recognised, and there is no doubt that, with regard to structure, they resemble very much the large globiferous pedicellariæ. Where no pronounced difference is found between large and small pedicellariæ, it may in fact be impossible to decide, whether a certain specimen is to be regarded as a large or as a small form. There seems to be no reason to give a special name to the small pedicellariæ; in the present work they will the mentioned as «small globiferous pedicellariæ». — Ophicephalous and triphyllous pedicellariæ are not found in the Cidarids.

O. F. Müller[3]) has originally given names to the pedicellariæ, viz. Pedicellaria globifera, triphylla, and tridens. These names have not been generally accepted, the reason being especially that Valentin in his classical monograph on the anatomy of *Echinus* has used other appellations: Pedicellaire gemmiforme, tridactyle, and ophicephale; these names have become the common ones. Sladen (366) justly maintains that it is incorrect to use these latter names. The figures of Müller

1) What has hitherto been regarded as ophicephalous pedicellariæ in the Echinothuridæ, are in reality triphyllous ones.

2) Also the globiferous pedicellariæ in *Stomopneustes* seem to form a peculiar type. They have no end-tooth, and there seems to be no poison gland on the outside of the blade.

3) Zoologia danica. 1788. pag. 16. Tab. XVI.

are perfectly recognisable, and therefore his names ought to be restored to their rights. The name of P. triphylla of Müller, however, no doubt includes as well ophicephalous pedicellariæ as triphyllous ones. This name must then be kept for the small form the valves of which resemble clover-leaves, while Valentin's name P. ophicephale is kept for the form described by him under this name. — Hamann (184) uses the name «Globiferen» especially of the pedicellariæ where the mucous glands on the stalk have been so highly developed, that the head has become rudimentary or is even quite wanting. Thus they, as is also admitted by Hamann himself, are not a peculiar kind of organs, but only transformed pedicellariæ; it may, perhaps, be as well to have a special name for these pedicellariæ, but the name of «Globiferæ» cannot be restricted to them, as has also been observed by Duncan (130). It is, in reality, contrary to all common practice not to use the names of Müller. The reason for keeping Valentin's names given by Geddes and Beddard (163): «both on account of their general acceptance and because they were the first names applied to pedicellariæ after the determination of their real nature; Müller's nomenclature refers to pedicellariæ as a genus of parasitic animals», is not sufficient for a disregarding of the common rules of priority. Accordingly the names that ought to be used, are the following:

Globiferous pedicellariæ	— *Pedicellaria*	*globifera* Müller	=	Pedic. gemmiforme Valentin, Perrier. P. armé Perrier (in the Cidarids). «Globiferen» Hamann.
Tridentate	— — —	*tridens* —	=	P. tridactyle Valentin etc. P. inerme Perrier (in the Cidarids).
Ophicephalous	— — —	*ophiocephala* Valentin	=	P. triphylla Müller pro parte. P. buccale Valentin, Hamann.
Triphyllous	— — —	*triphylla* Müller	=	P. trifolié Perrier.

To facilitate the understanding of the descriptions in the following, figures are annexed showing a single valve of each of the four kinds of pedicellariæ together with the names used for the separate parts.

To be able to study the pedicellariæ, especially the calcareous skeleton, which is of particular importance for the classification, they must necessarily be treated carefully. On being boiled in a not too strong solution of potash the separate pieces of the skeleton may easily be isolated, and no very great technical skill is necessary to be able to make preparations in Canada balsam of these pieces. (They cannot be kept in glycerine, as it resolves the lime). Accordingly I can in no way subscribe to the opinion of Pomel that the pedicellariæ only with difficulty can be used for the classification, because «leur ténuité en rend l'étude peu pratique» (324 p. 13).

Also the spicules yield good systematic characters, even if they are not, in this respect, equal to the pedicellariæ. They only rarely yield specific characters, and are oftenest very similar in the separate genera of the same family, but they may yield excellent family characters. They may be of a simple C-shape («bihamate») — the most common form — or a little branched in both ends (*Strongylocentrotus*), or pointed in both ends, and with one branch or a couple of small branches in the middle, «biacerate» (*Parasalenia*, *Anthocidaris*); in *Sphærechinus* and especially in *Toxopneustes* and

Tripneustes they are dump-bell-shaped, and in many genera they are irregular, perforated calcareous plates. Perrier (op. cit.) and especially Stewart[1]) have figured the spicules of many Echinoids; but they have not, any more than the pedicellariæ, hitherto been of any importance in the classification.

The sphæridia do not appear to show such differences in structure that they may yield systematic characters. On the other hand the structure of the spines is of no small systematic importance, as especially shown by Mackintosh (264—265), and they are never to be passed by in the descrip-

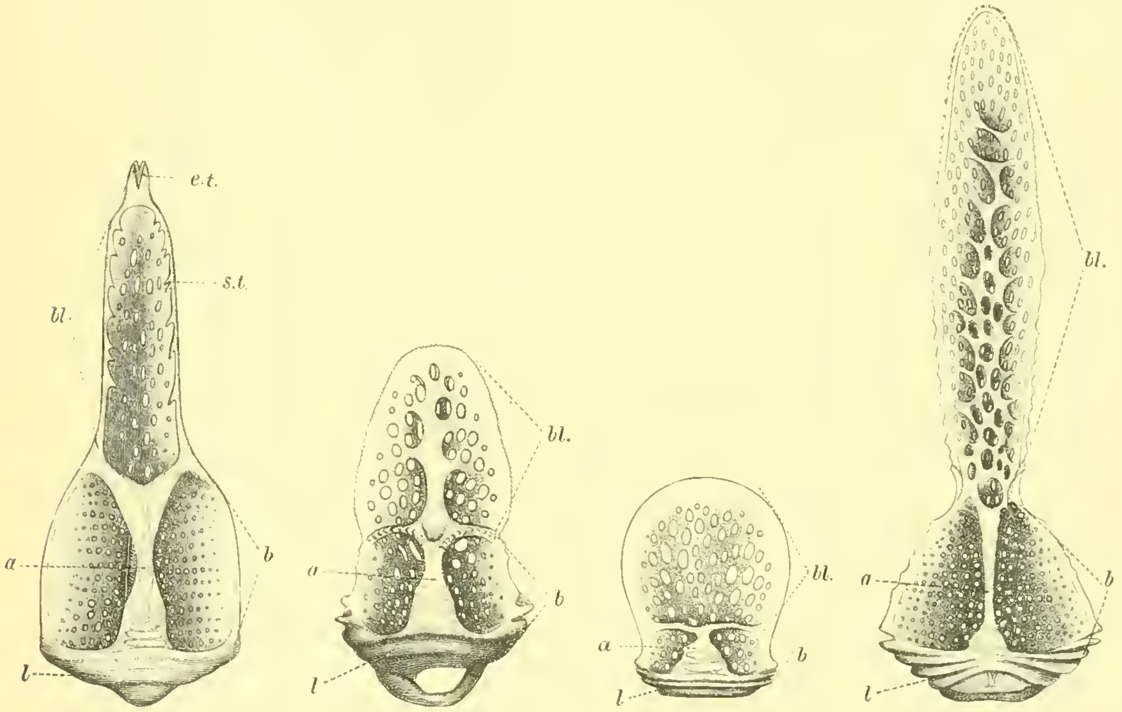


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 1. Valve of a globiferous pedicellaria of *Parechinus miliaris* (Müll.)
— 2. — - an ophicephalous pedicellaria of *Strongylocentrotus drobachiensis* (O. F. Müll.)
— 3. — - a triphyllous pedicellaria of *Parechinus miliaris*.
— 4. — - a tridentate pedicellaria of *Strongyloc. drobachiensis*.
In all the figures *a.* means the apophysis, *b.* the basal part, *bl.* the blade, *e.t.* the end-tooth, *s.t.* lateral teeth, *l.* the articular surface.

tions — as indeed nothing that may be of systematic importance. Above all, the most easily accessible and most reliable characters, viz. the pedicellariæ and spicules, ought never to be omitted in systematic descriptions of Echinoids.

Fam. **Cidaridæ.**

With regard to the classification of the Cidarids, all authors seem to agree in only one thing, viz. that all attempts made hitherto at giving a natural limitation to the genera have failed. Every

[1]) On the Spicula of the Regular Echinoidea. Transact. Linn. Soc. London. XXV. 1865. p. 365—71. Pl. 47—50.

writer upon the classification of the Echinoidea since Desor has complained of the unsatisfactory attempts of some of the most distinguished authorities to subdivide the genus Cidaris ... The divisions were made upon very unimportant external characters, and subsequent research has proved that these structures, the variations of which led them to be considered of good diagnostic value, are of no physiological importance (Duncan (132 p. 29)). In the excellent principal work on the Cidarids, Döderlein's Die japanischen Seeigel (116) he says (p. 35): «Eine wirklich befriedigende Gruppierung der lebenden und fossilen Cidariden in Gattungen und Untergattungen ist bisher eine ungelöste Aufgabe gewesen und wird es wohl noch lange bleiben». And then follows, to boot, a remark, anything but encouraging to a systematist, that es ist durchaus nicht zu erwarten, dass die Abgrenzung der Gruppen bei zunehmender Kenntniss eine schärfere werde. — Nevertheless I shall here make an attempt to solve the problem: the classification of the Cidarids.

Agassiz in his Revision of Echini keeps the genera: *Cidaris*, *Dorocidaris*, *Phyllacanthus*. *Stephanocidaris*, *Porocidaris*, and *Goniocidaris*; *Dorocidaris* and *Phyllacanthus*, however, are more nearly regarded as subgenera under *Cidaris*, what is also especially remarked later, in the Challenger-Echinoids (8 p. 33). They are here further defined in the following way: *Dorocidaris* would include all forms with narrow ambulacral areas and long slender, serrated spines, while *Phyllacanthus* would include species with broad ambulacral areas, having the poriferous zones joined by a furrow more or less distinct; while *Cidaris* proper would be restricted to species, in which the pores of the poriferous zone are not so connected. Wyville Thomson (395 p. 772) among the recent Echinoids only acknowledges the genera *Cidaris*, *Porocidaris*, and possibly *Goniocidaris*. Pomel (324) divides the Cidarids into three subfamilies, viz. *les Cidariens* with the genus *Eucidaris* (with trois espèces vivantes, none of which are mentioned) as the only recent representative; *les Goniocidariens* with the recent genera *Goniocidaris* and *Dorocidaris*; and *les Rhabdocidariens* with the genera *Phyllacanthus* (with the subgenus *Stephanocidaris*), *Leiocidaris* and *Porocidaris*. The genus *Schleinitzia* Studer is supposed to be a *Rhabdocidaris*, consequently also to belong to this subfamily. Duncan (132) only admits the genus *Cidaris* with the subgenus *Goniocidaris*; the other earlier genera are only classed as «divisions». De Loriol (245) comprises a great number of species under the name of *Rhabdocidaris* Desor; but he owns (p. 7) that au fond, toutes les tentatives, qui ont été faites pour demembrer le grand genre Cidaris, n'ont pas été heureuses; on trouvera toujours tant de passages entre les espèces, en apparence les plus distinctes, qu'il est douteux pour moi, s'il est vraiment nécessaire de diviser ce genre admirable, qui apparaît dès la fin de l'ère paléozoique et traverse dès lors tous les étages, sans manquer dans aucune, pour se retrouver enfin dans les mers actuelles sans avoir modifié aucun de ses caractères. The most important contribution to the classification of the Cidarids has been given by Döderlein in his above quoted, large and excellent work Die japanischen Seeigel where he attempts to group as well the recent forms as the fossil ones according to their real relation. With regard to the recent forms the following genera are retained: *Dorocidaris*, *Stereocidaris* (known until then only as fossil from the cretaceous period), *Eucidaris*, *Leiocidaris*, *Porocidaris*, and *Goniocidaris*. But neither is the limitation by Döderlein of these genera satisfactory; above all it holds good with regard to his genera as well as with regard to those of the other authors that nobody is able to recognise them with certainty by the diagnoses given, — when upon the whole diagnoses are given. After all it is a matter of judgment, to which genus one species or another is to be referred, and most of the species more frequently mentioned have also by and by been referred to almost all the different genera. So far it is very consistently done by Duncan and Bell (73) quite to strike out all these undistinguishable genera, and only retain the old genus *Cidaris*; but then on the other hand this way of proceeding means quite to abandon the pursuit.

The reason why the result of the earlier attempts at classification has been so meagre, has to be sought in the characters used. The most important ones have been, whether the two pores of each ambulacral plate are connected by a groove or not, and whether the tubercles are crenulated or not. Further the spines, the number of plates, the breadth of the ambulacral area, and upon the whole the structure of the test have been considered of great importance. All these characters, however, are insufficient or even unreliable. As has been pointed out by both Döderlein and Duncan, it is often impossible to decide, whether the pores are or are not connected by a groove. The crenulation is a very variable character; crenulated tubercles may be found in some individuals belonging to species normally without crenulation. The structure of the test, the tubercles, the number of plates etc. are very much dependent on the age of the animal. All these characters, says Duncan, are »of no physiological importance whatever»; »any classification in which these characters are used is artificial». On the other hand he thinks that »the number of interradial plates (is) of physiological importance; and there is a great temptation to consider typical Cidarids as having but a few, say not more than seven, in a vertical row» (132 p. 30). This character seems to be at least as gratuitous, as the others criticised by Duncan are relative ones; neither seems the result of his systematic researches in any way to show that he has found here a systematic character of any great importance.

Among the characters hitherto used in the classification, the spines seem to be one of the most reliable. They show a great richness of forms, but are at the same time of a rather constant form in the separate species. Also their microscopic structure differs to a high degree, and here, perhaps, we might find good generic characters. There are in the literature not a few examinations of the structure of the spines in the Cidarids. Stewart[1]), Bell (57), and Agassiz (Revision of Echini and Chall. Ech.) have figured transverse sections of the spines of different species; but especially H. W. Mackintosh has rendered great services to the question by his excellent researches on the structure of the Echinoid-spines (264—65). The spines of the Cidarids differ from those of the other Echinoids by having a compact outer layer (»*ostracum*» Bell); (such a layer is also found, however, in *Salenia* and *Arbacia* (on the point of the spines)); — »acanthostracous» this kind of spines is called by Mackintosh. Unfortunately it cannot with certainty be inferred from the existing examinations whether the structure of the spines yields good generic characters. Mackintosh is decidedly of opinion that the spines really yield characters of that importance; he finds »instances in which the acanthological characters would seem to call for a change in the position of a genus» (265 I p. 478), and he lays stress on the importance of always mentioning the structure of the spines in the description of Echinoids. Otherwise he has examined too few Cidarids to have got a sure impression of the

[1]) On the minute structure of certain hard parts of the genus Cidaris. Quarterl. Journ. Micr. Science. N. S. XI. 1871. p. 51—55. pl. IV.

systematic importance of the spines in this family. Bell (57) who has examined the spines in *Goniocidaris florigera*, *Phyllacanthus imperialis*, and *Stephanocidaris bispinosa*, finds that »within the limits of the true Cidaridæ stages in the extent of the fenestration, and the regularity of the spoke-like intermediate layers are to be observed; when combined with the inquiry into the relations of other structural characters .... they will perhaps be found to be of use in determining the minor questions of the limitations of the genera, of which that family is composed».

No doubt Bell is right when he thinks that the structure of the spines will be of systematic importance; it is, however, not the inner structure, which is highly homogeneous, but the outer layer that is of importance here. From the sections of the spines of 5 different Cidarids figured on Pl. XI, Figs. 1, 3, 14, 24, 31, 33, it will be seen that the outer layer is constructed in a highly different way. Sometimes it is quite smooth, with no indication of any roughness whatever on the surface, sometimes it is richly set with small, hairlike outgrowths especially between the ribs. These «hairs» may be more or less branched, and they may unite so as to form a dense reticulation. Special attention must, accordingly, be paid to this outer layer; no doubt, valuable characters will be found here, but for the present nothing can be said with regard to the fact whether only specific characters, or, what is more probable, also generic characters may be found. A clearer view of this question is not to be got until a larger number of species has been examined. The accounts hitherto given, unfortunately, have not been sufficiently exact with regard to the outer layer, so that they are not to be trusted in this respect. As it is the outer layer, which is mainly to be considered, it is of no use to examine old spines, they must be fresh, so that the outer layer is still undamaged (such as are not overgrown by foreign organisms).

The spicules of the tube feet seem only to be of slight systematical importance. Commonly they are formed like bows reaching over about half of the circumference of the foot or somewhat less. They are more or less spinulous; in some species of *Stereocidaris* they are formed as larger, fenestrated plates. Generic characters would seem not to be found in the forms of the spicules.

Then only the pedicellariæ are left where we might expect to find good specific characters; but to judge by the statements in the existing literature, it would also seem beforehand to be rather hopeless. Perrier, in his well-known large work on the pedicellariæ, has given (not very exact) figures and descriptions of several forms; but their systematic importance does not clearly appear from these figures and descriptions. Stewart (op. cit.) has given an excellent figure of a pedicellaria of »*Cidaris annulata*». According to Agassiz (Revision of Echini) *C. annulata* A. Ag. is = *C. tribuloides* Lamk., and *C. annulata* Gray = *Phyllacanthus annulifera* A. Ag. The figured pedicellaria, however, cannot belong to any of those species, although Agassiz (Revision p. 99) mentions the quoted work of Stewart under *C. tribuloides*; it seems to be a *Goniocidaris*, but which species cannot be determined. In (379) Stewart further gives a couple of excellent figures of globiferous pedicellariæ in *Dorocidaris papillata*. Also Wyville Thomson (395) gives excellent figures of the pedicellariæ in *Dorocidaris papillata* and *Porocidaris purpurata*. In »Revision of Echini» and in the »Challenger»-Echinoids (8) Agassiz figures pedicellariæ of several Cidarids, but generally the figures are not good. Döderlein (116), however, is the first author, who has tried to use the pedicellariæ in a correct way in the classification of the Cidarids. He has studied the pedicellariæ in a larger number of species, and thinks that they often give excellent specific characters, but he was disappointed »in ihrer erhofften Verwendbarkeit zur Unterscheidung natürlicher Gruppen innerhalb der Familie» (p. 1). »Nur mit grosser Vorsicht dürfen Pedicellarien als systematische Merkmale bei den Cidariden benützt werden». The small pedicellariæ are highly similar in almost all species, but they may vary very much in the separate individuals. (Only the form with a long terminal hook, occurring in *Goniocidaris mikado* and *clypeata*, is especially mentioned). The tridentate ones (»löffelartige Form») are better, but they are also highly varying in the separate individuals. Most applicable for the classification is the thick-headed form, (the large, globiferous pedicellariæ); it is highly constant in form and size, and shows many peculiarities, «die sehr wohl einzelne Arten, manchmal auch Gruppen charakterisiren können». He also tries to group the species according to these peculiarities, without, however, attributing to them any great systematic importance, and therefore he does not mention the pedicellariæ in his diagnoses of genera. The fact is that also this form of pedicellariæ shows some variability, is sometimes even quite wanting in some individuals, so that it is no quite reliable character. An extraordinary fact is »dass sehr ähnliche Formen dieser Pedicellarien bei Arten vorkommen können, die nach den übrigen Charakteren sehr wenig Verwandtschaft mit einander bekunden» (*C. metularia* and *verticillata*). His final result is: «In vielen Fällen hat nun ohne Frage die Vergleichung der Pedicellarien nicht geringen Werth für die Systematik; sie geben jedenfalls sehr brauchbare Charaktere zur Unterscheidung der Arten. — Zur Charakterisierung von grösseren Gruppen innerhalb der Familie finde ich aber Pedicellarien sehr wenig verwendbar» (p. 34).

And so the last hope of finding good generic characters in the Cidarids seems to have vanished. Fortunately, however, my researches have given another result than that of Döderlein, viz. that the pedicellariæ yield excellent generic characters, while they may only more rarely be used for distinguishing between the species. This seems to be irreconcilable with the above quoted statement of Döderlein that species not more nearly related, may have quite similar pedicellariæ. As instances are only named *Cidaris metularia* and *verticillata*. Now it is quite correct that they have the same kind of pedicellariæ; but then the question is whether the other characters, in which they differ, are sufficient to show that they cannot belong to the same genus. The most essential difference seems to be found in the spines, which are in *C. verticillata* provided with large thorns placed in circles far from each other, while in *C. metularia* the spines have the whole surface evenly set with homogeneous, small tubercles arranged in longitudinal series. Also with regard to the provision of the interambulacral plates with miliary tubercles a difference is found — they are almost naked in *C. verticillata*, closely covered in *C. metularia*. As it has otherwise proved to be a fact that the characters taken from the structure of the test have been anything but good as generic characters, and as there seems to be nothing unnatural in the fact that spines as those in *C. metularia* and *verticillata* are found in species of the same genus, I cannot but regard the fact of the two species having the same kind of (very characteristic) pedicellariæ as proving them to be nearly related, so that they will have to be regarded as not too closely allied species of the same genus. Besides there is another species of the same genus presenting considerably more resemblance to *C. verticillata* than the *C. metularia* mentioned by Döderlein. This is *C. baculosa* which is by Döderlein referred to the same genus (*Leiocidaris*) as *C. verticillata.* In this species the thorns are often placed in circles in a somewhat similar way as in *C. verticillata.*

Especially the large globiferous pedicellariæ are of importance in the classification, the blade and partly also the stalk offering a great variety of forms. Also the length of the stalk is very different; this fact, however, has to be used with great caution, at it is very varying. Döderlein seems to put no small weight upon it. Also the small globiferous pedicellariæ are of rather great importance; more important, however, are the tridentate ones, which in a single genus, *Porocidaris*, are two-valved. In this genus (and perhaps in the genus *Histocidaris*) globiferous pedicellariæ seem to be quite wanting; on the other hand tridentate pedicellariæ are wanting in several other species — but perhaps not constantly. That the globiferous or tridentate pedicellariæ may sometimes be wanting, is mentioned by Döderlein as an objection to their being used in the classification. I cannot see, however, that this objection is sound; a corresponding fact would be, if we were to give up using the teeth of the mammals as systematic characters, because now one, now another kind, or even sometimes all of them are wanting.

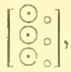
When we now look over the Cidarids, and place together the species with similarly constructed pedicellariæ, we shall get a grouping rather differing from all hitherto given classifications.

Dorocidaris papillata: the globiferous pedicellariæ have a powerful hook at the point, above the large, somewhat lenghtened, not terminal opening; small pedicellariæ of the same form; the tridentate ones simple (Pl. IX, Figs. 7, 25). Quite similar pedicellariæ are found in *Dorocidaris Blakei* A. Ag. (Pl. IX, Fig. 16), which is accordingly a genuine *Dorocidaris.* On the other hand the following species that have been referred to *Dorocidaris: D. Bartletti* Ag., *bracteata* Ag., and *Reini* Döderl. differ widely from this genus, and are moreover so different from each other that they must be referred to three different genera.

D. Bartletti: the globiferous pedicellariæ have a long powerful hook at the point. The opening is exceedingly small, as a fine pore, surrounded by small teeth; it is placed rather far from the point. (Pl. X, Figs. 23, 30). The stalk is most frequently provided with a limb of freely projecting calcareous ridges. The small pedicellariæ are of the same structure, only the opening is larger; tridentate pedicellariæ simple. There can be no doubt but that this species must form a separate genus; I propose the name of **Tretocidaris**[1]. To this genus must further be referred the two following new species, which I found in British Museum, both under the name of *Dorocidaris papillata.*

Tretocidaris annulata n. sp. The globiferous pedicellariæ differ somewhat from those of *T. Bartletti* the inside of the blade being provided with some dentate transverse ridges and crests forming a coarse, irregular reticulation; at the upper end of the apophysis the margin of the blade is somewhat widened, highly fenestrated in a reticulate way, and bent a little outward (Pl. X, Figs. 22, 31). The stalk (Pl. IX, Fig. 4) and the other pedicellariæ as in *T. Bartletti.* The spines are finely annulated with brown rings, the upper spines have powerful thorns especially on the side turned up; they are tapering, about one time and a half as long as the diameter of the test; the actinal spines were wanting in the specimen. There is a rather deep, naked furrow along the median line of the interambulacral areas, and it continues between the plates outward to where the scrobicular areas join each other.

[1]) τρητός = bored.

There are 7 plates in the interambulacral areas. In the ambulacral area there is a little tubercle alternately between each two primary tubercles , as in *Porocidaris purpurata.* The colour of the test is redbrown, and therefore the white, naked furrow of the interambulacral areas is especially conspicuous. — Locality: The West Indies (no nearer information). Should this species perhaps be Gray's *Cidaris annulata*?

Tretocidaris spinosa n. sp. The globiferous pedicellariæ have no such reticulation as those of *T. annulata*, and differ from those of *T. Bartletti* by the sides forming an almost straight line from the basal surface to the opening. (Pl. X, Figs. 10, 11). The small globiferous pedicellariæ as in the two other species (Pl. X, Fig. 16). On the stalk no distinct, freely projecting calcareous ridges are seen, only a marked swelling. (It is, however, possible that the limb of the stalk is found on other specimens; in the two other species it was not found either in all the large globiferous pedicellariæ); tridentate pedicellariæ were not found. The spines closely grooved, rather finely thorned, widened at the point, of the same length as the diameter of the test. The actinal spines smooth, not serrated, their points not widened. The small spines are strongly redbrown. There is a naked median line in the interambulacral area, but it is only little conspicuous. 9 plates in the interambulacral area; thus the large spines are somewhat more numerous than commonly, which gives to the animal a very characteristic appearance. The tubercles in the ambulacral areas as in *T. annulata.* Locality: St. Helena (no nearer information).

Dorocidaris bracteata Ag. The globiferous pedicellariæ much lengthened and narrow, with a powerful hook at the end, and a rather small, triangular opening a little below the point (Pl. X, Fig. 18); the small pedicellariæ of the same structure, tridentate ones simple. This form of pedicellariæ is further found in *Phyllacanthus annulifera* (Lamk.), Pl. X, Fig. 17, and *Stephanocidaris bispinosa* (Lamk.), and these species will have to be united into one genus, which must keep the name of *Stephanocidaris.*

Dorocidaris Reini Döderl. The globiferous pedicellariæ are of a very peculiar structure; the mouth is placed in the end of the blade, surrounded by well marked teeth on the margin which is bent a little outward. Schnauzenähnlich vorragend Döderlein says of the blade in this peculiar form of pedicellariæ, and it really resembles a snout to some degree. On the stalk a limb of short thorns is found. The small pedicellariæ are of a quite different structure, a well developed end-tooth being found here, and the large mouth situated below the point. This form of pedicellariæ is found in a series of species, viz. *Cidaris affinis* (Pl. IX, Figs. 9, 22, 24) (which is in no way synonymous with *Dorocidaris papillata*, as has been commonly supposed), *tribuloides*, *galapagensis* — and, I suppose, also in *Dorocidaris panamensis* Ag.; at all events this species, to judge by the figure, would seem to be most nearly related to *Cidaris affinis* and *Reini*; it is scarcely a *Dorocidaris.* The following species have pedicellariæ of the same structure, but are distinguished by having a limb of long, freely projecting calcareous ridges on the stalk of the globiferous pedicellariæ: *Cidaris metularia*, *Thouarsii* (according to Döderlein (116 p. 19) *Cidaris Thouarsii* has only a short limb on the stalk; the specimens examined by me have long limbs), *verticillata* and *baculosa.* Further has (according to the statement of Döderlein) *Phyllacanthus imperialis* the same kind of pedicellariæ (whether a limb is found on the stalk or not, is not mentioned; I have not been able to find any large globiferous pedicellariæ in the few specimens I have examined), and the same, I suppose, holds also good with regard to *Phyllacanthus dubia* and *parvispina* Woods. Finally a similar form of globiferous pedicellariæ is found in *Goniocidaris florigera* Ag. (Challenger-Echinoids, Pl. I. Fig. 12) (Pl. X, Figs. 27, 29); in the latter there is no trace of a limb on the stalk.

Do now all these species belong to one genus? — Surely not. We shall first have to separate *Goniocidaris florigera*. It has no trace of a limb on the stalk, the spines differ considerably from those of all the other mentioned species, and I suppose that a closer examination will show several other peculiarities. Döderlein (116) thinks it to be most nearly related to the species *Goniocidaris clypeata* and *G. mikado* described by him, which species are distinguished by the spines being provided with a peculiar flat widening at the base. Traces of such a widening are also found in *G. florigera*; but the pedicellariæ of this species are so different from those of the two mentioned species that their being united into one genus is out of the question. It differs also from the genuine *Goniocidaris*-species (*G. tubaria* etc.) by its pedicellariæ; it must form a separate genus, for which I propose the name of **Petalocidaris**. There can scarcely be any doubt, however, that it is closely related to *Goniocidaris*.

Next *Phyllacanthus imperialis* must form a separate genus. It has peculiar large tridentate pedicellariæ, the blades of which are quite filled by a close net of meshes forming irregular longitudinal ridges closely set with small teeth (Pl. X Fig. 8); (the valve figured here, is from a smaller pedicellaria where only two longitudinal ridges are seen). The small pedicellariæ have no end-tooth (Pl. IX. Fig. 6). The spines are peculiar, thick, with fine longitudinal striæ. Together with this species *Ph. dubia* has no doubt to be placed — if upon the whole it can be kept as a separate species, of which I can have no decided opinion, as I have had no occasion to examine it. Also *Phyllac. parvispina* Woods must, to judge by the figure given by Woods (443), belong here; its spines resemble very much those of *Ph. imperialis* though Woods states them to be «entirely different from any described species». Also Ramsay (331 p. 45) says of this species that on the Australian south-coast it is the «representative of *P. dubia* of the North Coast». — This genus, no doubt, must keep Brandt's old name of *Phyllacanthus*. Brandt[1]) gives *Cidarites dubia* as the type of the section »*Phyllacanthus*«, and observes that to this will have to be added *C. imperialis*, *hystrix*, *geranioides*, and *pistillaris*. The three latter can in no way be classed together with the two former; these two must keep the name of *Phyllacanthus*. Desor in his »Synopsis des Echinides fossiles« (1855) establishes the genus *Leiocidaris* (p. 48), and as the type of the genus he gives *Cidaris imperialis*. — Thus there will be no use for the name of *Leiocidaris*, it will only be a synonym of *Phyllacanthus*. — It will also be necessary to say some words of the much used name of *Rhabdocidaris* by the present occasion. The genus has been established by Desor (op. cit. p. 39) for fossil species; in a note is added: »Parmi les espèces vivantes on pourrait reporter à ce genre les *Cidaris tribuloides* et *C. imperialis*, si leurs tubercules n'étaient pas complètement lisses«. De Loriol (245) has later enlarged this genus to comprise: 1) The fossil species of the genus *Rhabdocidaris* sensu stricto, 2) the *Rhabdocidaris*-species with smooth tubercles, 3) the species of *Leiocidaris* Desor and Dames (emend.), 4) the recent species of the genus *Phyllacanthus* Brandt, 5) the genus *Stephanocidaris* Ag., and 6) the genus *Schleinitzia* Studer. »Ainsi constitué, le genre *Rhabdocidaris*

[1]) Prodromus descriptionis animalium ab. H. Mertensio in orbis terrarum circumnavigatione observatorum. 1825 p. 68.

groupera naturellement un assez grand nombre d'espèces vivantes et fossiles et me paraît utile à conserver». The advantage of such a «genus», however, seems to me to be rather illusory; with the limitation given by de Loriol *Rhabdocidaris* becomes still more heterogeneous than *Phyllacanthus*, as it is limited by Agassiz in «Revision». As the genus has originally only been used of fossil species, it is quite impossible to decide whether some of the recent forms really belong to it; by the tests and the spines alone the genera cannot at present be recognised with certainty, and no pedicellariæ of fossil species are known. Accordingly the name of *Rhabdocidaris* is not to be used for any recent Cidarid.

On the other hand the other species with terminal opening on the globiferous pedicellariæ and limb on the stalk seem to form a natural group; the shortness or length of the limb can scarcely be used as a character for the subdivision of the group. Possibly *C. affinis* and *Reini* (and perhaps *panamensis*) will prove to form a special group — their spines seem to differ somewhat from the other mentioned species; but this can only be decided by more thorough examinations. For the present all these species: *Cidaris affinis*, *Reini*, *(panamensis?)*, *tribuloides*, *galapagensis*, *metularia*, *Thouarsii*, *verticillata*, and *baculosa*[1]) must form one genus, which must keep the old name of *Cidaris*, Linné's «*Echinus Cidaris*», as has been proved by Lovén (252), being *Cidaris baculosa* Lamk. The name of *Eucidaris* Pomel, which has of late often been used for species of this group, cannot correctly be used. Pomel (324) enumerates as types of this genus some fossil forms (*moricri* etc.) from the trias, and «trois espèces vivantes», but he does not mention which species he means, and the fact is here, as in *Rhabdocidaris*, that it is quite impossible to decide whether any of the recent species belong to the same genus as the mentioned fossil ones.

Besides the species mentioned here, Döderlein still enumerates «*Leiocidaris*» *annulifera* Lam. as belonging to those species, the globiferous pedicellariæ of which have terminal opening and limb on the stalk; here *C. annulifera* is referred to the genus *Stephanocidaris* which has a quite different form of pedicellariæ (see above) — a contradiction which can only have its origin from a difference in the interpretation of the species *C. annulifera* Lamk. This species together with *C. baculosa* Lam. have caused and still cause many difficulties to the systematists. Lamarck[2]) in his diagnosis of *C. annulifera* says: «spinis majoribus longis, tereti-subulatis, asperulatis, albo purpureoque annulatis», and in his diagnosis of *C. baculosa*: «spinis majoribus subteretibus, tuberculato-asperis, apice truncatis, collo guttatis»; according to this Agassiz («Revision of Echini» p. 389) states as the only certain character of the highly varying *C. baculosa* «the spotted base of the shaft of the spine below the milled ring, which is of a light reddish or reddish-yellow ground-color, with deep violet spots marked extremely distinctly upon the fine longitudinal striation». Loriol (243) later describes and figures a Cidarid by the name of *C. annulifera* Lamk.; he has had a radiole of the type-specimen of this species for comparison, and has found it completely corresponding to those of the specimen described by him. These spines have «leur base couverte sur une longueur plus ou moins grande de petites taches pourpres, formant des lignes et entremêlées de petits points» — the character especially particular of *C. baculosa!* Thus, somehow or other, an error must have slipped in, and I think it most likely that

1) If *C. pistillaris* Lamk. be a good species, it must also be referred here.

2) Histoire naturelle des animaux sans vertèbres. II. Ed. 1840. T. III. p. 380.

the spine, which Loriol has got from Paris, has really been of *C. baculosa* — such a changing of loose spines in a museum is not absolutely inconceivable. The *C. Lütkeni* described by Loriol in the same work, seems rather to be the real *C. annulifera*, which must then be very nearly related to *C. bispinosa*, perhaps identical with it. Bedford (35 p. 274) also regards *C. Lütkeni* as synonymous with *C. annulifera* Lamk., but at the same time he seems to think it to be identical with Loriol's *C. annulifera*, which cannot be correct. Döderlein, who has examined a specimen of Loriol's *C. annulifera*, finds this species to be highly consistent with *C. baculosa*. Einen Unterschied zwischen den beiden Arten kann ich nur in der Färbung der Primärstacheln finden; denn selbst die Form der Primärstacheln kann bei bestimmten Individuen beider Arten identisch sein. — Nur die Färbung des Schaftes ist verschieden, indem *L. annulifera* Querbinden zeigt, die *L. baculosa* fehlen; die eigenthümliche und auffallende Tüpfelung des Stachelhalses dagegen, die sonst nirgends zu beobachten ist, findet sich bei beiden Arten in gleicher Weise. Nachdem aber eine Autorität wie Al. Agassiz auf Grund eines reichlichen Materials die Frage nach der möglichen Identität der beiden Arten überhaupt nicht aufwirft, kann ich es nicht wagen bei meinem ganz unzulänglichen Materiale eine solche zu behaupten. Ich kann hier nur constatieren, dass die oben beschriebene jugendliche *L. annulifera* nach ihren sämmtlichen Charakteren, abgesehen nur von der Färbung der Stacheln, unbedingt als ein junges Exemplar von *L. baculosa* gelten könnte (116 p. 24). Prominence is also given to the fact that the pedicellariæ are quite identical. In another work (245) Loriol gives a thorough description and figures of *C. baculosa*, but its resemblance with the *C. annulifera* before described by him, is not at all mentioned. Thus the fact seems to be: either Loriol's *C. annulifera* is really this species — and then *C. baculosa* Lamk. and *C. annulifera* are synonyms — or it has, on account of some error or other, been wrongly determined — and then *C. annulifera* is most nearly related to *C. bispinosa* Lamk. (perhaps synonymous with it). The latter is the more probable. An examination of the type-specimens, especially their pedicellariæ, will easily decide this question. To be sure, Perrier has figured pedicellariæ of these two species, but unfortunately only so little exactly and minutely that he has not at all contributed to the clearing up of the question, especially as of one species he has only figured a globiferous pedicellaria, of the other only a tridentate one.

According to Döderlein (116 p. 25) *Schleinitzia crenularis* Studer is very nearly related to *C. baculosa*; Studer's figures (386) agree also partly with it, the separately figured spines having all the characteristic spots on the neck. On the figure of the whole animal these spots, however, are not found, and as, according to informations I have received from both Geh.rath, Prof. E. v. Martens and Prof. Döderlein, spines of at least two different species are found in the glass together with the type-specimen (v. Martens has sent me some of the spines), the safest plan will be to say nothing definite of this species, till the pedicellariæ of the type-specimen have been examined. Studer only figures the small form of the globiferous pedicellariæ.

Among the species referred to *Phyllacanthus* by Agassiz, still one has not been mentioned, viz. *Ph. gigantea* Ag. It differs from all other known Cidarids by its peculiar spines, as well primary as secondary ones; also its pedicellariæ are peculiar. The large globiferous ones (Pl. X, Figs. 15, 19) have a large cordate opening the lower limit of which is formed like a highly protruding lower lip; the opening reaches to the very point, and no end-tooth is found. No limb on the stalk. The small pedicellariæ are of a somewhat different form (Pl. X, Fig. 26), and have a more or less powerful end-tooth. Tridentate pedicellariæ about as in *Dorocidaris papillata*, only with the edge somewhat more dentate. Spicules of the common form. It is obvious that this species cannot remain in the genus *Phyllacanthus* as here limited, or be referred to any of the mentioned genera; it must form a separate genus and retain the name of *Chondrocidaris*, originally given to it by Agassiz[1]).

The splendid *Cidaris curvatispinis* described by Bell (74), is in its whole appearance so unlike all other Cidarids that it is beforehand to be supposed that it represents a separate genus. The examination of its pedicellariæ also confirms this supposition. The globiferous pedicellariæ (Pl. VIII, Fig. 37) have no end-tooth; the opening is large, reaching to the point, but its lower limit is remarkably irregular — the figured one is one of the most regular; sometimes there seems to be no definite limit at all, the calcareous covering running out into irregular dents, as if it was broken off (which is, however, quite out of the question, as the pedicellaria was otherwise quite undamaged). The small pedicellariæ are of the same structure, the only difference being that the lower limit of the opening is here often a rather regular transverse line. (The possibility that the described and figured pedicellaria is really, in spite of its size, only the small form of the globiferous pedicellariæ, is not excluded; but on the only known specimen, which by the kindness of Prof. Bell I had the opportunity to examine in British Museum, there seemed to be found no other kind of globiferous pedicellariæ). The tridentate pedicellariæ (Pl. X, Fig. 9) are very peculiar, with some large, dentate crests of thin calcareous lamellæ longitudinally in the blade. No limb on the stalk. The spicules of the common form. For this species I propose the generic name of **Acanthocidaris**.

The genus *Porocidaris* is established by Desor (op. cit. p. 46) for some fossil Cidarids, especially distinguished by a circle of pores in the scrobicular area; to this genus Wyville Thomson (394—95) referred a Cidarid from "Porcupine" under the name of *Porocidaris purpurata*. Whether it really belongs to this genus cannot be decided, till the pedicellariæ of the fossil species referred to it by Desor, become known. But to judge by what is hitherto known the species may well seem to be a *Porocidaris*, and for the present there seems to be no reason to reject this commonly used name, and *P. purpurata* W. Th. may then be put down as the type of the genus. Peculiarities of this genus are then the depressions in the scrobicular area (not pores as in the fossil species), the highly developed neck of the spines, the highly serrate edge of the actinal radioles[2]). But the most particular feature are the pedicellariæ. Only one form is found which must be referred to the tridentate ones; they are two-valved, highly compressed, and exceedingly large and conspicuous. The spicules of the common form.

To *Porocidaris* have later been referred the following species: *P. elegans* Ag., *Sharreri* Ag., *Milleri* Ag., *Cobosi* Ag., *gracilis* Sladen, *gracilis* Döderl., *misakiensis* Yoshiwara, and *incerta* Koehler. Of these species *P. gracilis* Sladen is, no doubt, only a young *P. purpurata*, and this name is then to be omitted as a synonym. *P. elegans* (one of the type-specimens ("Challenger" St. 164a) examined in British Museum): the tridentate pedicellariæ are widely different from those of *P. purpurata*. There

[1]) List of Echinoderms sent to different Institutions in exchange for other specimens, with annotations. Bull. Mus. Comp. Zool. I. 1863.

[2]) Especially the latter fact is often mentioned as characteristic of the genus; this, however, is not at all reliable, as sufficiently shown by these researches.

are two forms, a larger and a smaller, both three-valved. In the larger form the blade is filled by an exceedingly rich net of meshes, in which the holes are rather distinctly arranged serially, and radiate in a fanshaped way from the upper end of the apophysis; this net is covered with numerous small thorns, especially towards the point. Also the upper edge of the apophysis is very broad and full of holes. (The figures in the «Challenger»-Echinoids, Pl. XLIV, 6—14, are not very good, especially not figs. 6 and 11, where it is not seen at all that the whole mass filling the blade, is really a net of meshes with innumerable larger and smaller holes). In the other, smaller form the apophysis has the common structure; the blade is highly compressed, deep, and filled with an irregular net of meshes where the holes are not at all serially arranged. Transitions are however found between the two forms, so that they cannot be said to be two distinct kinds. When Agassiz (Chall. Ech. p. 43) says of «the large-headed, shortstemmed pedicellariæ» that they are «very similar to those of *Dorocidaris*», this is only so far correct, as tridentate pedicellariæ, of course, always in some degree resemble each other; in the finer structure the large tridentate pedicellariæ of this species are especially widely different from those of *D. papillata*. The small ones are much more similar. — Agassiz (l. c.) mentions one more form of pedicellariæ, «shortstemmed globular abactinal pedicellariæ» (Pl. XLIV, 10); they are, as I have been able to substantiate, only developmental forms of the large tridentate pedicellariæ. I am a little in doubt whether globiferous pedicellariæ are found. In my preparation of isolated skeleton-pieces of pedicellariæ of this species is seen one valve of a small globiferous pedicellaria, which is very peculiar, with two large teeth at the point, and a rather small opening surrounded by well developed teeth (Pl. IX, Fig. 2). As, however, only one such valve is found, it may be thought to have come in by chance; in this case it must be abnormal, as no other Cidarid examined by me, is possessed of such pedicellariæ. For the present this must be left undecided. — It is obvious that this species has no relation with *P. purpurata*, and as it shows no nearer relation to any other known species, it must form a separate genus, for which I propose the name of **Histocidaris**.

P. Sharreri: Agassiz (9) unfortunately gives no details as to the pedicellariæ, and from the figure (op. cit. Pl. III) it cannot be decided whether it is a genuine *Porocidaris*. There seems to be no highly developed neck on the spines (in the text nothing is said of this feature); the pedicellariæ might well look like those of *P. purpurata*, but a close examination will be necessary for the decision. By the kindness of Prof. Rathbun I have from U. S. National Museum received a specimen determined as *P. Sharreri* («Albatross» 1885. St. 2415); it proved to be the new species *Stereocidaris ingolfiana* described hereafter; it has no relation to *P. Sharreri*. Further I have in British Museum seen a specimen determined as *P. Sharreri*, from U. S. Fish Commission («Albatross» 1885. St. 2345). Neither seems this specimen to be identical with the real, figured *P. Sharreri*, at all events it does not to any striking degree resemble the figure given by Agassiz. It is no *Porocidaris*. The pedicellariæ (Pl. IX, Fig. 26) are much like those of *Dorocidaris*, only the opening of the large globiferous pedicellariæ is more round and of a more definite form than is otherwise the case in this genus; but this fact might very well be interpreted as a specific difference. Tridentate pedicellariæ simple. A much more considerable difference is found in the spines; they are long, slender — unfortunately they were broken, so that their length and the form of their point are unknown. The base is finely pink, the outer part white. They are quite smooth and shining, as if polished, and the structure of the outer layer is peculiar (Pl. XI, Fig. 24) with no trace of roughness on the surface. Perhaps the specimen of *Porocidaris Sharreri* mentioned by Agassiz (9 p. 13) "which was of a light greenish pink color when alive, the spines white with a delicate brownish-pink base" is identical with the specimen described here — in this case this specimen mentioned by Agassiz has certainly not been of the same species as the one he figures; but this latter must, of course, keep the name of *Sharreri*. There can be no doubt that the specimen described here is a new species; whether it also is to be regarded as a new genus, or belongs to *Dorocidaris*, can only be decided, when the systematic significance of the spines has been established. For the present it ought to be classed with *Dorocidaris*, under the name of **D. micans** n. sp.

Neither is *P. incerta* Koehler (233 a), of which species Prof. v. Beneden has lent me a specimen for examination, a *Porocidaris*. I have only found one form of globiferous pedicellariæ on it; it has no end-tooth, the opening small, round (Pl. VIII, Fig. 31). Most likely another, larger form of globiferous pedicellariæ will be found in this species; but the figured form is a sufficient proof that this species has no relation to *Porocidaris*. Koehler also refers it only in a doubtful way to *Porocidaris* on account of the highly dentate actinal radioles. The spicules are simple.

Of the other species that have been referred to *Porocidaris*, *P. Cobosi* most likely is a genuine *Porocidaris*, but it cannot be decided with certainty, till the pedicellariæ have been examined. For the present nothing can be said with certainty of *P. Milleri* and *misakiensis*; according to Agassiz (13) *P. Milleri* is "closely allied to *P. elegans*". On the other hand it may be said with certainty that *P. gracilis* Döderl. is no *Porocidaris*. Its globiferous pedicellariæ of which only one form is known, recall to some degree those of *Goniocidaris canaliculata*; tridentate pedicellariæ unknown. Perhaps it ought to form a separate genus.

The genera *Stereocidaris* and *Goniocidaris* to which a whole series of species have been referred, are still left. The species referred to *Stereocidaris: japonica, grandis, sceptriferoides*, and the here described new species *St. ingolfiana* agree in the structure of the pedicellariæ: there is no end-tooth, and the large opening reaching to the very point is broad and well limited below, quite narrow above. The small globiferous pedicellariæ chiefly of the same structure, without end-tooth; the tridentate pedicellariæ seem to show no special peculiarities (they are not known in all the species). The spicules are rather large fenestrated plates, not thorny bows, as is else the case in the Cidarids — this, however, does not apply to all the species; in *St. grandis* they are of the common form, and so the spicules give no reliable generic character. There is no reason to doubt that also *St. indica* Döderl. really belongs to this genus, although we have no informations of its pedicellariæ. Döderlein further thinks (118) that *Dorocidaris tiara* and *alcocki* are perhaps only local forms of this species. Of the species *St. tenuispinus* and *microtuberculatus* Yoshiw. nothing can be said with certainty. — Whether this group of species really belongs to the same genus as the fossil *Stereocidaris*-species, cannot be definitely decided, until the pedicellariæ of the latter are known; but the probability is that they really belong here, and there is no reason, at all events not for the present, to reject the name of *Stereocidaris* for them.

To the genus *Goniocidaris*, the only one of the hitherto admitted genera that has been commonly acknowledged, the following species have been referred: *geranioides* Lamk., *tubaria* Lamk., *canaliculata* Ag. (to which *Cidaris nutrix* W. Th., *Gonioc. vivipara* Studer, and *G. membranipora* Studer are referred as synonyms), *florigera* Ag., *Döderleini* Ag., *biserialis* Döderl., *clypeata* Döderl., *umbraculum* Hutton, and *Mortenseni* Koehler. Types of this genus are the species *geranioides* and *tubaria*, especially peculiar by having rather deep pits between the plates, in each of which pits is placed an almost globular pedicellaria. These pedicellariæ are very peculiar, short and broad; the opening, which is small and surrounded with distinct teeth, reaches to the point, so that no end-tooth is found (Pl. X, Fig. 20). The small globiferous pedicellariæ have a powerful end-tooth; no tridentate pedicellariæ seem to be found. Spicules of the common form. There can be no doubt that *G. geranioides* has the same structure of the pedicellariæ as *G. tubaria*; the large globiferous ones are figured by Agassiz (Revision Pl. XXIV, 12—13), and they are obviously very similar to those of *tubaria*. Perrier (op. cit. Pl. III, 12) figures a small globiferous pedicellaria, but the figure gives no clear information of the structure of the point; the text, however, leaves no doubt that it is built as in *G. tubaria*. Most closely allied to these two species is no doubt *G. umbraculum* Hutton. The pedicellariæ (Pl. X. Figs. 13, 21) show only little difference from those of the two mentioned species. Also *G. biserialis* Döderl. belongs here; to be sure, it is not clear from the figures and description of Döderlein, in what way the small globiferous pedicellariæ are constructed, but Prof. Döderlein has kindly sent me a preparation, so that I have been able to substantiate that they are built as in the other species, with a powerful end-tooth (Pl. IX, Fig. 10). The two species *G. clypeata* and *mikado* are especially distinguished from the other *Goniocidaris*-species by the spines being highly widened, and having, moreover, a peculiar basal widening; the impressions in the angles of the plates are indistinct; the pedicellariæ seem also to be somewhat different from those of the typical *Goniocidaris*-species, although agreeing with them in main features (no end-tooth on the large pedicellariæ, an even uncommonly powerful one on the small ones). Thus there seems to be every reason to comprise these species in a separate subgenus, *Discocidaris*, as proposed by Döderlein (114). Döderlein thinks that *G. florigera* must be referred to the same group, especially because it also shows the basal widening on the spines, although only as a trace. It has long been doubtful to me, whether the two forms figured by Agassiz as *G. florigera* (Chall. Ech. Pl. I. Figs. 7 and 12), were really the same species, and my doubt was confirmed, when I had examined the type-specimens in British Museum. They are not only two different species, they will even undoubtedly have to be referred to two different genera — and moreover it appeared that among the specimens determined as *G. florigera* still a third form was hidden, which must also form a new genus. The form meant by Döderlein when he places *G. florigera* together with *clypeata* and *mikado*, is the one figured in Fig. 12; it is this form of which the spines show traces of the basal widening. It has already been mentioned above, and a new genus has been established for it: *Petalocidaris*, its pedicellariæ not admitting it to be referred to any of the other known genera. Otherwise it is presumably most closely allied to the two mentioned species. The other form, which is figured in Fig. 7, shows no basal widening on the spines, which are, upon the whole, very much different from those of *Petalocidaris*; they are highly and rather regularly thorny, evenly tapering. In none of the three specimens (Chall. St. 204) I have examined, large globiferous pedicellariæ were found, but only the small form, which is quite similar to the small pedicellariæ of *Discocidaris* (Pl. X. Figs. 6—7); for the present therefore, I think it better to refer it to this subgenus; the spines, to be sure, show no trace of the widenings peculiar to the two other species, but the not widened spines of the latter are rather similar to those of this species, for which I propose the name of **Discocidaris serrata** n. sp.

From st. 192 (Chall.) a specimen is found referred by Agassiz to *G. florigera*, which it also resembles rather well (i. e. it resembles the one figured in Fig. 12, *Petalocidaris florigera*). The spines are much richer thorny than in this species; the ambulacral areas almost naked. The pedicellariæ are very peculiar (Pl. X. Figs. 25, 28). The opening is a long, narrow slit reaching not quite to the point; a powerfully developed end-tooth is found. The small pedicellariæ are essentially of the same structure, the opening only being somewhat shorter and a little broader. Such pedicellariæ have not been found in any of the other known species, and accordingly this species must form a separate genus, for which I propose the name of **Schizocidaris** with the species **Sch. assimilis** n. sp.[1]).

According to Agassiz (Chall. Ech. p. 43 seq.), *Goniocidaris canaliculata* is exceedingly varying; he thinks that *Cidaris nutrix* W. Th. must be regarded as one of the many forms of this species, and also that *G. vivipara* and *membranipora* are synonymous with it. After having examined the specimens of *G. canaliculata* in British Museum I must admit that it really appears as if they all formed only one highly varying species, in which a great number of transitional forms connect the easily recognised extreme forms. If we examine the pedicellariæ, we shall get another conviction; we shall then see that at all events three different species are found among these specimens referred to *G. canaliculata.* There is a fact that ought to have made Agassiz hesitate in referring them all to one species. He quotes the description by Wyv. Thomson (397) how the eggs of *C. nutrix* »are passed along on the surface of the test towards the mouth, and the smaller slightly spathulate primary spines, which are articulated to about the first three rows of tubercles round the peristome, are bent inwards over the mouth, so as to form a kind of open tent, in which the young are developed«. Immediately after this quotation Agassiz (op. cit. p. 45) says: »The specimen (Pl. II. fig. 2) shows the manner in which they are held in a sort of marsupium by the folding of the abactinal spines over the young crowded upon the abactinal system«. Thus in this species not only a nursing of the brood should take place, but the young should even be placed, now round the mouth, now on the apical area. Even if this were not inconceivable, it would have been worthy of remark; but Agassiz has no word of it, though it might seem to imply that *Cidaris nutrix* is really specifically different from *Gonioc. canaliculata.* Wyv. Thomson (397 p. 66) also remarks expressly that in *G. canaliculata* we have the reverse of the fact in *C. nutrix*: »These spines ... lean over towards the anal opening, and form an open tent for the protection of the young as in *Cidaris nutrix*, but at the opposite pole of the body«. There is also another fact that ought to raise the suspicion against the interpretation of all these forms as one species: most of the specimens are coast-forms, taken on depths of 3—150 fathoms; from this there is a far cry to a depth of 1600 fathoms and more. Beforehand it is very improbable that the same species should be found in so varying depths. This fact is not mentioned by Agassiz either. According to my examinations *Cidaris nutrix* is specifically different from *G.*

[1]) Unfortunately I made no more thorough notes on this specimen, as during my stay at Br. Mus. I had no clear understanding of the fact that it was a genus quite different from the other specimens called *G. florigera*. I did not get a clear view of this fact till after my return, when I had examined the pedicellariæ more exactly. The peculiar pedicellariæ may, however, be sufficient for the identification of the species, and therefore I do not hesitate to give it a name here.

canaliculata; among the deep-sea forms at all events one new species is found, and upon the whole scarcely any genuine *G. canaliculata* is found among them.

In the typical *G. canaliculata* the large globiferous pedicellariæ do not differ much from those of *Goniocidaris tubaria*, or still less from those of *G. umbraculum*; they are somewhat narrower, and the blade is a little curved inward below the rather large opening that reaches to the point; there is no end-tooth (Pl. VIII. Figs. 8, 32). The small pedicellariæ, on the other hand, are very different from those of the genuine *Goniocidaris*-species, as there is no end-tooth (Pl. VIII. Fig. 6). Spicules simple. — The young are carried on the apical area. *Cidaris*» *nutrix* (Wyv. Thomson's type specimen examined): the large pedicellariæ (Pl. X. Figs. 3—4, 12, 14) very much resembling those of *Stereocidaris grandis* (Döderlein 116. Pl. VIII. 2); the small globiferous ones (Pl. X. Fig. 24) chiefly as in *G. canaliculata.* — The young are carried round the mouth.

The two species are most frequently easily distinguished as to their habitus. In *C. nutrix* the apical area is densely set with rather long, club-shaped spines, between which large pedicellariæ are found abundantly. In *G. canaliculata* the apical area is set with rather few and scattered, not club-shaped spines some of which are quite small, so that the area looks rather naked; generally no pedicellariæ are found on the apical area. This difference, however, is not absolutely reliable, and without the pedicellariæ the two species are not always to be distinguished with certainty.

It is evident that these two species cannot be referred to the genus *Goniocidaris*; especially the small pedicellariæ are different from those of *Goniocidaris*, as they have no end-tooth. Döderlein (116. p. 18) thinks *G. canaliculata* to be nearly allied to *Dorocidaris*; to be sure it occupies an extreme position in the *Dorocidaris* -group, and perhaps it might also be regarded as the only representative of a special group. In many respects it recalls the «*Eucidaris*»-group. «Wirklich nahe Beziehungen zu einer der bisher bekannten Arten von Cidariden bietet diese Form jedenfalls nicht dar». — As has already been mentioned, the pedicellariæ of *C. nutrix* are very similar to those of *Stereocidaris grandis*, and these two species would seem to have to be referred to the genus *Stereocidaris*; at all events there seems to be no objection of consequence to their being referred to this genus, and it might be difficult to point out a character, which would necessitate the establishing of a special genus for these species. The simple spicules are in accordance with those of *St. grandis* (in the other *Stereocidaris*-species they are, as mentioned, large fenestrated plates).

Of the species «*Goniocidaris*» *vivipara* and *membranipora* the former (according to Studer, 386) is synonymous with *G. canaliculata*, which statement I am able to corroborate from the examination of a specimen that our museum has received from the museum at Berlin. The other (also according to examination of specimens from the museum at Berlin) is identical with «*Cidaris*» *nutrix* W. Th., as has already been supposed by Studer (385). As the paper by Wyv. Thomson (397) bears the date of June 1st 1876, and that of Studer (384) the date of July 27th 1876, the name of *nutrix* has the priority. Now we meet here with a new difficulty. Studer says of *G. membranipora* (384 p. 455): «Die jungen *Cidaris* bleiben auf dem Analfelde der Mutter bis zu ihrer völligen Entwicklung, von den obern Stachelreihen geschützt, die sich kreuzweise darüber legen». According to this statement this species would seem nevertheless to carry the young now arround the mouth, now on the apical area. As this seems to me to be very improbable, I must suppose a mistake to have taken place, so that the specimen (or specimens?), which Studer has had, with young ones on the apical area, is not *G. membranipora* (= *nutrix*), but *canaliculata*, and then it is scarcely from Kerguelen (comp. the following about the occurrence of these two species). When the pedicellariæ are not examined — which has evidently not been done by Studer — it is, as has been stated above, not always to be decided with certainty, to which of the two species a specimen in hand belongs; this will especially hold good, when, as the case has been here, the apical area is not to be seen.

Among the rather numerous specimens of these two species examined by me (from «Challenger» at British Museum), *St. canaliculata* was only taken at the Falkland Islands and a station near those islands, (Chall.) st. 315, *St. nutrix* only at Kerguelen. Some specimens from st. 150 («Chall.») near Kerguelen, 150 fathoms, have pedicellariæ as those of the typical *St. nutrix* but the spines are much longer, three times the diameter of the test; perhaps it is a separate species. Wyv. Thomson (397) mentions *C. nutrix* from Kerguelen, *G. canaliculata* from the Falkland Islands. In the same way Studer's *G. vivipara* (= *canaliculata*) is from Patagonia, his *G. membranipora* from Kerguelen. Thus it would seem that these two species do not occur together; *St. canaliculata* is found at the southern coasts of South America, *St. nutrix* at Kerguelen. Agassiz, to be sure, mentions *St. canaliculata* from several other localities at Kerguelen, but according to what is shown here his statement is not to be relied upon. Until a definite proof of the opposite fact comes forth, I must believe that either of these species has a territory of its own, as represented here.

Among the deep-sea specimens referred by Agassiz to *G. canaliculata*, I have only examined two from Chall. st. 156 (the South Polar Sea, 1975 fathoms). No doubt they represent another species. The large globiferous pedicellariæ (Pl. VIII, Fig. 35) recall very much those of the *Goniocidaris*-species, but the small ones are like those in *canaliculata* and *nutrix*; and thus it would seem that this species must also be referred to *Stereocidaris*. The ground-colour is very dark, almost black; the primary spines are white, the actinal ones highly indented in the edge. Perhaps it may prove to be identical with «*Porocidaris*» *incerta* Koehler. I have not examined the specimens from st. 147 (1600 fathoms) and 153 (1675 fathoms), but that they are not identical with *St. canaliculata* or *nutrix*, which live on shallow water, may be said a priori with a great deal of probability.

Goniocidaris Mortenseni Koehler. Koehler (233 a) in his excellent description of this species mentions only one form of pedicellariæ with «ordinairement un ou deux crochets plus ou moins marqués» at the point of the valves. This statement does not give sufficiently clear information, neither does the figure of a whole pedicellaria given by Koehler show the systematically important structures in a sufficiently exact way. Prof. v. Beneden has most kindly sent me a couple of specimens for examination, so that I am able to supply the informations wanting, and assign to this uncommonly fine and characteristic species its place in the system. The large globiferous pedicellariæ have no end-tooth; they are quite similar to those of *Stereocidaris nutrix*, so that I can simply refer to the figures of the latter. The small globiferous pedicellariæ are rather characteristic (Pl. VIII, Fig. 34); they have no end-tooth, and the opening is small; they recall those of «*Porocidaris*» *incerta* very much. The spicules simple. Accordingly this species is no *Goniocidaris*, but will probably have to be referred to the genus *Stereocidaris*, to which genus perhaps also «*Porocidaris*» *incerta* ought to be referred.

Of the other species referred to *Goniocidaris*, *G. Döderleini*, according to Agassiz, is most nearly allied to *canaliculata*; nothing, however, can be said with certainty, till its pedicellariæ have been examined.

Phyllacanthus australis Ramsay is still to be mentioned. As to its place in the system can for the present only be said that it belongs scarcely to the genus *Phyllacanthus* as limited here; where it is else to be referred we can only learn when its pedicellariæ have been examined.

According to the researches reported here the system of the Cidarids will look as follows:

Dorocidaris A. Ag. (emend.).

Large globiferous pedicellariæ with well-developed end-tooth; the opening large, rounded or irregular below, not reaching the point. No limb on the stalk. Small pedicellariæ with end-tooth; tridentate pedicellariæ simple; spicules simple.

Species: *D. papillata* (Leske), *Blakei* Ag., (?) *micans* n. sp.

Distribution: The Northern Atlantic, the Mediterranean. Sublittoral-archibental forms[1]).

Tretocidaris n. g.

Large globiferous pedicellariæ with powerful end-tooth; the opening a quite small pore rather far from the point. A limb on the stalk, more or less developed. Small pedicellariæ like the large ones, only with a somewhat larger opening. Tridentate pedicellariæ simple; spicules simple.

Species: *T. Bartletti* (A. Ag.), *annulata* n. sp., *spinosa* n. sp.

Distribution: The warm regions of the Atlantic. Littoral(?)-sublittoral forms.

Stephanocidaris A. Ag. (emend.).

Large globiferous pedicellariæ much lengthened and slender with distinct end-tooth; the opening rather small, triangular, a little below the point. No limb on the stalk. Small pedicellariæ of the same structure; tridentate pedicellariæ simple. Spicules simple.

Species: *St. bispinosa* (Lamk.), *annulifera* (Lamk.), *bracteata* (Ag.).

Distribution: The Indian Archipelago, Australia. Littoral-sublittoral forms.

Schizocidaris n. g.

Large globiferous pedicellariæ with distinct end-tooth; the opening a long, narrow slit. No limb on the stalk. Small pedicellariæ like the large ones, only the mouth a little shorter and broader. Tridentate pedicellariæ? Spicules?

Species: *Sch. assimilis* n. sp.

Distribution: Near New Guinea (Chall. st. 192). Sublittoral.

Cidaris Klein (emend.).

Large globiferous pedicellariæ with small terminal opening; the blade somewhat prolonged in a snout-shaped way. No end-tooth. A more or less developed limb on the stalk. Small pedicellariæ with well developed end-tooth and large, not terminal opening. Tridentate pedicellariæ simple Spicules simple.

[1]) In the present work distinction is made between the littoral belt, the sublittoral, archibental, and abyssal belt. The first is reckoned from 0—ca. 50 fathoms, the second from ca. 50—ca. 300 fathoms, the third from ca. 300—ca. 1500 fathoms; greater depths are called abyssal. It is impossible to fix the limits between these regions more exactly.

Species: *C. affinis* Phil., *Reini* Döderl., *tribuloides* Lamk., *galapagensis* Döderl., *metularia* Lamk., *Thouarsii* Val., *verticillata* Lamk., *baculosa* Lamk.

Distribution: Cosmopolitan in the warm seas; the Mediterranean, Japan. Littoral-sublittoral forms.

Chondrocidaris A. Ag.

Large globiferous pedicellariæ with large, cordate opening, the lower limit of which forms a projecting lip; the opening reaches the point; no end-tooth; no limb on the stalk. Small pedicellariæ with a more or less developed end-tooth. Tridentate pedicellariæ simple (rather highly dentate). Spicules simple.

Species: *Ch. gigantea* A. Ag.

Distribution: The Sandwich Islands, Mauritius. Littoral.

Acanthocidaris n. g.

Large globiferous pedicellariæ with large opening, irregularly limited below and reaching the point; no end-tooth; no limb on the stalk. Small pedicellariæ of the same structure as the large ones. Tridentate pedicellariæ with delicate, dentate lamellæ in the blade. Spicules simple. The spines long, compressed, curved.

Species: *A. curvatispinis* (Bell).

Distribution: Mauritius. Littoral (?).

Stereocidaris Pomel.

Large globiferous pedicellariæ with large opening reaching quite to the point; no end-tooth; no limb on the stalk. Small pedicellariæ of the same structure, without end-tooth. Tridentate pedicellariæ simple. The spicules often larger, fenestrated plates; in some species simple.

Species: *St. japonica* Döderl., *grandis* Döderl., *sceptriferoides* Döderl., *indica* Döderl., *ingolfiana* n. sp., *nutrix* (Wyv. Thoms.), *canaliculata* (A. Ag.), *Mortenseni* (Koehler), (?) *incerta* (Koehler).

Distribution: Cosmopolitan. Littoral-archibental forms.

Goniocidaris Desor.

Large globiferous pedicellariæ with rather small opening reaching the point; no end-tooth. The valves very short and broad. No limb on the stalk. Small pedicellariæ with powerful end-tooth. Tridentate pedicellariæ seem not to be found. Spicules of the common form. The spines more or less irregularly widened. The test with deep impressions in the angles between the plates.

Species: *G. tubaria* (Lamk.), *geranioides* (Lamk.), *biserialis* Döderl., *umbraculum* Hutton.

Distribution: Australia, Japan. Littoral-sublittoral forms.

Subgen. **Discocidaris** Döderl.

Pedicellariæ chiefly as in *Goniocidaris*. The spines most frequently much widened at the point and with basal widening.

Species: *D. clypeata* Döderl., *mikado* Döderl., (?) *serrata* n. sp.

Distribution: Japan, the Philippine Islands. Sublittoral forms.

Petalocidaris n. g.

Large globiferous pedicellariæ with small terminal opening, the blade somewhat elongated.

No end-tooth; no limb on the stalk. Small pedicellariæ with end-tooth and large, not terminal opening. Tridentate pedicellariæ ?, spicules ?. Spines extended in a more or less flower-like way, trace of basal widening.

Species: *P. florigera* (A. Ag.).

Distribution: The Philippines (Chall. st. 204) (or New Guinea; Chall. st. 192). Sublittoral.

Phyllacanthus Brandt (emend.).

Synonym: *Leiocidaris* Desor.

Large globiferous pedicellariæ with small terminal opening; no end-tooth; the blade prolonged in a snout-like way. Limb on the stalk? Small pedicellariæ with end-tooth. Tridentate pedicellariæ with the blade filled by a close reticulation forming irregular longitudinal ridges closely set with teeth. Spicules simple. Spines large and thick, finely striated.

Species: *Ph. imperialis* (Lamk.), (?) *dubia* Brandt, (?) *parvispina* Woods.

Distribution: The Red Sea, the Indian Ocean, Australia. Littoral forms.

Histocidaris n. g.

Large globiferous pedicellariæ unknown; small pedicellariæ with two rather strong end-teeth (?). Tridentate pedicellariæ of a larger and a smaller form; the blade of the large ones is filled by a rich net of meshes, the holes of which are rather distinctly arranged in series, and radiate in a fan-shaped way from the upper end of the apophysis; numerous small thorns on the inner surface of the blade, especially towards the point; also the apophysis is broad and full of holes. The smaller form simple. Spicules simple. Spines long and slender.

Species: *H. elegans* (A. Ag.).

Distribution: Australia (New Guinea, the Philippines). Archibenthal.

Porocidaris Desor.

Only large two-valved pedicellariæ. The spines with very long neck. Spicules simple.

Species: *P. purpurata* W. Thoms.

Distribution: The Northern Atlantic. Archibenthal.

Incertæ sedis:

Dorocidaris panamensis Ag.
— *tiara* Anderson.
— *alcocki* —
Stereocidaris tenuispinus Yoshiw.
— *microtuberculatus* Yoshiw.
Porocidaris misakiensis —
— *Sharreri* Ag.
— *Milleri* —
— *Cobosi* —
— *gracilis* Döderl.
Phyllacanthus australis Ramsay.
Goniocidaris Döderleini Ag.

When in the diagnoses of genera given here other features than pedicellariæ and spicules have only been mentioned exceptionally the opinion of course is not that these structures should be sufficient for definitive diagnoses. It has already been emphasized above, and I shall here emphasize once more that all features must be thoroughly examined in order to get the mutual relations of the forms established. That I have here only treated the pedicellariæ more thoroughly is a consequence of the fact that neither my material nor my time has permitted me to treat the other features more particularly. The system of the Cidarids cannot get its definitive formulation, until all features have been examined in a greater number of species (or best in all species). What is given here is a provisional classification, which can scarcely be correct throughout, but it has the great advantage of the earlier systems that it is possible to recognise the genera with certainty. Several things, moreover, indicate that the genera, at all events most of them, have here been correctly interpreted. The species referred to the same genus are upon the whole of similar appearance, so that the genera may in most cases be recognised by their habitus alone. Also the distribution seems to become more clear by the grouping given here. — Whether the genera may be grouped in larger divisions — subfamilies — cannot be decided at present. In the structure of the pedicellariæ there seems only to be a single feature that might possibly be of some importance for such a grouping, viz. whether the large globiferous pedicellariæ have an end-tooth or not. Whether this feature is of so great importance, can only be decided, when the necessary thorough examinations have been made.

1. Dorocidaris papillata (Leske).

Pl. V, Figs. 6, 7, 8. Pl. VIII, Figs. 1, 3, 12, 14, 27. Pl. IX, Figs. 3, 5, 7, 13—15, 20, 25, 27. Pl. XI, Figs. 14, 26, 31.

Main synonyms: *Cidaris papillata* Leske.
— *hystrix* Lamk.
— *borealis* Düb & Kor.
Dorocidaris abyssicola A. Ag.
Non: *Cidaris affinis* Phil.

Principal literature: Sv. Nilsson & A. L. Holst: Collectanea Zoologiæ Scandinavicæ. 1817. p. 11. — Düben & Koren: Öfversigt af Skandinaviens Echinodermer. Kgl. Vetensk. Akad. Handlingar för år 1844. Stockholm 1846. p. 255. T. IX. 25—30. — M. Sars: Bidrag til Kundskaben om Middelhavets Littoralfauna. 1857. p. 109. Oversigt af Norges Echinodermer. 1861. p. 93. — A. Agassiz: Revision of Echini. Part. II. p. 254. Pl. I. etc. Challenger-Echinoidea (8). p. 38. Blake-Echinoidea (9). p. 12. — Wyv. Thomson: Echinoidea of Porcupine (395). p. 722. Pl. LIX. 1—13. — V. Gauthier: 160. — R. Koehler: 217. p. 113. — H. Prouho: 327. — R. Rathbun: 336. p. 611. — C. Stewart 379. — E. A. Verrill: 418. — W. E. Hoyle: Revised List of British Echinoidea. (202). p. 404. — F Jeffr. Bell: Catalogue of British Echinoderms. 1872. p. 139. 69.

With regard to the great number of other works in which this species is noticed or more particularly mentioned, reference may be made to Agassiz's Revision of Echini, Bell's Catalogue, and Ludwig (256); there complete lists of synonyms are also given.

This species has been so often mentioned and partly carefully described, that I do not think there is any reason to describe it here again; so I shall only make some observations with regard to a few separate features that have not before been described with sufficient exactness, viz. the arrangement of the tubercles, the pedicellariæ, the spicules, and the structure of the spines.

The interambulacral area: Round each areole there are nearest to the edge about 15 small tubercles with distinct articular head, and outside of these a new circle of tubercles a little smaller and situated in the intervals between the inmost ones. Outside of these are found more or fewer small tubercles according to the size of the animal, decreasing in size inward towards the median line of the area and outward towards the adjoining ambulacral area. The tubercles do not reach quite to the median line or to the pore area; a little naked space is left, and this — at all events in larger specimens — is furrowed by irregular transverse furrows crossing the median line from one plate to the other as also the line of separation between the ambulacral and the interambulacral area; the latter correspond rather exactly to the lower end of each ambulacral plate. The edges round the highly depressed areoles are high, the plates slope rather abruptly down towards the median line and outward towards the pore area (Pl. VI. Fig. 7).

The ambulacral area (Pl. VI. Fig. 8). Inside the pores a little tubercle is found on each plate; these tubercles form a fine, regular row down each side of the ambulacral area, as is commonly the case in the Cidarids; the primary series it is here called. Inside of this series still a smaller tubercle is commonly found on each plate, just opposite to the outer one; nearest to the apical area and the peristome the inner tubercle is commonly found only on one side, alternately — but irregularly — to the right and the left, and sometimes there is all the way down only a single series of these secondary tubercles. In young specimens they are only found on the middle part of the area, and only a single series; sometimes the small spines of these tubercles in the median line of the area raise perpendicularly; generally they lie over or between the bases of the primary ambulacral spines. — It is, no doubt, for want of place that these secondary tubercles appear only in a single series in small individuals and on the narrow actinal and abactinal end of the area in large individuals. It is especially on the base of these spines that the peculiar, gland-like ampulla (Pl. VIII. Fig. 14) is found highly developed, which has been more nearly examined by Prouho (327. p. 56) and Hamann (184. p. 28). It is also often much developed on the spines of the apical area.

A transverse section of the large spines (the radioles) (Pl. XI, Figs. 14, 31) shows that in the intervals between the crests the outer layer runs out in short, branched thorns that coalesce and form a coarse reticulation. There is no reason to describe the form of the spines here anew.

Although the pedicellariæ of this species have been figured several times, I nevertheless think it necessary to figure and describe them anew. Perrier's figures are neither good nor exact; the same may be said of the figures given by Agassiz (Revision of Echini. Pl. XXIV) and Koehler (217. Pl. 7) — neither of them give an exact representation of the finer structures that are of systematic importance. Stewart (379) on the other hand has given some excellent figures of the large globiferous pedicellariæ, and Wyv. Thomson (395) gives rather good figures of the small globiferous pedicellariæ and of the tridentate ones. — I think it unnecessary to give a full description of the pedicellariæ, and therefore I only mention the features being of systematic importance; for the rest the reader is referred to the figures (Pl. VIII. Fig. 27. Pl. IX. Figs. 3, 5, 7, 13—15, 20, 25, 27).

At the point of the large globiferous pedicellariæ (Pl. IX, Fig. 3, 5) is found a distinct tooth separated from the opening on the inside of the blade by a distinct curve; seen from the inside it appears as a long narrow point before the upper edge of the opening. A canal is seen to run through this point, and open on the upper side of the tooth — this canal is the efferent duct from the poison- or mucous gland enclosed by the blade. The inner opening is large, lengthened, most frequently running into a narrow point below. The edge round the opening is more or less thickened, with numerous small teeth and a few large ones placed irregularly. The outside of the blade is highly and irregularly perforated almost to the very point. The stalk of these and of the other pedicellariæ consists of a highly irregular, complicated calcareous network, with no conspicuous free points (limb) at the transition between the thick and the thin part. The length of the head is about 1^{mm}; the length of the stalk is somewhat different, but generally it is very short, even shorter than the head. They are found especially on the apical area, but also in the interambulacral areas, mostly on the naked spaces.

The small globiferous pedicellariæ (Pl. IX. Figs. 13—15, 20) are upon the whole constructed as the large ones; the tooth at the point is considerably smaller, may be very slightly developed. The inner opening is comparatively larger than in the large globiferous pedicellariæ; the lower edge may also here be irregular. They are more long-stalked and upon the whole much more slender than the large ones. They are especially found among the small spines round the radioles and on the peristome, but may otherwise be scattered over the whole test.

The tridentate pedicellariæ (Pl. IX. Figs. 7, 25, 27) are large and slender: the head is $1—2^{mm}$ long, the length of the stalk is very differing, but commonly it is considerably longer than the stalk of the large globiferous pedicellariæ. The blades are narrow, straight, and join close together in their whole length, when shut, or are at all events only apart for a very little space below. The edge is somewhat thickened and highly dentate; at the transition between the base and the blade the edge is often very irregularly serrate. The blade is narrow and deep, filled by an irregular network, which is often, in the lower part of the blade, provided with fine teeth; in the outer part of the blade most frequently only cross-beams are found connecting the edges with each other. These pedicellariæ are especially found in the middle of the ambulacral areas towards the mouth. In some individuals they seem to be quite wanting.

The spicules of the tube feet (Pl. XI. Fig. 26), as is known from Perrier and Wyv. Thomson, are bow-shaped and rather highly thorny. They are situated in two series in the skin of the tube foot, so as to join each other along one side of the foot — not, however, in a definite line, the ends catching irregularly in between each other. On the other side they are widely scattered; thus the tube-foot is closely mailed for $^3/_4$ or $^2/_3$ of its circumference, the other part is naked (Pl. VIII. Fig. 1). The naked side seems always to be the oral one; in this side the tentacle-nerve is lying, as shown by Prouho (op. cit.). Otherwise he also gives a quite correct description of the way in which the spicules are arranged in the tube-feet. — Down towards the base of the tube-foot the spicules become shorter and less thorny, and here they do not join on either side, and are thus arranged in two completely separated series. Towards the sucking disk they become larger and more thorny, at last highly complicate; the arcuate ground-form may, however, always be distinguished. They may here join on both sides, so that the foot is completely mailed.

Together with Agassiz, Ludwig, Koehler, Bell, a. o. I think it unquestionable that the Mediterranean form *C. hystrix* Lamk. is identical with this species. The only definite character found by Philippi and Sars for distinguishing between this latter and *D. papillata* is the fact that in the latter there are 16—18 raised, dentate, longitudinal ridges on the spines, in *C. hystrix* only about 12. As, however, in the same individual, as well of the northern form as of the Mediterranean one, some spines may be found with 12—13 ridges, and others with 16—17 such, this character is useless. It may be possible that the spines in the Mediterranean form are somewhat longer and slenderer than in the northern form; the tridentate pedicellariæ seem also to be somewhat more dentate in the edge than those of the northern form. I think that it may at most be regarded as an only little marked variety of *D. papillata*.

Dorocidaris abyssicola Ag. has by Agassiz himself been referred to *D. papillata* as a synonym; whether it may possibly be kept as a separate species, or at least a variety I am not able to decide from my material (one specimen from U. S. Fish Comm., and one from Mus. Comp. Zool.); it might, however, seem as if the small globiferous pedicellariæ might yield a character tending this way (Pl. IX. Fig. 14). — In "Revision of Echini" p. 256 Agassiz mentions a variety of *Doroc. papillata* with slender, highly dentate spines. Also Rathbun (op. cit. p. 611) mentions this variety. Our museum has received some specimens of this form from U. S. National Museum. A closer examination shows that it has nothing to do with *D. papillata*, it is *Cidaris affinis*, or a variety of this species.

Dorocidaris papillata is spread over the northern Atlantic and the Mediterranean; for the present it cannot be said how far south it reaches, nor can it be decided to how great a depth it is found. As there has proved to be a great uncertainty in the earlier determinations of Cidarids, and as especially a widely different species, even from a quite different genus, viz. *Cidaris affinis*, has generally been confounded with *D. papillata*, all the statements in literature as to its occurrence are not to be relied on with certainty. Only so much may be said of its distribution in the Atlantic that it is found along the coasts of Norway on depths from 100—200 fathoms, at the Shetland Islands, but not farther south in the North Sea, south of Iceland ("Ingolf"), at the Atlantic coasts of Great Britain, and presumably at the coasts over the whole of the North Atlantic, as well at the European side as at the American side (Florida). On the other hand it is not found in the territories of the North Atlantic where the bottom temperature is negative (the "cold area"). In Bell's Catalogue the depth is given to from 0—874 fathoms. This is scarcely correct; it seems to be found on no smaller depth than 30—40 fathoms. Wyv. Thomson (op. cit. p. 725) states that he has some small specimens from ca. 1000 fathoms. *D. papillata* is no abyssal form, it seems mostly to be found at a depth of some hundreds of fathoms. Its having pelagic larvæ of the typical *Pluteus*-form seems also to agree with the fact that it does not live on the very great depths.

D. papillata has been taken by "Ingolf" on st. 1 (62° 30' N. Lat., 8° 21' W. L., 142 fathoms; bottom temperature 7° 8), 1 specimen, and st. 54 (63° 08' N. Lat., 15° 40' W. L., 691 fathoms; bottom temperature 4° 2), 1 specimen.

The statements that it has been taken in the Red Sea (Russo 348), at the Canaries, the West Indies, St. Paul, La Plata, and even at the Philippines, it will be best for the present to leave out of consideration, until a renewed examination of the material from these localities has been made. The statement that it is found at the Philippines, is made by Agassiz (Chall. Ech.); but he has himself expressed a doubt as to the correctness of the determination — and with good reason. I have in British Museum had occasion to examine the two specimens from the Philippines (Chall. sts. 204 and 210), and have found the one from st. 204 to be a *Cidaris* sp., and that from st. 210 a *Stereocidaris* sp. (I could not enter into a determination of the species.) The statement by Studer (386) that it has been taken at the Cape Verd Islands, must no doubt apply to *Cidaris affinis*; he remarks that the small spines were of a scarlet colour, which agrees with *C. affinis*, but not with *D. papillata*. I am also fortunate enough to be able to correct the statement by Russo that it is found in the Red Sea, as Prof. Monticelli has sent me the specimens for examination — they are *Cidaris baculosa*.

2. **Cidaris affinis** Phil.

Pl. I. Fig. 1. Pl. VI. Figs. 9—10. Pl. VIII. Fig. 2. Pl. IX, Figs. 1, 8—9, 11—12, 17—19, 21—24. Pl. XI. Figs. 1, 22.

Synonym: *Cidaris Stokesii* L. Ag. & Desor.

Dorocidaris neapolitana? Ramsay 331.

A. Philippi: Beschreibung einiger neuen Echinodermen nebst kritischen Bemerkungen über einige weniger bekannte Arten. Arch. f. Naturgesch. 1845. I. p. 351. — L. Agassiz & E. Desor: Catalogue raisonné des familles, des genres et des espèces de la Classe des Echinodermes. Ann. Sc. naturelles. 3 Sér. VI—VIII. 1846—47. — M. Sars: Middelhavets Littoral-Fauna. p. 110. — Wyv. Thomson: Echinoids of "Porcupine" (395). p. 726. Pl. LX.

"Es ist mir unbegreiflich, dass man nicht schon längst die *C. affinis* von der *C. hystrix* unterschieden hat, da sie sich auf den ersten Blick durch dunkler rother Färbung und kürzere, spitzere und rauhere Stacheln auszeichnet — und bei Neapel gar nicht so sehr selten ist", says Philippi (op. cit. p. 352). It is still more inconceivable that later authors (Agassiz, Ludwig, Bell, a. o.) have reunited the two species. Wyv. Thomson himself is somewhat in doubt whether *C. affinis* is really specifically different from *Doroc. papillata*. By a thorough examination it is seen that they are not only two well separated species, but that they even belong to two different genera. *C. affinis* is to be referred to the genus *Cidaris* s. str., its nearest relations being *C. Reini* Döderl., *metularia* Lamk. *Thouarsii* Val. etc. — Although the northern boundary of this species is scarcely found so far north that it occurs in the territory the Echinid-fauna of which is treated in the present work, I nevertheless think it necessary to give a careful description of it, partly to prove my assertion that it has nothing to do with *Doroc. papillata*, but especially to prevent the two species being intermingled in future, as they have been so long, to the great injury of the study of the geographical distribution of these species. In the description those features are especially emphasized, in which it differs from *D. papillata*.

In the form of the test, the breadth of the ambulacral and the interambulacral areas, the number of ambulacral plates for each interambulacral plate (10—12), there is scarcely any difference of importance between this species and *D. papillata*. The interambulacral plates (Pl. VI. Fig. 10) are here more closely covered with tubercles; there are ca. 15 on the edge of each areole, and outside of these there is a circle of tubercles opposite to the intervals of those of the first circle. Outside of these again several tubercles are found, more or less circularly arranged, so that the whole plate is covered, with the exception of a quite narrow stripe at the median line, — and on the lower part of the test it is also covered by the tubercles. No furrows in the edge of the plates. In the depth of the areoles there seems to be no distinct difference between the two forms.

The ambulacral area is more peculiar (Pl. VI. Fig. 9); the secondary tubercles lie here in the lower edge of the plate, so that they are situated opposite to the intervals between the primary ones (in *D. papillata* they, as described above, are placed in the middle of the ambulacral plates, opposite to the primary tubercles). The whole form of the ambulacral plates is consequently somewhat different from that of *D. papillata*. Only on the very uppermost and lowermost plates of the area the secondary tubercles are wanting; in the middle part of the area inside the secondary series some tubercles are found still a little smaller (the secondary tubercles are somewhat smaller than the primary ones), placed opposite to the intervals between the secondary tubercles, and consequently opposite to the primary ones, not, however, very regularly. — The pore area is a little more than half the breadth of the interjacent space, comparatively a little broader than in *D. papillata*, scarcely, however, of any great importance.

The spines $1-1^1/_2$ time the diameter of the test (in *D. papillata* ca. $2-2^1/_2$ times); they are evenly tapering, and end bluntly. About 18 longitudinal series of coarse serrations. Between these longitudinal series fine, slightly branched thorns are found, which do not coalesce and form a reticulation as in *D. papillata* (transverse section Pl. XI, Fig. 1). The radioles round the mouth are short, blunt, somewhat flat, without any dents in the edge, what they commonly have in *D. papillata*. As in this latter an »ampulla» is found at the base of the small spines, especially well developed at those of the apical area. There seems to be no difference of any importance in the form of the small spines of the two species.

The pedicellariæ are of the structure characteristic of the genus *Cidaris*. The large globiferous pedicellariæ (Pl. IX. Figs. 9, 22, 24): the mouth is situated quite at the top of the blade which is round and somewhat bent inward; it is surrounded by a limb that is a little bent outward and provided with rather large teeth the number and size of which is rather irregular. The upper end of the mouth has no limb nor any teeth; no end-tooth. The edge of the blade towards the point irregularly dentate. — At the transition between the broad and the narrow part of the stalk a limb is found of freely projecting, short calcareous ridges, prolongations of the rind-layer of the thick part of the stalk (Pl. IX. Fig. 12). This limb is most developed on the large globiferous pedicellariæ, but may also be rather distinct on the small pedicellariæ and the tridentate ones. The whole stalk is far more regularly constructed than in *D. papillata*: here the outer layer consists of smooth longitudinal ridges with small knob-like swellings, in *D. papillata* it is an extremely irregular, more or less spinous reticulation. — Size: the head ca. $0{\cdot}7^{mm}$, the stalk ca. 2^{mm}, but especially the latter is rather varying.

The small globiferous pedicellariæ are of a quite different structure (Pl. IX. Figs. 8, 11); they have a distinct end-tooth, and the mouth is large and situated a little below the point. The back-side of the blade is almost without the common holes in the lime, only the basal part is perforated as usual. — The tridentate pedicellariæ are a good deal smaller, but more long-stalked than in *D. papillata*; the head ca. 0·5^{mm}, the stalk ca. 1^{mm} or a little more (Pl. IX. Figs. 1, 18, 19, 21, 23). The blade is somewhat slenderer, and when the pedicellaria is shut there is a wide open space between the blades below; they join only in the point — scarcely the outer half of the blade — and this part of the blade is then obliquely cut off, while in *D. papillata* the whole edge of the blade forms a chiefly straight line. For the rest the construction of the blade is far more simple and less complicate than in *D. papillata*; the edge is finely indented, and only a few smooth beams cross the cavity of the blade.

It is a curious fact that tridentate pedicellariæ seem to be wanting in all the (6) specimens of *C. affinis* from the Mediterranean. On the other hand they are found in large numbers, not only in the ambulacral areas, but all over the test, in 5 specimens from 33° 20′ N. Lat. 77° 5′ W. L. 90 fathoms (near Florida), which our museum has received from U. S. Fish Commission (Smiths. Inst.) under the name of *Dorocidaris papillata, var.* In return the large globiferous pedicellariæ are extremely few in these specimens. Otherwise there seems to be no other difference of importance between these specimens and those from the Mediterranean. To be sure the spines (Pl. VIII, Fig. 2) are comparatively a little longer in the specimens from Florida, but as these are only half so large as the specimens from the Mediterranean, it may be taken to be a difference of age. To judge from the material in hand I must, at all events, regard them as being the same species, while I do not venture to decide, whether a distinction may be made between a Mediterranean variety and an Atlantic one.

The spicules of the tube-feet are arranged as in *D. papillata.* They are upon the whole a little more spinulous than in this latter, but the difference is extremely slight (Pl. XI. Fig. 22).

The diameter of the test of the largest specimen 38^{mm}, the longest spine 54^{mm}. The colour of this species, as has been observed by all the authors that have taken it to be a separate species, is lively red; the spines are brownish, with darker and lighter bands. The colour keeps rather well in spirit, sometimes excellently, as in the specimen figured on Pl. I. Fig. 1. "As color forms such an unimportant feature in the specific characters of Echini, much stress cannot be laid upon this point", says Agassiz. (Revision p. 255.) Here, no doubt, it is of some importance, as upon the whole the colour may be an excellent guide for distinguishing the species, for instance of *Echinus.*

Among the other *Cidaris*-species *C. Reini* Döderl. seems to be the nearest relation of *C. affinis*; they have both of them slender spines and a little limb on the stalk of the pedicellariæ. There seems to be no important difference in the form of the pedicellariæ in the genus *Cidaris*; it will scarcely be possible to distinguish the species with certainty by means of the pedicellariæ, but there seems also to be characters enough to be got from other features. The spines especially show a rather great richness in forms in this genus.

Accordingly *Cidaris affinis* will have to be added to the not few Echinids, found both in the Mediterranean and at the eastern coast of America. As to its distribution in other places only little can be said, as it has been intermingled with *D. papillata.* No doubt it will be found at the Atlantic coast of Southern Europe, and, as has been observed above, Studer's statement (386) of *D. papillata* being found at the Cape Verd Islands must surely apply to *C. affinis.* That it will also be found at the Azores, may be said with some certainty. It seems to be a more littoral form than *D. papillata*;

Sars has it from 50—100 fathoms; the specimens taken by Dr. H. I. Hansen at Syracuse are from 20—30 fathoms. The form mentioned from Florida is stated by Rathbun (336 p. 611) to be from 25—426 fathoms.

3. Stereocidaris ingolfiana n. sp.

Pl. VI. Figs. 1—5, 11. Pl. VIII. Figs. 4, 10, 11, 16, 19—21, 23, 26, 28, 30, 36. Pl. XI. Figs. 12, 16, 17, 23, 28, 30, 32, 33. Pl. XVI. Fig. 1.

Diameter	Height	Diam. of the peristome	Diam. of the apical area	Longest spines
35 mm.	27 mm.	14 mm.	15 mm.	
32 —	29 —	12 —	13 —	65 mm.
28 —	17 —	10·5 —	10·5 —	48 —
27 —	20 —	10 —	13 —	62 —
25 —	18 —	9 —	12·5 —	47 —
24 —	17·5 —	9 —	13 —	50 —
16 —	10 —	6·5 —	8 —	50 —
9 —	6·5 —	4 —	5 —	26 —

As will be seen from the given measures the height of the test is rather varying. Nevertheless the form is upon the whole very characteristic (Pl. VI. Fig. 3). It is broader above than below; the upper side is generally very flat, and there is, about the middle of the first fully developed interambulacral plate, a rather steep bending from the upper side to the almost perpendicular, below slightly inward bent sides. Below at the edge of the peristome a rather abrupt bending is likewise found; the two lowermost interambulacral plates are situated almost horizontally.

The interambulacral areas are $3^1/_2$—4 times as broad as the ambulacral areas; they consist of 5—7 plates. The areoles are deep, the edge round them raised, with a single circle of 15—16 more conspicuous tubercles; in large specimens these are more indistinct. The other part of the plates is closely set with very small tubercles, which are in the larger specimens rather distinctly arranged in irregular transverse rows; in smaller specimens this arrangement is not distinct. Even at the median line where the plates join, a narrow naked stripe is scarcely seen, in the largest specimen not at all. The plates sink somewhat down towards the median line and outward towards the pore area. Even the lowermost areoles are separated by a rather broad space with distinct tubercles (Pl. XVI. Fig. 1).

The ambulacral areas: There are 10—12 ambulacral plates for each interambulacral plate. The pore area is half so broad as the middle part of the ambulacral area. The pores are only separated by a narrow partition-wall; the outer pore is a little smaller. (In *D. papillata* and *C. affinis* the pores are of equal size; in the latter there is a rather broad partition-wall between them)[1]. The primary series of tubercles is only little conspicuous; besides the primary tubercle about 3—5 small tubercles are found on each ambulacral plate, so that there is no trace of naked intervals; the whole area between the series of pores therefore appears as a densely granulous stripe in which the boundaries between the separate plates are only seen with difficulty (Pl. VI. Fig. 11).

The plates of the peristome are set with numerous small tubercles, but only on the free edge. The apical area (Pl. VI. Fig. 4) is, as the other part of the test, closely set with small tubercles. The genital openings are rather large, the ocular plates are widely separated from the periproct, which is covered by smaller plates rather regularly arranged.

[1]) The figures (Pl. VI. Figs. 8, 9, 11) do not show this feature clearly.

In a quite young specimen, of a diameter of 7^{mm}, with only 4—5 interambulacral plates, as yet almost no small tubercles (and spines) are found, excepting the primary series in the ambulacral areas, and the circle round the areoles (which are not yet deepened). Nevertheless no naked spots are seen on the test — there is no space for more tubercles. The apical area is closely set with small tubercles. There are as yet only 5 plates in the periproct, in the corners between the genital plates (which have not yet any genital opening). Round the anal opening there is a circle of small tubercles.

The spines are highly characteristic (Pl. VI. Figs. 1—2. Pl. VIII. Fig. 10). Most frequently they have a wing-shaped crest on the side turned upwards; sometimes 2—3 crests are found, sometimes none at all. Specimens are found, in which almost all the large spines are provided with wings, and other specimens, in which only a few spines or none at all have such crests. The more developed the crest is, the more compressed is the spine, to the very point. Where the crest is wanting, the spines are almost round and rather evenly tapering. There is a somewhat different number (10—16) of projecting longitudinal ridges with rather distinct thorns or dents. In young individuals (and spines) these ridges are more conspicuous, and they are here almost similarly developed, the thorns only a little more conspicuous in one of the ridges. Then the thorns of this ridge increase inordinately in size, and coalesce more and more from the base outward — and thus the crest is formed (Pl. XI. Figs. 17, 30, 32). Moreover the whole spine, the ridges (especially the crest), and the intervals are closely covered with delicate, obliquely situated "hairs", the points of which are directed upward or outward (on the thorns). In dried specimens the spines are somewhat shaggy, and have a whitish tint from the air that is found between the hairs as in the hairy coat of a plant. In old spines this tint is not distinctly seen, but in young spines it may be very beautiful. In transverse sections of the spines (Pl. XI. Fig. 33) these hairs are seen to form a thick, complicated network on the outside of the outer layer of the spines. — The large spines are almost always turned directly to the side, so that the animal gets a peculiar flat appearance recalling a wheel (Pl. VI. Figs. 1—2). The spines round the mouth are flat, and have most frequently distinct, sharp dents in the edge.

The secondary spines are exceedingly numerous, and give the animal an almost shaggy appearance. Round the radioles a single circle of larger flat spines, of a length of $2^1/_2$—3^{mm}, of the common form is found. In the primary series in the ambulacral areas the spines are somewhat narrower and only about half the length of those round the radioles, scarcely 2^{mm}, the other small spines are still much smaller, ca. $^1/_2$—1^{mm}. They are not distinctly compressed, and are not strongly pressed against the test, as is otherwise generally the case in the Cidarids. The spines round the radioles and those of the outer series of the ambulacral areas are often a little bent at the point and hollowed on the upper surface (Pl. VIII. Fig. 19), which is especially the case with the ambulacral spines nearest to the peristome. The spines of the peristome are generally somewhat widened at the point, and have, as it were, an indication of bisection, a thinner stripe being found downward from the middle of the point (Pl. VIII. Fig. 20). There is no "ampulla" at the base of the spines, at most a slight indication of such a one.

The pedicellariæ: The large globiferous pedicellariæ (Pl. VIII. Figs. 11, 16, 29) recall very much those of *D. papillata*, but by a closer examination they show no slight difference. There is no unpaired tooth at the point. The mouth is large, broad below, more narrow above; it reaches to the very point. The edge is set with small teeth, the upper one on each side somewhat more distinct, sometimes much larger than the others (Pl. VIII. Fig. 26). These two uppermost teeth may be bent towards each other and coalesced towards the point, so that a little opening appears on the upper side of this apparently unpaired end-tooth, and when this is the case the resemblance to the pedicellariæ of *D. papillata* is considerable; but here, however, is never found the rather long, closed part below the end-tooth, which is found in *D. papillata*. The lower limit of the mouth generally forms a fine, regular curve. In a couple of specimens the point of the large globiferous pedicellariæ showed a deviating, but very irregular construction, which was much more like that in *D. papillata*. As these individuals otherwise agree exactly with the others, this deviation must be taken to be abnormal. It is a very conspicuous peculiarity in the large globiferous pedicellariæ of this species that the back-side is quite clear without holes all over the outer part of the blade; in *D. papillata* the back-side is highly perforated and of a very complicate construction to the very mouth. — Length of the head ca. 1^{mm}, the stalk often a little shorter. The structure of the stalk as in *D. papillata*.

The small globiferous pedicellariæ are upon the whole of the same construction as the large ones (Pl. VIII. Figs. 28, 30, 36); the uppermost pair of teeth may also here be coalesced at the points (Pl. VIII. Fig. 23). I have not been able to find tridentate pedicellariæ in any of the specimens in hand.

The spicules of the tube-feet (Pl. XI. Fig. 28) are very characteristic, and yield an excellent mark by which this species may be distinguished from the other Atlantic Cidarids. They are small fenestrated plates placed in two separated longitudinal series; they do not join on either side, such as is the case in *D. papillata* and *Cidaris affinis*. They are most developed on the tube feet below at the peristome, in the upper ones they are more simple and more like the common Cidarid-spicules. In quite small individuals they are often only much branched, not yet perforated plates. Upon the whole they are comparatively smaller than in *D. papillata*; they are slightly arched corresponding to the form of the foot, and are as usual situated transversely on the longitudinal axis of the foot.

In the intestine, the genital organs, and the organs of Stewart numerous spicules are found; those of the intestine have three rays, the others are larger, irregular plates (Pl. XI. Figs. 12, 16, 23). The dental apparatus shows no marked peculiarities. The auricles are rather high and narrow; on the ambulacral areas small and fine processes are found. (In *D. papillata* and *C. affinis* are likewise found rather well developed ambulacral processes. (Comp. Duncan 129). (Pl. VI. Figs. 5—6.)

In some of the specimens the lower part of the spines is slightly reddish; otherwise this species appears to have no marked colour. The preserved specimens are brownish.

Ingolf	St. 9.	(64° 18′	N. Lat.	27° 0′	W. L.	295	fathoms.	Bottom temperature	6° 2).	16	specimens.
—	— 16.	(65° 28′	—	27° 05′	—	250	—	—	6° 4).	4	—
—	— 81.	(61° 44′	—	27° 11′	—	485	—	—	5° 7).	2	—
—	— 84.	(62° 58′	—	25° 24′	—	633	—	—	4° 4).	4	—
—	— 85.	(63° 22′	—	25° 21′	—	170	—	—	).	1	—
—	— 89.	(64° 45′	—	27° 20′	—	310	—	—	8°).	4	—
—	— 97.	(65° 28′	—	27° 39′	—	450	—	—	5° 1).	2	—

Further we have 5 specimens from the Denmark Strait (64° 42′ N. Lat., 27° 43′ W. L., 426 fathoms) obtained in 1889 by Wandel.

One more locality may be added for this species, viz. Albatross 1885, st. 2415, near Florida (30° 44′ N. Lat., 79° 26′ W. L., 440 fathoms) as, according to what has been mentioned above, a specimen received from U. S. National Museum under the name of *Porocidaris Sharreri* has proved to be identical with the species described here. I suppose that it has oftener been confounded with other Cidarids. At present, however, it is only known with certainty from the stations enumerated here: on the ridge south of Iceland, between Iceland and Greenland towards the ridge here separating the Atlantic from the Polar basin, and at Florida. The depth is 170—633 fathoms; accordingly it seems to be no genuine deep-sea form either.

Recent species of the genus *Stereocidaris* have first been described from Japan by Döderlein (Die japanischen Seeigel. 116); a species of the same genus, *St. indica* Döderl. (118) has later been taken by Valdivia in the Indian Ocean in many places and in many varieties, of which a couple, to judge from the preliminary description, seem to be so very like *St. ingolfiana*, that it will be difficult to distinguish between them; but Prof. Döderlein, to whom I have sent a specimen of *St. ingolfiana* for examination, has informed me that he thinks the two species to be good ones. With the species described here the occurrence of the genus also in the Atlantic is proved; this genus thus appears to be cosmopolitan.

4. **Porocidaris purpurata** Wyv. Thomson.

Pl. VI. Fig. 12. Pl. VIII. Fig. 22. Pl. X. Figs. 1—2, 5. Pl. XI. Figs. 3, 21.

Synonym: *Porocidaris gracilis* Sladen.

Wyv. Thomson: Echinoidea of Porcupine (395) p. 728. Pl. LIX. & LXI. 14—15. — Bell: Catalogue (73) p. 141. — Hoyle: 202. p. 405. — Sladen: 367.

With regard to this easily distinguished species I have only little to add to the excellent description by Wyv. Thomson.

The ambulacral areas: Inside the outer, primary series of tubercles a somewhat smaller tubercle is found in the lower corner of each plate, and moreover a quite small tubercle below the primary one, which accordingly does not fill up the whole breadth of the plate. There is, however, some irregularity; one or the other of the small tubercles are not rarely wanting, sometimes both of them. Also the pores are different from those of the other Cidarids mentioned here, as will be seen by a comparison of the figures (Pl. VI. Figs. 8—9, 11—12).

The spicules are arranged in the tube feet as in *D. papillata*; the two series, however, do not always join closely, naked spaces are often seen between them, in which only a few spicules are joining. They are somewhat complicated, the thorns on the outer side coalescing and forming a more or less distinct net of meshes (Pl. XI. Fig. 21).

Of the very characteristic two-valved pedicellariæ Wyv. Thomson (op. cit. p. 729) says: "Their structure is in every way the same as that of the ordinary three-valved pedicellariæ, except in the number of the valves. All the usual chambers and ridges are developed, and the different muscles are very evident through the transparent walls". In this statement I do not agree with Wyv. Thomson. These pedicellariæ are highly different in structure from common tridentate pedicellariæ, with which they must most nearly be compared (Pl. X. Fig. 1, 2, 5). They have no apophysis; the whole basal part is an undivided cavity in accordance with the fact that muscles are only running in one direction between the two valves. (In the common three-valved pedicellariæ muscles, as is well known, run in two diverging directions from each valve, and the apophysis may be taken to serve chiefly for the attaching of these muscles). The structure of the stalk is as in *D. papillata.* Other kinds of pedicellariæ do not appear to be found in this species (genus).

The spines have no »hair«-covering on the outer layer, as was the case in the three preceding species; but the outer layer itself is beautifully and regularly striped longitudinally, and is in transverse sections seen to be divided into areas, one area for each raised ridge. The more conspicuous ridges are formed by two parts of equal height, joined almost to the point (Pl. XI. Fig. 3).

»Ingolf«, st. 73 (62° 58′ N. Lat. 23° 28′ W. L. 486 fathoms. Bottom temperature 5° 1). 3 specimens.

Hitherto the species was only known from the Faröe Channel, from 530—542 fathoms.

The smallest of the specimens in hand (diam. 10^{mm}, height 7^{mm}, longest spine 27^{mm}) agrees exactly with the description of *Porocidaris gracilis* Sladen (op. cit.). The form is the same; the radioles are not separated, only one tubercle on each ambulacral plate, no openings in the genital plates — as in *P. gracilis*; only the colour is more light (bleached) than in Sladen's specimen. There can be no doubt, however, that it is a young *P. purpurata*, and *P. gracilis* Sladen must then, as supposed by Bell (op. cit. p. 142) be taken to be synonymous with *P. purpurata.*

It is especially by the spines that the young *P. purpurata* differs from the grown one. In Sladen's specimen they were »finely striated longitudinally, the ridges being very slightly prominent and marked with very faint and indistinct serrations«. In the specimen in hand, which is a smaller one, the spines are very different between themselves, some are provided with rather highly serrate longitudinal ribs, others are densely covered with coarse thorns, without any trace of longitudinal ribs; a couple are only faintly serrated, and a single one of the uppermost ones is completely smooth, quite as in the grown *P. purpurata.* Also in the grown one the lower radioles are rather distinctly serrated, while the upper ones, with the exception of a few coarse thorns, only are finely striated longitudinally. The radioles round the mouth are serrated as in the grown one, only, however, with 1—2 teeth on either side.

Sladen's specimen was taken S. W. of Ireland on 51° 1′ N. Lat., 11° 50′ W. L., 750 fathoms.

Table of the Cidarids occurring in the northern Atlantic and the Mediterranean.

1.	Pedicellariæ 2-valved; the spines with highly developed neck	*Porocidaris purpurata* W. Th.
	— 3-valved; the spines with short neck	2.
2.	The globiferous pedicellariæ, as well the large as the small ones, with an unpaired tooth at the point of the blade; the mouth does not reach to the point of the blade, and is most frequently irregularly limited below. The spicules formed as spinous arcs.....	*Dorocidaris papillata* (Leske).
	The large globiferous pedicellariæ withouth end-tooth; the mouth reaches to the point of the blade, and is regularly limited below. (Sometimes an unpaired end-tooth may apparently be	

found on the large pedicellariæ; when this is the case, the spicules (fenestrated plates) will show that it is no *Dorocidaris*)..... 3.

3. The large globiferous pedicellariæ with large mouth; the blade not prolonged. The stalk has no limb of projecting calcareous ridges. The small pedicellariæ without end-tooth. The spicules fenestrated plates .... *Stereocidaris ingolfiana* Mrtsn.

The large globiferous pedicellariæ with a little mouth at the end of the somewhat prolonged blade. The stalk with a limb of projecting calcareous ridges. The small globiferous pedicellariæ with end-tooth. The spicules spinous arcs .... *Cidaris affinis* Phil.

Fam. Echinothuridæ.

The classification of the Echinothurids is distinguished by a pleasing simplicity; only three recent genera are known, *Phormosoma*, *Asthenosoma* and *Sperosoma*, and, what is still more pleasing, there are only two synonyms of these names, viz. *Calveria* W. Th., and *Cyanosoma* Sarasin. To the genus *Phormosoma* 10 species have been referred, to *Asthenosoma* 11, and to *Sperosoma* 2 species, most of which species have been described by A. Agassiz, the rest by Wyv. Thomson, Koehler, Döderlein, and Yoshiwara, all during the last three decades. Here, then, we seem to have a division of Echinids where the classification is in the best possible order. — The joy, unfortunately! does not last longer than until the moment when one has to determine Echinothurids oneself. Then one will soon reecho the complaint of Sarasin: Wir wissen nicht, warum es A. Agassiz seinen Lesern so sehr sauer gemacht hat sich in seinen Challenger Echiniden zurecht zu finden. Um einen Echinothuriden daraus zu bestimmen ist es nötig die bei den einzelnen Arten gemachten Angaben sorgfältig zu analysieren, unter Rubriken zu ordnen und dann die Bestimmung zu versuchen (352. p. 96). We might, however, let that pass, if all the difficulties were to be superseded in this way; but this, unfortunately, is not the case, as it will soon appear that the two large genera, *Phormosoma* and *Asthenosoma*, are in reality not to be distinguished from each other with certainty.

The chief difference between these genera is stated to be the fact that in *Phormosoma* the plates overlap each other in the whole length of the edge, while in *Asthenosoma* the plates are narrower in the middle, so that naked interspaces are left only covered by the skin; only the broader ends of the plates overlap each other in the way peculiar for the Echinothurids. Now there is, however, the drawback by this statement that the arrangement of the plates is generally only to be seen in dried specimens. But the Echinothurids are only very little adapted for preservation in dried state, and if the material in hand be slight, one does not like to destroy it for the sake of determination. And even if the material is copious enough, so that it is possible to examine the plates exactly, we are by no means sure to arrive at a result. Bell (72) has shown that there is a considerable variation as to the size of the uncalcified membranous space between the plates: this may be quite conspicuous or calcification may have gone so far, that it is difficult to detect the membranous interspace. —

From the specimens before me I am compelled to conclude, that the amount of calcification of the plates is a point in which individuals living together may differ among themselves».

As another important difference between the two genera Wyv. Thomson (395) emphasizes the fact that in *Phormosoma* the actinal side is very different from the abactinal side, while in *Calveria* (which is, according to Agassiz, synonymous with *Asthenosoma*) both sides are rather equal. This character was excellent, as long as only the species described by Wyv. Thomson were known; but it could not hold good with regard to the large number of new species brought to light by the »Challenger«-Expedition. Agassiz has also several times declared, although only in an indirect way, that the two genera cannot in reality be kept distinct. In the »Challenger Echinids« (p. 87) he says of young specimens of *Asthenosoma pellucidum* that they show «how close is the relationship between the genera *Phormosoma* and *Asthenosoma* in spite of the apparently great structural differences existing between the adult of such species as *Asthenosoma Grubei* and *Phormosoma luculentum*. It is mainly from the comparatively larger number of coronal plates in the former genus, that the young of the two genera can be satisfactorily distinguished, the other characteristic features, the lapping of the plates appearing only in larger specimens». Of *Phormosoma panamense* Agassiz says (13. p. 77) that it has «on the actinal side the characters of *Phormosoma* most decidedly developed, while on the abactinal side the great elongation of the ambulacral plates and the arrangement of the coronal plates resemble the structural features of *Asthenosoma*».

Thus we have no fully reliable characters for the two mentioned genera. We have then to choose between two alternatives: to make the whole one genus, or to search for better characters. The first alternative is only a confession of incompetency; we must try the second. — It is beforehand probable that good characters must be found, as these animals show so rich a variety of interesting structures. The examinations have also in ample measure borne out the anticipations of finding good characters. The arrangement of the tube feet, the structure of the spines, the spicules, and above all the pedicellariæ, yield most excellent characters, as well with regard to genera as to species. The old genera Phormosoma and Asthenosoma prove to be highly heterogeneous; several new genera will have to be established.

Besides the rich material of the »Ingolf«-Expedition, and what was previously found in our museum, I have examined the type specimens of all the new species from »Challenger« described by Agassiz, to which species Prof. Bell most liberally granted me admission during my stay at British Museum. Further Prof. Pfeffer has kindly sent me a couple of specimens of *Asthenosoma varium* Grube for examination. Accordingly my examinations rest on a very broad base; with the exception of *Phormosoma hispidum*, *panamense*, *Asthenosoma longispinum*, *Ijimai*, and *Sperosoma biseriatum*, I have examined all known species, and of almost all of them the type specimens.

As already mentioned, it is the spines, the pedicellariæ, the tube feet, and the spicules, which bear the principal part in the new classification of the Echinothurids that is the result of these researches. Of course also the structure of the test is always of importance; but the all-predominant importance that has hitherto been attached to the form and mutual relation of the plates, will have to be very much reduced. In most Echinothurids the primary spines on the actinal side are provided with a peculiar, hoof-shaped terminal cap, of a structure different from that of the other part of the spine; it is very large and conspicuous in some species, as *Ph. hoplacantha*, *Sperosoma Grimaldii* a. o., small in *Asthenosoma Grubei*, *hystrix* a. o. These spines are always (?) more or less curved. — In a group of species: *Phormosoma placenta*, *bursarium*, and *rigidum* (a. o.?) the primary spines of the actinal side are surrounded by a bag of skin, and their points are swollen in a club-shaped way. In *Asthenosoma Grubei*, *varium*, *heteractis*, and *urens* the spines on the abactinal side, primary and secondary ones, are inclosed by a thick cutaneous sheath which is constricted one or several times; also in other Echinothurids, for instance *A. hystrix*, small bags of skin are seen at the point of the small spines. These spines are distinctly distinguished from the mentioned skin-covered spines in *Ph. placenta*, *bursarium*, and *rigidum* by being constructed as usual — simple perforated tubes with a long, fine point, while in *Ph. placenta* etc. they are swollen at the point, and filled by an irregular calcareous net of meshes.

The tube feet may be arranged in an almost straight line on the actinal side, as in *Ph. placenta*, or they may be trigeminous, about as in an *Echinus*, as for instance in *A. hystrix*, or they may be arranged in three widely separated series, as in *Sperosoma*. In some there is no trace of a sucking disk on the tube feet of the actinal side, in others there is a well-developed disk; on the abactinal side a sucking disk is never found. The spicules are almost always rather large, irregular, fenestrated plates situated more or less distinctly in 3—4 longitudinal series. In *A. varium*, *Grubei*, *heteractis*, and *urens* they are very slightly developed, only small, branched calcareous pieces, rarely with a hole. — The sphæridiæ, which follow the tube feet quite up on the abactinal side, show no differences so great that they can be of any systematic importance. The pedicellariæ, on the other hand, are of the greatest importance with regard to the classification.

No less than 5 different kinds of pedicellariæ are found in the Echinothurids, viz. the four kinds known from the Echinids, and further the very beautiful form, described by Wyv. Thomson in *A. fenestratum*, the tetradactylous pedicellariæ. Only the tridentate and the triphyllous pedicellariæ are found in all Echinothurids, each of the other kinds are only found in a single genus. The tetradactylous pedicellariæ have been so excellently described and figured by Wyv. Thomson, that I need not add anything. Globiferous pedicellariæ were hitherto unknown in the Echinothurids; I have found them in *A. pellucidum* (in one of the type specimens from Chall. st. 192; the other specimens I have not seen). They are highly primitive; the skeleton consists of three simple rods, a little widened below. No muscles seem to pass between them, which corresponds very well with the fact that the three glandular bags are quite inclosed by a common skin; the pedicellaria cannot be opened as other pedicellariæ. The valves have only half the length of the head, and they are placed between the glandular bags (Pl. XIII. Fig. 24). There can scarcely be any doubt that this interesting form of pedicellariæ is to be interpreted as a very primitive globiferous pedicellaria.

Neither were ophicephalous pedicellariæ hitherto known in the Echinothurids. The form of pedicellariæ figured and described by Wyv. Thomson as ophicephalous pedicellariæ, is indisputably the triphyllous pedicellariæ, very similar to the triphyllous pedicellariæ of the Echinids, only somewhat larger. Genuine ophicephalous pedicellariæ I have only found in the new form *Tromikosoma Koehleri*, described here. They are very characteristic, the blade is highly constricted just above the basal part, and abruptly widened above (Pl. XIV. Figs. 19, 23, 25). The somewhat contorted arc on the lower side of each valve, so characteristic of the ophicephalous pedicellariæ, is here typically developed, so that there can be no doubt that it is a genuine ophicephalous pedicellaria. It is a highly curious fact that each of these three kinds of pedicellariæ, two of which show a very perfect development, are only found in a single genus, while none of the other Echinothurids seem to have a corresponding form of pedicellariæ.

The tridentate pedicellariæ are very richly developed in the Echinothurids. Most frequently their form is simple; the valves are leaf-shaped, and the blade is more or less filled by a net of meshes which may be very spinous. In another common form the edges of the blade are involuted, so that only the point of the blade is somewhat widened; in this form the blade is commonly strongly bent, so that the valves are widely separated, and only join with their points when the pedicellaria is closed. Both these forms may be found in the same species; and in a group of species, *A. varium* and the species most nearly allied to it, even three different kinds of tridentate pedicellariæ are found, viz. besides the two mentioned forms a short, broad one with coarsely serrate edge (Pl. VIII, Figs. 4, 27). A peculiar short and broad form is found in *Ph. luculentum*; it recalls to some degree an ophicephalous pedicellaria, but as it has no indication of an arc, there can scarcely be any question of interpreting it as any thing else than a form of the tridentate pedicellariæ. The tridentate pedicellariæ may be very large, especially those with involuted edge; these have commonly a very short neck.

The triphyllous pedicellariæ (Pl. XII, Pl. XIII. Fig. 23) are very well developed in the Echinothurids; peculiar to these in comparison with the triphyllous pedicellariæ of the Echinids is the fact that the upper edge of the apophysis spreads over the lower part of the blade, and continues up along its sides; in some, for instance *Ph. placenta*, this »cover-plate« is not much developed, in most species it is highly developed, and covers a great part of the blade. Generally there are then some large holes in the median line, and some smaller holes around; the part continuing upward along the lateral edges of the blade, is most frequently without holes. The upper edge of the blade is generally finely serrate. The holes in the blade are always placed in rather regular curves from the middle obliquely upward on either side. — The peculiar bottle-shaped, two-valved pedicellaria, figured by Agassiz from *Phormosoma tenue* (Chall. Echinoidea. Pl. XLIV. Fig. 21) is presumably an abnormal form. I have examined a couple of the type specimens, but have only found the common, three-valved form. Agassiz (Chall. Echinoidea. p. 84) thinks that »this bottleshaped pedicellaria is only a modification of the ordinary type of pedicellariæ, in which the terminal edge becomes raised to form a spoon-shaped valve«. This is absolutely wrong; one form is a triphyllous pedicellaria, the other a tridentate one.

The stalk of the pedicellariæ in by far the greatest number of Echinothurids is thin, irregularly perforated, not distinctly tube-shaped (Pl. XIV. Fig. 31). In the large tridentate pedicellariæ, as in *A. varium*, also the stalk is somewhat coarser; the stalk of the ophicephalous pedicellariæ of *Tromikosoma* is a rather thick tube. In *Ph. asterias* the construction of the stalk is quite exceptional among the Echinothurids; it consists of some long, very thin calcareous threads, only united at the ends of the stalk, at most connected in the intervening part by quite few transverse ridges.

Also the inner anatomical structure seems to yield good systematic characters. Thus Bell (Catalogue p. 142) mentions as a chief difference between the genera *Phormosoma* and *Asthenosoma* that the latter has highly developed »longitudinal muscles« dividing the body-cavity into chambers, while such muscles are wanting in *Phormosoma*. — To this, however, is to be remarked that the specimens of *Phormosoma placenta* I have opened, had typically developed, but, to be sure, very fine and fragile longitudinal muscles. Bell (69) has likewise shown that the organs of Stewart are rudimentary or wanting in *Ph. placenta*, *bursarium*, and *tenue*, while in other forms they are highly developed, as has been shown by Sarasin (352) with regard to *A. urens*, and by Koehler with regard to *Ph. uranus* (229).

If we now look over the Echinothurids with regard to the structures mentioned here, we shall see that the old genera *Phormosoma* and *Asthenosoma* cannot be kept up to the extent in which they have hitherto been taken; several new genera will have to be established. The species will have to be grouped in the following way:

Phormosoma placenta. The primary spines on the actinal side are club-shaped, inclosed by a thick bag of skin. The tube feet on the actinal side arranged in a single series; no sucking disk developed. Tridentate pedicellariæ simple, with leaf-shaped, rather deep valves having only a slightly developed net of meshes at the bottom. The spreadings from the upper end of the apophysis do not reach to the lateral edges of the blade. Very nearly allied to this species is *Ph. bursarium* A. Ag. The spines on the actinal side are as in *Ph. placenta*; on the abactinal side the spines are curved, by which feature it is distinguished from the latter species. The pedicellariæ are as in *Ph. placenta*; the tridentate pedicellariæ occur (in the same individual) in a long, narrow form (Pl. XII, Fig. 1), and a short, broad form, as it will be described below in *Ph. placenta* (Pl. XII. Figs. 2, 3); (in this species both forms do not appear to be found in the same individuals). The narrow ones have often some rather large, inward directed teeth a little inside of the edge on the lower part of the blade. In the triphyllous pedicellariæ (Pl. XII, Fig. 28) the cover-plate is a little more developed than is the case in the form typical for *Ph. placenta*; but in this species similar triphyllous pedicellariæ may also be found together with the typical form. The spicules form two longitudinal series placed just above either edge of the partition-wall in the tube foot; from the middle of the lower side of the spicules a continuation passes into the partition-wall, by which means a dark line appears along the middle of each series of spicules. Such continuations from the spicules into the partition-wall are not seen in *Ph. placenta*, and seem upon the whole not to be found in other of the Echinothurids examined here. Besides the two longitudinal series more or fewer scattered spicules are found, sometimes so many, that the chief series become indistinct. The spicules are the common irregular fenestrated plates, perhaps a little larger than in *Ph. placenta*. No sucking disk is found.

Agassiz (Chall. Ech. p. 99 seq.) is not quite sure whether this species is not possibly identical with *Phormosoma luculentum*; more abundant material may prove, that the differences noticed, although important, are simply individual characteristics partly due to age». He takes much care to show, in which features the two species are distinguished — a rather superfluous work! The two species are very different, which may be seen directly by a glance at the figures given by Agassiz, and, as will be shown here, they cannot even be referred to the same genus. On the other hand Agassiz unfortunately has not observed that *Ph. bursarium* is very similar to *placenta*; it would have been of considerably higher importance, if we had been informed of the characters by which it is distinguished from this latter. To be sure Agassiz (Chall. Ech. p. 100) observes that it is distinguished from *Ph. placenta* «in the greater height of its coronal plates and the presence of large primary tubercles extending both in the ambulacral and interambulacral areas far towards the abactinal system». This, however, seems to be no conspicuous difference; on the other hand the curved spines on the abactinal side and the peculiar feature with regard to the spicules may perhaps be taken to be good characters of this species.

One more species must be classed with the two mentioned ones, viz. *Phormosoma rigidum* A. Agass. It resembles very much *Ph. placenta.* The primary spines on the actinal side are covered with skin, what I have been able to substantiate on the type specimen[1]). The pedicellariæ as in *Ph. placenta*; only a narrow form of tridentate pedicellariæ has been found (Pl. XII. Fig. 6). The spicules are placed in three rather distinct longitudinal series; they are a little lengthened, and are almost parallel to the longitudinal axis of the foot. No sucking disk. — It seems to be rather difficult after the only specimen in hand to give any sure character for the distinguishing between this species and *Ph. placenta*, nor do we get any guidance from the description by Agassiz; to be sure he has observed that the actinal side reminds very much of *Ph. placenta*, but otherwise he does not seem to regard them as more nearly allied. In reality it is not improbable that they may be the same species. *Ph. rigidum*, it is true, has only been taken at New-Zealand, and *Ph. placenta* only in the northern part of the Atlantic, — but if *Ophiomusium Lymani* can be found as well in the Atlantic as in the Pacific (which is a sure fact), the same may also be the case with *Ph. placenta.* New material, however, will be necessary for the decision of the question.

The three mentioned species form a separate group, sharply distinguished from all other Echinothurids, as far as known, above all by their peculiar, skin-covered spines on the actinal side. Agassiz, to be sure, thinks that this feature has no special systematic importance. «The presence of sheated spines in two species of *Phormosoma* shows that this character, which at first sight seems to separate so strikingly from the rest of the species of the group *Asthenosoma grubei*, is evidently one of little value, and which may be more or less developed in specimens of the same species in the same state of growth» (Chall. Ech. p. 101). — As already mentioned above, the facts here put together by Agassiz are quite different: in *A. grubei* it is the spines on the abactinal side that are wrapped by a bag of skin, and the spine itself is of the common structure, a perforated tube ending in a fine point; in *Ph. placenta* and the species allied to it, it is the primary spines on the actinal side that are clavately widened in the point and wrapped by a thick bag of skin. These spines must, of course, be compared with the primary spines on the actinal side of the other species; but then we find a marked contrast, these spines of the other species not being covered with skin — as far as is known — but ending in a larger or smaller hoof, distinctly marked off from the spine itself. There can be no doubt that the three mentioned species form a separate genus, to which, of course, the name of *Phormosoma* is due. The other species referred to *Phormosoma* must be referred somewhere else. Possibly, however, *Ph. panamense* is also a genuine *Phormosoma*; Agassiz (13) says that its actinal side has «the characters of *Phormosoma* most decidedly developed»; otherwise he takes it to be nearly related to *Ph. tenue*, but thinks that perhaps it may prove to belong to a new genus «intermediate between *Phormosoma* and *Asthenosoma*». The description gives otherwise only very incomplete informations of this species, and no figures are given.

[1]) As this specimen is said by Bell (69) to have disappeared, I must observe that it has later been found again.

Another very distinctly marked group is formed by the species *Asthenosoma varium* Grube, *Grubei* Agass., *urens* Sarasin, and *heteractis* Bedford, all which species I have had occasion to examine. The primary spines on the actinal side are curved, and end with a thin, but rather long, little conspicuous hoof; they are green with dark rings. All the spines on the abactinal side and the secondary ones on the actinal side are covered with skin; on the larger spines the bag of skin is repeatedly constricted (Chall. Ech. Pl. XVI), on the small spines there is only a simple bag of skin at the point (poison apparatus — Sarasin 350, 352); these skin-covered spines end in the usual point. The tube feet are placed in three dense series; in the actinal tube feet a well developed sucking disk is found. The spicules are small, irregularly branched, rarely with a single hole (Pl. XI. Fig. 20); only just below the sucking disk a few larger fenestrated plates are found. They are placed in 2—4 series, but only in the outer part of the foot, nearest to the sucking disk; in the other, larger part of the tube foot only quite few scattered spicules are found, and also in the abactinal tube feet only very few spicules are found. This feature of the spicules also separates this group of species very distinctly from all the other Echinothurids.

The pedicellariæ of these species are especially characteristic (while on the other hand there is only very little difference in this respect between the species themselves). Only tridentate and triphyllous pedicellariæ are found here, but in return the tridentate ones are found in no less than three well marked forms. In the largest form the blade is narrow, only widened in the point and provided with 2—3 very coarse indentations which work into each other when the pedicellaria is shut; below the blades are then widely separated; there are no fine teeth in the edge of the blade (Pl. XIV. Figs. 3, 7). Now, to be sure, I have only seen this form in *A. varium* and *Grubei*, but I think there is no doubt that it is also found in the two others. There appears, besides, some difference between *A. varium* and *Grubei* just with regard to this form of pedicellariæ, they being much slenderer in *A. varium* than in the other; in both they have a length of 2—2·2^{mm} (the head). The neck is quite short. — This difference in the pedicellariæ of the two species indicates that *A. Grubei* is really a good species, and not synonymous with *A. varium*, as Agassiz is inclined to think (Chall. Ech. p. 84).

The second, smaller form of tridentate pedicellariæ (Pl. XIII. Figs. 4, 27) reminds very much of ophicephalous pedicellariæ; but as no indication of arcs is found here, there can be no question of referring them to this kind; they are a highly modified form of tridentate pedicellariæ. The blade is short and broad, filled by a rich net of meshes, and with 2—3 large indentations in the edge, which is otherwise smooth as in the large form. When the pedicellaria is shut the blades join with the exception of a quite small space at the base. Also this form has a very short neck. The length of the head 1·2—1·5^{mm}. This form as well as the following one and the triphyllous pedicellariæ are quite identical in all four species. — On Pl. XVI. Figs. 10 and 11 in the »Challenger«-Echinids Agassiz gives tolerably recognizable figures of this and the following form of pedicellariæ; — »large, short-stemmed« and »small-headed, long-stemmed pedicellariæ« they are called. Pl. XLIV. Fig. 34 likewise gives a rather good figure of a valve of the second tridentate form, and Fig. 36 of the third form, which is here called »large-headed«. But it would be difficult to say what is meant by Pl. XLII. Fig. 9, and Pl. XLIII. Fig. 2, although the former is given as a »long-headed, long-stemmed«, the latter as a »long-stemmed, small-headed« pedicellaria of *A. Grubei*. On the other hand the pedicellaria figured on Pl. XLII. Fig. 8, which in the explanation of the figures is called a »globular-headed, short-stemmed pedicellaria» of *A. Grubei*, is easily recognizable; but does it really belong to *A. Grubei*? I have not been able to find such pedicellariæ, neither in *A. Grubei* nor in the other allied species. But it is strikingly similar to the peculiar short-headed pedicellaria of *Ph. luculentum* figured by Agassiz (Pl. X. a. Fig. 7, and Pl. XLIV. Figs. 25—26), and I must suppose a confounding to have taken place.

The third, smallest form of tridentate pedicellariæ (Pl. XIV. Fig. 10) is more simple, but also highly characteristic. The blade is simple, but the apophysis continues into it as a high, sharp, coarsely serrate keel; in the larger specimens of this form the keel reaches to the very point of the blade, in the smaller generally only to the middle of the blade. On the sides of the keel there is a rather coarse net of meshes which is, however, far from filling the blade; in the small specimens this net of meshes is only slightly developed. The edge of the blade is finely serrate. When the pedicellaria is shut, the edges join through the whole length, only a quite small opening is found below. This form has a rather long neck. The head 0·5—1^{mm}. — In the triphyllous pedicellariæ the cover-plate is well developed, with a few holes; the edge of the blade is beautifully rounded and finely serrate (Pl. XII. Fig. 18). The stalks of the pedicellariæ are of the common structure, only somewhat stronger than is else the case in the Echinothurids.

This group of species is very sharply distinguished from all the other Echinothurids, and must form a separate genus, which will, of course, get the old name of *Asthenosoma*. The other species referred to *Asthenosoma* do not justly belong to this genus, no more than the other species referred to *Phormosoma* do in reality belong there.

As mentioned above, Agassiz is inclined to think that *A. Grubei* is identical with *A. varium*. Also de Loriol (246) advocates the same opinion. »La réunion de ces deux espèces me paraît fort probable; cependant les exemplaires d'Amboine paraissent différer de ceux que M. Agassiz a fait figurer, par leur forme circulaire, un arrangement des plaques un peu différent dans les zones porifères et, aussi, par la structure de l'appareil apical qui, d'après le dessin ne serait pas la même» (p. 367). To this may be added the difference of the large pedicellariæ pointed out above. — As I have not had both species for examination at the same time, and have moreover only seen a large specimen of *A. Grubei* and a couple of small ones of *A. varium*, I shall give no decided opinion of this question.

In the work quoted above de Loriol further describes a young Echinid which he calls *Asthenosoma varium*?? — »Il me paraît extrêmement probable que le petit exemplaire..., qui est un jeune d'une espèce de la famille des Echinothurides, peut être envisagé comme celui d' *l'Asthenosoma varium* Grube». It is scarcely an Echinothurid at all, far less a young one of *A. varium*. As appears from the description and the figures, the arrangement of the pores (a single, regular series), the spines, the buccal membrane, the apical area are all so different from what is else characteristic of the Echinothurids, that there can certainly be no question of its being referred there. For the present I shall express no conjecture as to where it may really have to be referred.

Ludwig (257) is inclined to think that one of the specimens examined by him is a different species from *A. varium*, especially because its large pedicellariæ are different from those of *A. varium*. The figure given shows, however, that it is only the second, broad form of tridentate pedicellariæ that

Ludwig has found in this specimen, while he has not seen this form in the other specimens. I shall express no opinion whether it be otherwise the same species or not.

Asthenosoma hystrix. The tube feet are placed in three dense series; a well developed sucking disk is found in the actinal tube feet. In the upper part of the tube foot the spicules are large, irregular fenestrated plates quite inclosing the foot; in the lower part of the foot they are placed in two distinctly separated series, and are more or less rod-shaped, with few holes (Pl. XI. Fig. 29). The primary spines on the actinal side end in a little hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ two forms are found, not very sharply distinguished. In the larger form (Pl. XIV. Fig. 26) the edges of the blade are involuted, only the point is a little widened, with a remarkably irregular, finely serrate edge. In the smaller form (Pl. XIII. Figs. 17—18) the involuted part of the blade is shorter, the widened part comparatively larger and less irregular in the edge; when the pedicellaria is shut, the valves are far less separated below than in the larger form (see Wyv. Thomson: Porcupine -Ech. Pl. LXIV. Fig. 5). This form occurs in very varying sizes. In the triphyllous pedicellariæ the cover-plate is highly developed, with a few, large holes along the median line; the edge finely serrate (Pl. XII. Fig. 34). The stalk of the pedicellariæ of the common structure.

It is evident that this species is not nearly allied to *Asthenosoma*, as here limited. Accordingly it must form a separate genus keeping the name of *Calveria*, which was originally given to it by Wyv. Thomson, and which it has unjustly been deprived of. To the same genus *Asthenosoma gracile* A. Agass. will further have to be referred. Its pedicellariæ (Pl. XIII. Fig. 3) agree so exactly with those of *C. hystrix*, that no distinct specific difference seems to be found in this feature; only the smaller form of tridentate pedicellariæ is a little slenderer than in *C. hystrix*. The primary spines end in a small hoof as in *C. hystrix*; the tube feet are arranged in the same way as in this latter. The spicules are rather large, irregular fenestrated plates; in the lower part of the tube foot they are smaller and arranged in two well separated series, in the upper part they join completely, and form a close mail round the foot, as figured by Wyv. Thomson from *C. hystrix* (Porcupine -Ech. Pl. LXIV. Fig. 3). The sucking disk well developed. — Agassiz, who has seen, to be sure, that this species is very similar to *C. hystrix*, mentions in his description of it (Chall. Ech. p. 98) some peculiarities with regard to the arrangement of the tubercles as special characters; in pedicellariæ and tube feet no distinct specific difference seems to be found, so that for the present we must rest satisfied with the statements of Agassiz.

I discovered a very interesting feature by the examination of the type specimen of this species. Some of the secondary spines were swollen at the point (Pl. XIV. Fig. 27), and in the swollen part proved to be sitting a little parasitic Copepod. This seems to be a case of parasitism hitherto quite unknown, and in interest scarcely below that found by Koehler: the gall-forming, parasitic Copepoda in *Phormosoma uranus* (229)[1].

The characters here mentioned for *Calveria gracilis* as well as the mentioned feature of the parasitic Copepod, apply only to the specimen from Chall. st. 200. — Of some specimens from sts. 184 and 219 Agassiz says that he refers them to this species with considerable doubt, in which he is

[1]) The parasite will be described by Dr. H. J. Hansen in Vidensk. Medd. fra Nat. Foren. Kobenhavn.

quite right. They belong to two different species, most likely also to different genera, and none of them has any relation to *C. gracilis.*

The specimen from st. 219 has a remarkable form of tridentate pedicellariæ; the blade is long, narrow, with uneven, finely serrate edge, deep and in the lower part filled by a net of meshes. The valve figured on Pl. XIV. Fig. 20 is from one of the smaller pedicellariæ. I have only found this form of tridentate pedicellariæ. The triphyllous pedicellariæ (Pl. XII. Fig. 13) have a well developed cover-plate with few holes; the edge finely serrate. The stalk of the pedicellariæ of the common structure. The spicules are large fenestrated plates arranged in two well separated series; the sucking disk well developed. The tube feet are arranged in three series. None of the primary spines on the actinal side are whole, so that nothing can be said of the way in which the point is formed; there is, however, certainly no skin-bag round the point. This species must probably form a separate genus. As, however, no quite sufficient characterization can be given of it here, I shall propose no name for it, but be contented with having pointed out that it has no relation to *C. gracilis.*

The specimen from st. 184 has tridentate pedicellariæ somewhat recalling those of *Phormosoma*; but they are distinguished from the latter by the fact that the widenings from the upper end of the apophysis reach quite to the edge of the blade (Pl. XIII. Fig. 26); (in *Phormosoma* they, as stated above, end on the middle of the side of the blade.) The triphyllous pedicellariæ are similar to those of the specimen from st. 219. The stalk of the pedicellariæ of the common structure. The spicules are lengthened, narrow plates, arranged in 2—3 longitudinal series; no sucking disk is found. On the actinal side the tube feet are arranged in a single regular line (on the abactinal side the arrangement was indistinct in the specimen). All the primary spines on the actinal side are broken, so that the form of the point cannot be decided. — That this species has no relation to *C. gracilis* or to the specimen from st. 219 is evident. It seems to be nearly related to »*Ph.*» *tenue*, and would then have to be referred, together with this latter, to the genus *Echinosoma*. (See farther down p. 57.)

Although in the text Agassiz expresses a strong doubt whether the two species here mentioned, be really »*A. gracilis*», he nevertheless afterwards cites the stations from which they have been obtained, among the localities of this species without adding any interrogation; this way of proceeding is very objectionable — and this is, unfortunately, not the only case. I shall express no opinion whether the specimen(s) from st. 169 is really *C. gracilis*, as I have not seen it. It is not to be relied upon with certainty, until the pedicellariæ etc. have been examined.

Asthenosoma fenestratum Wyv. Thomson is by Bell (72, 73), and Koehler (229) thought to be synonymous with »*A. hystrix*». It has also to be admitted that there is a striking similarity as to habitus between the two species; but a closer examination of the pedicellariæ shows that the question is so far from being of one species, that they will even have to be referred to different genera. — There are three kinds of pedicellariæ, tetradactylous, tridentate, and triphyllous ones. The tetradactylous ones, which have been so excellently described and figured by Wyv. Thomson («Porcupine» Echinoidea. Pl. LXVII. Figs. 5—6), are something quite unique among the Echinids, and consequently an excellent character of this genus. Bell (72), to be sure, thinks it to be an abnormal form of pedicellariæ, as he has not been able to find it in the numerous specimens he has examined. As, however, I have succeeded in finding this form also in *A. coriaceum* Ag., there can, of course, be no doubt that it is a normal form of pedicellariæ characteristic of this group of species. Of tridentate pedicellariæ two kinds are found. The larger form has not been seen by Wyv. Thomson, but I have found it on a fragment kept in British Museum under the name of »*Calveria Phormosoma*«, but being undoubtedly an original specimen of Wyv. Thomson's *Calveria fenestrata*. The edges of the blade are much involuted, only the point is widened and deeply indented in the edge (Pl. XIV. Fig. 32). The valves are highly curved outward, so that they are wide apart when the pedicellaria is shut. The length of the head up to 2mm. The other form is very varying according to its size (Pl. XIV. Figs. 8, 17, 18, 24). Larger specimens recall to some degree the large form, but the widened part of the blade is comparatively larger, the involuted part smaller; the edge of the widened part is coarsely sinuate. When the pedicellaria is shut the valves are only a little apart (the figure by Wyv. Thomson. Pl. LXVII, 7). In the very smallest ones only a quite small space below is involuted, and the edge of the upper part is quite straight. All transitions between these forms are found, so that they can only be interpreted as modifications of one kind. Their neck is short, the stalk of the common structure. The triphyllous pedicellariæ have the cover-plate much developed, and are lengthened and narrow; the edge finely serrate (Pl. XII. Fig. 33). The primary spines on the actinal side are curved and end in a little hoof. The tube feet as in *C. hystrix* arranged in three separated series; the spicules large, irregular fenestrated plates, in the lower part of the tube foot arranged in four separated series; the sucking disk well developed. As characteristic of this species Wyv. Thomson lays stress on the large membranous interpaces between the plates; as Bell (72) has shown that this feature is very varying this character is not reliable. For the present there is no other sure character than the pedicellariæ, and even if the tetradactylous ones be wanting, which seems most frequently to be the case, be it now that they have fallen off, or perhaps may be quite wanting in some individuals, the tridentate pedicellariæ are sufficiently characteristic, so that no confounding can take place between this species and *Calveria hystrix*. A separate genus must be formed for this species; I propose the name of **Aræosoma**[1]. — No doubt it is this species that Agassiz (6) described as *Asthenosoma Reynoldsii*, but later (9) retired as a synonym of *A. hystrix*.

To this genus will further have to be referred *A. coriaceum* Ag. Of this species I have examined a specimen from Chall. st. 169. This station is not enumerated by Agassiz as a locality of the species, but according to the statement of Prof. Bell the determination of the animal has been made by Agassiz, so that it may be taken to be due to an omission that this station has not come in. — The tetradyctylous pedicellariæ agree exactly with those of *A. fenestratum*, so that no specific difference seems to be found in this structure. They were only found on the upper side, and only a few ones, as it was almost rubbed off. Of the tridentate pedicellariæ I have not found the largest form. The smaller form (Pl. XIV. Fig. 5) is especially highly developed, the head up to 2mm long. The blade is filled by a very complicated net of meshes, more developed than in *A. fenestratum*. As in this latter, forms are also here found with almost straight edge, as well as such as are rather similar to the large involuted form, and all transitions between them. Triphyllous pedicellariæ chiefly of the same form as in *A. fenestratum* (Pl. XII. Fig. 27). (The form figured of *A. fenestratum* with the cover-plate open in the median line, is not constant; they are as commonly found with the projections

[1]) ἀραιός — thin.

coalesced, so that a series of large holes is found along the median line — and they may also be found of the form, figured of *A. coriaceum*). The pedicellariæ (the tridentate ones) with short neck; the stalk of the common structure. The tube feet in three series. The spicules (Pl. XI. Fig. 15) are not so compact fenestrated plates as in *A. fenestratum*, the holes are much larger and fewer. In the lower part of the tube foot the spicules are more narrow, at last only fine, thorny, irregular needles, often a little widened as small fenestrated plates in one end or in both ends, or they have a larger hole in the middle. Below they seem to be arranged in four longitudinal series, above they inclose the whole foot as a close mail. The sucking disk well developed in the actinal tube feet. The primary spines on the actinal side form a very conspicuous, regular series along the outer edge of the interambulacral areas; in the ambulacral areas only 5—6 large spines are found scattered on the outer plates. They are curved, and end in a little hoof. Resembling more nearly the primary spines of *Phormosoma* than the characteristic flaring trumpet-shaped spines of *Asthenosoma*, Agassiz says of these spines (Chall. Ech. p. 88). As his «*Phormosoma*» contains so widely different forms as *Ph. placenta* and *hoplacantha* this statement gives no clear information; the meaning of it is that they are similar to those of *A. fenestratum*; the hoof is little, short, and broad.

Agassiz says of this species that it is «allied to *Asthenosoma grubii* in having an extremely thick leathery cuticle» (l. c.); according to the informations given here there is no nearer relation between these two species. Agassiz further thinks that it is «quite possible.... that this may be the adult of *Asthenosoma tesselatum*» (l. c.). After having examined the type specimen of this species I can say with certainty that this is not the case; the two species are not even so very nearly related even if they possibly belong to the same genus. — Tetradactylous pedicellariæ have not been found in this species. The tridentate pedicellariæ occur in two forms, between which there seem to be no transitions. The large form is quite similar to the large tridentate pedicellariæ in *A. fenestratum* (Pl. XIII. Fig. 5); the smaller form (Pl. XIII. Fig. 6, Pl. XIV. Fig. 15) is very peculiar, the blade deep, filled by a rich net of meshes, and with a highly irregular edge without such large sinuations as are found in *A. fenestratum* and *coriaceum*; the widenings from the upper end of the apophysis continue directly into the edge of the blade. When the pedicellaria is shut, the edges join completely, there is only at the basal part a small open space. This form is a little more long-necked than usual. The triphyllous pedicellariæ are quite similar to those of *A. fenestratum* and *coriaceum*; the stalk of the pedicellariæ of the common structure. Spicules and sucking disk as in *A. fenestratum*; the tube feet in three series. All the primary spines on the actinal side are broken in the only specimen known, so that it is impossible to say anything of the form of the point; surely, however, they are not skin-covered. — For the present it is impossible to decide whether this species is to be classed with *A. fenestratum* and *coriaceum*; but several things speak in favour of this supposition, and it will therefore be most correct provisionally to refer this species to the genus *Aræosoma*. That the membranous interspaces between the plates are especially large in this species speaks, of course, only in favour of the supposition that it really belongs to this genus.

Among the specimens kept in British Museum under the name of *Asthenosoma hystrix*, a piece was found (from Barbados, 137 fathoms), which is no doubt a new species, and probably also belongs to this genus. It is very similar to *Calveria hystrix*, but is of a darker colour (brownish violet).

Tetradactylous pedicellariæ have not been observed. Of tridentate pedicellariæ three kinds are found, with no transitions between them. The first form resembles that in *A. fenestratum*, but is finer and more slender (Pl. XIII. Fig. 22); the head 1mm. The second form (Pl. XIII. Fig. 10), which corresponds to the second form in *A. fenestratum*, is very large, the head 2mm. The blade much involuted; the widened part of the point rather large, coarsely sinuate in the edge. The valves only slightly curved, and accordingly the pedicellaria when shut has a peculiar lengthened appearance. The third, smallest form is very characteristic, with involuted edge and the outer end widened, without large curves in the edge (but with fine serrations) (Pl. XIII. Fig. 11). Triphyllous pedicellariæ of the same kind as in the other species, only more slender (Pl. XII. Fig. 29). The stalk of the pedicellariæ of the common structure. Spicules as in *A. fenestratum*, in two well-separated series to the very point. Well-developed sucking disk. — For this species I propose the name of **Aræosoma Belli** n. sp.

Asthenosoma pellucidum A. Ag. Of this species, which is easily recognised as well by its whole habitus, as by its light spines with red bands, Agassiz says (Chall. Ech. p. 87): »Unfortunately, the largest specimens of *Asthenosoma pellucidum* are so much smaller than the smallest *Asthenosoma coriaceum* or the single specimen of *Asthenosoma tesselatum*, that I am unable so satisfy myself that the present species (*Asthenosoma pellucidum*) may not be the young of *Asthenosoma coriaceum*. In the only species of the group of which the Challenger collected a complete series (*Phormosoma tenue*) there was little difficulty in recognising the young as belonging to the adult«. We could scarcely wish to find a more pregnant proof of the difficulty or impossibility of determining Echinids without taking the pedicellariæ into consideration. »*Asthenosoma*« *pellucidum* is so far from being identical with *A. coriaceum* or *tesselatum*, that it must form a separate, very well characterized genus, and with regard to the excellent long series of »*Phormosoma*« *tenue*, there are among the specimens referred to this species by Agassiz at all events two different genera, but no genuine *Phormosoma*!

In *A. pellucidum* three different kinds of pedicellariæ are found, viz. globiferous, tridentate, and triphyllous ones. The globiferous pedicellariæ are of a quite unique[1]) form (Pl. XII. Figs. 8–10, Pl. XIII. Figs. 20, 24, 25); they cannot be opened as other pedicellariæ, the three glandular bags are inclosed in a common skin, and open in the point, each through a separate pore. The valves are situated between the glandular bags; they are simple rods, slightly bisected in the point, a little hollow on the inside, and with a rather strong articular surface below. No apophysis is found, and no muscles seem to pass between the valves, what would not be of much use neither, on account of their being quite wrapped by the common bag of skin; they are far from reaching to the point of the pedicellaria. The tridentate pedicellariæ resemble to a high degree the pedicellaria of *Ph. tenue* figured by Agassiz (Chall. Ech. Pl. XLII. Fig. 7). The construction of the blade, however, is rather different: here only a little developed net of meshes is found, and the apophysis is not prolonged (Pl. XIV. Fig. 9), in *Ph. tenue* there is a rather well developed net of meshes, and the apophysis continues some way into the blade as a conspicuous, serrate crest. Only one form of tridentate pedi-

[1]) By a cursory examination one might be inclined to compare them with the »Globiferen« of *Centrostephanus longispinus* described by Hamann (184). This, however, cannot be done, at all events not for the present; perhaps the head of these modified globiferous pedicellariæ will show a structure recalling the form described here. But of this, I think, we know nothing. The large glands of the stalk in the globiferous pedicellariæ in *Centrostephanus* cannot, of course, be compared with the glands in the head of the pedicellariæ of *A. pellucidum*.

cellariæ is found, the large and small ones being upon the whole constructed in the same way. They are finely serrate in the edge. The neck long, the stalk of the common structure. The length of the head up to $1 \cdot 5^{mm}$. The triphyllous pedicellariæ of a very fine form, with well-developed cover-plate, without holes (always?), and the edge beautifully serrate (Pl. XII. Fig. 14). — The spicules are in the lower part of the tube foot almost rod-shaped, with a few holes in the middle (Pl. XI. Fig. 19); they are placed in two series, across the longitudinal axis of the foot. In the upper part of the tube foot they are larger fenestrated plates; the sucking disk well developed. The tube feet in three series, beautifully trigeminate as in an *Echinus*. The primary spines on the actinal side curved, with a rather long hoof almost not thicker than the spine. Besides the characters mentioned here, there seem to be found good characters in the structure of the test and in the apical area; with regard to these characters the reader is referred to the description by Agassiz. It is evident that this species cannot be referred to any of the other genera; especially characteristic are the globiferous pedicellariæ, to which nothing corresponding is known in other Echinothurids. It must form a separate genus, for which I propose the name of **Hapalosoma**[1]).

Of the species that have been referred to *Asthenosoma*, the two species *A. longispinum* and *Ijimaï* from Japan described by Yoshiwara (448), are still left to be mentioned. Of these nothing can for the present be said with certainty; *A. longispinum*, however, seems to be a *Calveria* or an *Aræosoma*.

Phormosoma tenue A. Ag. (A specimen from Challenger st. 237 examined). The tube feet are placed very close together, forming only one almost regular series. The spicules highly developed, irregular fenestrated plates. There is no distinct sucking disk, only some irregular, slightly branched or unbranched continuations passing from the outermost fenestrated plates of the foot into its point. The primary spines on the actinal side ending in a little hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ a larger and a smaller form are found. The larger form (of which a rather good figure is found in Chall. Ech. Pl. XLII. Fig. 7, and Pl. XLIV. Fig. 19) has a rather rich, coarse net of meshes in the lower part of the blade, and the upper end of the apophysis continues somewhat into the blade as a serrate crest (Pl. XII. Fig. 35). This crest is not distinctly seen in the figure in Chall. Ech. (Pl. XLIV. Fig. 19), possibly it may not be a constant feature. The length of the head up to $2 \cdot 8^{mm}$. The smaller form (the head up to 1^{mm}) reminds much of those in *Ph. placenta*, but the contour is somewhat different, and the widenings from the upper end of the apophysis reach to the edge of the blade (Pl. XII. Fig. 40). The neck is long, also in the larger form, the stalk of the common structure. The triphyllous pedicellariæ have a well developed cover-plate; the edge finely serrate. — I have not found the peculiar two-valved, bottle-shaped pedicellaria figured by Agassiz (Chall. Ech. Pl. XLIV. Fig. 21). As it is two-valved, it may be taken to be an abnormity. It is, no doubt, a modification of the triphyllous pedicellariæ. This I also take to be the opinion of Agassiz when he says (op. cit. p. 82), that perhaps it is only a modification of "the remarkable long-pronged pedicellariæ figured by Thomson as characteristic of the group"[2]). — In the description of this species

[1]) ἁπαλός = soft.

[2]) A few lines lower down in the same paragraph Agassiz seems to derive this form from the tridentate pedicellariæ (see above p. 46).

Agassiz (p. 96) mentions the pedicellariæ as long stemmed with a small head articulating with a second stem, from twice to three times the length of the head. This sounds very mysterious, and the figure, to which reference is made (Pl. XVIII. a. Fig. 11), gives no clear information — the pedicellaria figured there seems to be a quite common well-made one. May not this second stem› possibly be the neck? A second kind of pedicellaria with an inverted conical head, and a comparatively stouter joint articulating upon a long stem is seen from the figure to be, in spite of this remarkable description, a quite common triphyllous pedicellaria. Still a third kind of pedicellariæ with a shorter articulation and a large head is mentioned; to judge from the figure it must be the same kind as the one with the remarkable second stem, and they seem both of them to be the smaller form of tridentate pedicellariæ. To be sure, the similarity is not striking, and it may also be possible that they belong to a quite different species, which has wrongly been referred to *Ph. tenue*. The large form of tridentate pedicellariæ is not at all mentioned in the description. — The longitudinal muscles are well-developed, organs af Stewart seem not to be found. By its spines, pedicellariæ, and the structure of the test (the actinal side only little different from the abactinal side) this species is distinctly distinguished from the genus *Phormosoma*. It must form a separate genus, and must get the name of *Echinosoma* proposed by Pomel (324) for this species and *Ph. uranus*, although this name is not especially significant for these species the test of which is so very soft and thin, and which are only provided with uncommonly few spines.

Of the Echinothurids referred by Agassiz to *Ph. tenue* I have examined a specimen from Chall. st. 272. It proved to belong to a quite different genus together with *Ph. Asterias* A. Ag., under which species it will be more nearly mentioned. On the label was found a point of interrogation, but of this doubt nothing is said in the text, and st. 272 is given without any reservation as a locality of *Ph. tenue*.

The above mentioned specimen from Chall. st. 184, which is by Agassiz referred to *Asthenosoma› gracilis*, is no doubt very nearly allied to *Echinosoma tenue*. Of the large form of pedicellariæ I have, unfortunately, only seen one broken specimen, by which it was not to be decided with certainty whether the apophysis continues into the blade as a crest. The smaller form of pedicellariæ is very similar to those of *Ech. tenue*; the triphyllous pedicellariæ are a little narrower than in this species, but agree with it in the development of the cover-plate. Also the spicules are a little narrower than in *Ech. tenue*; no sucking disk; the tube feet in one almost regular series. There can scarcely be any doubt that it is a species of the genus *Echinosoma*, and, moreover, a new species. As I can give no sufficient description of it, I shall give no name to it.

Phormosoma uranus Wyv. Thomson is, no doubt, most nearly allied to *Ech. tenue*, as also observed by Agassiz (Chall. Ech. p. 103). Only 3—4 large primary spines are found in each side of the ambulacral and interambulacral areas on the actinal side at the ambitus, otherwise only scattered small spines. All the primary spines are broken on the type specimen of Wyv. Thomson, but no doubt they are provided with a little hoof in the point as in *Ech. tenue*. The tube feet on the actinal side are arranged almost in one series , only a few outside of it. Of the tridentate pedicellariæ I have only found the smaller form (Pl. XII. Fig. 36). (The head up to 1^{mm}); they resemble very much those of *Ech. tenue*, and almost still more those of *Ph. placenta*. The widenings from the upper end of the apophysis reach most frequently, to be sure, to the edge of the blade, but they end rather often quite down at the side as in *Ph. placenta*. In the triphyllous pedicellariæ (Pl. XII. Fig. 17) the cover-plate is well developed, the edge finely serrate. There can scarcely be any doubt that also this species will have to be referred to the genus *Echinosoma*.

In the description of «*Phormosoma uranus* (loc. cit.) Agassiz uses the expression «the only specimen collected», but nevertheless puts down for it two different localities, st. 6 and st. 78. This riddle I am able to solve. In British Museum a quite small Echinothurid is found from Chall. st. 78, determined by Agassiz as *Ph. uranus??* On this basis st. 78 is named without any reservation as a locality of «*Ph. uranus* (comp. *Calveria gracilis* and *Echinosoma tenue*). With regard to this specimen, it is otherwise very badly preserved, and not a single pedicellaria is kept. It is quite indeterminable, and consequently it cannot be considered to be correct to figure details of this specimen under the name of *Phormosoma uranus* (without any interrogation), as has been done by Agassiz (Chall. Ech. Pl. XVIII. c. Fig. 12).

The description of *Ph.» uranus* given here does not at all agree with the excellent description given by Koehler (229). The incongruity arises from the fact that the species described by Koehler is no *Ph. uranus* at all. As I have examined the type specimen of Wyv. Thomson and also a specimen of the species Koehler has had before him, I am able to express myself with absolute certainty.

In the preliminary report of the Echinids from «Blake» (6) Agassiz establishes a new species under the name of *Phormosoma Petersii*, and describes it as «a species with an extremely thin test, and one which, when alive, is greatly swollen, assuming a nearly globular outline. It is of a brilliant light claret color. As in *Ph. uranus*, there is but little difference between the spines of the actinal and abactinal surfaces. The coronal plates of this species are more numerous than in any other species of the genus» (p. 76. op. cit.). In the final report of the «Blake»-Echinids (9) Agassiz states *Ph. Petersii* to be synonymous with *Ph. uranus*. Although the form he called *Ph. Petersii*, «differed very strikingly» from the specimen of Wyv. Thomson, he thinks now, after having got a specimen from the Faröe-Channel of a size between the type specimen of *Ph. uranus* and the «Blake»-specimens of *Ph. Petersii*, that «the differences which had been noticed between them were merely due to age, and that in this species the great development of the large primary tubercles of the actinal surface takes place at a late period of growth».

Koehler mentions a specimen of this «*Ph. uranus*», which he has got from the Smithsonian Institution (from «Albatross»), and by which he has determined his specimens as *Ph. uranus*. Our museum has also from Smithsonian Institution received a specimen of this «*Ph. uranus*», which is identical with the form more nearly described by Koehler. Now the question is whether this form is really identical with the original *Ph. Petersii* of Agassiz. The expression above quoted from the first note of *Ph. Petersii*: «there is but little difference between the spines of the actinal and abactinal surfaces» does in no way agree with the species of Koehler, in which the spines of the actinal side have a large, conspicuous hoof. It is possible, however, that they may have been broken in the specimens of Agassiz, and in this case there is really not much difference to be seen between the spines of the actinal side and those of the abactinal side. (Our specimen is exactly in this condition). It does not appear from the habitus figures given by Agassiz and Koehler that it is the same species — but as Agassiz only figures the abactinal side, Koehler only the actinal one, the figures do not disprove the identity either. On the other hand, the detail-figures seem to agree, especially with regard to the arrangement of the pores which is rather characteristic. I therefore think it very probable that the species of Koehler is really identical with the *Ph. Petersii* of Agassiz, which latter is accordingly in no way synonymous with *Ph.› uranus* Wyv. Thomson.

This species is distinguished by the following characters. The tube feet are placed on the actinal side in one almost regular series, on the abactinal side they are placed in three series very close together. The spicules are irregular fenestrated plates that do not seem to be arranged in longitudinal series; no sucking disk. The primary spines on the actinal side curved, with a large hoof. Only tridentate and triphyllous pedicellariæ are found. Of tridentate pedicellariæ only one form is found, with involuted edge, and the outer part widened in a spoon-like way, with straight and finely serrate edge (Pl. XIII. Figs. 8, 13). It is found of different sizes, up to 1^{mm} (the length of the head). The neck rather long, the stalk as usual. (A figure of the whole pedicellaria is given by Koehler (op. cit. Pl. IX. Fig. 49)). The triphyllous pedicellariæ with well developed cover-plate with many small holes; the edge finely serrate (Pl. XII. Fig. 42). The organs of Stewart well developed. — It is evident that this species cannot be referred to any of the preceding genera; it must form a new genus, for which I propose the name of **Hygrosoma**[1]), and its name will then be *Hygrosoma Petersii* (A. Ag.).

Phormosoma› hoplacantha Wyv. Thomson seems to be very nearly allied to this species. Its whole exterior is quite like it; the spines have a similar large, white hoof, and the primary spines are arranged in the same way as in *H. Petersii*; also the tube feet are arranged quite as in the latter species. Of pedicellariæ only a large tridentate form is known, figured by Agassiz (Chall. Ech. Pl. XLIII. Fig. 1, and Pl. XLIV. Fig. 29). It seems to be very similar to the above described form in *H. Petersii*. Although I have not examined the pedicellariæ of this species, I do not doubt that it belongs to the same genus as *Hygrosoma Petersii* — the difficulty is rather to state any difference between the two species. To judge by the figures of Agassiz, the pedicellariæ, however, seem to differ somewhat from those of *H. Petersii*, so that presumably specific characters will be found in these structures. As *H. hoplacantha* has only been taken in the Pacific (at Australia, Japan, and Juan Fernandez), and as *H. Petersii* is only known from the Atlantic, there can scarcely be any doubt that they form two well distinguished species.

No doubt ‹*Phormosoma› luculentum* A. Ag. is nearly allied to these two species. As in these the spines of the actinal side end in a large, white hoof. The tube feet are arranged in the same way; the spicules are rather large, irregular fenestrated plates, somewhat indistinctly arranged in two series. A rather well developed sucking disk is found. The tridentate pedicellariæ (Pl. XIII. Fig. 14) are very much similar to those of *Hygrosoma Petersii*; the triphyllous ones (Pl. XII. Fig. 20) are of a somewhat different form, but otherwise with large cover-plate and serrate edge as in *H. Petersii*. But besides these forms still a very peculiar kind of pedicellariæ is found (Pl. XIII. Fig. 16), which is, no doubt, a modified form of tridentate pedicellariæ. The valves are very broad, constricted in the middle.

[1]) ὑγρός — elastic.

The blade is filled by an exceedingly dense and complicated net of meshes. In the figures of Agassiz (Pl. XLIV. Figs. 25—26, Chall. Ech.) this net of meshes is not seen, but otherwise these figures give a good representation of the single valve. The length of the head $1{\cdot}5^{mm}$, the neck very short, the stalk thicker and stronger than usual, with a constriction above. They seem only to be found on the actinal side. Agassiz further figures (Pl. XLIV. Fig. 27) a single valve of a «small short-headed, shortstemmed pedicellaria», which seems to be an ophicephalous one. This form I have not found in the specimen I examined in British Museum (Chall. st. 200); but as, at the time, I had not noticed the mentioned figure, I have not, of course, made any special search for it, and so I dare say nothing of it. If this species should thus prove to be possessed of two kinds of pedicellariæ, to which nothing corresponding is found in any other known Echinothurid, there might be some reason to establish a separate genus for it. For the present, however, I think it most correct to refer it to the genus *Hygrosoma*, as in so many important structures it agrees exactly with the other species referred to this genus.

The last of the Echinothurids described from «Challenger», *Phormosoma asterias*, differs to a high degree from all the others; to be sure, its peculiarities do not appear from the description of the species by Agassiz (Chall. Ech. p. 104), but his figures give more information, and the examination of the type specimen in British Museum revealed still more interesting features. — The ambulacral areas show the quite unique feature that the small secondary ambulacral plates are wanting; there is only one tube foot for each ambulacral plate. Thus only a single series of tube feet is found, and the distance between the feet is rather large. This highly interesting feature is seen very well on the figures of Agassiz (Pl. XII. a. Figs. 8, 9); in the description he only says that «the course of the poriferous zone is quite sporadic». (It is a matter of course that this very interesting feature ought to be examined exactly, as it is possible that traces may be found of the secondary ambulacral plates and their tube feet.) The spicules are lengthened, narrow, with few or no holes (comp. Pl. XI. Fig. 18); they are arranged parallel to the longitudinal axis of the foot, in 2—3 well separated series; in the outer part of the foot they may join completely. No sucking disk is found. — The spines are of a quite peculiar structure, that is to say they are flat and broad towards the point (Pl. XIV. Fig. 29). I can give no information whether a hoof is found on the point of these spines or on other spines of common form, as I have not made sufficient notes on this fact. The pedicellariæ are not less peculiar. The blade of the tridentate pedicellariæ (Pl. XIII. Fig. 9) is rather flat, with a more or less well developed, perforated cover-plate below reminding of that in the triphyllous pedicellariæ. The point is hastately cut off, a little widened, with finely dentate outer edge; the apophysis and the lateral edges more or less thorny. In the triphyllous pedicellariæ the cover-plate is very slightly developed, highly perforated (Pl. XII. Fig. 12). The edge shows only very slight indications of teeth, so that they are only to be seen under especially high magnifying powers. The stalk of the pedicellariæ is quite different from that of all other Echinothurids, as it consists of long, thin calcareous threads, almost without any connection except in the upper and lower end of the stalk — as in an *Echinus*. It is evident that this species cannot be referred to any of the other genera; it must form a separate genus, for which I propose the name of **Kamptosoma**[1]).

[1]) κάμπτω — bend.

To this genus belongs further one specimen (or more?) from Chall. st. 272 determined by Agassiz as *Phormosoma tenue?* — The spicules (Pl. XI. Fig. 18) are as in *K. asterias* and arranged in the same way; no sucking disk. I can give no information of the fact whether the spines are as in *K. asterias*, as I have no notice of this feature. The pedicellariæ are very similar to those of *K. asterias*, but here moreover a larger form of tridentate pedicellariæ is found (Pl. XIII. Figs. 15, 21), which I have not seen in the type specimen of *K. asterias*. As, however, the pedicellariæ agree otherwise so exactly, it may be supposed that this form will also be found in *K. asterias*. This larger form of pedicellariæ is chiefly constructed as the smaller one; the cover-plate has only a few holes in the median line, or is quite open the edges not joining completely. The point is a little widened, broadly hastate, with exceedingly finely serrate edge; (as in the triphyllous pedicellariæ the serrations are only to be seen under very high magnifying powers); the holes in the blade are beautifully arranged in curved series. They are very long-necked; the head up to 0·8^{mm}; the stalk is of the structure characteristic of the genus *Kamptosoma*. The smaller form of tridentate pedicellariæ resemble to a high degree those of *K. asterias* the only difference being that the apophysis and edges have no thorns. The triphyllous pedicellariæ are somewhat shorter and more arched than those of *K. asterias*, but they have the same peculiar cover-plate, and the serrations of the edge are likewise exceedingly slight. — There can be no doubt that this species also belongs to the genus *Kamptosoma*; but it may be doubtful whether it is a separate species, or identical with *K. asterias*. The small differences in the pedicellariæ are suggestive of its being a distinct species; but this question cannot be decided with certainty, till a direct comparison of the two specimens has been made.

Now we have only left two of the species referred to *Phormosoma*, viz. *Ph. panamense* A. Ag., and *Ph. hispidum* A. Ag. As to the former it has been supposed above that it may be a genuine *Phormosoma*, of the latter nothing at all can be said. Both species have only been preliminarily and very incompletely described.

The genus *Sperosoma* established by Koehler (228, 229) is especially characteristic by the peculiar construction of the ambulacral areas on the actinal side. The secondary ambulacral plates are of about the same size as the primary ones; the primary ambulacral plate is divided into an outer part, in which the pore is found, and an inner part. Thus on the actinal side the ambulacral area consists of 8 series of plates. The tube feet are placed in three widely separated series. The spicules are large fenestrated plates, not arranged in series; there is a well developed sucking disk (Pl. XIV. Fig. 4). Only tridentate and triphyllous pedicellariæ are found. The tridentate ones (Pl. XIV. Figs. 2, 6, 33) remind somewhat of those in *Ph. placenta*, especially the small forms are only with difficulty to be distinguished from those; the widenings from the upper end of the apophysis do not reach to the edge of the blade. There is a rather coarse net of meshes in the bottom of the blade, slightly developed in the small forms, more developed in the larger ones, and in these latter it is set with thorns (Pl. XIII. Fig. 12.) The length of the head up to 2^{mm}, the neck rather short in the large ones; the stalk of the common structure. In the triphyllous pedicellariæ the cover-plate is rather slightly developed, with numerous small holes. The edge finely serrate. The primary spines on the actinal side curved, with a large, white hoof.

Besides the species of Koehler, *Sp. Grimaldii*, a species established by Döderlein (118), *Sp.*

biseriatum, has been referred to this especially well characterized genus; but it has not hithertho been more thoroughly described, so that for the present nothing can be said of this species.

One more genus will have to be established for a large Echinothurid obtained by the «Ingolf»-Expedition. The tube feet form one irregular series on the actinal side; the spicules irregular fenestrated plates not arranged in series; no sucking disk. The primary spines on the actinal side curved, with large hoof. Three kinds of pedicellariæ are found: tridentate, ophicephalous, and triphyllous pedicellariæ. The tridentate ones occur in two forms; in the larger form (length of the head up to $3{\cdot}5^{mm}$) the blade is filled by a coarse, very thorny net of meshes (Pl. XII. Fig. 41). The edges are not involuted; the outer part of the blade somewhat widened. The neck very short, the stalk of the common structure. The smaller form resembles those in *Ph. placenta*, but the widenings from the upper end of the apophysis reach to the edge of the blade. The ophicephalous pedicellariæ (Pl. XIV. Figs. 19, 23, 25) are very peculiar, the upper end of the valve being widened in a wing-shaped way, while the middle part is very narrow. The length of the head ca. $0{\cdot}5^{mm}$. The neck is quite short, contrary to the ophicephalous pedicellariæ of the Echinids, and the stalk is a thick, perforated tube. — As ophicephalous pedicellariæ, as far as hitherto known, are not found in other Echinothurids (perhaps they are found, however, in *Hygrosoma luculentum* (see above p. 59—60), but then they have quite another form) they yield an excellent character for this genus. In the triphyllous pedicellariæ the cover-plate is rather slightly developed, richly perforated (Pl. XII. Fig. 31). — For this genus I propose the name of **Tromikosoma**[1]).

According to these researches the system of the Echinothurids gets the following appearance:

Phormosoma Wyv. Thomson (emend.).

The primary spines on the actinal side straight, club-shaped, inclosed by a thick bag of skin; marked difference between the actinal and the abactinal sides. The areoles of the actinal side very large. The tube feet are arranged in a single series on the actinal side. The spicules large fenestrated plates; no sucking disk. Only tridentate and triphyllous pedicellariæ. The tridentate ones are simply leaf-shaped, with little developed net of meshes. The widenings from the upper end of the apophysis do not reach to the edge of the blade. The stalk of the pedicellariæ irregularly perforated.

Species: *Ph. placenta* Wyv. Thomson, *bursarium* A. Ag., *rigidum* A. Ag.

Distribution: Northern part of the Atlantic, Japan, the Philippines, New-Zealand. — Archibenthal forms.

Echinosoma Pomel (emend.).

The primary spines on the actinal side curved, with a little hoof at the point; the actinal and the abactinal sides look almost quite alike, only a few, large spines being found near the ambitus. The areoles large. The tube feet are placed in one almost regular series on the actinal side; the spicules large fenestrated plates, no sucking disk. Only tridentate and triphyllous pedicellariæ. Of tridentate pedicellariæ two forms are (always?) found, a large one, flat, with a rich net of meshes, and with the upper end of the apophysis continuing some way into the blade as a serrate crest, and a smaller one,

[1]) τρομικός — quivering.

simply leaf-shaped, with a little developed net of meshes. The stalk of the pedicellariæ irregularly perforated.

Species: *Ech. tenue* (A. Ag.), *uranus* (Wyv. Thomson).

Distribution: The Pacific, the northern Atlantic. — Abyssal forms.

Asthenosoma Grube (emend.).

Synonym: *Cyanosoma* Sarasin.

The primary spines on the actinal side curved, with a rather long, narrow hoof; rather great difference between the abactinal and the actinal sides, on account of the numerous primary spines covering the whole actinal side; the areoles are almost of equal size on both sides. The spines on the abactinal side inclosed by a thick, annularly constricted bag of skin. The tube feet form three dense series; the spicules small branched bodies, arranged in longitudinal series. Sucking disk well developed. Only tridentate and triphyllous pedicellariæ. The tridentate ones occur in three distinct forms. The largest form has a long, narrow blade, widened in the point where it is coarsely serrate (not observed in all the species); the second form has a short, broad, and flat blade filled by a rich net of meshes and with coarsely sinuate edge. The third form is simply leaf-shaped, with the apophysis continued to the middle of the blade, or quite to the point as a sharp, serrate crest. The stalk irregularly perforated.

Species: *Asth. varium* Grube, *Grubei* A. Ag., *urens* Sarasin, *heteractis* Bedford.

Distribution: Ceylon, the East-Indian Archipelago. — Littoral forms.

Calveria Wyv. Thomson (emend.).

The primary spines on the actinal side curved, ending in a little hoof; only a slight difference between the actinal and the abactinal sides. The areoles rather small. The primary spines form a rather conspicuous series along the outer margin of the interambulacral areas, especially towards the ambitus on the actinal side. The tube feet in three dense series: the spicules in the outer part of the tube foot larger fenestrated plates, in the lower part smaller and arranged in longitudinal series. Sucking disk developed. Only tridentate and triphyllous pedicellariæ. In the large form of tridentate pedicellariæ the blade is much involuted, only at the point a little widened, and the edge of this widened part is irregularly serrate. The smaller tridentate pedicellariæ chiefly of the same form, only the widened part of the blade comparatively larger, the involuted part smaller. The stalk irregularly perforated.

Species: *C. hystrix* Wyv. Thomson, *gracilis* (A. Agass.).

Distribution: The northern Atlantic, the Philippines. — Archibenthal forms.

Aræosoma n. g.

The primary spines on the actinal side curved, ending in a little hoof; only a slight difference between the actinal and the abactinal sides; the areoles rather small. The primary spines form a rather conspicuous series along the outer margin of the interambulacral areas, especially on the actinal side towards the ambitus. The tube feet in three dense series. The spicules larger fenestrated plates, in the lower part of the tube foot smaller, sometimes irregular needles, more or less distinctly arranged in longitudinal series. Sucking disk well developed. Besides the commonly occurring tridentate and triphyllous pedicellariæ also tetradactylous pedicellariæ are found. The tridentate ones occur in 2—3 different forms. In one form the blade is highly involuted, only the point is widened, deeply indented in the edge. The second form has a shorter involuted part, and a comparatively larger widened point, with coarsely sinuate edge; in the smaller specimens of this form the edge of the widened part may be quite straight. (In one species (*A. tesselatum*) instead of this form a tridentate pedicellaria is found, in which the edge of the blade is not at all involuted, and the blade is filled by a coarse net of meshes; in another species (*A. Belli*) only (?) very large specimens are found of the second form, and here occurs moreover a third, smaller form with involuted edge and widened point the edges of which are not sinuate. — The position of these two species is somewhat uncertain). The stalk of the pedicellariæ irregularly perforated.

Species: *A. fenestratum* (Wyv. Thoms.), *coriaceum* (A. Ag.), *tesselatum* (A. Ag.) (?), *Belli* n. sp. (?).

Distribution: The northern Atlantic, the Viti Islands, the Philippines. — Sublittoral-archibenthal forms.

Hapalosoma n. g.

The primary spines on the actinal side curved, with a rather long, thin hoof; they form a regular, conspicuous series along the outer margins of the interambulacral areas, which series continues some way up on the abactinal side. The areoles not very large; no conspicuous difference between the actinal and the abactinal sides. The tube feet in three series — almost as in an *Echinus*. The spicules almost rod-shaped, above somewhat larger fenestrated plates, arranged in two series; the sucking disk well developed. Three kinds of pedicellariæ: globiferous, tridentate, and triphyllous ones. In the globiferous ones the glandular bags are quite wrapped in a common skin; they open in the point of the head each through a separate little pore. The valves, which are situated between the glandular bags, reach only half-way to the point. The tridentate pedicellariæ are simply leaf-shaped, with an only slightly developed net of meshes; only this form is found. The stalk of the common structure.

Species: *H. pellucidum* (A. Ag.).

Distribution: The Philippines, New Guinea. — Sublittoral form.

Hygrosoma n. g.

The primary spines on the actinal side curved, with a large, white hoof; they are scattered near the ambitus; the areoles large; the difference between the actinal and the abactinal sides rather great. The tube feet are arranged in one almost regular series on the actinal side. The spicules large fenestrated plates, no sucking disk. Only tridentate and triphyllous pedicellariæ. The tridentate ones occur only in one form, highly involuted; the point is widened in a spoon-like manner, and its edge is straight. The stalk of the pedicellariæ of the common structure. In one species, *H. luculentum*, another kind of tridentate pedicellariæ is found, with very thick and broad blades, almost as ophicephalous pedicellariæ; but the species cannot with certainty be referred here.

Species: *H. Petersii* (A. Agass.), *hoplacantha* (Wyv. Thoms.), *luculentum* (A. Ag.) (?).

Distribution: The northern Atlantic, the Pacific. — Sublittoral-archibenthal forms.

Tromikosoma n. g.

The primary spines on the actinal side curved, with a large hoof, they are only few and scattered, and form no regular series; the areoles of a middle size; no great difference between the actinal and the abactinal sides. The spicules irregular fenestrated plates, not in series; the tube feet in one irregular series on the actinal side; no sucking disk. Three kinds of pedicellariæ: ophicephalous, tridentate, and triphyllous ones. The ophicephalous ones with the valves highly constricted in the middle, short neck, and tube-formed stalk. The tridentate ones occur in two forms, a larger one with leaf-shaped point, filled by a coarse, thorny net of meshes, not involuted; and a smaller one, simply leaf-shaped, with the widenings of the apophysis ending at the very edge of the blade. The stalk of the tridentate and the triphyllous pedicellariæ of the common structure.

Species: *T. Koehleri* n. sp.

Distribution: The Davis Strait. — Abyssal form.

Sperosoma Koehler.

The primary spines on the actinal side curved, with a large white hoof; they occur scattered; the areoles large. Rather great difference between the actinal and the abactinal sides. The secondary ambulacral plates on the actinal side of the same size as the primary ones; the ambulacral areas consist on the actinal side of 8 series of plates. The tube feet on the actinal side in three widely separated series. The spicules large, fenestrated plates, not arranged in series; sucking disk well developed. Only tridentate and triphyllous pedicellariæ. The tridentate ones are simply leaf-shaped; the widenings from the upper end of the apophysis do not reach to the edge of the blade; in the large ones the blade is filled by a coarse, thorny net of meshes. The stalk of the common structure.

Species: *Sp. Grimaldii* Koehler, *biseriatum* Döderlein.

Distribution: The northern Atlantic, the Indian Ocean. — Archibenthal forms.

Kamptosoma n. g.

The spines (at all events some of them) flat and widened towards the point; hoof (?); no great difference between the actinal and the abactinal sides. Secondary ambulacral plates seem to be wanting. The tube feet form a single series. Only tridentate and triphyllous pedicellariæ; in the tridentate ones the blade is flat with more or less developed cover-plate; a larger and a smaller form are found, only little different. In the triphyllous pedicellariæ the cover-plate is uncommonly slightly developed. The stalk consists of long threads almost only united at the ends.

Species: *K. asterias* (A. Agass.).

Distribution: The Pacific. — Abyssal form.

Incertæ sedis:

Phormosoma panamense A. Ag.

— *hispidum* A. Ag.

Asthenosoma longispinum Yoshiwara.

— *Ijimai* Yoshiwara.

As has been done above in the Cidarids I shall also here expressly observe that I do not regard the generic diagnoses given here as complete. As well the structure of the test as the inner anatomy stands in need of an exact examination in several of the genera. I must, however, regard all the genera established here as good ones, and also the limitation of the old genera *Phormosoma* and *Asthenosoma* is no doubt correct. Only the genera *Aræosoma* and *Hygrosoma* are perhaps still taken in too wide a sense, in as far as the species *A. tesselatum* and *Belli*, as also *H. luculentum* ought perhaps to be separated as particular genera; at all events, however, they are most nearly allied to the genera to which they are here referred.

In stead of the former confusion of species and the two genera that were not to be kept distinct, we have got a number of definitely characterized and easily recognisable genera — a result that has been obtained especially by a careful examination of the pedicellariæ. Thus it proves here as in the Cidarids to be a fact that the spines and the structure of the test are in no way a sufficient basis for the classification. Otherwise the spines play a prominent part in the classification of the Echinothurids, and by means of these alone a far better classification might have been obtained than the one expressed in the old genera *Phormosoma* and *Asthenosoma*.

For the present it must be left undecided whether there may be any question of a grouping of the genera into subfamilies. There is, however, no doubt that the genera *Phormosoma* and *Kamptosoma* are rather distantly allied to the other genera.

5. **Phormosoma placenta** Wyv. Thomson.

Pl. IV, Figs. 1–2. Pl. XI, Figs. 7, 10, 25. Pl. XII, Figs. 2—3, 7, 11, 19, 21, 23, 25, 26, 37, 39. Pl. XIII, Fig. 7.

Synonym: *Phormosoma Sigsbei* Agassiz.

Principal literature: Wyville Thomson: «Porcupine»-Echinoidea (395). p. 732. Pl. LXII—LXIII. — A. Agassiz: 6. p. 75. «Blake-Echini» (9) p. 30. Pl. XII, XV. Fig. 3—19. — E. A. Verrill: 418. p. 139. — W. E. Hoyle: Rev. List of Brit. Ech. (202). p. 406. — F. Jeffr. Bell: 69. p. 436—38. Catalogue of Brit. Ech. (73). p. 144.

This species has been so carefully described by Wyv. Thomson and Agassiz, that there is no reason to give here again a complete description of it. Only a few structures need still a more exact description, viz. the spines, the tube feet, and the pedicellariæ; some remarks must also be made with regard to the development and transformation of the apical area, as also with regard to the inner structure.

Of the spines on the actinal side of this species Bell (Catal. p. 144) says: «from what is known ... it is probable, that they are rather long and have a stout calcareous cap». This is wrong. Wyv. Thomson, to be sure, says (l. c.) that two kinds of spines are found, but what he describes and figures is only larger and smaller spines of the kind found on the abactinal side; the large spines on the actinal side have been broken in his specimens. Agassiz, in the description of *Ph. placenta* («Blake-Echini»), says nothing of the spines of the actinal side, but from his fig. 8. Pl. XII it is seen that they are club-shaped, and in the explanation of the figures they are called «clubshaped». In the diagnosis of *Ph. Sigsbei*, which, according to Agassiz himself, is synonymous with *Ph. placenta*, it is said: «primary radioles on the actinal surface resembling those of *Ph. bursaria*», and of these latter he says (Chall. Ech. p. 100): «on the actinal surface the primary spines are not tipped with a solid hoof, but all end in a fleshy bag». — Thus it may be seen, by comparing the several statements, to be substantiated in an indirect manner in the literature that the primary spines on the actinal side are inclosed in a thick bag of skin, and it may be seen rather easier on the animals themselves when they are fairly well preserved. — These bags of skin may possiby contain poison apparatus; at all events the living Phormosomes are said to sting when touched, and there seems to be no poison bags on the spines of the abactinal side.

These skin-covered spines are of a more complicated structure than the spines of the abactinal side; only at the base it may still be seen that they have originally been tubular as the other spines. They end in a broad serrate point (Pl. XII. Fig. 11). In transverse sections it is seen that they are tubular in the lower part with projecting, hollowed ridges (Pl. XI. Fig. 7 b); towards the point these ridges become much less conspicuous and quite irregular. At the same time the cavity is filled by an irregular net of meshes of fine calcareous threads running parallel to the longitudinal axis of the tube (Pl. XI. Fig. 10). The spines of the abactinal side, as is seen from the excellent figure by Wyv. Thomson (Pl. LXII. 3), are hollow tubes, very regularly perforated, and ending in a long, fine point. Most frequently, however, the thorns are both fewer and more feeble than in this figure. Transverse sections show that here no projecting longitudinal ridges are found (Pl. XI. Fig. 7 a). The spines on the peristome are covered in their whole length by a thick skin, but they have no bag-shaped widening in the point. The spines themselves are constructed as the primary spines of the actinal side, the only difference being that they are not widened at the point (Pl. XII. Fig. 19).

The expression of «marginal fasciole», used by Agassiz of the close-sitting small spines at the ambitus («Blake»-Echini. p. 34) is to be avoided, at all events for the present. Agassiz, to be sure, thinks that they «take(s) almost the prominence of a fasciole, and are (is) interesting as showing how such a structure may exist in a rudimentary form in the Desmosticha» (Chall. Ech. p. 98). I do not think that it recalls to any striking degree the fascioles of the Spatangids, and at all events we have for the present no safety that they are homologous formations. The expression of «marginal fringe» used by Wyv. Thomson is therefore to be preferred, as it is quite without morphological pretensions.

Wyv. Thomson (op. cit. p. 735) states that the tube feet «are provided with a sucker with a well-developed calcareous rosette of four or five pieces». This sucker I have not been able to find; according to my examinations all the tube feet, as well actinal as abactinal, end in a point, without sucking disk. The spicules, which are, as stated by Wyv. Thomson, irregular, larger or smaller fenestrated plates, are commonly arranged in 4 longitudinal series. This is especially distinct in the lower part of the tube foot; towards the point the plates become larger and arcuate, and at last they surround the foot as a mail. There is no great difference between the spicules of the tube feet of the actinal and the abactinal sides; they are only more slightly developed in the latter (Pl. XI. Fig. 25).

In young specimens of *Ph. placenta* the peculiar feature is found in the tube feet of the abactinal side that only the uppermost one of the three tube feet that correspond to each ambulacral plate, is well developed, while the other two are quite rudimentary. The same fact may also be found in large specimens, and it may at all events most frequently be seen that the uppermost one of each set of three tube feet (the one belonging to the inner one of the two small secondary ambulacral plates) is more developed than the others. In these rudimentary tube feet no spicules are developed; neither are any spicules found in the skin on the outside of the plates (which may easily be prepared off) or in the bag of skin round the spines of the actinal side.

The pedicellariæ. The tridentate pedicellariæ occur only in one form, with simply leaf-shaped valves. The size is very different, from quite small ones to such where the head has a length of 2^{mm}. The form of the valves is rather varying, sometimes short, broad, and flat, almost without any net of meshes, sometimes long, narrow, and deep, or long and broad, with a rather well developed net of meshes at the bottom. On Pl. XII. Figs. 2, 3, 7, 26, 37, 39 some forms are given; all transitions between them are found; but narrow and broad forms do not seem to occur in the same individual, as in *Ph. bursarium*. The upper end of the apophysis is widened, but these widenings do not reach to the edge of the blade, they cease about midway on the side. Also the net of meshes at the bottom of the blade is an immediate continuation of the upper end of the apophysis; it is always smooth. The sides of the blade are most frequently a little bent outward, especially on the narrow forms. The edge is finely serrate, which is only to be seen under higher magnifying powers. The tridentate pedicellaria figured on Pl. XIII. Fig. 7, is the long, narrow form. The neck is rather long, the stalk is thin, irregularly perforated.

In some specimens from st. 40 the tridentate pedicellariæ are especially long and narrow (the pedicellaria figured on Pl. XIII. Fig. 7 is one of these), so that we might be inclined to regard these as a separate species or variety. As there seems, however, to be no other characters, — with the exception that the tube feet of the actinal side are more rudimentary than usual — and as the form of the pedicellariæ may be rather varying, there can scarcely be any question of regarding these specimens otherwise than as good *Ph. placenta*.

The triphyllous pedicellariæ have been excellently figured by Wyv. Thomson (Pl. LXII. Fig. 6), so I only figure one valve seen from the inside (Pl. XII. Fig. 21). The cover-plate is here very slightly developed, but in this feature some variation is found. The outer edge is finely serrate.

Sometimes two-valved pedicellariæ are found, especially tridentate ones, more rarely triphyllous ones. They are constructed as the normal three-valved pedicellariæ, and have an apophysis as these, only more slightly developed. It is rather interesting to compare these pedicellariæ with the normally two-valved ones in *Porocidaris*; in the latter the apophysis is quite wanting. I have found a few instances of a tridentate pedicellaria, in which the edge of the blade was a little involuted for a short space below, so that it reminded of the small tridentate pedicellariæ in *Aræosoma fenestratum*.

The sphæridiæ (Pl. XII. Figs. 23, 25) are commonly almost globular, but show too great variation to be reliable specific characters. As observed by Agassiz they are placed in a series along the tube feet from the mouth far up on the abactinal side.

According to Bell (69. p. 438) the longitudinal muscles are «altogether absent from *Phormosoma*». I cannot agree with Bell in this statement; they are also found in *Ph. placenta*, and are of the common form, but they are fine and break easily, so that the preparation must be made with great caution, in order to get a distinct view of them. I think it only little probable that any greater individual variation with regard to the development of the longitudinal muscles should be found in *Ph. placenta*, so that they might even sometimes be quite wanting. The organs of Stewart, as shown by Bell (op. cit.), are very little developed.

Agassiz (»Blake«-Echini. Pl. XV) has figured several stages of development of this species. As among the material of *Ph. placenta* collected by the »Ingolf« several small specimens are found, especially from st. 25 (the Davis Strait), I have been able to follow the development of the apical area, and have found that the description of this development given by Agassiz does not agree very well with what is shown by the specimens before me. Whether this is due to the fact that the figures given by Agassiz are inaccurately drawn, or perhaps a confounding with another species has taken place, I shall not try to decide. (The possibility of the West-Indian specimens of *Ph. placenta* being a special local form, seems to be excluded: some specimens from the Gulf of Mexico, which our museum has received from the Smithsonian Institution, agree exactly with those taken in the Davis Strait.) I shall only figure a couple of stages of the development of the apical area in the specimens in hand.

On Pl. IV. Fig. 2 the apical area of a specimen of a diameter of 7^{mm} is figured. Agassiz on Pl. XV. Fig. 3 figures the apical area of a specimen of a diameter of 8^{mm}. The difference between these two figures is rather conspicuous. In the specimen figured here the ocular plates have a peculiar, »spade«-like form, and the genital plates almost join inside of them, so that the ocular plates only just touch the anal area; the madreporite may already be distinguished. In the figure of Agassiz the form of the ocular and the genital plates is quite different, and the ocular plates reach far inside of the genital plates. On Pl. IV. Fig. 1 the apical area of a specimen of a diameter of 37^{mm} is figured. The development of small plates, partly at the cost of the genital and ocular plates, is here already rather advanced, the ocular plates, however, having still essentially kept the form characteristic of the younger stages. (In the adult animal this form is no more to be recognized.) Even if all possible transitional stages between the two figured here were not found, there could scarcely be any doubt that they are developmental stages of the same species. The peculiar small, oblong plates in the skin of the region round the anal opening, begin already to appear in specimens of a diameter of 15^{mm}. (They have here been drawn a little too regular.) Agassiz (Pl. XV. Figs. 9 and 11) figures the apical area of specimens of a respective diameter of 28^{mm} and 41^{mm}. The resemblance to the figures given here is not striking; but the figures are rather indistinct, so that it is difficult to compare the details of the two sets of figures. Further Agassiz (Pl. XV. Fig. 5) figures the apical area of a *Ph. placenta* of a diameter of 17^{mm}; this figure agrees as badly with a specimen of 17^{mm} now before me, as does the figure 3 of Agassiz with the apical area of a specimen of 7^{mm} figured here. — A comparison of these two figures in Agassiz (Figs. 3 and 5) conveys the direct impression that they do not belong to one species. But whatever the case may be with regard to these figures, it is a sure fact that the specimens before me are really *Phormosoma placenta*. It is still to be observed that the figures given here have been drawn from dried specimens; in specimens in spirit it is generally impossible to see the limits between the plates distinctly.

A large material of this species has been obtained by the »Ingolf«-Expedition on the following stations:

St. 24.	(63° 06' N. Lat.,	56° 00' W. L.	1190 fms.	Mud.	2°7 bottom temp.).	1	specimen.
— 25.	(63° 30' —	54° 25' —	582 —	—	3°6 —).	167	—
— 28.	(65° 17' —	55° 42' —	420 —	—	3°8 —).	27	—
— 40.	(62° 00' —	21° 36' —	845 —	—	3°9 —).	5	—
— 63.	(62° 40' —	19° 05' —	800 —	—	4°3 —).	2	—

St. 69.	(62° 40′ N. Lat.,	22° 17′ W. L.	589 fms.	Mud.	3° 9 bottom temp.).		1 specimen.
— 73.	(62° 58′ —	23° 28′ —	486 —	—	5° 1	—).	3 —
— 76.	(60° 50′ —	26° 50′ —	806 —	—	3° 7	—).	1 —
— 83.	(62° 25′ —	28° 30′ —	912 —	?	3° 1	—).	3 —

From previous collections we have some specimens from the Davis Strait (66° 49′ N. Lat., 56° 28′ W. L. 235 fathoms. Wandel).

Phormosoma placenta is distributed over the whole northern part of the Atlantic, from the West Indies to the Davis Strait, from the Bay of Biscay to the Faröe Islands and Iceland. It has been taken on depths from 150—1356 fathoms (Bell Catalogue, Hoyle 202, Rathbun 337), but it seems chiefly to be found on ca. 400—1000 fathoms. Koehler (226. p. 91) also observes that it is «relativement rare dans les dragages profonds». It is an archibenthal form scarcely occurring on the great depths in the Atlantic, but limited to the territories of the mentioned depth that stretch across the Atlantic south of Iceland and then follow the European and American coasts southward. It is scarcely found north of the ridge across the Denmark Strait or that between Iceland and the Faröe Islands. It seems absolutely to demand a positive bottom temperature.

6. **Calveria hystrix**[1]) Wyv. Thomson.

Pl. III. Figs. 1—2. Pl. XI. Figs. 5, 29. Pl. XII. Fig. 34. Pl. XIII. Figs. 17, 18. Pl. XIV. Figs. 13, 26.

Synonym: *Asthenosoma hystrix* (Agassiz, Bell, Koehler etc.).

Non: *Calveria* (*Asthenosoma*) *fenestrata* Wyv. Thomson.

Principal literature: Wyv. Thomson: Echinoidea of «Porcupine» (395) p. 738. Pl. LXIV—LXV. — A. Agassiz: Revision of Echini II. p. 273. Pl. II. c. Fig. 1—5 (?). — 6 p. 74. — 14 p. 3. Pl. II. Fig. 1—2. — W. E. Hoyle: Revised List of Brit. Echinoidea. (202) p. 407. — F. Jeffr. Bell: 72 p. 526. Pl. XXIV—XXV. — Catalogue of British Echinoderms. p. 143. — R. Koehler: 229 p. 9.

After the excellent description of this species by Wyv. Thomson it is unnecessary here to give a new thorough description of it; only a few points stand in need of a somewhat more exact description than has hitherto been given.

The primary spines on the actinal side are curved (somewhat more than shown by the figure (Pl. III. Fig. 2)), and end in a small, short, and somewhat widened hoof; it is whitish, and consequently rather conspicuous on the pink spine. «Flaring at the extremity», Agassiz (14 p. 5) says of the spines, otherwise their ending in a hoof is not mentioned in the literature. In transverse sections of the spines (Pl. XI. Fig. 5) it is seen that the longitudinal ridges are rather low, widened in the outer part, with a little projection (indented) on the outside. The small spines on the abactinal side give in transverse sections a figure a little different (Pl. XI. Fig. 5 b); the outer surface of the longitudinal ridges is finely arcuate, and their edges are almost joining.

The pedicellariæ have been excellently described and figured by Wyv. Thomson, who gives, however, no figures of the single valves, so that the features systematically most important cannot be seen in his figures. In the larger form of tridentate pedicellariæ (Pl. XIV. Fig. 26) the blade is highly

[1]) On Pl. III it is wrongly called *Asthenosoma*; this plate was reproduced before my stay at British Museum, that is to say, before I had a quite clear understanding of the generic relations of the Echinothurids.

involuted, only the point is somewhat widened, and the edge of this terminal part is almost straight cut off, but irregularly serrate. The involuted part of the blade is filled by an irregular net of meshes. In the smaller form of tridentate pedicellariæ (Pl. XIII. Figs. 17—18) there is a comparatively larger widened part in the point of the blade, and a corresponding smaller, involuted part; this feature is rather varying according to the size. The edge of the widened part is also here irregularly serrate, but may in the smallest specimens be almost quite straight and regularly serrate. The blade is less curved in the small form than in the large one, and accordingly the valves are less wide apart when the pedicellaria is shut, which feature is excellently seen in the figures of Wyv. Thomson. I quite agree with Wyv. Thomson, when he thinks this smaller form to be «a modification of the first more or less reduced in size and lengthened in its proportions ; on the other hand I must protest against his finding it like some of the common varieties in the Cidaridæ (op. cit. p. 739). Any resemblance to the pedicellariæ of the Cidarids is absolutely not found, except so far that both forms are pedicellariæ, and as such agree in their chief structures. — The size of the tridentate pedicellariæ (the head) is up to 1·2^{mm}, as stated by Wyv. Thomson. The neck is rather short in the large pedicellariæ, somewhat more developed in the small ones. The triphyllous pedicellariæ have a very large cover-plate, most frequently almost without holes; only in the median line there is a series of large holes, made by protuberances from the sides of the cover-plate growing towards the middle and coalescing there (Pl. XII. Fig. 34). The outer edge is rather strongly dentate. The stalk of the pedicellariæ is of the structure common in the Echinothurids, irregularly perforated. The sphæridiæ are rather long-stalked, their head beautifully round and smooth (Pl. XIV. Fig. 13).

The spicules are arranged in two series in the lower part of the tube feet; they are here narrow, more or less rod-shaped, with few, sometimes no holes (Pl. XI. Fig. 29); they are placed across the longitudinal axis of the foot. Above they are large, irregular fenestrated plates quite encompassing the foot.

The longitudinal muscles are well developed; on the other hand no distinct organs of Stewart were seen in the specimen I opened. To be sure, Koehler (op. cit.) states the organs of Stewart to be well developed. As Koehler, however, follows Bell in regarding *Calveria hystrix* and *fenestrata* as synonyms, it cannot be seen, which of these species he has examined. Nor could I see the organs of Stewart in a specimen of the latter species.

Of *Calveria hystrix* two specimens have been obtained by the «Ingolf»-Expedition on the stations 89 (64° 45′ N. Lat., 27° 20′ W. L. 310 fathoms, the bottom mud, bottom temperature 8°), and 97 (65° 28′ N. Lat., 27° 39′ W. L. 450 fathoms. Sandy mud. Bottom temperature 5° 1). The specimen from st. 97 is very beautifully preserved, and as the colour has almost not faded — to judge by a coloured sketch made on board from the living animal — it is here figured in colours (Pl. III. Figs. 1—2); only the darker bands mentioned by Wyv. Thomson (p. 740), are no longer seen distinctly; in the original sketch they are indicated.

Whether the specimen of 3^{mm} mentioned by Agassiz in Rev. of Echini, Pt. II. p. 273, really is a *C. hystrix*, cannot be seen from the figures. Agassiz, to be sure, says that the pedicellariæ are similar ; but it is not quite evident whether they resemble those of *C. hystrix*, or those of *Asthenosoma Grubei*; and even if the meaning be that they resemble the figures of the pedicellariæ in *C. hystrix* given by Wyv. Thomson, the statement is not to be relied on, as the most characteristic feature of these, the irregular edge of the terminal part of the blade, has not before been observed.

The statements in the literature with regard to the distribution of this species, are upon the whole quite unreliable, as we cannot be sure that it is really this species which has been examined in each case. No doubt the statements apply often to *Aræosoma fenestratum*, and probably also to *A. Belli* Mrtsn. (see above p. 54—55), which has likewise been confounded with *C. hystrix*. It may, however, be taken to be probable that its distribution is the same as that of *Phormosoma placenta*, viz. ca. 100—ca. 1000 fathoms along the coasts of Europe and North America, and across the Atlantic south of Iceland. It is only known from the territory with positive bottom temperature. In the »cold area» it is certainly not found.

7. **Aræosoma fenestratum** (Wyv. Thomson).

Pl. XI. Fig. 8. Pl. XII. Fig. 33. Pl. XIV. Figs. 1, 8, 14, 17, 18, 24, 32.

Synonyms: *Calveria fenestrata* Wyv. Thomson.
Asthenosoma fenestratum (A. Agass.).
— *Reynoldsii* A. Agass.
Non: *Calveria* (*Asthenosoma*) *hystrix* Wyv. Thomson.

Principal literature: Wyv. Thomson: Echinoidea of »Porcupine» (395) p. 741. Pl. LXIII. 9—10, LXVI—LXVII. — A. Agassiz: 6. p. 75. »Blake»-Echini (9) p. 29. Pl. XIII—XIV. (»*Asthenosoma hystrix*»). — W. E. Hoyle: Rev. List of Brit. Echinoidea (202). p. 408. — F. Jeffr. Bell: 72. Pl. XXIV. Fig. 1, Pl. XXV.

The reasons why this species is not, as has been supposed by Bell (72) and Koehler (229), synonymous with *Calveria hystrix*, but on the contrary must be referred to another genus, have been given above (p. 52—53). — In »Preliminary Report of the »Blake»-Echini» (6. p. 75) Agassiz describes an *Asthenosoma* by the name of *A. Reynoldsii*, »readily distinguished from *A. hystrix* by the larger, higher coronal plates, the prominent vertical row of primary tubercles on the outer edge of the interambulacral area on the abactinal side, the less numerous secondaries and miliaries and the color of the test. The primary spines, quite closely packed, on the actinal side, are long, slender, slightly curved, and trumpet shaped; on the abactinal side they form one principal vertical row extending half-way to the apical system near the outer edge of the interambulacral areas. The rest of the test is covered by distant small secondary spines». After having examined a great many specimens, Agassiz has later (9. p. 29) got the conviction that the specimens he separated as *A. Reynoldsii*, are only large specimens of *Asthenosoma hystrix*; »the differences, striking as they appear, are merely due to age».

From the »Ingolf» (st. 89) we have a specimen, no doubt identical with the »*A. Reynoldsii*» of Agassiz; it agrees very well with the description quoted, and with a specimen received from U. S. National Museum under the name of »*Asthenosoma hystrix*», and both agree exactly with a fragment of a type specimen of *Calveria fenestrata* which I had occasion to examine in British Museum (see above p. 53). It is true that the tetradactylous pedicellariæ are wanting in both specimens as well as in the mentioned type specimen; but in all other respects they are quite similar, and above all, the tridentate pedicellariæ are identical in all of them. There can be no doubt that the long missed, at last almost mystical *Calveria fenestrata* has here been refound. It proves, into the bargain, to be common enough, and has only been missed, because it has been confounded with *Calveria hystrix*. The exceedingly remarkable tetradactylous pedicellariæ, which would be an excellent character of this species, seem generally to be wanting, probably broken off, possibly originally wanting in some specimens (as in other Echinids individuals are often found quite wanting some kind of pedicellariæ normally found in the species, — for instance globiferous pedicellariæ in *Echinus Alexandri*). To be sure, the difference between the two species with regard to their habitus is considerable; but if we examine more exactly the details of this difference, we shall be much surprised to find a great conformity in almost all external features, above all in the arrangement of the tubercles. No other difference can in reality be given with regard to the common appearance than the fact that *A. fenestratum* is far more robust than *Calveria hystrix*, and that the colour is different. The great difference in the form of the plates in the two species emphasized by Wyv. Thomson as a chief character, is only to be seen in dried specimens, and, strictly speaking, only from the inside; it is moreover, as shown by Bell (op. cit.), subject to great variation. It is only by examining the pedicellariæ that we find sure characters. As the pedicellariæ have not hitherto been taken into consideration, there is, so far, a good excuse of the fault committed by the confounding of the two species.

A thorough description of this species is not necessary here, any more than with regard to the two preceding ones; I shall only make some supplementary remarks, and for the rest the reader is referred to the descriptions by Wyv. Thomson and Agassiz (the latter one to be found under *A. Reynoldsii*).

The primary spines of the actinal side end in a small, short, and rather broad hoof; this I take to be what Agassiz means by calling them trumpet-shaped . The structure is as in *Calveria hystrix*, only that the spines seem here always to be smooth, while in *C. hystrix* they are more or less thorny. (Transverse section. Pl. XI. Fig. 8). The spicules are large, irregular fenestrated plates, which in the outer part of the tube foot encompass it completely; in the lower part they are somewhat smaller, and are arranged in four longitudinal series. Sucking disk well developed.

The tetradactylous pedicellariæ I have not seen, but as in *A. coriaceum* they are quite similar to those figured by Wyv. Thomson for *A. fenestratum*, it may be considered rather certain that no specific characters are found in them. Such characters are, on the contrary, found in the tridentate pedicellariæ, as shown above. There are two forms of tridentate pedicellariæ. In the larger form, which has been overlooked by Wyv. Thomson, but which I have found in the mentioned type specimen, the blade is much involuted and curved outward. The point is somewhat widened, and has two deep sinuations in the edge on each side (Pl. XIV. Fig. 32), but the edge is otherwise not indented. The blade is filled by a rather coarse net of meshes. The valves are very wide apart when the pedicellaria is shut. The base is especially large, so that there is room for a great many muscular fibres; no doubt these pedicellariæ are very powerful. The head has a length of up to 2^{mm}, the neck is quite short. — The smaller form is very much varying as to size and form; the larger ones (Pl. XIV. Fig. 24) recall the large form very much, but the valves are much less curved, the widened part of the point is comparatively larger, and the edge not so deeply sinuate. In the smallest ones the valves are almost not separated, and the edge is almost quite straight. Wyv. Thomson has figured one of these smaller forms (Pl. LXVII. Fig. 7). On Pl. XIV. Figs. 8, 17, 18, 24 valves of larger and smaller specimens of this form have been figured; they are all extremely finely serrate in the edge. They are short-necked as the large form, the smallest ones, however, with a somewhat longer neck. The stalk of the common structure. The cover-plate of the triphyllous pedicellariæ is highly developed (on Pl. XII. Fig. 33 there is a broad, open space in the median line, but most frequently the projections of the edges join in the middle, so that the common series of large holes in the median line is formed); the valves are lengthened, narrow below, rather abruptly widened above. The edge finely serrate. — The sphæridiæ (Pl. XIV. Fig. 14) are somewhat more lengthened than in *C. hystrix*.

Wyv. Thomson (op. cit. p. 473) describes the colour of this species very thoroughly. Bell (72. Pl. XXIV) gives a couple of excellent coloured figures of the two species *hystrix* and *fenestratum* (only the test). As already mentioned he regards them as one species, as he finds very great variation in the size of the uncalcified space between the plates. With regard to the different colouring Bell remarks: «The coloration of tests, however, does not often go far in helping in the discrimination of species of Echinoids». He finds a considerable variation in the extent and intensity of the colour, and some specimens are, moreover, quite bleached. — I am inclined to attach more importance to the colour as a distinguishing mark between the Echinids. To be sure, bleached specimens are often met with, and they, of course, cannot be recognised by the colour, but fortunately specimens are very often found that have kept their natural colour almost completely, and such specimens are found, at all events, in most of the divisions of Echinids. In such specimens the colour is a really good character, as, according to my observations (and I have seen numbers of living Echinids, as well in northern as in tropic seas) the species have most frequently a rather constant and characteristic coloration. However, I think the colour to be only rarely an absolutely reliable character. As to the two figures given by Bell there is, in my opinion, no doubt that Fig. 1 is *A. fenestratum* and Fig. 2 *Calveria hystrix*.

The longitudinal muscles are well developed; I have not been able to find organs of Stewart in the specimen I have opened.

Only one specimen has been taken by the «Ingolf», st. 89 (64° 45' N. Lat. 27° 20' W. L. 310 fathoms. Bottom temperature 8°), the Denmark Strait.

With regard to the distribution of this species we have only few sure facts. The «Porcupine»-Expedition took it off the Portuguese coast; that it is also found off the western coast of Ireland appears with certainty from the paper by Bell (72) quoted above. Agassiz enumerates several localities from the sea round Barbados for *A. Reynoldsii*, and in British Museum I have myself seen a specimen (called *A. hystrix*) from Barbados, which is no doubt *A. fenestratum*. Our museum has further received a specimen from Smithsonian Institution obtained near Florida (32° 36' N. Lat. 77° 29' 15" W. L. 258 fathoms); it is also called *A. hystrix*, but is *A. fenestratum*. From these statements it may be concluded with rather great certainty that like *Ph. placenta* and *C. hystrix* it is found in the whole northern Atlantic, as well on the American as on the European side, and across the Atlantic south of Iceland on the slopes towards the deep. Its vertical distribution seems to be somewhat smaller than that of the other species, the greatest depth from which it is mentioned, being 373 fathoms (*A. Reynoldsii*, Agassiz, 6); the smallest depth on which it has been taken, is 81 fathoms

(Hoyle, op. cit.). Thus it seems to belong more to the sublittoral fauna than to the archibenthal one. It is certainly only found in places with positive bottom temperature. North of the ridge in the Denmark Strait and the one between Iceland and the Faröe Islands it is scarcely found — still less in the deep regions North of Iceland.

8. **Sperosoma Grimaldii** Koehler.

Pl. IV. Figs. 3—5. Pl. XI. Fig. 9. Pl. XII. Fig. 16. Pl. XIII. Figs. 12, 23. Pl. XIV. Figs. 2, 4, 4 a, 6, 11, 31, 33.

Literature: R. Koehler: 228. 229, p. 16. Pl. II, III etc.

Of this species we have two fine specimens from the «Ingolf»-Expedition, st. 83 (62° 25′ N. Lat. 28° 30′ W. L. 912 fathoms. Bottom temperature 3°. The ridge south west of Iceland), a large one of a diameter of 150^{mm}, and a small one of a diameter of 27^{mm}. The large specimen is much bleached, and shows the violet colour only in spots — it has already been observed by Koehler that this species has a tendency to lose the colour in alcohol; — the small specimen has kept the colour very beautifully.

The large specimen agrees, with regard to the actinal side, exactly with the description by Koehler; the abactinal side, on the other hand, shows some deviations, so that I felt a doubt whether it might not possibly be another species than the specimens Koehler has had. So I sent the original drawing of Pl. IV. Fig. 3 to Prof. Koehler, and asked him to give me his opinion with regard to this fact, calling his attention to the deviations from his description, found in this specimen. He has then informed me that in spite of the difference in the form of the plates and the arrangement of the pores on the abactinal side he thinks it to be the same species, and trusting to his authority I refer this beautiful specimen to *Sp. Grimaldii*.

The ambulacral areas (of the abactinal side) are not narrower than the interambulacral ones, but even a little broader. Just above the ambitus the middle part of the ambulacral area is only formed by the primary plates, the inner accessory ambulacral plate is quite small, placed about at the middle of the primary plate; the outer one is large reaching quite to the edge of the area, and often expanding so much, that the primary plate does not reach to the edge. A little way, ca. 5—6 plates, above the ambitus, the inner accessory ambulacral plate increases rather abruptly so much in size, that it reaches quite to the median line of the area, and so it continues quite to the apical area. Thus the primary ambulacral plates are here separated for their whole length; they are of almost the same height from the median line of the area to its edge, and so the whole area looks rather regular[1]. — The tube foot belonging to the inner accessory ambulacral plate, is well developed, that of the outer accessory plate and of the primary one is quite rudimentary. The two tube feet of the accessory plates are placed quite near each other, just at the boundary line between the plates, and in about the same height; that of the primary plate is placed opposite to the interspace between the two others. The form of the interambulacral plates is also somewhat different from that in the figure of Koehler; they are distinctly bent in an angular manner, with the point turned towards the apical area.

The plates of the apical area cannot be seen through the skin, only the madreporite; the

[1]) The figure (Pl. IV. Fig. 3) does not render all these details of the structure of the ambulacral areas quite clear nor quite exactly, but on the other hand it renders the habitus of the animal quite excellently.

latter is very large and broad, and the pores spread also over some of the small plates inside of it. Koehler says that the madreporite is triangular, very large, and prolonged; his figure does not show this, there it is scarcely larger than the other genital plates. — The genital openings are covered by a large genital papilla, 3—4^{mm} long, resembling a tube foot. Prof. Koehler informs me that a similar formation was found in his specimens; he has seen traces of it on some of the plates; but as his specimens were badly preserved he could not distinguish the nature of these traces with certainty, but took them to be loosened pieces of skin. After having seen my drawing he feels certain that they were the genital papillæ. — A similar formation is mentioned by de Loriol (246 p. 369) in the specimen he (wrongly) takes to be a young *Asthenosoma varium*: «les pores génitaux sont très grands, circulaires, couverts d'une fine membrane au milieu de laquelle saillit la papille génitale»; for the rest de Loriol has no further remarks of this peculiar formation.

Neither with regard to the spines of the dorsal side does this specimen quite agree with the description of Koehler: Dans les zones interambulacraires les tubercules primaires forment, vers le milieu de chaque rangée de plaques, une file assez regulière qui s'étend jusqu'à une petite distance du périprocte, mais toutes les plaques interambulacraires ne portent pas de ces tubercules primaires» (p. 19). Here they do not at all form a regular series, are on the contrary placed very irregularly. According to Koehler the spines are much shorter on the abactinal side than on the actinal side; in the specimen in hand the fact seems not to have been so. To be sure all the primary spines on the abactinal side are broken, but to judge from the fragments kept, they must have been of about the same length as the primary spines on the actinal side. As observed by Koehler, the abactinal side looks rather naked here being far fewer spines than on the actinal side. — The structure of the spines is the common beautiful one: regularly perforated tubes with raised longitudinal ridges, ending in a fine point. Transverse sections of the large primary spines from the actinal side (Pl. XI. Fig. 9 a) show the longitudinal ridges highly developed, with the outer surface widened, so that their edges join completely; they are much hollowed along the median line; secondary connecting beams between the longitudinal ridges may be more or less developed. The small spines on the abactinal side are also provided with strong longitudinal ridges, with widened outer surface, and hollowed along the median line (Pl. XI. Fig. 9 b). The primary spines on the actinal side as also the spines of the peristome are somewhat thorny, the abactinal ones are quite smooth.

Koehler gives a figure of a whole tridentate pedicellaria, but he gives no informations of the structure of the blade except the one thing that the edge is not serrate — and this is scarcely correct, at all events it does not apply to the specimen in hand. In the largest pedicellariæ (the head of a length of up to 2^{mm}) the valves are very broad and flat, and join completely, when the pedicellaria is closed (Pl. XIV. Fig. 33). The widenings from the upper end of the apophysis reach almost or quite to the edge of the blade, which is not involuted; in the outer part of the blade the edge is somewhat sinuate. The blade is filled by a very complicated net of meshes continuing into strong spines, arranged tolerably in longitudinal series (Pl. XIII. Fig. 12). In smaller pedicellariæ the net of meshes is more slightly developed, and only quite few teeth or none at all are found (Pl. XIV. Figs. 2, 6). The quite small ones have only an indication of a net of meshes above the apophysis, and their blade is much narrower. As all transitions are found between these forms, no distinction can be made between two kinds of tridentate pedicellariæ. The neck is rather short, the stalk of the common structure (Pl. XIV. Fig. 31). The cover-plate of the triphyllous pedicellariæ is rather well developed, with numerous small holes; the outer part of the blade is not very broad, the edge finely serrate (Pl. XII. Fig. 16).

The spicules of the tube feet on the actinal side are large, generally somewhat curved fenestrated plates (Pl. XIV. Fig. 4a); they inclose the foot completely and are not distinctly arranged in longitudinal series. A little sucking disk is found with a rather irregular calcareous rosette (Pl. XIV. Fig. 4). Just below the sucking disk the spicules stick, so that this part of the tube foot cannot be contracted, whereas the other part is highly contractible, as is commonly the case in the Echinids; the point with the sucking disk is then seen to be sharply marked off from the other, much thicker part of the tube foot. In the contracted part the spicules are arranged in such a way as to form an imbrication. The tube feet of the abactinal side have, as usual, no sucking disk, and the spicules are small, irregular, branched calcareous bodies (Pl. XIV. Fig. 4 a), arranged in 2—3 longitudinal series.

The sphæridiæ are as usual placed along the tube feet quite up on the abactinal side, where they are situated at the large tube foot, 1—3 sphæridiæ at each foot. They are rather lengthened (Pl. XIV. Fig. 11).

Together with this specimen a beautiful, small one has been taken, as mentioned above, of a diameter of 27^{mm}, which I suppose will have to be referred to the same species, although it differs somewhat from the large specimen with regard to the structure of the test (Pl. IV. Figs. 4, 5). The ambulacral areas are somewhat narrower than the interambulacral ones, also on the actinal side. The tube feet are placed in three series, but not very far from each other; they are arranged in arcs of three as in an *Echinus*, which is especially distinctly seen on the abactinal side. The small ambulacral plates are not distinct, the primary ones are especially regular and straight; this applies also to the interambulacral plates, which are, accordingly, not yet angularly bent as in the adult. The primary spines and tubercles form rather regular series in both areas; in the ambulacral areas there are on the actinal side a couple of especially large ones near the ambitus, much larger than the adjoining ones; in some plates spines are quite wanting. In the interambulacral areas they form a more regular series on either side gradually increasing in size towards the ambitus; primary tubercles are found in all the plates, and some have, besides, a few secondary tubercles. On the abactinal side the series of tubercles are very regular in the ambulacral areas where the size is about the same till towards the apical area. The tubercles of the interambulacral areas are more unequal, some being quite small, others very large. The spines, unfortunately, are all broken. The apical area is large, the madreporite rather distinct. No genital papillæ are as yet developed, nor are the pores as yet formed. The pedicellariæ are as in the large specimen, but as yet no large tridentate pedicellariæ with the blade filled by a thorny net of meshes are found. Of the tube feet on the abactinal side only the innermost one of each arc is well developed, the two others are rudimentary as in the large specimen. The spicules of the tube feet of the actinal side are as those of the large specimen, only somewhat smaller and distinctly arranged in series. The sucking disk only slightly developed. In the abactinal tube feet the spicules have only just begun to appear.

Sperosoma Grimaldii was hitherto only known from the Azores, from c. 600—930 fathoms. As it is now also known from the sea south of Iceland, it is to be supposed that its distribution will prove to agree with that of the three other Echinothurids mentioned in the preceding, so that it belongs to the rich fauna found on the large slopes towards the deep of the Atlantic.

9. **Tromikosoma Koehleri** n. g., n. sp.

Pl. XI Figs, 2, 13. Pl. XII. Figs. 22, 31, 41. Pl. XIV. Figs. 12, 16, 19, 21, 23, 25, 28, 30.

Of this species we have only one very large specimen, 180^{mm} in diameter, from st. 36 (61° 50' N. Lat. 56° 21' W. L. 1435 fathoms, bottom temperature 2°), the Davis Strait. Unfortunately it is very badly preserved, so that the description cannot be complete, and no figure can be given of the whole animal. So many characters may, however, be distinguished in the animal before us, that genus and species can be recognised with certainty. — With regard to the generic characters see above p. 64—65.

The structure of the test cannot be described completely, as the whole actinal side is torn; the abactinal side, on the other hand, is whole, and permits an examination of the form of the plates (Figs. 5—6). The ambulacral areas (Fig. 5) are uncommonly broad, a little broader than the interambulacral areas. The primary ambulacral plates are angularly bent, with their top turned towards the ambitus; the outer half is a litte narrower than the inner one. The secondary ambulacral plates are particularly well developed, especially the outer one which reaches quite to the edge of the ambulacral area. Near the apical area the inner accessory ambulacral plate reaches quite to the median line where it adjoins the point of the primary ambulacral plate from the opposite side. Thus the primary ambulacral plates of the same side are here quite separated. The pores of the accessory plates are situated near the boundary line between the plates, the pore of the primary ambulacral plate is placed about under that of the inner accessory plate. Also the interambulacral plates are angularly bent, but in a direction contrary to that of the ambulacral plates (Fig. 6).

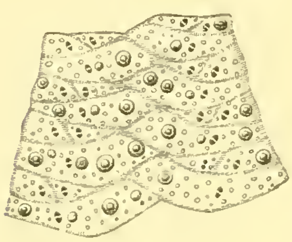


Fig. 5.

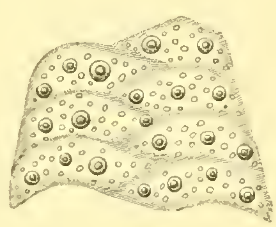


Fig. 6.

Piece of ambulacral and interambulacral area of *Tromikosoma Koehleri* (1/1). In the animal the boundaries between the plates are white, the plates of a bluish gray.

The primary spines are placed rather scattered and irregularly. On the actinal side, near the ambitus, 3—5 large spines are found, ending in a large, white hoof (Pl. XIV. Fig. 30); (this, I suppose, applies to all of them, but they were all broken, and the hoofs torn off were at the bottom of the glass in which the animal was kept.) They are not placed in regular series, in the ambulacral areas only one is found in each plate, in the interambulacral areas two in each plate. The areoles are rather large, but widely separated, forming no horizontal series. The whole actinal side is otherwise rather closely set with fine secondary spines. The peristome is closely set with shorter, somewhat club-shaped, in the lower part skin-covered spines, which are — at all events some of them — provided with a little hoof in the point narrower than the spine (Pl. XIV. Fig. 28). The hoof, as is commonly the case, is of another structure than the spine, being smooth, compact, while the spine (at all events in the lower part) is tubiform, and provided with thorny ridges; the hoof is very distinctly limited, so that it looks like a little joint on the end of the spine. (Also the hoof of the large spines is sharply limited from the other part of the spine (Pl. XIV. Fig. 30), being placed like a cap on the point.) — It cannot be decided, whether the spines of the peristome are placed in concentric circles, but I think it probable. On the abactinal side the rather numerous primary spines are irregularly scattered over the whole surface, not arranged in series (Figs. 5—6). A great many miliary tubercles carrying small spines or pedicellariæ, are scattered over as well the ambulacral as the interambulacral plates.

The structure of the spines is as usual. The small ones are regular, perforated tubes ending in a fine point; no thorns seem to be found on them. The large spines with the hoofs are constructed in a more complicated manner. The longitudinal ridges are very prominent, narrow, widened in the outer end, and a little hollow on the outside; in transverse sections they are T-shaped. Between these ridges connecting beams are often developed, so that a rather complicated reticulation is formed; towards the central hollow the boundary is regular. The small abactinal spines have little conspicuous longitudinal ridges, not widened along the outer surface (Pl. XI. Fig. 2, a—c).

The apical area resembles that of *Hygrosoma luculentum*, which has heen figured by Agassiz (Chall. Ech. Pl. X. a. Fig. 3); but the form of the plates is otherwise only seen with difficulty.

The tube feet are placed in one irregular series on the actinal side; on the abactinal side they are placed alternally two opposite each other, and one single, as is shown by the pores in Fig. 5; most frequently the inner one of the two placed at the same height (the one in the inner accessory ambulacral plate) is somewhat larger than the others. The spicules are irregular, net-shaped plates; they may be exceedingly complicated, and are not arranged in longitudinal series, but inclose the whole foot. They are placed in 2—3 layers; in the tube feet of the abactinal side the inmost layer consists of larger, perforated plates, the outermost one of irregularly branched spicules (Pl. XI. Fig. 13), in the tube feet of the actinal side the whole thing forms a complete confusion of net-shaped plates. No sucking disk is developed.

The sphæridiæ (Pl. XIV. Fig. 12) are of the common form, and, as is commonly the case in the Echinothurids, are placed along the series of tube feet quite up on the abactinal side.

The pedicellariæ: The tridentate pedicellariæ occur in two different forms, not, however, sharply distinguished. In the larger form (Pl. XII. Fig. 41, Pl. XIV. Fig. 21), the head of which reaches a length of up to $3{\cdot}5^{mm}$, the blade is filled by a very complicated net of meshes rising into strong thorns, partly arranged in series; it is somewhat widened in the point, more narrow in the middle, but the edges, which are here coarsely serrate, are not involuted. The valves are rather wide apart, when the pedicellaria is shut. The neck is very short, the stalk of the common structure. In the smaller form the blade is almost of the same breadth throughout its whole length, not widened in the point; it resembles very much the form found in *Phormosoma placenta* — which is, no doubt, as well the most frequent as the simplest form of tridentate pedicellariæ in the Echinothurids — but the widenings of the upper end of the apophysis reach quite to the edge of the blade, they do not end down on the side as in *Ph. placenta*. In the bottom of the blade there is a not very much developed reticulation, in the smallest ones almost none is found (Pl. XII. Fig. 22), in the larger (Pl. XIV. Fig. 16) it is more developed, in the largest ones even with a short, prominent, serrate crest, thus forming a transition to the large form. In the small ones the valves join completely, when the pedicellaria is shut; the edge is finely serrate; the neck is rather long, the stalk of the common structure.

In the triphyllous pedicellariæ the cover-plate is rather little developed; the outer edge is finely serrate (Pl. XII. Fig. 31); upon the whole they show no great difference from the common form. On the other hand the ophicephalous pedicellariæ are very peculiar (Pl. XIV. Figs. 19, 23, 25). The valves are highly constricted in the middle, the outer part widens suddenly to the same breadth as below, so that the blade is somewhat widened in a wing-shaped manner. The edge is thick and strongly serrate; the middle part of the blade is deep and perforated, the wing-shaped widenings flat, without holes. The arcs below the articular surface peculiar of the ophicephalous pedicellariæ, are well developed. The neck is short — contrary to the ophicephalous pedicellariæ of the Echinids — and it seems to contain only longitudinal muscles. The stalk is quite different from that of the other pedicellariæ: a wide tube with rather few, small holes, somewhat widened above, but not below, only are the holes here placed more close together than in the other part of the stalk. The length of the head is ca. 0·5^{mm}, that of the stalk ca. 3^{mm}. They are only (?) found on the abactinal side.

The colour is gray with a slight indication of violet; in the living animal the colour was about the same as in the preserved one. The spines white.

Besides the species here described, at least one more species of the family of Echinothurids is found in the northern Atlantic; Agassiz in Blake -Echini (9) p. 35 mentions a specimen of *Phormosoma uranus* from the Faröe Channel; and on the basis of this statement Bell (73) and Hoyle (202) mention *Phormosoma uranus* among the Echinids occurring in the British seas. Also Sladen (367. p. 701) mentions *Ph. uranus* from the south west coast of Ireland, as he finds a specimen before him agreeing with the figures and descriptions of Wyv. Thomson and Agassiz. According to what has been stated above (p. 58) with regard to *Phormosoma uranus*, it is impossible to know with certainty, whether the specimens that Agassiz and Sladen have had, have really been *Phormosoma* (*Echinosoma*) *uranus* and not *Hygrosoma Petersii*. As no specimen of these two species has been obtained by the Ingolf -Expedition, I shall give no thorough description of them, but only refer to what has been said above of these species. Otherwise it may be taken to be probable that both these species and also the *Aræosoma Belli* hitherto only known from Barbados, are found in the northern Atlantic on the slopes towards the deep, and belong to the wonderfully rich archibenthal fauna, peculiar to the smaller depths along the European and American coasts and across the Atlantic, south of Iceland. The three mentioned species are therefore included in the following table of the North-atlantic Echinothurids.

Table of the Echinothurids occurring in the Northern Atlantic.

1. The primary spines on the actinal side straight, inclosed by a thick bag of skin; great difference between the actinal and abactinal sides. The tube feet on the actinal side in one series. Only tridentate and triphyllous pedicellariæ, the former simply leaf-shaped .... *Phormosoma placenta* Wyv. Thomson.

   The primary spines on the actinal side curved, ending in a larger or smaller hoof .... 2.

2. The tube feet on the actinal side in a single, almost regular series; the test very soft	3.
The tube feet on the actinal side in three more or less separated series	5.
3. Ophicephalous pedicellariæ are found	*Tromikosoma Koehleri* Mrtsn.
Only tridentate and triphyllous pedicellariæ	4.
4. The tridentate pedicellariæ simply leaf-shaped	*Echinosoma uranus* (Wyv. Thomson).
The tridentate pedicellariæ with much involuted blade, the point widened in a spoon-like manner with straight, finely serrate edge	*Hygrosoma Petersii* (A. Agass.).
5. The three series of tube feet rather close together; the ambulacral areas of the common structure; the tridentate pedicellariæ not simply leaf-shaped. The hoof small	6.
The three series of tube feet widely separated; the ambulacral areas on the actinal side formed by 8 series of plates. Tridentate pedicellariæ simply leaf-shaped, the largest ones with a rich, thorny net of meshes filling the blade. The hoof large	*Sperosoma Grimaldii* Koehler.
6. The large tridentate pedicellariæ with much involuted edge; the widened part of the point finely, but irregularly serrate in the edge; the smaller tridentate pedicellariæ of a similar structure	*Calveria hystrix* Wyv. Thomson.
The large tridentate pedicellariæ with much involuted edge; the widened part of the point is deeply and coarsely indented in the edge. Tetradactylous pedicellariæ may be found	7.
7. The smaller pedicellariæ with the widened part of the point coarsely sinuate in the edge	*Aræosoma fenestratum* Wyv. Thomson.
The smaller pedicellariæ with the widened part of the point of the blade straight and finely serrate in the edge. Moreover a very large form is found with coarsely indented edge	*Aræosoma Belli* Mrtsn.

Fam. Temnopleuridæ.

Hypsiechinus n. g.

The test generally without distinct grooves or furrows; no distinct slits in the edge of the mouth. The buccal membrane covered with large plates; all the buccal tube feet are generally well developed in the adult individuals. None of the ocular plates reaches quite to the periproct, which is covered by one large plate and several small ones. The pores are trigeminate, but placed in an almost straight line; only in the lower part of the areas they are distinctly seen to be trigeminate. The spines are rather highly thorny, those nearest to the peristome curved. The globiferous pedicellariæ without any neck; the blade with simple edges, not connected by cross-beams; 2—3 teeth on either side. The spicules irregular, three-radiate. The auriculæ are formed as two narrow crests, not joining above.

This little Echinid recalls to some degree *Prionechinus* A. Ag., and together with the latter genus and the genera *Trigonocidaris*, *Temnechinus*, and *Cottaldia* it may be taken to form a special group of the Temnopleurids. I shall not, however, here enter into a nearer examination of the classification of the Temnopleurids, as I have not yet studied this question sufficiently, but shall only make some observations with regard to the mentioned genera, which I have had occasion to examine. Especially *Prionechinus* and *Cottaldia* stand in need of a more thorough description than has hitherto been given, and I have in British Museum seen the type specimens of both of these genera.

Prionechinus sagittiger A. Ag. According to Agassiz only badly preserved specimens of this species are found in the collections from «Challenger». I have, however, seen a very well preserved specimen from st. 218, and the figure (Chall. Ech. Pl. VI. a. Fig. 11) of the whole animal given by Agassiz is, I suppose, taken just from this specimen. Further I have seen a specimen from st. 207, determined as *Prionechinus sagittiger*; it is, no doubt, a quite different genus. The specimen from st. 218, which corresponds to the habitus figure of this species given by Agassiz, must then be considered as the type of it.

«There is but a single row of plates of pores of equal size in the ambulacral zone», it is said in the description (Chall. Ech. p. 109). I do not understand the meaning of this sentence; according to my observations the ambulacral areas show no unusual structures. — It is further said in the description that «the pairs of large pores are arranged in a single vertical row», and according to Pl. VI. a. Fig. 14 there are only two pairs of pores for each ambulacral plate. This does not at all hold good with regard to *Prionechinus*; first this figure is no doubt drawn from the specimen from st. 207, in which the pores are really very large and form a straight line, and secondly the figure is incorrect — also in this specimen 3 pairs of pores are found for each ambulacral plate. In the real *Prionechinus* the pores are very small, and only one pore for each tube foot is seen distinctly. There are as usual three pairs of pores for each ambulacral plate. — «In all the buccal plates the tentacle of one of the pairs is rudimentary or even wanting». The meaning of this indistinct sentence is that in each pair of buccal tentacles one is rudimentary or wanting; it is seen on the Fig. 12 of Agassiz — and in the specimen from st. 207. Perhaps this fact also applies to *Prionechinus*; it is now and then found in *Hypsiechinus*, so that the feature is not at all unique. The peculiar spines resemble those of *Hypsiechinus*, but they are not curved. The spicules are bihamate, but very few, in most of the tube feet none are found. The sucking disk is typically developed. — «The pedicellariæ are numerous —; they are all of the large-headed slender-stemmed form»; Agassiz gives no more informations of the pedicellariæ, and no figures are given. The four usual kinds of pedicellariæ are found. The globiferous ones (Pl. VII. Fig. 29) have only one, unpaired lateral tooth on the blade, the edges of which are thick, not connected by cross-beams. The poison glands are very small, not reaching to the basal part of the valve. The tridentate pedicellariæ have rather strong teeth in the point of the blade (Pl. VII. Fig. 21); along the median line of the blade the holes are large, lengthened; no net of meshes in the bottom. Only the points of the valves join when the pedicellaria is shut; below they are wide apart. The neck rather long. The ophicephalous pedicellariæ are of the common structure resembling those of *Hypsiechinus*; they are short-necked. The triphyllous pedicellariæ are very small, with finely serrate edge (Pl. VII. Fig. 25). The stalk of the pedicellariæ consists of longitudinal fibres connected by cross-beams to a compact reticulation, as in *Hypsiechinus*.

That the specimen from st. 207 is no *Prionechinus* has been stated above; unfortunately it is impossible to decide with certainty what it is, as all the pedicellariæ are wanting. The spicules are bihamate; the tube feet are remarkably broad at the base, corresponding to the uncommonly large pores. The spines are of the same structure as in *Prionechinus*. As no sufficient characters can be given of this form, I shall give it no name, but only separate it from *Prionechinus*.

From the Indian Ocean another species of *Prionechinus* has been described, *Pr. Agassizii* Wood-Mason & Alock (441); whether it really belongs to the genus *Prionechinus* cannot bee seen from the description, and no informations are given of the pedicellariæ or spicules; no figure is given. As the original description of the genus *Prionechinus*, as here shown, is anything but good and faultless, the referring to this genus must be considered uncertain, until a closer examination has been made with regard to the characters pointed out here.

Cottaldia forbesiana A. Ag. To the description of Agassiz I can add the following informations. The globiferous pedicellariæ (Pl. VII. Fig. 32), like those of *Prionechinus*, have only one, unpaired lateral tooth, and the edges of the blade are thickened, but not connected by cross-beams; the basal part is somewhat more rounded than in *Prionechinus*. The tridentate pedicellariæ (Pl. VII. Fig. 22. Pl. VIII. Fig. 33) resemble those of *Prionechinus*, but have only small teeth in the point of the blade. The valves join only with the points, and are wide apart below, when the pedicellaria is shut. The neck very short. The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 26) resemble those of *Prionechinus*. The stalks of the pedicellariæ are of the same structure as in *Prionechinus* and *Hypsiechinus*, only a little more dense. The spicules, as shown by Bell (50), are bihamate. The spines are thicker and not so sharply serrate as in *Hypsiechinus*, but the point is constructed as in the latter, only more rounded. — Whether this species really belongs to the genus *Cottaldia*, which has been established by Desor for some small fossil Echinids, must be regarded as very doubtful, as has also been observed by Agassiz himself. Upon the whole the referring of recent forms to genera established for fossil ones, is exceedingly problematic, if the tests do not show particularly characteristic features. It has even proved impossible to classify the recent species correctly after the tests and spines only, as has been shown above with regard to the Cidarids and Echinothurids, and it will be shown below that the fact is quite corresponding with regard to Echinometridæ and Triplechinidæ. Pomel (324) refers this species to the genus *Arbacina* established by him. As the type of this species he[1]) gives *Arbacia monilis* (Ag.) that is to say, a fossil form, and here the same observation holds good as with regard to *Cottaldia*: we cannot prove at all that the recent form is the same genus, as we want the most important characters. It must be admitted, however, that *A. forbesiana* shows really a great

1) Revue des Échinodermes et de leur classification p. XLI. 1869 (?).

resemblance in the structure of the test to *A. monilis* (comp. Chall. Ech. Pl. VII. Fig. 15 with Pl. XVIII. Fig. 12. a in Desor: »Synopsis des Échinides fossiles«, or with Pl. XV. Fig. 11 in Agassiz and Desor: »Catalogue raisonné«), and so I shall establish no new genus for this form, but for the present let it remain in the genus *Arbacina*.

Trigonocidaris albida A. Agass. The globiferous pedicellariæ (Pl. VII. Fig. 31) chiefly as in *Arbacina*, a single cross-beam may, however, be found between the edges of the blade; the poison gland large reaching almost to the articular surface. I have found no tridentate pedicellariæ in the specimen before me. The ophicephalous pedicellariæ are short-necked, with no special peculiarities. The triphyllous pedicellariæ are very small and of a rather peculiar form (Pl. VII. Fig. 23). The blade is rather broad, round, the edge exceedingly finely serrate (the serrations can only be seen under rather higher magnifying powers than those under which the figure is drawn). The spicules are bihamate (Pl. VII. Fig. 28), very few. The spines are constructed after the same type as those of *Hypsiechinus* and *Prionechinus*; the primary spines round the mouth are curved.

The difference between *Trigonocidaris* and *Prionechinus* seems to be very slight. The most important one seems to be that *Prionechinus* has no such grooves in the test as those of *Trigonocidaris*. To be sure, Agassiz does not mention the feature at all, and neither have I examined myself how the facts are in this respect; but I think that the very fact of none of us having observed such grooves, may be taken as a proof that they, at all events, are only slightly developed; if this was not the case they would certainly have been observed.

Whether *Trigonocidaris monolini* A. Ag. is a real *Trigonocidaris* cannot be decided after the one known specimen. Only ophicephalous and triphyllous pedicellariæ are found on it, and they show nothing remarkable; the latter are of the same peculiar form as in *Trigonoc. albida*, but the edge does not appear to be serrate, even under the highest magnifying powers. The ophicephalous ones are short-necked, and the stalk is constructed as in the other forms mentioned here. The spicules are bihamate, rather small and numerous (Pl. VII. Fig. 27). To be sure, this very peculiar Echinid will easily be recognised, even if our knowledge of its pedicellariæ is deficient.

Temnechinus maculatus A. Ag. The buccal membrane, as stated by Agassiz, is quite naked with the exception of the buccal plates; but it does not seem to have been observed that it contains a great many bihamate spicules. Also the spicules of the tube feet are bihamate. Koehler (229) has described the ophicephalous and globiferous pedicellariæ, not, however, with a sufficiently exact representation of the characteristic structure of the latter. The ophicephalous pedicellariæ are long-necked; Koehler thinks the valves to be uncommonly long, which does not appear to me to be the case; at all events they show no peculiar structure. The globiferous pedicellariæ, on the other hand, are very peculiar and interesting. The small poison glands are double, and separated through their whole length (Pl. VIII. Fig. 7), a feature which was hitherto quite unknown in the Echinids, but which I have also found in *Parasalenia* and »*Strongylocentrotus*« *erythrogrammus*. Whether this feature is a primitive one, is, I think, to be regarded as doubtful; at all events neither *Temnechinus*, *Parasalenia*, nor *Strongylocentrotus* can be regarded as primitive forms. In other Echinids the poison gland, to be sure, has a deep furrow above on the outside, and opens by a double canal into the end-tooth — at all events in *Sphærechinus* (v. Uexküll 406); but this does not appear to me a sufficient proof of the original structure having been a double poison gland. We should then except to find a double poison gland in forms as *Hypsiechinus* and *Parechinus*; in these, however, it is not found — but on the contrary in such specialised forms as the three species mentioned above. More thorough examinations will be necessary in order to decide the question. The histological examinations hitherto made of the globiferous pedicellariæ, have chiefly been directed to *Sphærechinus* and *Echinus acutus*; a much broader base of the examinations is necessary. — The form of the valves is rather peculiar; the basal part is flatly widened, with rather sharp corners, the blade very narrow, almost tubiform, the edges being almost quite coalesced on the inside, so that only a series of small holes are found along the median line and one larger hole at the point; only one unpaired lateral tooth (Pl. VII. Fig. 30). The triphyllous pedicellariæ (Pl. VII. Fig. 24) are very small and resemble those of *Trigonocidaris*; no teeth are found in the edge.

Agassiz originally described this species under the name of *Genocidaris maculata*, later he thought that it ought to be referred to the genus *Temnechinus*, established by Forbes[1]) for some fossil forms with rather deep grooves in the sutures. The present species, however, has no such grooves; Agassiz also admits that it shows »very marked differences from the species of *Temnechinus* figured by Forbes (Rev. of Ech. p. 286). But when the structure of the test is not the same in the fossil species and the recent one, we cannot be warranted in classing them together; even if the structure of the tests was identical, we might doubt whether they were the same species, for, as has constantly been shown by these examinations, identical structure of the test is no proof of near relationship. But when the structure of the test is so different, as the case is here, there can be no question of classing them together. Nor does it show any nearer relation to *Opechinus* Desor, to which genus it, according to Agassiz (Rev. of Ech. p. 286), is closely allied ; *Opechinus* is a genuine Temnopleurid with deep grooves in the sutures. I must completely assent to the opinion of Pomel that this form ought to keep its original name of *Genocidaris maculata*.

This little Echinid, which was hitherto only known from the American side of the Atlantic and the Azores, is also found in the Mediterranean. In our museum four specimens of it are found taken at Syracuse on a depth of 12—15 fathoms by Dr. H. I. Hansen in 1893. Another species, *Temnechinus*» *Scillæ*, from the Red Sea, has been described by Mazzetti (277—78).

By the name of *Arbacina Pallaryi* Gauthier (162) has described a little Echinid from the coasts of Algeria, but it cannot be seen from the description and the figures where this form is to be referred. Prof. Pallary has most kindly sent me some specimens of it, among others three which have been determined by Gauthier himself as *A. Pallaryi*. They proved to be *Genocidaris maculata*; thus the name of *Arbacina Pallaryi* may be struck out as a synonym. That it has no relation to the genus *Arbacina* is sufficiently evident from the fact that in *Arbacina* the base of the tubercle is smooth, as is expressly stated by Agassiz, Desor, and Pomel, and shown in the figures of *A. monilis* quoted above. But it is quite incredible that a form with a stellate tubercle-base should be of the same genus as the mentioned *Arbacina* with smooth tubercle-base.

It seems to be unquestionable that *Hypsiechinus* is most nearly related to the forms here mentioned; its spines, buccal membrane, and structure of the test reminds very much of those, especially

1) Monograph of the Echinodermata of the British Tertiaries. 1852.

Prionechinus and *Trigonocidaris.* Nevertheless its peculiar spicules and globiferous pedicellariæ show that the relation is not so very close. The globiferous pedicellariæ are quite similar to those of *Echinus miliaris*, but there can be no question of any nearer relation to this latter. On the other hand this form of pedicellariæ might indicate that it is a more primitive form than the other genera here mentioned, in which the globiferous pedicellariæ have only one unpaired lateral tooth. Also the spicules indicate that it is a more primitive form; bihamate or similar regular spicules are otherwise found in all «*Echinidæ*» and «*Echinometridæ*» (with the exception of *Stomopneustes*), but are wanting in *Cidaridæ*, *Salenidæ*, *Diadematidæ*, *Echinothuridæ*, and *Arbaciadæ*, where only more or less irregular fenestrated plates or thorny bows are found (Bell 50). Without entering on a nearer discussion of the relationship of these forms, I shall here only give a table of the mentioned genera, which may, I think, be of practical importance, as it is evident that these small forms have occasioned some difficulties to the systematists. A facilitation of the determination will, I hope, lead to the discovery of more related forms that may, no doubt, be found in the large, hitherto only little known tracts of the ocean. That *Genocidaris maculata* has hitherto been overlooked in the Mediterranean, or at all events misjudged, although it is, no doubt, rather commonly found in the Strait of Messina, presages that we may still expect many new discoveries of these interesting small forms.

Table of the Genera.

1. The buccal membrane outside of the buccal plates covered by large plates..	2.
— — — — — — — naked	4.
2. The globiferous pedicellariæ with the edges of the blade sharp, not connected by cross-beams; several lateral teeth on either side. The spines strongly thorny, those around the mouth curved; the spicules a little irregular, three-radiate, not bihamate	*Hypsiechinus.*
The globiferous pedicellariæ with the edges of the blade thickened, with only one unpaired lateral tooth; the spicules bihamate....................	3.
3. The test much grooved..........................	*Trigonocidaris.*
— — not —	*Prionechinus.*
4. The globiferous pedicellariæ with the edges of the blade almost quite coalesced on the inside, so that only a series of small holes is left. One very large anal plate..........................	*Genocidaris.*
The globiferous pedicellariæ with the edges of the blade thickened, but not connected by cross-beams. No very large anal plate....................	*Arbacina.*

10. **Hypsiechinus coronatus** n. sp.

Pl. V. Fig. 1. Pl. VII. Figs. 1—20. Pl. VIII. Figs. 5, 9, 15, 17, 18, 24, 25, 38. Pl. XI. Fig. 6.

The test is flattened, more than twice as broad as high (the remarkably raised apical area not included); the outline most frequently beautifully round, sometimes a little pentagonal. It is not curved inward at the edge of the mouth. The mouth-slits indistinct, the peristome large. The apical area is large, in ♂ and young specimens slightly raised, in the adult ♀ so much raised as to form a very conspicuous knob (Pl. VII. Figs. 1—4). When both the peristome and the apical area are wanting, the test resembles a little ring.

Diameter.	Height (apical area not included).	Diameter.		Greatest Breadth.		Number of plates.		Longest spines.	Sex.
		Peristome.	Apical area.	Ambulacral area.	I.-Ambulacral area.	Ambulacral area.	I.-Ambulacral area.		
9	3·5	4	5	2	3·5	8—9	7		♂
9	4	4	4·2	2	3·2	8	8		♂
8	3·5	4·5	4					7	♂
8	3·2	4	3·5	1·5	3	8—9	7—8		♀
8	3·5	3·5						5—6	♀
6·8	2·5	3·5	2·5	1·2	2·5	8—9	7—8		♀
4	1·8	2·5	2·2	1	1·8	5—6	5—6		
3	1·8	2	2					4	

All the measures are in millimetres.

The interambulacral areas are about twice as broad as the ambulacral ones; the boundaries between the plates are very indistinct, especially in the ambulacral areas; they are given too distinctly in the figures (Pl. VIII. Figs. 24—25). Near the apical area the ambulacral plates are single, farther down they are coalesced in the common way, three and three. Here one larger tubercle is found for each compound plate, and besides some quite small ones above each primary tubercle. The ambulacral plates are comparatively high, so that upon the whole the same number of ambulacral and interambulacral plates is found. The pores form almost a straight line, but are in reality trigeminate, which fact, however, is not distinct in the upper part of the area; the upper hole of each pair of pores is larger than the lower one. The interambulacral plates, especially above, are rather broad, the horizontal boundary line between the plates bends downward in the middle; the median line of the area is only slightly sinuate, likewise in the ambulacral areas. Each interambulacral plate has a not very conspicuous primary tubercle near the sinuate lower edge and besides some miliary tubercles. In ♂ the upper plates are almost smooth, in ♀ these plates are very richly provided with miliary tubercles. In the adult ♀ the test most frequently has an irregular, grooved-netshaped surface, especially between the close-set tubercles on the upper interambulacral plates.

The primary spines are in the adult specimens hardly as long as the diameter of the test, in small specimens somewhat longer than the diameter; the spines around the mouth are somewhat curved in the point. All the spines are strongly indented, and end in a little, conical point, surrounded by ca. 6 smaller points (Pl. VIII. Fig. 9); the actinal spines end irregularly truncate, presumably owing to wear (Pl. VIII. Fig. 17). In transverse sections (Pl. XI. Fig. 6) the spines are seen to consist of 6 longitudinal ridges the outer edge of which is somewhat widened; they are united with each other so as to form a little cavity in the middle, and 6 smaller cavities in a circle round this.

The buccal membrane is covered by large plates, which under the microscope are seen to be common, almost smooth fenestrated plates. Those inside of the buccal plates are smaller and quite smooth, and the plates decrease likewise in size towards the edge of the peristome (Pl. VII. Figs. 11, 15). The buccal plates are more complicate, and form a little arch, as it were, over the base of the tube foot, with the opening directed towards the mouth. The two buccal tube feet are not placed in quite the same line, but one a little outside of the other; this is most distinctly seen in younger specimens, and in quite small young ones of a diameter of up to 2—3^{mm} only one tube foot of each pair is developed at all. Also in a single specimen of a diameter of 6^{mm} only one tube foot of each pair of mouth-feet is developed; sometimes it may also be seen that one tube foot is quite wanting in one pair, rudimentary in another, while both the tube feet are well developed in the other pairs. — A similar feature is found, as stated by Agassiz, in *Prionechinus*, or, at all events, in a form by Agassiz wrongly referred to *Prionechinus* (see above p. 82—83). Spicules are not found in the buccal membrane, the small gills contain the common irregular calcareous plates (Pl. VII. Fig. 12), only, however, in the basal part; spines or pedicellariæ are not found on the buccal membrane.

The apical area is very peculiar, especially in ♀ — a well marked sexual difference being found. In ♂ the apical area is only slightly raised in the middle (Pl. VII. Fig. 9); the ocular plates are small, all widely separated from the periproct, the genital plates are much larger, truncate, rather regularly septangular, only the boundary line towards the ocular plates somewhat curved. Each genital plate has one rather strong tubercle or a pair of such tubercles at the inner edge, the ocular plates are quite smooth, or more rarely with a few, very small miliary tubercles. The genital pore is very small, situated about in the middle of the plate. The madreporite is very little conspicuous, has only few (2—3) pores. The periproct is covered by one larger plate and some smaller ones; in quite small specimens the large plate covers the whole periproct.

In ♀ the mutual relation of the plates is chiefly the same as in ♂, but the ocular plates and especially the genital ones have been very much elongated and bent upward, so that the whole apical area is raised like a knob. The lower part of the genital plates and the ocular plates in their whole extent are quite smooth, but the inner (upper) part of the genital plates is very richly set with tubercles forming, as it were, a crown round the upper edge of the knob (Pl. VII. Fig. 1). The periproct as in ♂, without tubercles. The genital pores are large, and situated nearer to the outer (lower) edge.

Of pedicellariæ only three kinds are found: globiferous, ophicephalous, and triphyllous pedicellariæ. Tridentate pedicellariæ are wanting — at all events in the specimens in hand. The globiferous pedicellariæ (Pl. VII. Figs. 19, 20) remind very much of those in *Echinus miliaris*. The upper ends of the apophysis continue directly in the edges of the blade, which are sharp and run out into 2—4 teeth on either side; there are no cross-beams connecting the edges across the hollow inside of the blade; the end-tooth especially large, of the structure typical in the Echinids. The glands are quite small reaching only to the basal part; no neck. The ophicephalous pedicellariæ (Pl. VII. Fig. 18, Pl. VIII. Fig. 38) have a quite short neck, but otherwise they do not, any more than the triphyllous pedicellariæ (Pl. VII. Fig. 16), show conspicuous peculiarities. It is, however, to be noted that in the triphyllous pedicellariæ the edge is quite smooth. — The stalks of the pedicellariæ consist of longitudinal fibres connected by cross-beams to a rather compact reticulation; they are not hollow; they increase evenly in strength downward, but are not widened at the base. — The sphæridiæ (Pl. VII. Fig. 17) show no marked peculiarities; they are slightly spinulous in the point, short-stalked, often somewhat irregular, and more globiform than the figured one.

The tube feet have a typical sucking disk, as in an *Echinus*, but generally there are only three leaves in the rosette (Pl. VII. Fig. 10). In the mouth feet the sucking disk, as in an *Echinus*, is an oval, continuous ring, of a far more complicate structure than the parts of the sucking disk in the other tube feet. The spicules (Pl. VII. Fig. 13) are small three-radiate, somewhat irregular bodies. In the lower part of the tube feet almost none are found, nearest to the sucking disk they are more numerous, and are here often a little branched and larger. No spicules are found in the skin at the base of the spines, nor in the genital organs.

The dental apparatus is of the structure common in the Echinoids; on the other hand the auriculæ are peculiar, only consisting of a pair of small processes, not joining above. None of the specimens in hand show indication of any coloration.

This little Echinid is especially interesting by nursing its brood — a fact hitherto unknown among the regular Echinids, with the exception of two Cidarids: *Stereocidaris nutrix* and *canaliculata*. As mentioned in the description there are in ♀ a great many tubercles on the upper coronal plates, and on the upper edge of the genital plates. The spines of these latter are bent downwards thus joining those of the upper coronal plates. By this means a protected space is formed round the knob-like process; the genital apertures open into this space, and here then the eggs and young are placed protected by the spines (Pl. VII. Fig. 5). The number of the eggs varies from 3—7; they are about $0{\cdot}5^{mm}$ in diameter. Sometimes they are all in the same stage of development, sometimes may be found in the same individual almost quite developed young and eggs or embryos where the first skeletal structures have not yet been formed.

It was not possible, by means of the material in hand, to study the whole development of the young, only a few stages have been given (Pl. VII. Figs. 6—8). In the youngest stage (Fig. 6) the first beginning of the teeth is seen; the buccal plates are begun, and the primary tentacles may be discerned through a plate, which I take to be the terminal plate (the ocular plate). Between each pair of buccal plates, a little outside, a larger unpaired plate is found, the basal plate (the genital plate?). In the following stage (Fig. 7) the different parts of the dental apparatus are begun, and in some of the buccal plates a larger hole has appeared. In the oldest stage (Fig. 8), in each pair of buccal plates one large opening has been formed for the buccal tube foot, and this feature of only one tube foot being developed, is still found, as mentioned above, in young specimens of a diameter of 2—3^{mm}, and sometimes in still larger specimens. The smallest individuals, in which I have found both buccal tube feet developed, had a diameter of 4^{mm}. In the oldest stage figured, the five primary tube feet are seen distinctly, and the five first spines, interambulacral ones, are begun. In corresponding stages only one large anal plate is found (Pl. VII. Fig. 14), which may be perforated by a larger opening; accordingly it seems quite to encompass the anal aperture.

Of this especially interesting little Echinid several specimens have been taken by the "Ingolf"-Expedition on the following stations:

St. 73	(62° 58′	N. Lat.	23° 28′	W. L.	486	fathoms.	5°1	bottom temp.	Bottom	[?]).	1	specimen.
— 78	(60° 37′	—	27° 52′	—	799	—	4°1	—	Mud.	).	40	—
— 81	(61° 44′	—	27° 11′	—	485	—	5°7	—	?	).	18	—
— 84	(62° 58′	—	25° 24′	—	633	—	4°4	—	?	).	15	—

St. 90 (64 45′ N. Lat. 29° 06′ W. L. 568 fathoms. 4° bottom temp. Mud.). 2 specimens.
— 97 (65° 28′ — 27° 39′ — 450 — 5°1 — —). 3 —

Further three specimens have been taken by Ryder (1888) on 553 fathoms in the Denmark Strait.

Thus this species also belongs to the rich archibenthal fauna of the northern Atlantic; it is scarcely to be doubted that it is also found in other places than in the Denmark Strait and on the ridge south of Iceland.

On the Fam. Echinometradæ Gray and the Subfam. Triplechinidæ A. Agass.

It has been shown in the preceding, how little successful the previous attempts at a classification of the Cidarids and Echinothurids have been. It is still worse with regard to the forms that are to be treated here. In the former only the species and genera were confused; here not only the species and genera, but also the families have been mingled to such a degree, that species which have proved by a closer examination to belong to at least three different families, have been referred to the same genus (*Strongylocentrotus*). The «family» *Echinometridæ* and the «subfamily» *Triplechinidæ* prove to be interwoven to such a degree, that it is impossible to treat each group separately. I have examined almost all the genera and species referred to these groups, and have found the relation between these numerous forms that all look rather uniform, to be widely different from what has formerly been supposed — although these suppositions have otherwise been sufficiently different.

The earlier attempts at a classification of the forms belonging here, have been put together by Lütken, to whose paper I shall only here refer[1]). Gray is the first author, who has tried to arrange the genera into families; he establishes the following system[2]):

Fam. Hipponoidæ. The ambulacral areas as broad as the interambulacral areas; the pores form three separate series. — *Amblypneustes*, *Boletia*, *Hipponoë*, *Holopneustes*.

Fam. Echinidæ. The ambulacral areas half as broad as the interambulacral areas; the pores form arcs of 3. A. With pores at the sutures. *Mespilia*, *Microcyphus*, *Salmacis*, *Temnopleurus*. B. Without pores at the sutures. *Echinus*, *Psammechinus*, *Heliocidaris*.

Fam. Echinometradæ. The ambulacral areas half as broad as the interambulacral areas; the pores in arcs of 4 or more. A. Test round: *Strongylocentrotus*. B. Test oblong: *Echinometra*, «*Holocentronotus*», *Colobocentrotus*.

In the following time repeated attempts have been made to improve the system, but none of these attempts have been very successful. A short survey of these systems is given here.

Troschel (403. p. 297). (No genera are named.)

Fam. Echinidæ. Pores trigeminate; mouth-slits insignificant; no ocular plate reaches the periproct.

Fam. Tripneustidæ. Pores trigeminate, mouth-slits deeper than broad; two ocular plates reach the periproct.

[1]) Bidrag til Kundskab om Echiniderne. Kobenhavn 1864. p. 84 f. (Vid. Medd. Naturh. Foren. Kbhvn. 1863.)

[2]) An arrangement of the families of Echinida, with descriptions of some new Genera and species. Proc. Zool. Soc. 1855. p. 35—39.

Fam. Toxopneustidæ. Pores multigeminate; the test round or pentagonal.

Fam. Echinometradæ. Pores multigeminate; the test elliptical.

Agassiz (Revision of Echini).

Fam. Echinometradæ. Pores multigeminate — *Colobocentrotus*, *Heterocentrotus*, *Echinometra*, *Parasalenia*, *Stomopneustes*, *Strongylocentrotus* (Subgen. *Sphærechinus*, *Pseudoboletia*), *Echinostrephus*.

Fam. Echinidæ. Pores trigeminate. (Subfam. Temnopleuridæ.)

Subfam. Triplechinidæ. *Phymosoma*, *Hemipedina*, *Echinus*, *Toxopneustes*, *Hipponoë*, *Evechinus*.

Bell (40).

Fam. Echinidæ.

Group I. Test round. Echininæ.

α) The ambulacral plates formed of three primary plates. *Echinus* etc.

β) — — — — four or more primary plates. *Strongylocentrotus* etc.

Group II. The morphological axis obliquely to the longitudinal axis. Echinometrinæ.

— III. — — — at right angles to the longitudinal axis. Heterocentrotinæ.

Pomel (324). (In this account of the system of Pomel the fossil genera are omitted).

Les Echinométriens. *Colobocentrotus*, *Podophora*, *Heterocentrotus*, *Acrocladia*, *Echinometra*, *Ellipsechinus*, *Parasalenia*.

Les Héliocidariens. *Strongylocentrotus*, *Toxocidaris* (= *Anthocidaris* Ltk.), *Loxechinus*, *Echinostrephus*, *Stomopneustes*, *Heliocidaris* (= *Evechinus*), *Holopneustes*.

Les Schizechiniens. *Toxopneustes* (= *Boletia*), *Pseudoboletia*, *Hipponoë*, *Sphærechinus*, *Anapesus* (= *Lytechinus* Ag., *Psilechinus* Ltk., *Schizechinus* Pomel).

Les Psammechiniens. *Echinus*, *Psammechinus* (*miliaris* etc.), *Arbacina* (*forbesiana*).

Duncan (132).

Fam. Echinometridæ.

Subfam. Echinometrinæ. *Heterocentrotus*, *Colobocentrotus*, *Echinometra*, *Stomopneustes*, *Parasalenia*.

Subfam. Polyporinæ. *Strongylocentrotus*, *Sphærechinus*, *Echinostrephus*, *Pseudoboletia*.

Fam. Echinidæ. *Echinus* (Subgen. *Psammechinus*), *Toxopneustes*, *Boletia*, *Tripneustes* (Subgen. *Evechinus*).

I. W. Gregory[1]).

Fam. Triplechinidæ. *Echinus*, *Psammechinus*, *Tripneustes* (= *Hipponoë*), *Toxopneustes*, *Boletia*, *Evechinus*.

Fam. Strongylocentrotidæ. *Strongylocentrotus*, *Sphærechinus*, *Pseudoboletia*.

Fam. Echinometridæ. *Echinometra*, *Stomopneustes*, *Heterocentrotus*, *Colobocentrotus*, *Parasalenia*.

[1]) Echinoidea, in «A treatise on Zoology, edited by E. Ray Lankester». Part. III. Echinoderma. London. 1900.

Lambert (238. a).

Fam. Echinometridæ.

Subfam. Echininæ.

Tribus. Oligoporinæ. *Triplechinæ*, *Schizechinæ*.

— Polyporinæ. *Sphærechinæ*. *Heliocidarinæ*, *Acrocladinæ*.

The characters, on which the systems hitherto established have chiefly been based, are: the number of the pores, the breadth of the ambulacral areas, the slits and form of the test. Desor[2]) is the first author, who uses the number of the pores as a principle of division, dividing the forms belonging here into «Oligopori» and «Polypori». In this he is followed by all the later authors (even if they do not use the expressions of «Oligopori» and «Polypori») with the exception of Pomel and Bell. In the essay on the Echinometrids quoted above, Bell has given a thorough criticism of this feature, and has shown that it is by no means a natural principle of division, in spite of the assertion of Agassiz (Rev. of Ech. p. 423) that «this division, although it appears a numerical one, is yet one of great physiological importance, as the mode of growth of the poriferous zone in these two families is totally unlike». I must assert, still more strongly than has been done by Bell, that this division is a quite numerical one, not at all corresponding to the natural relation of the forms. Moreover it cannot be carried through at all, some species having on the lower ambulacral plates (i. e. as young individuals) trigeminate pores, on the others multigeminate ones. Besides the instances mentioned by Bell: *Echinostrephus*, *Strongylocentr. drobachiensis*, *Echinometra macrostoma* and other *Echinometra*-species, I can name «*Strongylocentrotus*» *albus* and *lividus* that have also only three pairs of pores in the lower ambulacral plates. Also in young *Sphærechinus granularis* trigeminate pores may be found in the lower plates, and this feature, I think, may be taken to be found in all polypore forms. When Bell, in his group of *Echininæ*, uses the number of the pores as a base of further subdivision, I cannot agree with him; so much importance is not due to this feature, it can by no means be regarded as more than a generic character, and I should not wonder, if in some cases it should prove to be no more than a specific character. At all events the number of the pores has only slight importance or none at all with regard to the natural grouping of the genera; Pomel seems to be the only author, who has hitherto seen this fact.

The breadth of the ambulacral areas is used by Gray as a distinguishing character. That it is especially unfortunate is shown by the result, as Gray thereby is brought to the uniting of *Amblypneustes*, *Holopneustes*, *Boletia*, and *Hipponoë* into one family, what is absolutely wrong; neither has any author followed him in this respect.

The slits of the test are used by Pomel and Troschel, by the latter, however, only as a subordinate character, the number of the pores being used as the first principle of division, so that only the forms with trigeminate pores are referred to his family *Tripneustidæ*, while *Sphærechinus* and *Pseudoboletia* are referred to the family *Toxopneustidæ*. — Agassiz says of the deep slits of the test in *Sphærechinus* (Rev. of Ech. p. 451): «the presence of deep, sharp cuts in the actinal system ... are simply quantitative characters, the value of which a better acquaintance with the subject will deter-

[1]) Synopsis des Echinides fossiles. 1855.

mine". The better acquaintance, however, does not grant that Agassiz is right, on the contrary we find that we have here an especially important systematic character. All the genera with deep slits of the test agree also in other respects, as will be shown hereafter, and form a separate, distinctly limited group (that is to say in such a way that not all the forms belonging to this group have deep slits of the test, but that all forms with deep slits of the test belong to this group; for in some small forms no doubt belonging here, the slits of the test are not very large). The group of "Les Schizechiniens" of Pomel is completely correct — the only correct thing in all the systems hitherto given.

The form of the test plays a very great part in the previous systems; that all oblong forms belong to the Echinometridæ is considered as a matter of course. Even by Agassiz, who characterizes the family *Echinometridæ* as "having always more than three pairs of pores to each arc", *Parasalenia* is referred here, although it has only three pairs of pores in each arc; but it is oblong, and accordingly it must be an Echinometrid! That the obliquity, however, is a character insufficient for being the base of a family *Echinometridæ*, has been justly emphasized by Agassiz (Rev. of Ech. p. 436). In *Stomopneustes* there is in large individuals an indication of obliquity, and "there are in *Echinometra*, in one and the same species, specimens in which the elongation of the axis cannot be traced". — Already Stewart (381) has called attention to the fact that *Parasalenia* is distinguished from the *Echinometridæ*, to which family most would, I should think, refer *Parasalenia*, in the structure of the spines and the pedicellariæ. According to my examinations that quite corroborate the observations of Stewart, there can be no question of referring *Parasalenia* to the Echinometrids. And so the obliquity of the test must be dropped as a reliable character; not every oblique Echinid can beforehand be taken to be an Echinometrid. That the obliquity is not the same, the morphological axis not being in the same proportion to the longitudinal axis in all the oblique forms, has been shown by Joh. Müller[1]), and again emphasized by Bell (op. cit.), who according to this fact distinguishes between *Echinometrinæ* and *Heterocentrotinæ*.

As consequently none of the characters hitherto used, with the only exception of the slits of the test, have any greater systematic importance, we must seek other characters, by means of which we can set this chaos right. The characters, of which there can be any question, are the following: the structure of the test, the apical area, the spines, the gills, the buccal membrane, the inner anatomical structures, especially the dental apparatus and the auriculæ, the sphæridiæ, the spicules, and the pedicellariæ.

The structure of the test cannot be expected to yield more important characters; if such were to be found they would no doubt have been found long ago, as the attention has hitherto almost exclusively been directed to the form of the test, the arrangement of the tubercles etc. in the descriptions. The systematic attempts mentioned above, show to a sufficient degree of how little value the characters found here are. One feature of not quite small importance is found, however, which seems to have been quite overlooked by almost all later authors, viz. that in several forms only every other ambulacral plate has a primary tubercle, while in others every ambulacral plate is provided with such a one. Only in Lütken (op. cit. p. 87) I have found a remark "that it is not always the case that

1) Über den Bau der Echinodermen. Abh. d. Berl. Akad. d. Wiss. 1853. p. 128.

every (ambulacral) plate has its primary tubercle well developed". He has not, however, used this feature as a systematic character. On the other hand Düben & Koren[1]) and G. O. Sars[2]) have carefully noted this fact in their descriptions, and Koehler (233. a) has recently given prominence to this feature in his description of *Sterechinus antarcticus*.

The apical area, no doubt, shows some difference: sometimes all the ocular plates are shut off from the periproct, sometimes one or more reach to it. That no greater importance can be attached to this feature is a sure fact, which may be seen with especial clearness from a case as that of *Sterechinus antarcticus* (= *Ech. margaritaceus*), where in young individuals all the ocular plates are shut off from the periproct, while in the adult they reach, all of them, to it (Koehler, 233. a).

The structure of the spines does not seem to yield very good systematic characters. Mackintosh (265) has given numerous excellent figures of transverse sections of spines from a great number of species. But I do not think that he has found so great and reliable differences in this feature, that it can be used as a criterion of a nearer or farther relation between the separate forms. Especially I think that a greater variation in the structure of the spines of the same species may be found, than is to be seen from the work quoted. Also the secondary spines of the different species may deserve a nearer examination. Hesse (195. a) has recently made thorough studies of the structure of Echinid-spines, especially the fossil ones. He arrives at the result, "dass fast jede der einzelnen Familien der Echinoideen ihren eigenen mikrostrukturellen Stacheltypus besitzt, und dass die histologischen Verhältnisse der Stacheln ein wichtiges systematisches Kennzeichen für die Familien und in gewissen Zügen von secundärer Werthigkeit oft sogar für die Gattungen, ja für einzelne Arten der Seeigel liefern" (p. 204). He establishes 6 types: *Cidaris*, *Echinus*, *Diadema*, *Clypeaster*, *Scutellidæ*, and *Spatangus*, and if we take the families to be of a corresponding extent, the spines may be seen to yield "family"-characters. The type of *Echinus* comprises both Temnopleurids, Echinometrids, and Echinids s. str. He divides them into two parts, a) with the radial septa not perforated, b) with the radial septa perforated. To the first division belongs among others *Toxopneustes pileolus*, to the second *Hipponoë esculenta* — two forms that are no doubt very nearly related. Such things prove how little value is to be ascribed to this character. Upon the whole it must be said that the structures mentioned by Hesse will scarcely be of any great importance with regard to the recent Echinids; with regard to the fossil ones, on the other hand, they will, no doubt, be of some importance, as we may always from the structure get some instruction with regard to the correct referring of the animal or the single spine, even if it will only in rare cases be possible to get at the genus or the species. — Rothpletz (346. p. 289) says of "Radioli cancellati" (corresponding to the "polycyclic acanthosphenote" spines of Mackintosh): "Nach Agassiz wäre dieser letzte Typus auf die Familie der *Echinometradæ* beschränkt, während der zweite Typus (Rad. radiati) allen übrigen Familien mit Ausnahme der Cidariden und Saleniden zukäme". As far as I can see Agassiz has said no such thing; in Rev. of Echini (p. 654) he says: "In the *Echinometradæ* we find the concentric rings most distinctly developed"; but that is

[1]) Skandinaviens Echinodermer. Vet. Akad. Handl. 1844.

[2]) Nye Echinodermer fra den norske Kyst. Vidensk. Selsk. Forhandl. 1871. p. 23 (in the description of *Ech. depressus* (= *norvegicus*)).

not the same as what Rothpletz has made of it. At all events Hesse is right, when he says that the cancellate structure is only compliciertere Wachsthumserscheinungen an Stacheln seines zweiten Bauplanes, so dass die Stacheln ein und derselben Species, z. B. von *Strongylocentrotus albus* Ag. .... je nach dem Stadium ihrer Verdickung theils zu den Radiaten, theils zu den Cancellaten zu rechnen sein würden (op. cit. p. 192). — To judge by what has hitherto been brought to light, we may scarcely expect to find features of any greater systematic importance in the structure of the spines with regard to the forms treated of here.

The gills will scarcely present peculiarities that may be used as systematic characters of greater importance. They generally contain some irregular spicules and fenestrated plates, which are in the lower part rather large and pass evenly into the plates of the buccal membrane; towards the ends of the branches they become smaller and more irregular, at last only branched calcareous needles. Common bihamate spicules are most frequently found together with these, sometimes in very great numbers (*Pseudoboletia*). *Heterocentrotus* and *Colobocentrotus* are distinguished by having pedicellariæ on the gills (placed on the larger fenestrated plates). In *Stomopneustes* only small three-radiate spicules are found in the gills (Pl. XVII. Fig. 13). — The sphæridiæ are very similar; their shape, number, or position can in no way be used as distinguishing characters between species, genera, or greater groups within this division of the Echinids.

The buccal membrane may be covered with plates, or naked, and this feature has played no small part in the classification, and will also persistently be of importance. It is, however, to be observed that it cannot always be seen directly whether plates are found in the buccal membrane or not. Often it looks quite smooth and naked — as for instance in *Echinus acutus* — but if a piece of it is cleared in potash or Canada balsam, it is seen to be quite full of larger or smaller, simple fenestrated plates; only when these plates carry pedicellariæ they become more complicate, and may then be seen on the dried skin. Thus a microscopic examination is necessary in order to ascertain whether plates are found in the buccal membrane or not. Most frequently among the fenestrated plates more or fewer spicules of the common bihamate form are found. The part inside of the buccal plates generally contains numerous smaller fenestrated plates, arranged more or less radially; these plates are upon the whole more simply constructed than those outside the buccal plates. In several species the buccal membrane is almost or quite naked (with the exception of the buccal plates), for instance *Echinus magellanicus*, *albocinctus*, *Robillardi*. In some species small spines are found on the buccal plates (for instance *Ech. esculentus*), and in *Pseudoboletia*, *Heterocentrotus*, and *Colobocentrotus* spines are even found in the plates of the buccal membrane outside the buccal plates.

The inner anatomical structures are especially little known in the different genera, with the exception of the dental apparatus and auriculæ. These, however, show a so similar structure, that important differences that might be of systematic significance, are scarcely to be found, and as to the other anatomical features, it is still more improbable that here should be found differences of any importance — apart from the fact that it would be very unpractical, if the inner anatomy was to be much used in the classification. Thus we have only left spicules and pedicellariæ — but here we also find what we want.

Perrier[1]) and Stewart[2]) have given informations of the spicules in several genera and species, and especially Stewart thinks that „they will be found to afford most valuable and interesting additional points of generic and specific distinction". I must think it very improbable that good specific characters should be found in the form of the spicules; as far as my examinations reach they are very similar in all the species belonging to the same genus. On the other hand I quite agree with Stewart that the spicules yield valuable generic characters, and even excellent family characters. — The most common type is the simple, c-shaped, „bihamate" form; it is found in *Echinus* and *Echinometra* and the genera more nearly allied to these. In *Strongylocentrotus drobachiensis* and some other *Strongylocentrotus*-species the form is the same, only that here the spicules are a little branched in the ends (Pl. XX. Fig. 12). A very peculiar form of spicules is found in *Toxopneustes*, *Pseudoboletia*, *Sphærechinus*, and upon the whole in the forms with deep mouth-slits. They are dumb-bell-shaped, as two small balls connected by a short bar (Pl. XXI. Fig. 28 etc.). In *Sphærechinus* they resemble more the common bihamate spicules, but they are not at all pointed at the ends. Also a few typical bihamate spicules may be found among the others; this is also the case in *Strongylocentrotus.* Sometimes all possible stages of development of these spicules may be found, from a little ball to the form of the dumb-bell, and farther to the bihamate form (Pl. XXI. Fig. 31). That these forms are really developmental stages can, I think, scarcely be doubted. It is evident that a considerable rearrangement of the mass of lime must take place; but a similar resorption and new deposition of the lime is already known from Théels examinations of the resorption of the larval skeleton in the Echinoderms[3]). The form of spicules mentioned here is an excellent character of the family *Toxopneustidæ* (see below). Another peculiar form of spicules is found in *Parasalenia* and *Anthocidaris*; they are arcuate, with 1—2 small projections in the middle (Pl. XXI. Figs. 30, 32). Stewart calls this form of spicules „biacerate". Also common bihamate spicules are found together with these, but in small numbers. A quite unique form of spicules is found in *Stomopneustes*; they are of two kinds: smaller, irregular fenestrated plates, and large, thorny, perforated tubes that may be a little branched (Stewart. Op. cit. Pl. L. Fig. 1).

The spicules are especially found in the tube feet, but also in the skin round the pedicellariæ (especially the globiferous ones), both on the stalk, the neck, and the head, and round the base of the spines they occur frequently. In the gills and the buccal membrane bihamate spicules are often found together with the more or less irregular fenestrated plates that are commonly found here. Also the inner organs are often richly provided with spicules that may be of a very irregular form, as has been shown by Stewart with regard to *Echinometra.* This, however, is of no practical importance in the classification where regard must chiefly be paid to the regular spicules of constant form in tube feet and pedicellariæ.

With regard to the pedicellariæ we have some good informations, especially in the works by Perrier and Agassiz. From these informations it is evident that an abundance of peculiar structures may be found here which are, no doubt, of great systematic importance. Thus Perrier has

[1]) Recherches sur les Pedicellaires et les Ambulacres des Astéries et des Oursins. Ann. Sc. nat. 5. Série. Zool. T. XII—XIII. 1869—70.

[2]) On the Spicula of the Regular Echinoidea. Trans. Linn. Soc. XXV. 1865.

[3]) Notes on the formation and absorption of the skeleton in Echinoderms. Öfvers. Kgl. Vet Akad. Förh. 1894.

rightly mentioned as a character of the Echinometrids that the globiferous pedicellariæ »se termine(nt) par deux crochets, mais ces deux crochets naissent à des hauteurs différentes, quoique assez rapprochés du sommet du Pédicellaire». Even if Perrier has not understood this feature quite correctly, his figures are sufficiently clear and good. Accordingly no excuse can be found for the later authors, when they have overlooked this excellent character and in stead of it have stuck to the useless ones: the number of the pores and the form of the test. If they had made use of this character, they might have avoided the many systematical errors they have now fallen into. Beyond the peculiarity of the globiferous pedicellariæ of the Echinometrids emphasized by Perrier, no attempts, as far as I know, have been made to find other characters in the structure of the pedicellariæ that might be used for a limitation of larger or smaller groups inside this difficult division of the Echinids. The reason why no such characters have hitherto been found, is partly that far too few genera and species have been examined, partly that the examinations have not been made with sufficient exactness. My examinations have shown that in the structure of the pedicellariæ such peculiarities are found as yield excellent characters, by which the genera may be grouped.

In *Echinus miliaris* and some other species the blade of the globiferous pedicellariæ is provided with a larger or smaller number of teeth on either side; the edge is not thickened, but thin and sharp, and continues directly into the teeth; there are no cross-beams connecting the edges across the inside of the blade (Pl. XVII. Figs. 1, 7). In *Echinus esculentus* a. o. the edges are connected by cross-beams across the inside of the blade; they may be few and narrow, or so strongly developed, that the inside of the blade is almost quite covered with the exception of a series of larger or smaller holes along the median line. One or more pairs of lateral teeth are found placed on the thickened edge, but they do not form a direct continuation of it as in the preceding form (Pl. XVIII. Figs. 2, 3, etc.). — In *Echinometra* and the forms allied to it, as already mentioned, only one large lateral tooth is found on one side (Pl. XIX. Figs. 4, 13), and in *Strongylocentrotus*, *Sphærechinus* etc. no lateral teeth are found at all (Pl. XX. Figs. 14, 16, 26, etc.), only a little obliquity near the point shows that this form must be regarded as a further development of the pedicellaria that is provided with one unpaired lateral tooth, — not so much the strongly modified form in *Echinometra* as the less modified form in *Ech. albocinctus*. Besides these differences in the structure of the valves, also a few peculiarities in the structure of the stalk and in the neck are to be noted. In most genera the stalk consists of numerous long calcareous threads connected with each other by a few cross-beams; in some forms, *Strongylocentrotus drobachiensis* and its nearest relations, it is a thin perforated tube. In most forms the neck is quite short, or, more strictly speaking, quite wanting, in a few ones — also the *Strong. drobachiensis*-group — there is a long neck provided with powerful longitudinal and circular muscles (Pl. XX. Figs. 25. 29).

The other pedicellariæ seem only to contribute little to the limitation of the genera, still less to the characterization of the larger groups; on the other hand the tridentate and ophicephalous pedicellariæ yield often excellent specific characters. The triphyllous pedicellariæ are exceedingly similar, and yield scarcely any sufficiently certain systematic character, with one exception: *Evechinus chloroticus*; in this latter some digitate prolongations pass from the upper end of the apophysis over the blade (Pl. XIX. Fig. 29), a quite unique feature. As a common feature may be noted that the edge is not serrate, and that the apophysis does not widen to a cover-plate, contrary to the triphyllous pedicellariæ of the Echinothurids. All four kinds of pedicellariæ are certainly found in every species; but of some species individuals may often be found, where globiferous or tridentate pedicellariæ (sometimes both forms) are quite wanting or very few in number (for instance *Echinus Alexandri*). This fact, of course, is an unfortunate circumstance, but the value of the pedicellariæ as systematic characters are not otherwise lessened by it.

If we now examine the genera and species referred to »*Triplechinidæ*» and «*Echinometradæ*» with special regard to the features described above, we shall get a view of their relations very different from the views expressed in the above mentioned systems.

The genus *Echinus* is notorious for its difficulty. A great many species have been described, but most frequently the descriptions are insufficient, so that the species cannot be recognized by them. One species, *Ech. acutus*, is very varying, and has occasioned the establishing of a great many »species», which nobody has been able to recognize with certainty, and by which the confusion has only been increased. But even excellently characterized species, as for instance *E. elegans*, have often been confounded with other species, what I have repeatedly been able to substantiate; what is hitherto stated with regard to the distribution of the *Echinus*-species, must accordingly be used with great caution. The reason of all these difficulties is almost exclusively to be found in the literature: an exact examination of the animals themselves shows that the species upon the whole have rather distinct characters.

The following species are referred to the genus *Echinus*: *miliaris* Müll., *microtuberculatus* Blv., *angulosus* (Leske), *esculentus* L., *acutus* Lamk., *norvegicus* Düb. Kor., *Flemingii* Forb., *microstoma* Wyv. Thoms., *melo* Lamk., *elegans* Düb. Kor., *gracilis* Ag., *Wallisi* Ag., *lucidus* Döderl., *Robillardi* Loriol, *darnleyensis* Woods, *magellanicus* Phil., *margaritaceus* Lamk., *horridus* Ag., *Alexandri* Dan. Kor., *albocinctus* Hutton, *diadema* Studer, *Neumayeri* Meissner, *multicolor* Yoshiwara. A great many older names are cited as synonyms to several of these species in Agassiz's »Revision of Echini»; a renewed examination of the type specimens of these »species» with especial regard to the pedicellariæ might perhaps give other results than those of Agassiz; but until such examinations have been made, we must build on the results laid down in »Rev. of Ech.». Of all the above mentioned species, with the exception of *Ech. multicolor*, I have had occasion to examine authentic specimens, of *Ech. horridus*, *Neumayeri*, and *Alexandri* even the type specimens. The result is a considerable reduction of the number of species in the genus *Echinus*, some of the mentioned species being dropped as synonyms, some proving to belong to other genera.

As the type of the genus *Echinus E. esculentus* must be put down, the only one of the species established by Linné. Of its characters the following ones must be mentioned here. Only every other ambulacral plate carries a primary tubercle (in large specimens often 2—3 plates without primary tubercle follow each other). All the ocular plates are shut off from the anal area. The buccal membrane with numerous small and larger plates; spines on the buccal plates. The globiferous pedicellariæ without neck, the blade with a lateral tooth on either side, the edges connected across the inside. The tridentate pedicellariæ (Pl. XVIII. Fig. 20) long, narrow, the edge set with numerous small teeth arranged in transverse series. The stalk of the pedicellariæ consists of long calcareous threads connected by few cross-beams. Spicules bihamate.

With this species must be classed *Ech. melo* and *acutus* (under which *E. Flemingii, norvegicus,* and *microstoma* are to be named as synonyms, the reasons of which will be given hereafter in the description of *Ech. acutus*). They are distinguished from *E. esculentus* by having fewer and longer spines, by wanting spines on the buccal plates, and by the plates in the buccal membrane being fine and quite imbedded in the skin, so that it looks as if the buccal membrane were naked. Further primary tubercles are also here generally wanting in more or fewer interambulacral plates besides in every other ambulacral plate. The difference between *melo* and *acutus* is very slight, they seem only to be differing in form and colour — perhaps they cannot upon the whole be kept as distinct species (for particulars see under the description of *Ech. acutus*). The pedicellariæ and spicules essentially as in *Ech. esculentus.*

Ech. elegans. It seems almost hopeless to attempt to distinguish the species of *Echinus* known as *E. elegans, E. norvegicus, E. melo,* and *E. Flemingii*, Agassiz says (Blake Echini. p. 39), and also Wyv. Thomson classes *Ech. elegans* among the critical species (395. p. 744). In this statement I cannot at all agree with the two celebrated authors. *Ech. elegans* is very different from *Ech. acutus*; the question might rather be of referring it to another genus than of confounding it with *Ech. acutus.* The most essential difference is that it has a primary tubercle on all the ambulacral plates. The globiferous pedicellariæ (Pl. XVIII. Figs. 2—3) have generally two lateral teeth on either side, the tridentate ones are somewhat shorter and broader than in the preceding species, but the edge is also here set with transverse series of small teeth. In some specimens only quite small tridentate pedicellariæ occur of a somewhat other form than the large ones (Pl. XX. Figs. 9, 19), but in other specimens both the small and the large form as well as all transitional sizes are found. Apical area, buccal membrane, and spicules as in *Ech. esculentus.* — The difference here stated between *Ech. elegans* and *acutus* is already seen from the description of Düben & Koren[1]), where it is said that de primära knölarne bilda paa skalet, från anus till munnen, 20 ytterst tydliga, aldrig afbrutna rader, while it is said of *Ech. Flemingii* (p. 267): de 10 rader primära knölar, som upptaga ambulacralplåtarne, äro esomoftast afbrutna; this feature is also emphasized by the authors under *Ech. norvegicus.* To be sure it is not clearly seen in the Latin diagnoses, so that it is perhaps on account of the language that this feature has been overlooked by the later authors[2]) to great injury for the correctness of the determinations; especially *Ech. elegans* may often have been confounded with quite red specimens of *Ech. norvegicus.*

Ech. Wallisi Ag. In the description of this species (Blake-Echini. p. 39) it is said that it is readily distinguished .... by the arrangement of the pairs of pores in sets of two. If this be correct it can scarcely be an *Echinus*, in which genus the pores are always trigeminate; Agassiz himself, however, thinks that it is closely allied to, if not identical with, *Echinus Alexandri*, in which the pores are arranged in the common way. Agassiz further thinks it to be allied to *E. Flemingii* and

1) Skandinaviens Echinodermer. p. 273.

2) Thus in Bell's Catalogue of British Echinoderms it is said of *Ech. acutus*: each of these (the compound Ambulacra plates) has a large primary tubercle set about the middle of each plate. p. 146.

E. elegans; according to what has been stated above it cannot be closely allied to both these species, and no inference can be drawn from the quite insufficient description that is not even accompanied by figures. From U. S. National Museum I have received a specimen on loan, determined as *Ech. Wallisi.* It is a large, fine specimen of *Ech. elegans* (only with somewhat shorter spines and higher than the typical form); but it is unfortunately not certain that it is really identical with *Ech. Wallisi*, as it does not agree very well with the description, except in the colour. Thus *Ech. Wallisi* must for the present remain somewhat problematic.

Most nearly related to *Echinus elegans* are the species: *gracilis*, *Alexandri*, and *lucidus*, and the new species described here: *Ech. affinis* n. sp. and *atlanticus* n. sp.; they have all of them a primary tubercle on every ambulacral plate; numerous fenestrated plates imbedded in the buccal membrane (this feature, however, not observed in *E. lucidus*); no ocular plates reach to the periproct; the spicules bihamate; all with rather strong, long, and pointed spines. *Ech. Alexandri* is rather sharply distinguished from the other species by its tridentate pedicellariæ, which are especially broad and comparatively short (Pl. XX. Fig. 1), while in the other species they are long and narrow (Pl. XVIII. Fig. 4). In the smaller forms of tridentate pedicellariæ the blade is more flat and broad, and the upper end of the apophysis is a little widened as a more or less perforated plate; in the larger forms there is some mesh-work in the bottom of the blade. As in *E. elegans* there are in these species all transitions between the largest and smallest tridentate pedicellariæ; to be sure, I have only seen a few of smaller size in *Ech. lucidus*, but as these resemble to a high degree, those of a corresponding size in the other species it may be supposed that also in this species large tridentate pedicellariæ will be found of the same form as in the other mentioned species. In all these species the tridentate pedicellariæ are upon the whole so similar, that reliable specific characters can scarcely be found in them (Pl. XVIII. Figs. 15, 21—22, 26—28). — The globiferous pedicellariæ in *Ech. Alexandri* have generally 3—4 teeth on either side, in the other species there are most frequently 1—1 or 1—2 lateral teeth. Also the globiferous pedicellariæ are very similar in all these species (Pl. XVIII. Figs. 9—11, 16—18, Pl. XIX. Fig. 18).

Ech. affinis is distinguished from the other species by the peculiar feature that the two series of tubercles in each ambulacral area are of unequal size or quite irregular; there is, however, always a primary tubercle on every ambulacral plate (see the particular description below). *Ech. gracilis* is easily distinguished from the other related species by its beautiful green coloration; the tridentate pedicellariæ (Pl. XVIII. Figs. 15, 21) are a little more serrate below than in the other species, it is however, scarcely a reliable character. Agassiz, in his description of it (Rev. of Ech. p. 293), says: »this species holds an intermediate position between *E. Flemingii* Ball and *E. melo* Lamk., to both of which it is allied«. This, according to what is stated here, is incorrect; its nearest relations are *E. elegans* and the other species named here. — *Ech. lucidus*, of which species Prof. Döderlein has kindly lent me a specimen for examination, is most similar to *Ech. Alexandri*, but may easily be distinguished from this species by its tridentate and globiferous pedicellariæ (Pl. XIX. Fig. 18).

In Challenger-Echinoidea (p. 114) Agassiz mentions *Echinus acutus* from st. 343, off Ascension, 425 fathoms. I have had occasion to examine these specimens in British Museum, and I must positively assert that it is not *Ech. acutus.* The test is high; the peristome very small (15^{mm} in a specimen of a diameter of 65^{mm}), the edge of the mouth not bent inward. There are very few spines on the abactinal side, almost only the primary ones, and as the plates are very high, the primary spines are also widely separated; on the actinal side there are more secondary spines, they are not, however, very close-set. The primary spines are of a middle length, and do not decrease much in length towards the apical area. A primary spine is found on each ambulacral plate, and they are of equal size in both series. The buccal membrane with numerous, lengthy, simple fenestrated plates outside the buccal plates; inside of these they are small and a little less perforated, as in *E. Alexandri.* The colour is beautifully red, the point of the spines white. The globiferous pedicellariæ (Pl. XVIII. Fig. 17), which are very few in number, have 1—1 lateral tooth, but are otherwise similar to those of *Ech. affinis*; also the tridentate pedicellariæ are scarcely to be distinguished from those of *E. affinis.* On the other hand the ophicephalous pedicellariæ are very characteristic, lengthy, and the teeth in the edge are uncommonly fine, only to be seen under especially high magnifying powers (Pl. XIX. Fig. 37). Triphyllous pedicellariæ of the common form; spicules bihamate. — There can be no doubt that this is a new species of *Echinus*, closely allied to *E. elegans*, *gracilis* etc.; I propose to call it **Echinus atlanticus**.

Presumably there are among the Echinids obtained by the »Challenger«-Expedition still one or two species allied to those mentioned here. Agassiz has determined these specimens partly as *Ech. elegans* (from Tristan d'Acunha), partly as *Ech. norvegicus* (from Patagonia, st. 308, and Japan, st. 232). That these determinations are incorrect is a sure fact. »*Ech. elegans*« from Tristan d'Acunha is a large form, very similar to *Ech. Alexandri*, that is to say, to the most long-spined specimens of this species (see the description below), but its tridentate pedicellariæ are narrow as in *Ech. affinis.* »*Ech. norvegicus*« from Japan is absolutely not this species; as far as I am able to see from my notes, it must be *Ech. lucidus*; the pedicellariæ are quite agreeing with those of that species. The specimens from Patagonia, at all events, are not *Ech. norvegicus*; they belong to two different species, of which one (3 large specimens) belongs to this group of species with a primary tubercle on all the ambulacral plates; perhaps it is *Ech. affinis*, but I am not able to determine it with certainty after my notes. The other species (4 small specimens) is *Ech. magellanicus* Phil. — The incorrect referring of these specimens to *Ech. norvegicus* has unfortunately given rise to the fact that this species is now constantly named among the »bipolar« animals.

Ech. margaritaceus Lamk. Of this species it is justly said in »Rev. of Ech.« (p. 493) that it has »very marked features«, but in the description only one of its peculiarities is mentioned, viz. the nature of its covering with spines; »the plate is densely covered with minute secondary tubercles carrying short, slender, yellowish spines closely crowded together, which are a lower groundwork from which the primary spines, long, slender, and white, project prominently«. This description of the spines is excellent, it is only to be added that these spinules are richly set with fine thorns, which gives them a peculiar silky gloss; further that the primary spines round the mouth are curved in the point, and that generally, but not always, some small, club-shaped spines are found on the buccal plates. Only every other ambulacral plate carries a primary tubercle. The apical area is very peculiar, all the ocular plates reach to the periproct, which is large and covered by numerous small plates among which the central plate is especially distinct. In small specimens all the ocular plates are shut off from the periproct. The buccal membrane has inside of the buccal plates numerous small fenestrated plates imbedded in the skin; just outside of the buccal plates there are a few small plates, as thick and complicate as the buccal plates, and like these set with pedicellariæ. Nearest to these plates some small, fine fenestrated plates are found, but all the rest of the buccal membrane is quite naked. The globiferous pedicellariæ (Pl. XIX. Fig. 20) are of the same form as in *Ech. elegans* etc., but only one tooth is found on either side. The tridentate pedicellariæ are more peculiar and of a rather varying form (Pl. XIX. Figs. 3, 33). The blade is broad and deep, without or with a quite feeble net of meshes at the bottom; the edge is more or less sinuate in the part where the valves join: sometimes almost through the whole length (Fig. 3), sometimes only in the outer half (Fig. 33); it is finely serrate, but not thickened, and has no transverse series of teeth as in the *Echinus*-species mentioned above. The huge pedicellariæ .... covering the whole test , mentioned by Agassiz, are the globiferous pedicellariæ, which are rather long-stalked and conspicuous, not the tridentate ones. The ophicephalous and triphyllous pedicellariæ of the common form; it may, however be noted that in the latter the upper ends of the apophysis do not reach to the edge of the blade, and that there seems to be a tending to a formation of a little mesh-work in the blade. The stalks of the pedicellariæ of the common structure; the spicules bihamate, very numerous. — That this species is not most closely allied to *Ech. norvegicus*, as Agassiz thinks (14. p. 11) is clearly shown by the characters here mentioned.

The description of *Ech. margaritaceus* given here agrees remarkably well with the description of *Sterechinus antarticus* by Koehler (233. a.), and after having examined some specimens from Belgica which Prof. E. van Beneden has most kindly lent me, I must positively assert that it is *Ech. margaritaceus*; no single character can be pointed out that might be a mark of distinction between them. — *Echinus diadema* Studer is by Agassiz (Chall. Ech.), Bernard (79), and Meissner (285) thought to be synonymous with *Ech. margaritaceus*. Studer (386) admits, to be sure, that they are very similar, but thinks that some difference is found in the pedicellariæ — i. e. the ophicephalous ones. Now it is true that his figures show a slight difference; but the ophicephalous pedicellariæ are generally of very little importance with regard to the distinguishing between the species, and yield only quite exceptionally good specific characters (as in *Ech. atlanticus*). In this case there can be no question of distinguishing between the two species , either by the ophicephalous or the other pedicellariæ. After having examined some specimens, determined by Studer himself as *Ech. diadema*, which I have received for examination from the museum at Berlin, I must decidedly follow the mentioned authors; *Ech. diadema* cannot be distinguished from *Ech. margaritaceus.*

Echinus horridus A. Ag. is not closely allied to *Ech. norvegicus*, as stated by Agassiz (Chall. Ech. p. 116); its nearest relation is no doubt *Ech. margaritaceus.* The spines are quite as in this species, and also the pedicellariæ are very similar to those of the latter species. The tridentate pedicellariæ (Pl. XIX. Fig. 2) are rather much open and rather sinuate in the outer part, where the valves meet; they may become pretty large (a little more than 1^{mm}), and then they have a rather strong, coarse net of meshes in the blade (it may be described as cross-beams rather far from the bottom). In the globiferous pedicellariæ (Pl. XIX. Fig. 22) cross-beams are wanting between the edges of the blade (also in young *Ech. margaritaceus* they may be found without cross-beams), and there are

2—4 teeth on either side. The basal part has somewhat projecting outer corners. The ophicephalous pedicellariæ are of the common form, the triphyllous ones resemble those of *Ech. margaritaceus.* — Agassiz says, but wrongly, that only two kinds of pedicellariæ are found in this species, one small-headed, long-stemmed, the other short-stemmed with a conical head. He gives, however, no figures of them. Unfortunately I can give no informations as to the peristome, as I forgot to examine it during my stay at British Museum. Neither can I tell whether the actinal primary spines are curved at the point. Primary spines are found on all the ambulacral plates; all the ocular plates are shut off from the periproct. The central plate little conspicuous. The spicules bihamate, numerous.

Echinus Neumayeri Meissner is also to be classed with these species, but is, however, rather sharply distinguished by several characters. In the description by Meissner (285) only the apical area is more thoroughly examined; as the type specimen has been sent me for closer examination, I am able to call attention to several other characteristic features of this species. A primary tubercle is only found in every other ambulacral plate. Unfortunately all the primary spines are broken, so that nothing can be said as to their length, or whether the actinal ones are curved at the point — what is probable. The secondary spines are rather coarse, not fine, silky, as in the two preceding species; they are, however, finely serrate. Three of the ocular plates reach to the periproct, as observed by Meissner; no conspicuous central plate is found. The apical area of the type specimen is, no doubt, abnormal, two of the genital plates being coalesced, and the adjoining one uncommonly broad; by this arrangement the two ocular plates at these genital plates are situated opposite to the latter, and not, as is elsewhere the case, opposite to the interspaces between them. (See the figure of Meissner. Op. cit. p. 12). The buccal membrane contains numerous small fenestrated plates inside of the buccal plates, outside of these it is almost naked, only with quite few, small fenestrated plates. Spines are found on the buccal plates. The globiferous pedicellariæ (Pl. XIX. Fig. 14) recall those of *Ech. horridus* very much, but the outer corners of the basal part are somewhat more conspicuous, and the edges of the blade are connected by cross-beams; there are 1—1 or 1—2 lateral teeth. The tridentate pedicellariæ (Pl. XX. Fig. 11) resemble those of *Ech. margaritaceus*, as is also the case with the triphyllous ones (Pl. XX. Fig. 7); the ophicephalous ones of the common form. The spicules bihamate, very few; I have only seen a few in the buccal membrane, none in the tube feet.

Echinus magellanicus Phil. To the descriptions of this species by Philippi and Agassiz the following informations must be added. A primary tubercle is found on all the ambulacral plates; the actinal primary spines are curved at the point, the secondary spines are coarse as in *Ech. Neumayeri* and almost smooth. The buccal membrane is quite naked both inside and outside of the buccal plates, and no spines seem to be found on these. The periproct is small, covered by a few, rather large plates, without distinct central plate; generally one ocular plate reaches to the periproct, as observed by Agassiz. The globiferous pedicellariæ (Pl. XIX. Fig. 23) chiefly as in *Ech. margaritaceus*, with 1—2 teeth on either side. The tridentate pedicellariæ (Pl. XIX. Figs. 11, 17), which are (always?) very small, 0.5^{mm}, are rather different from those of the other species; in the outer part where the valves join, the edge is finely serrate, in the lower part it is smooth, but rather thick; no net of meshes at the bottom. The valves are apart for a rather long space, but the slit between them is quite narrow. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules bihamate, numerous.

In Challenger-Echinoidea p. 116 *Ech. magellanicus* is mentioned from Prince Edward Island and Crozet Islands, from the latter place at a depth of 1600 fathoms (st. 147). I can assert positively that the latter is not *Ech. magellanicus*; its globiferous pedicellariæ are of quite another form than in this species. I suppose it to be a new species allied to *Ech. Neumayeri* and the other species belonging here, but as I have not a sufficient material of pedicellariæ of it, nor sufficient notes of it, I must restrict myself to show that it is no *Ech. magellanicus*. I also take it to be doubtful whether the specimens from Prince Edward Island are *Ech. magellanicus*; at all events they will have to be examined more thoroughly with regard to the characters mentioned here. That this species is found at Australia and New-Zealand I must also regard as doubtful, until renewed, thorough examinations have confirmed these statements. To be sure, Farquhar (144) enumerates *Ech. magellanicus* among the Echinids of New-Zealand, but it may, perhaps, be *Ech. albocinctus*, which, in a communication from Prof. Hutton, is said to be the same species. That this statement is incorrect will be shown hereafter. Perhaps also *Ech. darnleyensis* may be hidden among the Australian Echinids referred to *Ech. magellanicus*, as has been supposed by Woods (442. p. 165). For the present *Ech. magellanicus* is only known with certainty from the coasts of Patagonia and the adjoining seas. — Some small specimens from Chall. st. 308 (Patagonia), by Agassiz referred to *Ech. norvegicus*, are *magellanicus*.

Echinus albocinctus Hutton. A specimen of an *Echinus*-species from New-Zealand which from earlier times is found in the museum of Copenhagen, must, no doubt, be referred to this species, as it agrees exactly with the description. The description by Hutton, however, is far from being exhaustive — what may be applied to almost all descriptions of Echinids — and so some informations of this species are given here. — A primary tubercle is found on all the ambulacral plates; the actinal spines are not curved at the point, the small spines rather thick, almost smooth. One of the ocular plates reaches almost quite to the periproct which is small, and (as far as can be seen) covered by few, rather large plates without central plate. The buccal membrane is quite naked, with the exception of the buccal plates; whether spines are found on these cannot be decided. The globiferous pedicellariæ (Pl. XIX. Fig. 19) have only one unpaired lateral tooth; the basal part is very varying in form, sometimes with strongly projecting outer corners, sometimes rounded — or rounded on one side, projecting on the other. The tridentate pedicellariæ (Pl. XIX. Fig. 25) are most similar to those of *E. magellanicus*, but the edge is a little serrate, not thick and smooth where the valves are open; in the little space at the point where the valves meet, the edge is finely serrate. Below the articular surface there is a peculiar arc reminding of that of the ophicephalous pedicellariæ; also in other Echinids an indication of such an arc may be found. The ophicephalous and tridentate pedicellariæ of the common form. The spicules bihamate, they seem to be rather few. — That this species is well distinguished from *Ech. magellanicus* is evident from the informations given here. — *Echinus elevatus* Hutton, according to an information received from Prof. Hutton, is synonymous with *Amblypneustes formosus*.

Echinus fasciatus Parfitt (311), no doubt, is only a young specimen of one of the Echinids occurring at the coasts of England, but to which of these it may belong, it is impossible to see from the description — it may be applied to each and all of them, from *Strongyloc. drobachiensis* to *Ech. miliaris*. Philippi (323) enumerates the species *Echinus Cunninghami*, *lepidus*, and *rodula* without giving any information whatever of them; as far as I can see they are nomina nuda, and Philippi deserves no praise for having introduced them.

Echinus multicolor Yoshiwara I have not seen; the description gives no information of pedicellariæ, spicules, and several other important features, so that nothing can be said with regard to its being a genuine *Echinus* or not.

The species *Ech. miliaris*, *microtuberculatus*, *angulosus*, *verruculatus*, *Robillardi*, and *darnleyensis* are no genuine *Echinus*-species. For the present then they may be left out of consideration, while the question of the grouping of the species above mentioned is treated.

Do all these species really belong to the same genus, or can there be any question of grouping them into more genera? The question is partly answered already, Koehler having established the genus *Sterechinus* on *E. margaritaceus* (without knowing, to be sure, that it was this species). The characters upon which the genus is based, are: the comparatively large central plate, the narrow apical plates, of which all the ocular plates reach to the periproct, and the comparatively great height of the coronal plates. — The character of the apical plates is evidently useless, all the ocular plates being shut off from the periproct in smaller specimens. Also the central plate seems to me to be an only little valuable character; in every young *Echinus* the central plate is distinct, it does not disappear till a later stage, other small plates being formed round it, so that at last it cannot be distinguished from the secondary plates. Neither seems the height of the coronal plates to be a valuable character, as it varies much according to the size of the animal. — Now it is not my meaning to say that the genus *Sterechinus* cannot be kept up, only that the characters upon which it is based, cannot be used; we must seek other characters for it. May, then, other characters be found by which to group the species?

Among the characters mentioned above one is found that might beforehand be thought to be of great importance, viz. whether a primary tubercle is found on every or only on every other ambulacral plate. In the species *esculentus*, *acutus*, *melo*, *margaritaceus*, and *Neumayeri* a primary tubercle is only found on every other ambulacral plate, in all the other species it is found on every ambulacral plate. That this feature, however, can be of no primary importance is evident from the fact that it separates *Ech. margaritaceus* and *horridus*, two species that are, no doubt, very closely allied. — Another character of undoubtful value is whether the buccal membrane contains numerous fenestrated plates, or is quite (or almost) naked, at all events outside of the buccal plates. Numerous plates in the buccal membrane are found in the species: *esculentus*, *acutus*, *melo*, *elegans*, *gracilis*, *Alexandri*, *affinis*, *atlanticus*, and *lucidus* (not examined); naked buccal membrane is found in the species: *margaritaceus*, *horridus* (not examined), *Neumayeri*, *magellanicus*, and *albocinctus*. This character does not separate allied species, but divides them into two groups which seem to be well divided as to habitus, but where the species of each group seem to be mutually rather closely allied. It is evident then that we have here a specially important systematic character. Another feature gives quite the same grouping of the species, viz. whether the edge of the tridentate pedicellariæ is thick and provided with numerous small teeth arranged in more or less regular transverse series, or it is thin and simply serrate. In the former group, *Ech. esculentus* etc., the edge is thick with transverse series of small teeth, in the latter group, *Ech. margaritaceus* etc., it is simply serrate. This character, however, is not quite reliable, as the small tridentate pedicellariæ in the former group have also a simply serrate edge. Other characters giving the same natural grouping of the species, do not seem to be found.

The former group may be subdivided according to the ambulacral plates, the species *esculentus*, *acutus*, and *melo* having only a primary spine on every other ambulacral plate, while the species *elegans*, *gracilis*, *Alexandri*, *affinis*, *atlanticus*, and *lucidus* have a primary spine on every ambulacral plate. Thus this group might be subdivided into two genera according to this character. This division, however, I do not think good; *Ech. esculentus* differs so much from *acutus* and *melo*, that it seems to be incongruous to class it with these two species contrary to the other species of the group; in quite young specimens of *Ech. acutus* a primary spine is often found on all the ambulacral plates, which also tells against using this feature as a generic character. Finally it is also seen in the other group that neither there a natural division can be obtained by means of this character. Thus it seems to be correct to regard this whole group as one genus keeping the name of *Echinus*. The feature of the ambulacral plates may here be used practically by the determination of the species.

The other group, the species *margaritaceus*, *Neumayeri*, *horridus*, *magellanicus*, and *albocinctus*, shows a series of striking peculiarities, so that the question naturally arises, whether all these species are to be referred to one genus. The characters by which a subdivision might be made, are, whether every ambulacral plate or only every other plate has a primary spine, whether the secondary spines are fine, silky, or not, whether or not the actinal spines are curved in the point, whether the buccal membrane is quite naked, or fenestrated plates are found inside of the buccal plates; finally the question might also be of using the pedicellariæ or the features of the ocular plates as a basis of the distribution of the species.

E. albocinctus is the most isolated one, especially distinguished by having only one unpaired lateral tooth on the globiferous pedicellariæ. As this feature, as will be shown below, is of very great systematic importance, it seems reasonable to separate this species as a separate genus, even if in some features it agrees very exactly with *Ech. magellanicus* (the quite naked buccal membrane, primary tubercle on every ambulacral plate). For this form the name of **Pseudechinus** is proposed. — To separate the other four species is scarcely correct; according as one or other of the mentioned characters is used as a base of the division we get a different grouping. Here a so curious intermingling of all characters is found, that we only seem to have two chances left: to establish each species as a separate genus — by which nothing is gained — or to unite them all to one genus, which latter I think to be the most correct thing. Then this genus gets the name of *Sterechinus* Koehler. Considering the common opinion of the difficulty of these species I shall give the following

Table of the Sterechinus-species[1].

1. The secondary spines fine, silky .... 2.
   — — — coarse .... 3.
2. Primary tubercle only on every other ambulacral plate; the globiferous pedicellariæ with 1—1 lateral tooth, the edges connected by cross-beams .... *St. margaritaceus.*

[1]) A table of the *Echinus*-species will be given below, after the description of the northern species.

Primary tubercle on every ambulacral plate; the globiferous pedicellariæ with 2—4 teeth on either side, the edges not connected .... *St. horridus.*

3. Primary tubercle on every other ambulacral plate .... *St. Neumayeri.*
— — - — ambulacral plate .... *St. magellanicus.*

Echinus miliaris, *microtuberculatus*, and *angulosus* form a separate group chiefly characterized by the globiferous pedicellariæ (Pl. XVII. Figs. 1, 7). The blade is rather flat, comparatively broad, and passes evenly into the basal part; no cross-beams connect the edges across the inside of the blade; the edges are not thickened, and project into more or fewer teeth on either side. There is no neck; the stalk as usually constructed of long threads connected by cross-beams. A somewhat similar form of globiferous pedicellariæ is found in *Sterechinus horridus* (Pl. XIX. Fig. 22), and sometimes also in *Echinus Alexandri* (Pl. XVIII. Fig. 9). A comparison of the figures will show, however, that they are very different, even if it is not easy to point out a particular distinguishing character; the most significant one is, I think, that here the edge is somewhat thickened, so that the teeth are placed on it, while in *Ech. miliaris* etc. the edge is quite sharp, and the teeth are simply indentations in the edge; also the whole form is somewhat different, as shown by the figures.

The following characters of the separate species must be pointed out. In *Ech. miliaris* the buccal membrane is covered by large, thick fenestrated plates. The globiferous pedicellariæ have numerous lateral teeth; the tridentate ones have a rather strong net of meshes in the bottom of the blade (only the large ones); the edge is coarsely indented below, in the outer part where the valves join coarsely sinuate, but the sinuations are again finely serrate; the small teeth form no transverse series (Pl. XVII. Fig. 11). The ophicephalous and triphyllous pedicellariæ with no conspicuous peculiarities. — All three species have a primary spine on every ambulacral plate; in *miliaris* and *microtuberculatus* the ocular plates are shut off from the periproct, in *E. angulosus* the two (three) reach to the periproct; no distinct central plate.

Ech. microtuberculatus agrees exactly with *miliaris* in the structure of the pedicellariæ; it is only to be observed that the tridentate pedicellariæ have rather distinct transverse series of teeth on the edge. The plates of the buccal membrane are especially characteristic (Pl. XVI. Fig. 14). They are large, thick, greenish, and of quite another structure than in *miliaris*, not consisting of the usual reticulation, but of a homogeneous mass of lime, in which the pores appear as deep, funnel-shaped holes. Also the plates inside of the buccal plates are constructed in this way. Otherwise it is distinguished from *miliaris* by its somewhat finer spines and corresponding smaller tubercles (Pl. XV. Figs. 8, 9); the colour of the test and spines is more intensely green. — In the original diagnosis of *Ech. microtuberculatus*[1]) it is said: »ambulacres à denticules très-arquées et composées de six paires de pores«; in Blainville's »Manuel d'Actinologie» 1834 p. 228 *E. parvituberculatus*, de Blainv. «Dict. tom. 37. p. 88, sous le nom d'*E. microtuberculatus*» is enumerated under the division D. »Espèces régulières, de forme un peu variable; les denticules des lignes ambulacraires droites ou arquées de cinq paires de pores au moins«. Accordingly it is no doubt wrong when Agassiz and Desor (Catalogue raisonné des Echinides p. 64) enumerates it (referring to the passages quoted above) under their fourth type,

[1]) Dictionnaire des Sciences naturelles. T. XXXVII. p. 88. (1825.)

with „trois paires de pores obliques". Now if the two authors had done so consciously, they would certainly have made a remark to the effect that the type specimen had not the six pairs of pores, but only three. Such a remark, as far as I can see, they have not made, and so there can scarcely be any doubt that this species has quite wrongly got the name of *microtuberculatus*. As a synonym of it Agassiz & Desor (loc. cit.) mention *Ech. pulchellus* Ag. and *decoratus* Ag., and the former of these names should then be employed for this species. The description of *Ech. pulchellus*[1]) may agree rather well with it, even if it cannot be said to be a very appropriate one; it might also agree with young specimens of *Strongyloc. lividus*. Therefore I think it better to wait for a renewed examination of the type specimens, before the commonly used name of *microtuberculatus* is rejected.

Ech. angulosus is distinguished from the two other species by the two ocular plates reaching to the periproct, and by the plates of the buccal membrane being fine and quite imbedded in the skin; only a few are thick and carry pedicellariæ. The globiferous pedicellariæ have only two, more rarely three teeth on either side; the tridentate ones are more strongly sinuate in the outer part where the valves join (Pl. XVII. Fig. 6); the larger ones have a rather strong net of meshes, the edge is thick, in the lower part with very distinct transverse series of small teeth. The ophicephalous pedicellariæ have generally only a simple keel in the middle of the blade, without any net of meshes (Pl. XVII. Fig. 3).

These three species must absolutely form a separate genus. Most recent authors use the name of *Psammechinus* Ag. for them, but wrongly. In „Catalogue raisonné" p. 64 under the fourth type „Sous-genre *Psammechinus* Ag." are named first the species *variegatus* Lamk. and *semituberculatus* Val. and as no. 3 *subangulosus* Lamk. There can be no doubt, then, that the two first-named may claim the name of *Psammechinus*, as it appears that they cannot be classed with the genus *Toxopneustes*, to which they are referred in „Rev. of Ech.", but must form a separate genus (see below). For the species *miliaris*, *microtuberculatus*, and *angulosus* a new genus must then be established; I propose the name of **Parechinus**.

Psammechinus verruculatus Ltk. Agassiz (Rev. of Ech. p. 122) mentions this species as synonymous with *Parech. angulosus*; de Loriol (245. p. 21) objects to this and maintains that they are two well distinguished species. I must not only grant that de Loriol is right in his statement, but shall have to go much farther and assert that it cannot be referred to the same genus, nay, not even to the same family as *Parech. angulosus*. Prof. de Loriol has kindly sent me a specimen of his „*Echinus verruculatus* Ltk." from Mauritius, and so I have been able to compare it with the type specimens of Lütken, which are found in the museum of Copenhagen. All the type specimens are naked tests, so that it is impossible to tell quite certainly, whether the species of de Loriol is really identical with these specimens; all the most important characters are wanting on the naked tests — nay, it is, moreover, probable that the type specimens really belong to two different species. It is, however, certain, that the description given by de Loriol of the coloration of his specimens[2]), agrees exactly with two of the type specimens, and I think it very likely that they are really identical. Full

[1]) Introduction to Valentin's Anatomie du genre Echinus. p. VI.
[2]) In the specimen sent me by de Loriol, there is no trace of coloration on the test; only the spines have the colour described by de Loriol.

certainty, I think, can never be obtained, and there is nothing to be done but to resolve that the species of de Loriol shall in future be taken to be the *Psammechinus verruculatus* of Lütken.

To the description by de Loriol I shall here make some additions. A primary tubercle is found on every ambulacral plate. De Loriol states that two ocular plates reach to the periproct; in the specimen before me this is only the case with one plate. The genital pores are especially large. The buccal membrane contains numerous small fenestrated plates both inside and outside of the buccal plates; those outside the buccal plates are a little larger, a few are thick and carry pedicellariæ, while most of them are simple fenestrated plates, quite imbedded in the skin; a few bihamate spicules are also found in the buccal membrane. The gills contain the usual fenestrated plates. The mouth-slits, as observed by de Loriol, are small, but very distinct. The globiferous pedicellariæ are very different from those of the genera *Echinus*, *Sterechinus*, and *Parechinus*; by this reason only this species was to be separated from those genera. The blade is quite closed to a thin tube without lateral teeth, as in *Sphærechinus granularis*; no neck; I suppose that glands are found on the stalk, but this fact could not with certainty be substantiated from the dried specimen in hand. The tridentate pedicellariæ (Pl. XXI. Fig. 2) have a broad, deep blade with a slight indication of a net of meshes in the bottom; the valves join for almost their whole length, the edge is rather strongly, but simply serrate. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules are very peculiar (Pl. XXI. Fig. 28), small, with a little ball at each end, quite resembling dumb-bells. They are found in especially great numbers in the globiferous pedicellariæ, also, however, in the tube feet, but in rather small number. Genuine bihamate spicules do not appear to be found in the tube feet.

This peculiar form of globiferous pedicellariæ and spicules is also found in «*Echinus* *Robillardi*, and *darnleyensis*, further in the genera *Toxopneustes* and *Tripneustes*, and there can be no doubt that the mentioned species belong here. To which genus they will have to be referred cannot be decided, until we have examined the *Toxopneustes*- and *Tripneustes*-species.

Echinus Robillardi Loriol. To the description of this species by de Loriol (245 p. 23) I may add the following informations (a specimen received from Prof. de Loriol). A primary tubercle is found on every ambulacral plate. The peristome is very peculiar, quite naked. Inside of the buccal plates a belt is found with numerous bihamate spicules, and in the inner edge a few larger, irregular needles are found (Pl. XXI. Fig. 24. b). At the outer edge of the peristome again rather numerous bihamate spicules are found, and in the gills seem to be found, not the usual fenestrated plates, but numerous bihamate spicules. Otherwise no other plates than the buccal ones are found in the buccal membrane; these buccal plates are not placed in pairs opposite to each other as usual, but one outside the other; neither spines nor pedicellariæ are found on the buccal plates. The very peculiar, oblique apical area has been accurately described by de Loriol, who also points out that the slits of the test are small and indistinct. The globiferous pedicellariæ as in *Sphærechinus*, without lateral teeth, the blade a closed tube; I have not been able to decide from the dried specimen in hand whether glands are found on the stalk. The tridentate pedicellariæ very peculiar (Pl. XXI. Figs. 4, 11); the lower part of the blade is narrow and quite filled by a net of meshes, so that the edges are quite coalesced; the upper part is a little widened with straight, finely serrate edge. Only this part of the valves join, so that they are wide apart below. The ophicephalous pedicellariæ without conspicuous peculiarities; triphyllous pedicellariæ I have not seen. In the globiferous pedicellariæ numerous spicules are found, somewhat thickened in the ends (Pl. XXI. Fig. 24. a), although not markedly dumb-bell-shaped; also a few common bihamate spicules are found among them. In the tube feet the bihamate spicules are predominant, but the other form is also found. — De Loriol, no doubt, is right that this is a distinct species; but it is no *Echinus*. Its nearest relations are «*Echinus*» *verruculatus* and especially *darnleyensis*.

Echinus darnleyensis Woods. Of this species I have had occasion to examine a specimen from Thursday Island, Torres Strait, 4 fathoms (the «Alert»-Expedition) in British Museum. (I cannot answer for the correctness of the determination; that it corresponds with the description is no guarantee for its being the same species, as the description gives only the usual things: spines, tubercles etc., but mentions neither spicules nor pedicellariæ.) A primary tubercle is found on every ambulacral plate; according to Woods (442. p. 165) the ocular plates are quite shut off from the periproct — but according to an information from Prof. Bell they are not shut off from the periproct in these specimens (I have forgotten to ascertain it myself). The buccal membrane is quite naked with the exception of the buccal plates which are placed in pairs opposite to each other, and carry a few pedicellariæ. «With ten rounded small openings surrounded by Pedicellariæ», it is said in the description by Woods; this, I think, must be the holes in the buccal plates for the buccal tube feet — a rather common feature to note in a description of species! Innermost in the edge of the mouth numerous needle-shaped, more or less irregular spicules are found resembling those of «*Ech.*» *Robillardi*; they are arranged parallel to the edge of the mouth; a few are a little fenestrated. Outside of these some bihamate spicules are found, but far from so great a number as in *Robillardi*. Near the gills numerous bihamate spicules are found in the buccal membrane. The gills themselves contain the common irregular fenestrated plates. According to Woods the auriculæ are only «slight thin processes, which do not meet»; Prof. Bell informs me that they are here of the common form. (In *verruculatus* and *Robillardi* they are also of the common form.) The globiferous pedicellariæ as in *Sphærechinus*, only is the blade uncommonly short (Pl. XXI. Fig. 36). In the tridentate pedicellariæ (Pl. XXI. Fig. 7) the blade is broad, open, with only a slight net of meshes in the bottom. The edge is finely, simply serrate in the outer part where the valves join; in the lower part a few larger indentations are found. The valves are rather wide apart. Ophicephalous and triphyllous pedicellariæ of the common form. The spicules (Pl. XXI. Fig. 23) of the globiferous pedicellariæ arcuate, but not pointed at the ends; in the tube feet only a few bihamate spicules are found. — Woods thinks that it is this species Agassiz has wrongly referred to *Ech. magellanicus*; that it has nothing to do with *magellanicus* is certain, although the differences pointed out by Woods: «in the actinostome being larger; in the abactinal system, where the genital plates have only two tubercles, and in the color of spines and test» are quite irrelevant. The principal difference is to be found in the globiferous pedicellariæ and the spicules; they show that this species is no *Echinus* or *Sterechinus* at all, but like *Ech. Robillardi* and *verruculatus* is closely allied to *Toxopneustes* and *Tripneustes*.

To the genus *Toxopneustes* Ag. are referred the species: *maculatus* (Lamk.), *pileolus* (Lamk.), *elegans* Döderl., *variegatus* (Lamk.), and *semituberculatus* (Val.); to the genus *Tripneustes* Ag. (in Rev. of Ech. this genus is called *Hipponoë*) are referred the species: *esculentus* (Leske), *depressus* Ag., and *variegatus* (Leske). I have had occasion to examine all these species, with the exception of *T. maculatus*; of *T. elegans* Prof. Döderlein has most kindly sent me a specimen, *T. semituberculatus* I have seen in British Museum, the other species are found in the museum in Copenhagen. I shall therefore make a few supplementary remarks to the existing descriptions of these species. Information is especially wanting with regard to pedicellariæ and spicules.

Toxopneustes pileolus (Lamk.). Some specimens found in our museum have by Lütken been determined as *T. maculatus*, but this determination, no doubt, is incorrect. They agree exactly with the description of *T. pileolus*, having especially the characteristic coloration so often mentioned; on the other hand they do not at all agree with Lamarck's diagnosis of *E. maculatus*. Therefore I do not hesitate to refer them to *pileolus*. — Only every other ambulacral plate has a primary tubercle; two ocular plates reach to the periproct. The buccal membrane contains numerous fenestrated plates as well inside as outside of the buccal plates; not a few of them are thick and carry pedicellariæ. Besides the fenestrated plates the buccal membrane contains numerous bihamate spicules; also in the gills bihamate spicules are found in great numbers together with the common irregular fenestrated plates. No spines on the buccal plates. The globiferous pedicellariæ without lateral teeth and with tubular blade as in *Sphærechinus*, but they are remarkable by the extraordinary length of the blade and the end-tooth (Pl. XXI. Fig. 13); in the apophysis there is a long, narrow slit; no neck; small glands are found on the stalk. The tridentate pedicellariæ are very large, the head up to a length of 3^{mm}; the neck very short. The outer part of the blade where the valves join, is coarsely and irregularly indented in the edge, in the lower part the edge is smooth, or has a few larger thorns. In the bottom of the blade a strong and very complicate net of meshes is found hiding the usual regular arrangement of the holes, even at the point of the blade (Pl. XXI. Fig. 41). In smaller pedicellariæ this net of meshes, no doubt, will be much less developed, but such pedicellariæ I have not found in the specimens in hand. For a long way the valves are apart, but not much, so that only a narrow slit is found between them. Ophicephalous and triphyllous pedicellariæ without particular peculiarities. The stalk of the pedicellariæ compact. The spicules (Pl. XXI. Fig. 21. a) in the pedicellariæ are of the typical dumb-bell shape; in the smaller globiferous pedicellariæ on the abactinal side they form a thick white border all round the head, the valves being united almost through their whole length by a fine skin. These pedicellariæ are almost always open, and give the animal a very characteristic appearance — which, no doubt, also holds good with regard to *T. elegans*. When they are shut the border of spicules is slackened to as to make a kind of fringe round the point; the large globiferous pedicellariæ of the actinal side do not seem to have such a border. In the tube feet a few dumb-bell-shaped spicules are found together with more numerous bihamate spicules; most of the latter, especially those nearest to the sucking disk, have some small branches on the outside at the points (Fig. 21. b); the spicules of the buccal membrane are much finer (Fig. 21. c); also here a few dumb-bell-shaped spicules are found.

As a synonym of *T. pileolus* Agassiz in Rev. of Ech. mentions the species *Boletia rosea* before established by himself. To judge from the authentic specimens before me of *B. rosea* (from Mus. Comp. Zool.) I think it, however, somewhat doubtful that they are really only one species. Besides the difference with regard to colour (the spines uniformly brown, the test only with a slight reddish tint, otherwise quite brown), there is another fact that may, perhaps, be of some significance. In *T. pileolus* the secondary tubercles in the ambulacral areas — on the plates wanting the primary tubercle — are as large as the primary ones, so that it can only be seen from their position, whether they are primary or secondary ones; in *roseus* the primary tubercles are distinctly larger than the secondary ones on the plates where the primary tubercle is wanting. If this feature proves to be constant, there can scarcely be any doubt that they are two well distinguished species. In spicules and pedicellariæ any difference of importance is scarcely to be found.

Toxopneustes elegans Döderl. agrees exactly with *T. pileolus* (I have not, however, seen the tridentate and triphyllous pedicellariæ); as far as I can see it is only distinguished from *T. pileolus* by its peculiarly coloured spines — they have a sharply limited dark band near the point — and by the colour of the test, it being in *T. elegans* yellowish without any indication of coloration, only the median suture of the ambulacral and interambulacral areas is dark violet on the apical side . (Döderlein 114. p. 99.)

Toxopneustes variegatus (Lamk.). To the existing descriptions I shall add the following remarks. A primary tubercle is found on all the ambulacral plates. The globiferous pedicellariæ (Pl. XXI. Figs. 38, 40) with tubular blade, without lateral teeth, not very much lengthened. Glands may be found on the stalk, but are most frequently wanting. The tridentate pedicellariæ (Pl. XXI. Fig. 10) are large, the head up to 1·5^{mm}, and long-necked. There is only little mesh-work in the blade, the edge is straight, rather thick, with numerous, irregularly placed small teeth; the valves are only a little apart below. The triphyllous and ophicephalous pedicellariæ of the common form. The spicules (Pl. XX. Fig. 15) are dumb-bell-shaped, exceedingly numerous in the skin of the globiferous pedicellariæ (as in all these species); here all transitional forms may be found from small, oval bodies to typical, bihamate spicules (Pl. XXI. Fig. 31), but the really dumb-bell-shaped ones are by far the most numerous. In the tube feet only bihamate spicules are found in small number.

Toxopneustes semituberculatus (Val.), no doubt, is most nearly allied to *T. variegatus*; especially must be emphasized that it likewise has a primary tubercle on all the ambulacral plates. Spicules and pedicellariæ as in *T. variegatus*, only the globiferous pedicellariæ show a conspicuous peculiarity 'the lime in the valves being of a deep violet colour, with the exception of a small, oblong, clear spot in the basal part on either side of the apophysis. Glands are found on the stalk. — Otherwise, as is well known, it is distinguished from *variegatus* by the less marked plate-covering on the buccal membrane.

Tripneustes esculentus (Leske). A primary tubercle is only found on every third or fourth ambulacral plate. The buccal membrane contains numerous small fenestrated plates inside of the buccal plates, outside of these fewer, small, round, thick plates with pedicellariæ are found. The pedicellariæ are numerous, much pigmented, and form a quite black ground between the spines. The globiferous pedicellariæ are small, the valves as in the other allied forms (Pl. XXI. Fig. 39). Glands are found on the stalk. In the tridentate pedicellariæ (Pl. XXI. Fig. 16) the blade is filled by a highly developed net of meshes; the point rather abruptly widened with the edge exceedingly finely serrate, in the lower part of the blade the edge is more or less coarsely dentate. The valves are rather wide apart, only joining at the point. Together with these a smaller form of tridentate pedicellariæ

(Pl. XXI. Fig. 3) is found, with a broader blade and less developed mesh-work; the part where the valves join, is comparatively larger than in the large form; transitional forms are found. The ophicephalous pedicellariæ shorter and broader than usual (Pl. XXI. Fig. 22); the triphyllous pedicellariæ of the common form. The spicules of the pedicellariæ are typically dumb-bell-shaped (Pl. XXI. Fig. 33. a); in the tube feet common bihamate spicules are found together with very small spicules, also bihamate (Fig. 33. b) or a little dumb-bell-shaped; in the buccal membrane numerous small spicules are found with truncate ends (Fig. 33. c) together with larger bihamate spicules (Fig. 33. d).

Tripneustes depressus A. Ag. is, with regard to spicules and pedicellariæ, quite similar to *esculentus*; I have not, however, been able to find tridentate and triphyllous pedicellariæ on the only, badly preserved specimen before me. As in *esculentus* only every third or fourth ambulacral plate has a primary tubercle. The difference between the two species is very well given in Rev. of Ech.

Tripneustes variegatus (Leske). A primary tubercle is only found on every third ambulacral plate; the secondary tubercles almost as large as the primary ones, so that the latter are only to be distinguished with difficulty, while in *esculentus* the primary tubercles form a beautiful, rather conspicuous series. As in *esculentus* two ocular plates reach to the periproct; no central plate. The buccal membrane with numerous thick fenestrated plates carrying pedicellariæ; even globiferous pedicellariæ may be found on the buccal membrane, a fact I have not seen in any other Echinid. The globiferous pedicellariæ quite as in *esculentus*, the tridentate ones resemble very much the smaller form in *esculentus*; a form corresponding to the larger form in this species I have not found in *T. variegatus*. Ophicephalous and triphyllous pedicellariæ as in *esculentus*; the spicules of the pedicellariæ typically dumb-bell-shaped; in the tube feet only really dumb-bell-shaped spicules seem to be found, in the buccal membrane there are comparatively few spicules, partly larger, bihamate ones, partly smaller, somewhat dumb-bell-shaped ones. According to Lovén (252) this species corresponds to Linné's *Echinus Gratilla*; this name must then be adopted instead of *variegatus* (Leske).

According to the definition given by Agassiz (Rev. of Ech. p. 297 seq.) the genera *Toxopneustes* and *Tripneustes* (*Hipponoë*) are chiefly distinguished by the fact that in *Toxopneustes* the pores are arranged in oblique arcs of three pairs, while in *Tripneustes* the pores form three vertical series; the series in the middle is irregular, the two outer ones are regular. The other characters — whether the peristome is large or small, and whether the tubercles form more or less regular vertical and horizontal series — are of a so relative nature, that it will be better to leave them out of consideration. Unfortunately the mentioned principal character is not reliable either; in larger specimens of *Toxopneustes* the pores may form three irregular longitudinal series as in *Tripneustes*, what has already been mentioned by Agassiz in his diagnosis of the genus *Toxopneustes*, and in smaller specimens of *Tripneustes*, up to a diameter of ca. 20^{mm}, the pores are arranged in quite similar arcs of three pairs as in *Toxopneustes* without any indication of an arrangement in longitudinal series. Accordingly none of the characters hitherto pointed out are reliable. It must, however, be admitted that the species *esculentus*, *depressus*, and *gratilla* form a group that is, as to their habitus, very different from the species referred to *Toxopneustes*, so that it seems natural to keep them as a separate genus. To this is to be added that, if the genera *Toxopneustes* and *Tripneustes* were to be united, it would give rise to a complete rearrangement of the nomenclature; especially the name of *Toxopneustes* would then have to be used for a quite different series of forms: «*Strongylocentrotus*» *tuberculatus* etc., which, as will be shown below, do not at all belong to the genus *Strongylocentrotus*. This would certainly create much confusion, and only to avoid this calamity these genera ought to be kept up, if there are no cogent reasons for uniting them. Now such reasons are not found; on the contrary a closer examination shows that other characters are found, more reliable than those given by Agassiz, which characters may also be used for the small specimens, where the characters mentioned above cannot be used at all.

While all the species referred to *Tripneustes* are no doubt closely allied, the same thing cannot be said of the *Toxopneustes*-species; they form two well distinguished groups. The species *pileolus*, *elegans*, and *roseus* form a group characterized by having only a primary tubercle on every other ambulacral plate, by the peculiar globiferous pedicellariæ with a border of spicules and much lengthened blade and end-tooth, and by the branched bihamate spicules in the tube feet. The species *variegatus* and *semituberculatus* have a primary tubercle on all the ambulacral plates; the globiferous pedicellariæ have no border of spicules, the blade is not much lengthened, the bihamate spicules in the tube feet are not branched in the ends. That the buccal membrane is more richly provided with plates and the spines longer than in the former group, I take to be less reliable characters, especially as there is a rather great difference between *variegatus* and *semituberculatus* with regard to the plates of the buccal membrane. Thus the two groups are seen to be very well distinguished, and each of them ought no doubt to form a separate genus. As *pileolus* is the type of the genus *Toxopneustes*[1]) of Agassiz, this group must keep this name. The other group gets the name of *Psammechinus*, which name here gets its definitive place, after having so long been abused (comp. p. 108); the numerous names that in the course of time have been applied to *Ps. variegatus*: *Lytechinus*, *Psilechinus* etc., become only synonyms of *Psammechinus*.

After having thus limited the genus *Toxopneustes*, it is easy to state the characters, by which the genus *Tripneustes* is distinguished as well from the former genus as from *Psammechinus*. A primary tubercle is only found on every third ambulacral plate; no border of spicules on the globiferous pedicellariæ, the blade not much lengthened; the bihamate spicules in the tube feet not branched in the ends. To these characters is then to be added with regard to the larger specimens the characteristic arrangement of the pores in three separated longitudinal series. — In «Rev. of Ech.» Agassiz has adopted the name of *Hipponoë* Gray in stead of *Tripneustes* Ag. Bell (38) maintains that this is unwarranted, as the name of *Hipponoë* has originally only been published as a nomen nudum, for which no species is given as the type. That Gray himself has later shown Agassiz, which species he regarded as the type of his genus *Hipponoë* (Agassiz, 7), does not justify the adoption of this name, any more than the assertion of Agassiz senior that if the name of *Hipponoë* proves to be a synonym of his *Tripneustes*, the former is to be preferred (Introd. to Valentin's Anat. du genre Echinus. p. IX.). As well known the author of a name has himself no more command of it

[1]) The name of *Toxopneustes* has first been proposed by L. Agassiz in «Observations sur les progrès récens de l'histoire naturelle des Echinodermes». (Monographies d'Echinodermes. p. 7.) «Dans un travail encore inédit sur les espèces vivantes de l'ancien genre *Echinus* .... j'ai établi les coupes suivantes, dont je me bornerai à citer ici les types: *Temnopleurus* (*E. toreumaticus*), ... *Toxopneustes* (*E. pileolus*)». Later, in the preface to Valentin's «Anatomie du genre Echinus». p. X. Agassiz says of *Toxopneustes*: «Je prends pour type de ce genre l'*Echinus tuberculatus*». — As a matter of course *pileolus* must have the prior right to the name of *Toxopneustes*.

than others, when it has first been published. I must decidedly follow Bell and de Loriol in the opinion that the name of *Tripneustes* has the priority.

The species «*Echinus* *Robillardi*, *darnleyensis*, and *verruculatus* belong, as stated above, also here, but to which genus? They have, all of them, a primary tubercle on all the ambulacral plates; by this feature they are excluded from the genera *Toxopneustes* and *Tripneustes*, this character being here evidently of rather more value than among the *Echinus*-species. They must then either be referred to *Psammechinus* or form a new genus. In *verruculatus* the buccal membrane contains numerous fenestrated plates, to be sure much smaller and finer than in *variegatus*, where the buccal membrane is closely covered with large, thick plates; but in this respect *semituberculatus* keeps an intermediate position between the two, so that no definite limit can be given. The feature is quite analogous with that of *Parechinus microtuberculatus*, *miliaris*, and *angulosus*. Otherwise I can see no character that would justify a referring of this species to another genus. The mouth-slits are in no way smaller than in small specimens of *variegatus* of a corresponding size; in a specimen of *verruculatus* of a diameter of 21^{mm} they have a depth of 1^{mm}, in a specimen of *variegatus* of a diameter of 23^{mm} they have only the same depth. Further the coloration of the test in young *variegatus* is so very similar to that typical of *verruculatus*, that a comparison gives the immediate impression that they must be very closely allied. Accordingly I can only regard it as correct to refer this species to the genus *Psammechinus*, where it has already been referred by Lütken — who did not, to be sure, interpret the genus *Psammechinus* in the way it is done here, since he establishes the genus *Psilechinus* for *Ps. variegatus*, and in the same paragraph he names *verruculatus* as a typical *Psammechinus*[1]).

The species *Robillardi* and *darnleyensis* are distinguished from *Psammechinus* by their naked buccal membrane; it is, as described above, quite naked with the exception of the buccal plates, but contains more or fewer irregular spicules in the inner edge. The spicules of the pedicellariæ are not quite dumb-bell-shaped as in *verruculatus* and the other *Psammechinus*-species, but are formed as bows, which are a little thicker at the ends or of the same thickness in their whole length. These two features, I think, render the referring to the genus *Psammechinus* impossible, and they must consequently form a separate genus, for which I propose the name of **Gymnechinus**.

Whether *Toxopn. maculatus* really belongs to *Toxopneustes* or must rather be referred to another genus cannot be decided from the existing descriptions.

To the genus *Evechinus* Verr. are referred the species *chloroticus* (Val.), *australiæ* Woods, and *raritubercululatus* Bell; of these I have examined *chloroticus* and *rarituberculatus* (the type specimen), with regard to which I can give the following informations in addition to what is hitherto known.

Evechinus chloroticus (Val.). The 4—5 nethermost ambulacral plates have all a primary tubercle, then only every other plate, and above the ambitus only every third plate has a primary tubercle. In small specimens a primary tubercle will thus be found on every other plate on the abactinal side. The small spines are club-shaped. The buccal membrane inside and outside the buccal plates is richly provided with rather small, simple fenestrated plates, some of those outside the buccal plates are complicate and carry pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ (Pl. XIX. Figs. 6, 12) are very characteristic. There is only one unpaired, very strong lateral

[1]) Bidrag til Kundskab om Echiniderne. p. 27.

tooth; the outer corners of the basal part are strongly produced in a wing-shaped manner, and the holes in the corners are most frequently somewhat lengthened. No neck or perhaps a short one; as I have only had dried specimens for examination, I have not been able to decide this fact with certainty; the stalk compact. In the tridentate pedicellariæ (Pl. XIX. Fig. 39) the blade is rather broad with a strong, somewhat thorny net of meshes at the bottom. The edge is strongly indented, especially in the outer half, where the valves join; in the lower half they are apart, but not very much. The ophicephalous pedicellariæ have an almost straight edge, which is otherwise finely serrate as usual; the teeth, as is often the case, continue down the upper ends of the apophysis. The triphyllous pedicellariæ (Pl. XIX. Fig. 29) are very peculiar, the upper end of the apophysis forming a cover-plate, from which digitate projections pass over the blade, which is curved strongly inward in the middle. The edge smooth as usual. The spicules are bihamate, very few in number.

Evechinus rarituberculatus Bell is by Farquhar (145) taken to be young specimens of *E. chloroticus.* It is certain that it is very similar to *chloroticus*, but I cannot regard it as proved that it is synonymous with this species, as the tridentate pedicellariæ (Pl. XIX. Fig. 7) show a considerable difference from those of *chloroticus.* They have no coarse indentations in the edge, which is almost straight and very slightly serrate, only at the lowermost part there are a few larger indentations; the net of meshes in the bottom is slight, not thorny. The valves join through almost their whole length. — Perhaps similar pedicellariæ may be found in *chloroticus* together with the form described above; in my specimens, however, I have not been able to find such. For the present I must then regard *rarituberculatus* as a separate species. — The globiferous and ophicephalous pedicellariæ are quite as those of *chloroticus*, the triphyllous ones I have not seen. — Of *Evech. australiæ* Woods I know nothing.

Agassiz (Rev. of Ech. p. 502) thinks *Evechinus* to be closely allied to *Tripneustes* (*Hipponoë*); that there is no nearer relation at all between these two genera is seen with all desirable distinctness from the facts given above. The unpaired lateral tooth on the globiferous pedicellariæ draws the attention to *Pseudechinus albocinctus*; but the naked buccal membrane in the latter and the fact that a primary tubercle is here found on all the ambulacral plates, do not indicate a very near relation between the two forms. A quite similar form of globiferous pedicellariæ is found in *Strongylocentrotus tuberculatus* and closely allied species, and these, no doubt, are its nearest relations. A more thorough inquiring into this question must, however, be put off, until these species are treated.

In Cat. rais. the species *variolaris* Lamk., *paucituberculatus* Blainv., and *chloroticus* Val. are enumerated under the genus *Heliocidaris.* — For the first of these species the older name of *Stomopneustes* must be used; according to Agassiz (Rev. of Ech.) *paucituberculatus* is synonymous with this. As far as I can see, *chloroticus* must then be the type of the genus *Heliocidaris*; the name of *Evechinus* Verr. (1871) must then be dropped as being a much younger one, and I cannot but wonder, why Agassiz, who otherwise takes great care to reestablish the oldest names, has here preferred the name of *Evechinus.*

To the genus *Sphærechinus* Desor the species *granularis* (Lamk.), *roseus* Russo, *australiæ* A. Ag., and *pulcherrimus* (Barn.) are referred; of these I have had no occasion to examine *Sph. roseus*, but the existing figures and the description (347) show distinctly that it is closely allied to *granularis*. The other three species I have examined, and can give some new informations of them.

Sphærechinus granularis (Lamk.). All the ambulacral plates have a primary tubercle. The buccal membrane contains outside of the buccal plates only few, small fenestrated plates, but they are thick and carry pedicellariæ, inside of the buccal plates there are numerous small, little complicate fenestrated plates. No spines on the buccal plates. The globiferous pedicellariæ, which have often been described and figured, have a tubular blade without lateral teeth (Pl. XXI. Figs. 35, 37); the end-tooth is peculiarly furrowed, so that it is a little difficult to see the open canal on the upper side. No neck. Glands on the stalk are found (were formerly only known in this species), the stalk tubular or compact[1]). The tridentate pedicellariæ (Pl. XXI. Fig. 34) with a well developed net of meshes, almost to the point of the blade; the edge is thick with an indication of transverse series of teeth. The valves are apart for about half their length, but the slit between them is rather narrow. The length of the head up to 2^{mm}. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules in the globiferous pedicellariæ are slightly thickened at the ends (Pl. XXI. Fig. 12), but not really dumb-bell-shaped. In the tube feet only a few spicules are found just below the sucking disk; they are bihamate with small branches on the outside at both ends — quite as in *Toxopneustes pileolus*. In the buccal membrane, especially nearest to the gills, and in the gills, fine, genuine bihamate spicules are found; in the gills the usual irregular fenestrated plates are also found.

Sphærechinus australiæ Ag. agrees with regard to spicules and pedicellariæ exactly with *granularis*. Whether a primary tubercle is found on all the ambulacral plates, I cannot tell with certainty, as I have omitted the examination of this feature during my stay at British Museum; but as all other polypore Echinids that I know, have a primary tubercle on all the ambulacral plates, there can scarcely be any doubt that the fact is the same in this species. In Challenger-Echinoidea (p. 106) *Sph. australiæ* is mentioned from st. 162 (Bass's Strait). In British Museum I have examined the specimen upon which this statement rests, and have found that it is no *Sphærechinus* at all. The globiferous pedicellariæ have one unpaired lateral tooth, and recall those of »*Strongylocentrotus*» *tuberculatus* very much; otherwise I shall not decide to which genus and species this young specimen belongs, but rest satisfied with having pointed out that it is no *Sphærechinus*.

Sphærechinus pulcherrimus (Barn.), as well by its whole habitus as by its spicules and pedicellariæ, differs so much from the other *Sphærechinus*-species that there can be no question of referring it to this genus. On the other hand it shows great conformity with some *Strongylocentrotus*-species (*intermedius* and *chlorocentrotus*), and so it will be more particularly mentioned together with these species.

Agassiz says of the genus *Sphærechinus*: »this genus can hardly rank as more than a subgeneric division of *Strongylocentrotus*; the presence of deep, sharp cuts in the actinal system and the regularity of the arrangement of the tubercles, although giving to the species of this genus a striking facies, are simply quantitative characters, the value of which a better acquaintance with the subject will determine» (Rev. of Ech. p. 451). I shall readily admit that the difference between the deep slits

[1]) The so-called »Globiferæ» (Hamann 184) can only be interpreted as globiferous pedicellariæ, where the glands on the stalk have been highly developed at the cost of the head. The head is perhaps even torn off; at all events it is a sure fact that animals which are attacked by the pedicellariæ, can tear off the heads of the globiferous pedicellariæ. The so-called *Trichœlina paradoxa* (Barrois. 28), as is a well known fact, is only torn-off heads of globiferous pedicellariæ.

in *Sphærechinus* and the small ones in *Strongylocentrotus* is a quantitative one, as also the difference between the numerous tubercles in the former and the fewer ones in the latter genus. This, however, does not preclude the fact that especially the deep slits are a character very sharply distinguishing *Sphærechinus* from *Strongylocentrotus*. But other characters are found, not quantitative, but structural, which also make a sharp distinction between the two genera, viz. spicules and pedicellariæ (comp. the description below of *Strongylocentrotus drobachiensis*). There can be no question at all of making *Sphærechinus* only a subgenus of *Strongylocentrotus*; it is a very well characterized genus, evidently most closely allied to *Psammechinus*, *Toxopneustes* etc.

To the genus *Pseudoboletia* Troschel are, in «Rev. of Ech.» referred the species *granulata* (Ag.) and *indiana* (Mich.); of the latter Prof. de Loriol has kindly sent me a specimen. To the description of this species by Agassiz and de Loriol (245) I can add the following informations. A primary tubercle is found on all the ambulacral plates. The buccal membrane contains, besides the numerous thick plates carrying both spines and pedicellariæ, a great number of dumb-bell-shaped spicules and some bihamate ones; inside of the buccal plates numerous small, rather thick fenestrated plates without spines or pedicellariæ, and a few spicules, most of which are bihamate, almost none of them dumb-bell-shaped. The gills with common fenestrated plates, a few dumb-bell-shaped spicules, and innumerable bihamate ones. The globiferous pedicellariæ as in *Sphærechinus*; they are strikingly different as to size, but otherwise similarly constructed. The figure given by Agassiz in «Challenger»-Echinoidea (Pl. XLIV. Fig. 38) is not quite good, as the end-tooth seems there to be constructed quite as the tubular blade; I need scarcely mention that it is constructed in the common way. In the same place is given a rather good figure of a tridentate pedicellaria (Fig. 39), the only objection is that the oblique striæ in the blade give a somewhat coarse idea of the little developed net of meshes in the blade. The edge is thick with numerous small teeth, which in the lower part are placed in transverse series, in the outer part irregularly. Ophicephalous and triphyllous pedicellariæ of the common form. The stalk compact. In the globiferous pedicellariæ numerous spicules are found of about the same form as in *Sphærechinus*; the same form is also found in the tube feet, especially near the sucking disk, together with bihamate spicules that are not branched in the ends.

According to Agassiz (Rev. of Ech. p. 153) *Pseudoboletia maculata* Troschel is synonymous with *Ps. indiana*. De Loriol (op. cit.) does not think them to be the same species, and Bell (53) follows this opinion, and maintains farther that *Ps. granulata* is identical with *indiana*. After having examined a couple of specimens of *Ps. maculata* in British Museum I must also regard *maculata* as a well distinguished species. The globiferous pedicellariæ are as in *indiana*, the glands of the stalk are peculiarly lengthened and narrow, almost linear. (Whether this also holds good with regard to *indiana*, I am not able to decide by the dried specimen in hand.) The tridentate pedicellariæ (Pl. XXI. Fig. 1) yield scarcely a sure mark of distinction from *indiana*; together with the large form (the head up to $1{\cdot}5^{mm}$) where the valves join only in the outer half, a smaller, somewhat different form is found (Pl. XXI. Fig. 17) where the valves join through their whole length. The ophicephalous pedicellariæ (Pl. XXI. Fig. 5) are peculiarly elongate with almost straight, finely serrate edge and little developed mesh-work. It is, however, to be observed that on the buccal membrane of *Ps. indiana* ophicephalous pedicellariæ are found, resembling the figured one rather much, and as I do not remember, and have made no note, whether those of *Ps. maculata* are taken exclusively from the buccal membrane or perhaps also from the test, I do not venture for the present to put too much stress on this feature. The triphyllous pedicellariæ and the spicules show no difference from *Ps. indiana.* — The features stated here, together with those mentioned by de Loriol and Bell: the size of the peristome and the slits etc., and especially the peculiar coloration, which, according to de Loriol, is not found in *indiana*, seem to leave no doubt of the fact that they are two well distinguished species.

In »Rev. of Echini» *Pseudoboletia* like *Sphærechinus* is enumerated as a subgenus of *Strongylocentrotus*, and at the end of the diagnosis (p. 455) it is thereupon said: »This is an interesting genus, forming, as it were, a link between the Echinometradæ and Echinidæ; its position is still doubtful». In none of these statements I can agree with Agassiz. *Pseudoboletia* is neither a subgenus of *Strongylocentrotus* nor a transitional form between Echinometrids and Echinids, and its position is not at all doubtful — it is a near relation of *Sphærechinus.* It agrees with *Sphærechinus* with regard to the pedicellariæ, the spicules of these, the number of pores, and the structure of the test; only in two features a difference of any importance is found: the spicules of the tube feet are simply bihamate (in *Sphærechinus* a little branched in the ends) and — as the more important fact — the buccal plates and the other plates of the buccal membrane are set with small spines and pedicellariæ (in *Sphærechinus* only with pedicellariæ). That the spines are a little longer and the test somewhat more flattened than in *Sphærechinus* can hardly be used as a generic character. Thus it is rather unimportant characters, by which *Pseudoboletia* is distinguished from *Sphærechinus*; at all events, however, the peculiar covering with spines of the buccal membrane seems to be a sufficient reason for the keeping of the genus, and nothing would be gained by uniting it with *Sphærechinus.*

The genus *Strongylocentrotus* Brandt is in Rev. of Echini (p. 276) enlarged to comprise «all species having a somewhat circular or subpentagonal, regularly arched or slightly depressed test, with smooth, imperforate, not crenulate tubercles of unequal sizes, forming primary and secondary vertical rows. Pores arranged in arcs of at least four to five pairs. Actinostome decagonal; very slight cuts; buccal membrane bare; spines moderately slender, longitudinally striated, longer proportionally than those of true *Echinus*, and more slender than those of *Sphærechinus*». According to this diagnosis a great number of species will be referred to this genus, viz. *albus* (Mol.), *armiger* Ag., *depressus* (Ag.), *drøbachiensis* (Müll.), *erythrogrammus* (Val.), *franciscanus* (Ag.), *Gaimardi* (Blainv.), *gibbosus* (Val.), *intermedius* (Barn.), *lividus* (Lamk.), *mexicanus* (Ag.), *nudus* (Ag.), *purpuratus* (Stimpson), *tuberculatus* (Lamk.); to which are to be added some species which Agassiz, but no doubt wrongly, regards a synonyms, viz. *chlorocentrotus* (Brandt), *globulosus* Ag. (according to Rathbun, 337. p. 274), and *omalostoma* (Val.); finally a new species, *bullatus*, has been described by Bell (46). Further *Sphærechinus* and *Pseudoboletia* are classed as subgenera of *Strongylocentrotus.* »The homogenous nature of the genus as now limited cannot fail to be apparent», says Agassiz (loc. cit.). A closer examination shows, however, that this large genus is anything but homogenous. Apart from *Sphærechinus* and *Pseudoboletia* there proves to be among the mentioned species at least 6 well characterized genera, which are to be referred to 3 different families! Perhaps still other genera may be represented among the species I have had no occasion to examine. I must grant Agassiz to be right, when he says that it is impossible «upon the mere question of quantity or direction of the pores to subdivide this genus»; but fortunately other characters are found which prove to be quite efficient, above all the pedicellariæ and the spicules. The species *mexicanus*, *nudus*, and *globulosus* I have not seen. The other species may be divided into 5 groups, which I shall here characterize.

Strongylocentrotus drobachiensis (Müll.). Primary tubercle on all the ambulacral plates; the buccal membrane with rather few plates outside of the buccal plates, some of them thick carrying pedicellariæ; inside of the buccal plates there are more smaller, smooth or somewhat complicate plates. The globiferous pedicellariæ are highly characteristic, having a long neck provided with as well circular as longitudinal muscles, so that it may be retracted and stretched out (Pl. XX. Figs. 25, 29). The valves have a tubular blade without lateral teeth; the stalk is tubular, its upper end with peculiar ribs. The tridentate pedicellariæ are very much varying as to form (Pl. XX. Figs. 4, 6, 20); the small teeth on the edge may form beautiful transverse series; the ophicephalous and triphyllous pedicellariæ show no conspicuous peculiarities. The spicules of the pedicellariæ and tube feet are branched in the ends (Pl. XX. Fig. 12), otherwise most nearly of the bihamate form; simple bihamate spicules may also be found. In the globiferous pedicellariæ a dense series of spicules is often found along the outer edge of the valves (Pl. XX. Figs. 25, 29).

The same peculiar form of globiferous pedicellariæ is found in the species *purpuratus* (Stimps.), *intermedius* (Barn.), *franciscanus* (Ag.) (probably), and *chlorocentrotus* Brandt. In *St. purpuratus* the globiferous pedicellariæ are distinguished by the uncommonly well developed articular surface (Pl. XX. Figs. 14, 28); the stalk is strong, and seems to be compact. The tridentate pedicellariæ resemble very much the smaller form with the large indentations in *drobachiensis* (Pl. XX. Fig. 20), only the net of meshes is a little more developed. — Of *Str. franciscanus* I have only seen a large, fine, dried specimen in British Museum, and unfortunately I could find no globiferous pedicellariæ on it; but as the spicules of the tube feet are quite identical with those of *drobachiensis*, I have no doubt that also its globiferous pedicellariæ agree with those of this species. The tridentate pedicellariæ of very different form; in this one specimen no less than three different forms were found corresponding to the three forms figured from *Str. drobachiensis*. The larger ones have a strong net of meshes, the smaller ones almost none. — Of *Str. intermedius* a fine specimen is found in the museum of Copenhagen (received from the museum in Vienna), and further I have examined a specimen in British Museum. The two specimens prove, however, to be two different species, and it is not easily decided, which is the real *intermedius*. As far as I can see from the description in »Rev. of Ech.« and in Sladen (365. p. 434) the specimen in the museum of Copenhagen must really be *intermedius*. There are only four pairs of pores in each arc, and the spicules seem all to be simple, bihamate. The tridentate pedicellariæ resemble those of *Sphærechinus pulcherrimus* (Pl. XX. Fig. 10). The specimen in British Museum has also globiferous pedicellariæ with neck and branched spicules.

Str. chlorocentrotus Brandt is by Agassiz regarded as synonymous with *drobachiensis*, but no doubt wrongly. In the description of Brandt[1]) it is said among other things: »spinæ breves, virides, maximæ 4 linearum longitudinem vix superantes, latitudinem autem lineæ dimidiæ partis æquantes«. (The diameter of the test is given to be 1—$^1/_2$"). This does not hold good with regard to *drobachiensis*. De Loriol (248) has lately described a species from Sitka, which he refers to *Str. chlorocen-*

[1]) Prodromus etc. p. 64.

trotus. In our museum is found a small Echinid from Japan, received from the museum in Vienna under the name of *Str. intermedius*; this determination is scarcely correct, but it might agree with the description of *chlorocentrotus.* At all events it is another species than that of de Loriol; it has four pairs of pores, while Brandt gives 5 pairs. (That of de Loriol has 7—5 pairs). In this specimen the globiferous pedicellariæ are as in *drobachiensis*; but the spicules are simple, bihamate. Nothing definite can be said of *Str. chlorocentrotus*, until the type specimen has been reexamined.

To the species here mentioned, especially *intermedius* and *chlorocentrotus* (?) has to be added *Sphærechinus pulcherrimus*, of which I have received a couple of specimens from Prof. Döderlein; some specimens of this species were further found among some Echinids from Japan, which Prof. d'Arcy Thompson has sent me for examination. Of this species I shall give the following informations. A primary tubercle is found on all the ambulacral plates (as in all the preceding species and, as far as I know, in all polypore species). Only four pairs of pores in each arc, as in *intermedius* and *chlorocentrotus* (mentioned by Agassiz). Three ocular plates reach to the periproct. The buccal membrane is highly pigmented, with numerous small fenestrated plates, some few of those outside the buccal plates thick, with pedicellariæ. The globiferous pedicellariæ quite as in *drobachiensis*; of tridentate pedicellariæ a larger form is found (Pl. XX. Fig. 10), a little widened at the point and with rather sinuate edge, and a smaller form, where the edge is straight or only very slightly sinuate. The other pedicellariæ show no peculiarities. The spicules are bihamate, not branched.

As none of the other species referred to *Strongylocentrotus* — and, upon the whole, no other Echinids of *Triplechinidæ* and *Echinometradæ* that I know, with the exception of the *Anthocidaris homalostoma* Ltk. mentioned below — have the same peculiar form of globiferous pedicellariæ, it is evident that the mentioned species form a separate group, while it is a less sure fact whether they form also one genus. The species *pulcherrimus*, *intermedius*, and *chlorocentrotus* (?) are distinguished from the others by having simple bihamate spicules, only four pairs of pores in each arc, and by the very flat form of the test; in all of them the spines are very short, the primary ones very little conspicuous, also the primary tubercles are only little conspicuous among the numerous secondary tubercles arranged in horizontal series. I am most inclined to interpret these species as a particular genus (they form, perhaps, even only one species), which genus, if the mentioned specimen should really prove to be identical with Brandt's *Str. chlorocentrotus*, must get the name of *Strongylocentrotus*. The other species: *drobachiensis*, *purpuratus*, and *franciscanus*, would then have to form a separate genus, which, if the name of *Strongylocentrotus* is to be restricted to the above named species, must get the name of *Euryechinus* Verrill[1]). As long as we have no sufficient knowledge of the species that has to be called *Strongylocentrotus*, viz. *chlorocentrotus* Br., it will be most correct to call all the species mentioned here *Strongylocentrotus*, and leave the name of *Euryechinus* for disposal, if it should prove to be necessary to use it.

Strongylocentrotus depressus (Ag.). Of this species I have received a specimen from Prof. Döderlein, and another specimen I have found among the Echinids from Japan sent me for determination by Prof. d'Arcy Thompson. Accordingly I am able to give some informations of it, which

[1]) E. A. Verrill: On the Polyps and Corals of Panama, with descriptions of new species. Proc. Boston Soc. Nat. Hist. X. 1866. p. 340.

may be found to be so much the more important, as the description of this species by Agassiz is very unsatisfactory, and we have no figures of it at all. A primary tubercle is found on all the ambulacral plates; the pore areas of the actinal side are much extended, a little petaloid; the two lowermost plates have only three pairs of pores. Two ocular plates reach to the periproct. The buccal membrane contains numerous lengthened fine fenestrated plates, only a few are complicate and carry pedicellariæ; a few small bihamate spicules in the buccal membrane. No spines on the buccal plates. The gills contain the usual irregular fenestrated plates, but no bihamate spicules. The slits of the test not large, but very distinct. The globiferous pedicellariæ are as in *Sphærechinus*, but here no glands are found on the stalk. The tridentate pedicellariæ occur in three different forms (Pl. XXI. Figs. 8, 9, 15); between the two former of these transitions may perhaps be found, while no transitional forms seem to be found between the latter two. The teeth on the edge form no transverse series. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules in the globiferous pedicellariæ (Pl. XXI. Fig. 14. b) are chiefly as in *Sphærechinus*, only more lengthened; those of the tube feet are rather much branched, but they belong, however, to the bihamate form (Pl. XXI. Fig. 14. a); they are numerous in the abactinal tube feet, but very few in number in the actinal ones.

It is evident from the features mentioned here that this species is not closely allied to the *Strongylocentrotus*-species mentioned above. Its nearest relation, no doubt, is *Sphærechinus*; but it cannot be referred to this genus either; especially the strong extension of the pore areas on the actinal side renders the referring to *Sphærechinus* impossible, as in the latter no indication of such an extension is found. The form is also very different from the high form of *Sphærechinus*. The slits of the test, on the other hand, are scarcely to be used as a distinguishing mark, as they are not much smaller than in specimens of *Sphærech. granularis* of a corresponding size. A new genus must be formed for this species, and for this genus I propose the name of **Pseudocentrotus**.

Strongylocentrotus albus (Mol.). A primary tubercle is found on all the ambulacral plates; on the lowermost ones there are only three pairs of pores. One ocular plate reaches to the periproct, the others almost reach it. The buccal membrane with numerous, rather large, lengthened fenestrated plates, some of those outside the buccal plates thick, carrying pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ are very similar to those of *Parechinus miliaris* etc., but the apophysis ends far from the edge of the blade (Pl. XVII. Fig. 5); there is a short, but distinct neck, only, however, containing longitudinal muscles, not also circular muscles, so that it cannot be retracted and stretched out as in *Str. drobachiensis* etc. The tridentate pedicellariæ are very peculiar (Pl. XVII. Fig. 18), with a keel in the middle of the blade, which is short and narrow; the point is a little widened with 3—4 strong teeth on either side. There are no transverse series of small teeth. The ophicephalous pedicellariæ are somewhat lengthened, but without conspicuous peculiarities; the triphyllous pedicellariæ of common form. The stalk of the globiferous and triphyllous pedicellariæ consists of long, slender calcareous threads, almost only connected at the ends of the stalk; the stalk of the tridentate and ophicephalous pedicellariæ is compact. The spicules bihamate, very few in number.

With *Str. albus* must be classed the species *gibbosus* (Val.) and *bullatus* Bell. With regard to pedicellariæ they are so very similar to *albus*, that herein scarcely any specific difference can be pointed out. In *gibbosus*, however, I have only seen a small form of tridentate pedicellariæ (Pl. XVII. Fig. 12); but I suppose that also the peculiar large form is found in this species, and likewise may perhaps the small form be found in the two other species, although I have not found it. It is, however, to be noted that *gibbosus* has only 4 pairs of pores, while the two others have 7—8 pairs; and so it would be no strange thing, if its tridentate pedicellariæ were different from those of the others. As in *albus* only very few bihamate spicules are found. Agassiz (Rev. of Ech. p. 444) states that three ocular plates reach to the periproct; on the specimen I have examined (Challenger st. 304, western coast of Patagonia), no ocular plate reaches to the periproct. The same fact holds good with regard to *bullatus*. (Of *Str. bullatus* I have examined the type specimens in British Museum, of *albus* a couple of specimens are found in the museum of Copenhagen.)

That these species are nearly related is quite undoubtful, and it is as sure a fact that they have nothing to do with the real *Strongylocentrotus*-species. They must form a separate genus getting the name of *Loxechinus* Desor[1]), which has just been established for *Echinus albus* Mol. As already mentioned the globiferous pedicellariæ are constructed as in *Parechinus* (*miliaris* etc.), apart from the short neck, and I must regard these two genera as closely allied, so that *Loxechinus* is chiefly to be regarded as a polypore *Parechinus*. That the whole habitus of the *Loxechinus*-species recalls *Parechinus* very much, speaks, of course, together with the other features, also in behalf of such a relation, although a similar habitus alone in no way can be regarded as a proof of near relationship (comp. *Pseudocentrotus depressus* and *Anthocidaris homalostoma*).

Strongylocentrotus lividus (Lamk.). Of this species, which is so well known especially by the examinations of Valentin, I can give no new informations; I shall only here mention the features which in my opinion are of essential importance for the determination of its systematic position, but which are generally omitted in the systematic descriptions. A primary tubercle is found on all the ambulacral plates; in the lower ambulacral plates there are only three pairs of pores. In the smaller specimens all the ocular plates are shut off from the periproct, in the larger ones one or two may reach to it. The buccal membrane contains rather few fenestrated plates; most of those outside of the buccal plates are thick, round, and carry pedicellariæ; nearest to the edge a sphæridia may be found, sometimes one more may be found farther in on the buccal membrane. There are no spines on the buccal plates or on the other plates of the buccal membrane. To be sure Valentin says (Anatomie du genre Echinus. p. 62): il existe encore à la surface de la membrane buccale de petits piquants microscopiques, dont la structure ne diffère en rien de celle des piquants ; but I suppose it to be stalks of pedicellariæ he has mistaken for spines. On the figure to which he refers, no spines are found, but only stalks of pedicellariæ. The globiferous pedicellariæ are most nearly alike to those of *Parechinus*. The blade is quite open with 1—1 lateral tooth (Pl. XVII. Fig. 19), but the edge is thick, not thin and sharp as in *Parechinus*. There is no neck; the stalk consists of long, thin threads, only little connected, except at the ends of the stalk. (Also in the other pedicellariæ the stalk is constructed in this manner.) The tridentate pedicellariæ are very peculiar with long, narrow blade, coarsely serrate through the whole edge (Pl. XVII. Fig. 21); there are no small teeth. The ophice-

[1]) Synopsis des Ech. fossiles. p. 136.

phalous pedicellariæ have only a strong keel in the middle of the blade, as is seen on the figures of Valentin; otherwise almost no net of meshes is found. The triphyllous pedicellariæ of the common form. The spicules bihamate; I have only found them in the buccal tube feet. — Otherwise I may refer to Valentin's excellent figures of pedicellariæ and spicules.

Very closely allied to *Str. lividus* is *Str. Gaimardi* (Blainv.); it agrees exactly with *lividus* with regard to pedicellariæ and spicules. Unfortunately I have not been able to find tridentate pedicellariæ on any of the three specimens found in the museum of Copenhagen, and it is just in the tridentate pedicellariæ we might expect to find the difference. I shall express no definite opinion as to the fact, whether it be really the same species as *lividus*, what Agassiz is inclined to think; at all events the tridentate pedicellariæ must be examined, before the question can be answered with certainty. The peculiar, striped apical plates seem, however, to indicate that it is a distinct species.

It is a sure fact that these two species have nothing to do either with the genuine *Strongylocentrotus*-species or with *Pseudocentrotus*; on the other hand they seem to be more nearly allied to the genus *Loxechinus*, a rather great resemblance being found between the globiferous pedicellariæ. These pedicellariæ, however, seem to remind more of the genus *Echinus* itself, where globiferous pedicellariæ with quite open blade may also sometimes be found (*Ech. Alexandri*). Also the tridentate pedicellariæ remind most of the long, narrow form common in *Echinus*. As *Loxechinus* seems to be a polypore *Parechinus*, so must also, I suppose, *Str. lividus* be regarded as a polypore form of *Echinus*. That it must form a separate genus is not to be doubted. I propose the name of **Paracentrotus.**

Strongylocentrotus tuberculatus (Lamk.). To the description of this species by Agassiz (Rev. of Ech. p. 449) the following informations must be added. A primary tubercle is found on all the ambulacral plates; two ocular plates reach to the periproct. The buccal membrane contains comparatively few plates, all those outside of the buccal plates, with the exception of the plates at the very edge, are thick and carry pedicellariæ. Inside the buccal plates a rather great number of small fenestrated plates are found. The globiferous pedicellariæ have glands on the stalk; no neck; the valves (Pl. XIX. Figs. 4, 13), are constructed as in *Echinometra*: with one unpaired lateral tooth, almost as large as the end-tooth, but, of course, without a poison-canal on the upper side. The blade is tubular, but not quite closed; the basal part is much widened with the fore corners a little produced in a winglike manner. The tridentate pedicellariæ occur in two forms, a more narrow one (Pl. XIX. Fig. 8) with only little developed net of meshes, and a broader one (Pl. XIX. Fig. 9) with a well developed net of meshes, the meshes of which are somewhat lengthened, especially towards the point of the blade. On the lower part of the edge transverse series of small teeth are found. The ophicephalous and triphyllous pedicellariæ show no peculiarities. The stalk of the pedicellariæ compact. The spicules bihamate, also those of the globiferous pedicellariæ.

Strongylocentrotus erythrogrammus[1]) and *armiger* correspond so exactly with *tuberculatus* with regard to pedicellariæ and spicules, that a reliable specific difference is scarcely to be found in these features; I have not, however, seen the broad form of tridentate pedicellariæ in these two species.

That we have here a type which cannot be classed with any of the preceding genera, is

[1]) Not *eurythrogrammus*, as it is wrongly spelled in Rev. of Echini.

evident; these three species must form a separate genus which gets the name of *Toxocidaris* Ag.[1]). As the first species of this genus (of which no diagnosis is given) is named *T. Delalandi* Ag., which is synonymous with *erythrogrammus* (Rev. of Ech. p. 163); thus this species becomes the type of the genus *Toxocidaris*. Agassiz is surely right when he maintains (Rev. of Ech. p. 450) that the somewhat petaloid structure of the pore areas on the actinal side is no valid generic character of *Toxocidaris*, but the peculiar globiferous pedicellariæ leave no doubt of the correctness of the genus with the limitation given here.

As a synonym of *Strongyloc. tuberculatus* Agassiz (Rev. of Ech. p. 165) names *Anthocidaris homalostoma* Lütken[2]). I am so fortunate as to be able to prove this to be incorrect. The specimens of Lütken are only naked tests, of which one is from China, for the others no locality is given. Among the Echinids from Japan, sent me by Prof. d'Arcy Thompson, is a specimen, which with regard to the structure of the test agrees so exactly with the specimens of Lütken, that there can be no doubt of their being identical. So I shall here give the necessary informations of this species. The specimen in hand has a diameter of 30^{mm}, and is from Yokohama Bay. The primary tubercles of the ambulacral areas are almost as large as the interambulacral primary tubercles. There is an irregular series of small tubercles in the middle, and a similar one outside of the primary series on either side; this outer series is formed of a larger and a smaller tubercle alternately, a larger tubercle being found below on each ambulacral plate, and a smaller one above; besides some small tubercles are found outside the latter ones, nearer to the pores. The interambulacral areas have a double series of secondary tubercles between the primary series, and one outside on either side; just at the ambitus two series are found outside of the primary ones, and all these tubercles form here distinct oblique series. The colour of the test is grayish green. The spines are thick, evenly tapering, the longest half as long as the diameter of the test; they are of a deep violet colour. Two ocular plates reach to the periproct. The pore areas are rather highly petaloid on the actinal side, and as only a few small spines are found nearest to the mouth, almost only tube feet are seen here. In the lower ambulacral plates only 3 pairs of pores are found, above there are 8—9 pairs. The buccal membrane contains rather numerous fenestrated plates, of which some of those outside of the buccal plates are thick and carry pedicellariæ. The gills contain the common irregular fenestrated plates. The slits distinct. The globiferous pedicellariæ are as in *Strongyloc. drobachiensis* with well developed neck (in the specimen in hand I succeeded only with much difficulty in finding one small globiferous pedicellaria). The tridentate pedicellariæ (Pl. XXI. Fig. 6) resemble much the narrow form in *Toxocidaris tuberculatus*; but also another form is found with the blade somewhat widened in the point, and with a more developed net of meshes. As I have not been able to find a whole specimen of this form, I have given no figure of it, so much the less as its seems that no great stress can be laid on the tridentate pedicellariæ as specific characters in most of the *Strongylocentrotus*-like forms. No transverse series of small teeth are found on the edge. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules of the tube feet are very characteristic (Pl. XXI. Fig. 30), biacerate, a little curved, generally with a rather strong point in the middle of the outer side.

[1]) List of Echinoderms etc. Bull. Mus. Comp. Zool. I. p. 22.
[2]) Bidrag til Kundskab om Echiniderne. p. 96.

That this form is widely different from *Toxocidaris tuberculatus* is evident from the characters mentioned here; on the other hand the globiferous pedicellariæ show that it is rather closely allied to *Strongylocentrotus*. But the peculiar spicules and the petaloid pore areas characterizes it sufficiently as a separate genus, which keeps, of course, the name of *Anthocidaris*. Lütken (loc. cit.) regards it as identical with *Echinus homalostoma* Valenc.; I do not know whether this is correct, but it is so far of no consequence, as this species will, at all events, get the name of *Anthocidaris homalostoma*. I suppose that this species has hitherto been confounded with *Toxocidaris tuberculatus*, which it resembles to some degree, and which is also said to occur at Japan. *T. tuberculatus*, however, is indigenous in the Australian seas, and until renewed examinations have corroborated its occurrence at Japan, I must suppose a confounding with *A. homalostoma* to have taken place. As to habitus *A. homalostoma* is very similar to *Pseudocentrotus depressus*, which latter has also petaloid ambulacra; but its colour is (always?) brownish red, and it is somewhat more flattened. The examination of pedicellariæ and spicules will immediately show them to be two widely different forms.

Where the species *Str. mexicanus*, *nudus*, and *globulosus* are to be referred, cannot be seen from the existing descriptions. The other species referred to *Strongylocentrotus* thus prove to belong to no fewer than 6 different genera: *Strongylocentrotus*, *Pseudocentrotus*, *Loxechinus*, *Paracentrotus*, *Toxocidaris*, and *Anthocidaris*, and it may perhaps even be necessary to divide the first one into two genera. And these genera are excellently characterized, and so far from being closely allied, that they are to be grouped into three different families. We can scarcely wish for a more striking proof of the insufficiency of the characters that are taken only from the test and the spines.

Stomopneustes variolaris (Lamk.). Of this very peculiar form I am able to give some new informations; I have not, however, had material sufficient for clearing up everything that might be wished for. — A primary tubercle is only found on every fourth or fifth ambulacral plate; each of these large tubercles spreads over more plates — but it is difficult to decide over how many, as no boundary lines are seen between the plates; it may, however, be seen from the pores that the fact is so, as more arcs are found opposite to each tubercle. Two ocular plates reach to the periproct. The buccal membrane contains numerous lengthened, fine fenestrated plates, of which a few are a little complicate and carry pedicellariæ. Small spines are found on the buccal plates. The gills contain numerous, mostly three-radiate spicules (Pl. XVII. Fig. 13), but not the common irregular fenestrated plates. The globiferous pedicellariæ are of a quite unique form. There is no end-tooth, but the blade ends truncately with a long tooth in each corner (Pl. XVII. Fig. 17), sometimes two teeth on one side, or that on the one side a little below the corner. These teeth have no poison canal, and upon the whole no poison gland seems to be found (I have not, however, been able to ascertain this fact with full certainty). The blade is open, rather flat, the apophysis ends abruptly without any widening above. There is no neck, and the stalk is very short and compact. This very peculiar, large, and powerful form of pedicellariæ is, unfortunately, very scarce; in the two specimens I have examined, I have only been able to find one in each specimen, placed in one of the interambulacral furrows near the ambitus. Besides another, smaller form of globiferous pedicellariæ seems to be found, with end-tooth and 1—1 lateral tooth, very similar to those of *Paracentrotus lividus*; but I have not been able to make quite sure of this fact. The tridentate pedicellariæ are distinguished by the apophysis continuing some way into the blade as a distinct, a little serrate crest (Pl. XVII. Figs. 16, 20); the form is otherwise somewhat varying, as the blade may be more or less widened in the outer part; the larger ones have a rather powerful net of meshes, the small have almost none. The edge is rather coarsely serrate in the lower part, finely serrate towards the point; there are no transverse series of small teeth. A form as that figured by Agassiz (Rev. of Ech. Pl. XXIV. 31), where, moreover, the apophysis does not continue into the blade, I have not seen. Stewart (381) figures a valve of a tridentate pedicellaria, and mentions this crest. In the same place he figures a valve of an ophicephalous pedicellaria to which I may refer; they are dentate in the edge to an uncommonly high degree, although some difference is found in this respect, but I have not seen them with so smooth edges as in the figure by Agassiz (loc. cit. Fig. 32). The ophicephalous pedicellariæ have almost no neck, as has already been observed by Stewart. The stalk, which is, like those of the other pedicellariæ, thick and compact, has a little constriction above. The triphyllous pedicellariæ are uncommonly lengthened (Pl. XVII. Fig. 4) without teeth in the edge. What Stewart has taken to be triphyllous pedicellariæ (he does not figure them), I think to have been quite small, tridentate pedicellariæ. The great variation in the size of these (the tridentate) pedicellariæ, and the broad, spoon-shaped character of their jaws make the smaller forms closely resemble the trifoliate variety and lend weight to Prof. Agassiz's view, that the latter are rarely (sic! — early) stages of the former (381. p. 911). That there can be no question of this need not be more nearly explained here, a reference to the informations given above with regard to the development of the pedicellariæ, will be sufficient. The spicules of the tube feet are very peculiar; along one side of the tube foot is found a series of large spicules formed as long, fenestrated, thorny tubes; they are parallel to the longitudinal axis of the foot, and are placed in such a way, that the upper end is projecting, while the lower end is covered by the spicule following below. Towards the sucking disk the spicules become smaller, at last only flat, lengthened fenestrated plates. On the opposite side of the tube foot is often — but not always — found an irregular series of much smaller spicules more or less perforated. Stewart[1]) has given figures of these spicules, to which the reader is referred; I have never, however, seen the large spicules branched, as they are figured here, Stewart does not know in which species it is that he has found these remarkable spicules; later (381) it has become clear to him that it is *Stomopneustes variolaris.* — Whether *Stomopn. atropurpurea* Woods (447) is a separate species, or, as Ramsay (311. p. 11) thinks, only a variety of *variolaris*, I cannot tell with any certainty, as I have not seen this form, and the description gives no information of pedicellariæ and spicules. These structures must be examined, before the question can be definitively decided.

Parasalenia gratiosa Ag. I can only give little information of this very characteristic form beyond what has been stated by Agassiz, Lütken, and Stewart. A primary tubercle is found on all the ambulacral plates; the buccal membrane contains numerous, rather large, fine fenestrated plates, of which only a few are complicate and carry pedicellariæ. No spines on the buccal plates. The globiferous pedicellariæ have a tubular blade, without lateral teeth. No neck; glands seem to be found on the stalk, which is compact. The tridentate pedicellariæ are long and very narrow, finely serrate in the edge; they remind very much of those in *Paracentrotus lividus*, but the serrations are finer.

[1]) On the Spicula of the regular Echinoidea. Transact. Linn. Soc. XXV. Pl. L. fig. 1. 1865.

No transverse series of small teeth. The ophicephalous and triphyllous pedicellariæ without conspicuous peculiarities. The spicules of the globiferous pedicellariæ are bihamate, those of the tube feet of a very peculiar form: biacerate, a little arcuate, with two small, axe-shaped projections on the concave side (Pl. XXI. Fig. 32). — *Parasalenia Pöhlii* Pfeffer (314) I have not seen.

In Revision of Echini p. 423 the family *Echinometradæ* is defined as having always more than three pairs of pores to each arc ; nevertheless *Parasalenia* is also referred to this family, although it has only three pairs of pores in each arc. Setting aside this contradiction is must be admitted that when only the form and habitus of the test is taken into consideration by the determination of the relationship of the Echinids, *Parasalenia* must be regarded as an oligopore Echinometrid. The examination of its pedicellariæ and spicules show, however, that it has no nearer relation with the Echinometrids. The spicules remind most of those in *Anthocidaris*, but are, nevertheless, very different also from these; also the globiferous pedicellariæ recall those of *Anthocidaris*, but are distinguished from these by having no neck. Thus it is not too closely allied to *Anthocidaris*, but it does not seem possible, at all events at present, to point out any nearer relation. That the structure of the spines is very different from that of the *Echinometra*-spines (Mackintosh 265, Stewart 381) is a further proof that *Parasalenia* has nothing to do with *Echinometra*; now, to be sure, we cannot lay any great stress on some difference in the structure of the spines, when this character is standing alone; but when, as in *Parasalenia*, it is added to other characters of more significance, it will also get some importance.

After it has been pointed out that *Parasalenia* is no Echinometrid, this form becomes of considerable interest as proving a parallel development within two different families.

Echinostrephus molare (Blv.). Also this peculiar form is well known, especially Stewart (381) has figured its pedicellariæ with the exception of the triphyllous ones; accordingly only the most important features are to be briefly mentioned here. A primary tubercle is found on all the ambulacral plates; all the ocular plates are shut off from the periproct. The buccal membrane with rather numerous fenestrated plates, not only opposite to the ambulacra (Rev. of Ech. p. 457); most of them are thick and carry pedicellariæ. No spines on the buccal plates; the gills with the usual irregular fenestrated plates. The globiferous pedicellariæ as in *Echinometra* with one large, unpaired lateral tooth. There is no neck; whether glands are found on the stalk could not be decided with certainty, as the examined specimen is a dried one. In the tridentate pedicellariæ the blade is widened in a somewhat spoon-shaped manner, rather strongly serrate in the edge in the outer part, without transverse series of small teeth; only a little developed net of meshes. The ophicephalous and triphyllous pedicellariæ of the common form. The stalk of the pedicellariæ compact. The spicules of tube feet and pedicellariæ bihamate. — Although this genus has most frequently trigeminate pores, it is also referred to *Echinometradæ* in Rev. of Ech. ; this is no doubt correct, both spicules and pedicellariæ being as in *Echinometra*. *Ech. pentagonus* Yoshiw. (449) not examined.

To the genus *Echinometra* are referred the species: *lucunter* (L.)[1], *oblonga* (Blv.), *Mathæi* (Blv.),

[1] Lovén (252. p. 153) has definitively shown the common Westindian *Echinometra* to be the *Echinus lucunter* of Linné; thus that species must keep the name, and the name of *E. subangularis* (Leske) used by Agassiz (Rev. of Ech.) must be rejected. The species from the Pacific for which Agassiz unjustly reserves the name of *lucunter*, must give up this name, and in future be called *Echinometra Mathæi* (Blv.), which name thus, according to Agassiz (Rev. p. 115), becomes the older one.

van Brunti Ag., *viridis* Ag., and *macrostoma* (Ltk.). Whether the last-named one is a genuine *Echinometra* cannot be decided for the present, as only naked tests and loose spines are known. The other species agree in the main features, also with regard to pedicellariæ and spicules; so there is no reason to enter into details with regard to the separate species, only a few features characteristic of the genus are to be mentioned. A primary tubercle is found on all the ambulacral plates; no ocular plate reaches to the periproct in *Ech. oblonga* and *viridis*, while in *lucunter* generally one plate, rarely two or none at all reach to it. The buccal membrane contains numerous large, but fine fenestrated plates, almost all without pedicellariæ. Spines on the buccal plates. The globiferous pedicellariæ have one unpaired, strong lateral tooth, as Perrier has pointed out, and he has figured it in an excellent manner[1]). There is no neck; the stalk is compact. In *E. oblonga* is found the peculiarity that the stalk has a joint in the middle; in *E. van Brunti* the globiferous pedicellariæ are very small, but otherwise of the common form. The tridentate pedicellariæ are narrowly leaf-shaped with little developed mesh-work (see Rev. of Ech. Pl. XXVI. Figs. 9, 12—13); in *van Brunti* they are of a quite different form, short, narrow, a little widened in the point, and the blade quite filled by a complicate mesh-work (Pl. XIX, Fig. 21). The ophicephalous pedicellariæ with a rather strong mesh-work, a little different in form, although upon the whole of the common structure; the triphyllous pedicellariæ of the common form. The spicules bihamate.

The genera *Heterocentrotus*, with the species *mamillatus* (Klein) and *trigonarius* (Lamk.), and *Colobocentrotus*, with the species *atratus* (L.) and *Mertensii* Br. are most nearly allied to *Echinometra*, as is commonly supposed; the globiferous pedicellariæ and the spicules are chiefly as in this genus. A primary tubercle is found on all the ambulacral plates; no ocular plate reaches to the periproct. The buccal membrane with numerous fenestrated plates several of which carry pedicellariæ and small spines as the buccal plates. The gills are in *Heterocentrotus* uncommonly well provided with fenestrated plates some of which even carry (triphyllous) pedicellariæ; rather numerous small bihamate spicules are also found among the fenestrated plates. In *Colobocentrotus* fewer fenestrated plates are found, but also here they carry triphyllous pedicellariæ. — Only in these two genera I have seen this peculiar feature that pedicellariæ are found on the gills. — In *Colobocentrotus* the globiferous pedicellariæ are quite small and placed quite down among the flat spines on the abactinal side; the edges of the blade not connected by cross-beams (Pl. XIX. Fig. 5). The stalk is curved. (In *C. Mertensii* I have not seen the globiferous pedicellariæ.) Of the tridentate pedicellariæ in *Heterocentrotus* Agassiz (Rev. of Ech. p. 665) has the remarkable expression that "the tridactyle pedicellariæ are of the type called trifoliate". I do not understand the sense of this expression; otherwise a rather good figure is given of these pedicellariæ in *H. mamillatus* (XXVI. Fig. 2). There is a striking difference between the tridentate pedicellariæ in *mamillatus* and *trigonarius*. In the former (Pl. XIX. Fig. 15) the blade is narrow in the lower part, widened at the point, with a pair of rather projecting corners; the valves only join at the point, and are otherwise wide apart; in *trigonarius* the blade is of the common leaf-shape (Pl. XIX. Fig. 35), with no widening at the point, and the valves join through their whole length. In both of them the edge is very slightly serrate, but there are some larger indentations in the narrow part of those of *mamillatus*. Perrier (op. cit.) thinks that several *Heterocentrotus*-species

[1]) Rech. sur les Pédicellaires etc. Pl. VI.

may be distinguished by the pedicellariæ; after the material before me I must agree with Agassiz that only two species can be distinguished: *mamillatus* and *trigonarius*. But then these two species may immediately be recognized by their tridentate pedicellariæ (besides by the characters stated by Agassiz [Rev. p. 427 seq.]). The tridentate pedicellariæ in *Coloboc. atratus* are very similar to those of *H. trigonarius*; the valves join through their whole length (Pl. XIX. Fig. 1); in *C. Mertensii* I have not succeeded in finding these pedicellariæ. The ophicephalous and triphyllous pedicellariæ of the common form. The spicules are bihamate; in *Heterocentrotus* they are exceedingly numerous as well in tube feet as pedicellariæ, in *Colobocentrotus* they are very few in number.

Of the forms referred to »*Triplechinidæ*» we have still left *Phymosoma crenulare* Ag., *Hemipedina cubensis* Ag., and *mirabilis* Död. None of these forms I have been able to examine, so that their place must for the present remain undecided. We may, however, draw same conclusions from the existing descriptions. Of *Phymosoma* Agassiz figures valves of globiferous and tridentate pedicellariæ (Rev. of Ech. Pl. XXV. 4, 5) from which is seen that no lateral teeth are found on the globiferous pedicellariæ; whether a neck is found or not is not mentioned. The spicules are not known. A peculiar feature is seen from the figures given by Agassiz (Rev. Pl. VII. a. f. 6, 8, 9), viz. that the pores form arcs with alternately two and three pairs. As the figures cited are photographs, there can be no doubt of their correctness, although Agassiz, as far as I can see, does not mention this fact. This peculiar feature together with the crenulate tubercles renders it undoubtful that this form has nothing to do with the genuine Echinids. Pomel (324) puts it down as the only recent representative of »Les Phymosomiens», and readopts the name of *Glyptocidaris*, by which it was originally described by Agassiz. I shall express no opinion whether it really is to be classed with »Les Phymosomiens», partly because my knowledge of these fossil forms is too small, partly because upon the whole I am rather sceptical with regard to the possibility of referring with certainty the recent forms to the fossil ones. Accordingly I agree with Pomel that the name of *Glyptocidaris* must be readopted for this form, as the name of *Phymosoma* has originally been used of fossil forms.

Of *Hemipedina cubensis* Ag. are figured (Rev. of Ech. Pl. III. f. 6—7) a tridentate pedicellaria and a smaller one which is stated to be a young tridentate pedicellaria, but which is rather a globiferous or ophicephalous one; neither is given with sufficient details. The spicules are not known. The perforated tubercles show, however, that this form has nothing to do at all with the other »*Triplechinidæ*». Agassiz says himself that it is a Pseudodiadematid, but to refer all *Pseudodiadematidæ* to »*Triplechinidæ*» is by no means admissible, so much the less as these »*Triplechinidæ*» prove to be so heterogeneous that the genera referred thither must be distributed to three different families. Pomel (324) refers it to »Les Pediniens» as the only recent representative, and he readopts the name of *Cænopedina* by which Agassiz has originally described it. With regard to the name I must agree with Pomel for the same reasons as stated above under *Glyptocidaris crenularis*. I shall not contest that the referring to »Les Pediniens» is correct, but I must regard it as certain that it has nothing to do with »*Triplechinidæ*».

Having thus given a natural grouping of the species I shall have to treat the question of the grouping of the numerous genera. That the systems mentioned above, which are chiefly based on the number of the pairs of pores, give no impression of the real relation of the forms need not to be pointed out more nearly. By an interpretation of the genera so confused as has been the case here, it is of course impossible to have a clear understanding of the relation between them. Of the characters hitherto used any greater importance can only be attributed to one, viz. the deep slits in the test (Troschel, Pomel). The genera with deep slits in the test prove to be all closely allied. But this character is no quite reliable one; partly it is a matter of degree whether a slit is deep or not, and especially there is the unfortunate circumstance that the slits are always small in young specimens, also in the species where they are deep in the adult ones; partly forms are found with small slits, which are, no doubt, most nearly allied to those with deep slits (*Gymnechinus*). Then we have left no other characters than the pedicellariæ and the spicules, but they prove also to be excellent. Of the pedicellariæ only the globiferous ones can be used for the grouping of the genera; the other pedicellariæ are upon the whole very similar in all the forms treated here.

The simplest form of globiferous pedicellariæ is evidently the one found in *Parechinus*; the blade is open, the edges are not connected by cross-beams, not thickened, and project in two or more rather long teeth on either side. A quite similar form is found in *Loxechinus*, only here a short neck is found, while *Parechinus* has no neck. — This form of pedicellariæ is only found in these two genera which form accordingly a separate group; they are very similar as to habitus, so that nothing seems to be found that might prevent a putting together of them. — A somewhat more complicate form is found in the genera *Echinus* and *Sterechinus*. The edges of the blade are thickened, and are (with a single exception: *Sterech. horridus* and [rarely] *Ech. Alexandri*) connected across the inside by more or fewer cross-beams. One or more lateral teeth are found on either side, most frequently there is a tendency to obliquity in the outer end of the blade, just below the end-tooth, and frequently there are two teeth on the stronger, a little projecting edge, and only one on the other, more straight edge. This form of pedicellariæ is only found in the two mentioned genera, and so they evidently form another group; also the forms belonging here show considerable similarity as to habitus. — A similar form of pedicellariæ is found, however, in one more genus, viz. *Paracentrotus*; also here the edges are thickened, with a tooth on either side, but they are not connected across the inside of the blade. It seems that this genus, which is polypore and, with regard to habitus, very different from the other genera mentioned here, must be interpreted as a somewhat farther relation of *Echinus* and *Sterechinus*. In all these genera only simple bihamate spicules are found.

From these forms the development goes in two diverging directions: complete reduction of all the lateral teeth, or strong development of the one unpaired lateral tooth. In *Psammechinus*, *Toxopneustes*, *Gymnechinus*, *Tripneustes*, *Sphærechinus*, *Pseudoboletia*, and *Pseudocentrotus* all lateral teeth have disappeared, and the blade has become quite closed, tubular. Besides all these genera are distinguished by having small, thick, more or less dumb-bell-shaped spicules. There can be no doubt that they form a separate group. The three first have regularly trigeminate pores, in *Tripneustes* the young individuals have also regularly trigeminate pores, but in the adult the pore areas extend so much, that they look as if they were polypore; but they continue as a matter of fact to be oligopore. *Sphærechinus* and *Pseudoboletia* are polypore, mostly, however, with four pairs of pores in each arc. As the uppermost one in the series of development we find *Pseudocentrotus* with 5–6 pairs of pores where the pore areas are even somewhat petaloid on the actinal side.

The same form of globiferous pedicellariæ is found in *Strongylocentrotus*, *Anthocidaris*, and *Parasalenia*. The two former are distinguished by the globiferous pedicellariæ having a well developed neck, provided with circular and longitudinal muscles — an otherwise unknown feature. These three genera are likely to be rather nearly related; their spicules, however, show that the relation is not very close. In *Strongylocentrotus* the spicules are a little branched in the ends, but otherwise the original form is bihamate; in some species only (?) common bihamate spicules are found. In *Anthocidaris* the spicules are biacerate, pointed in both ends and with a branch in the middle. A somewhat similar form of spicules is found in *Parasalenia*; but in this genus the globiferous pedicellariæ have no neck. Thus this latter seems to form a special group; its obliquity and the peculiar anal plates indicate also that it must be interpreted as an aberrant form, of which the nearest, although not very near, relations are: *Anthocidaris* and *Strongylocentrotus*. In the genera *Heliocidaris*, *Echinostrephus*, *Toxocidaris*, *Echinometra*, *Heterocentrotus*, and *Colobocentrotus* there is a strong, unpaired lateral tooth on the globiferous pedicellariæ, and they have all simple bihamate spicules. *Heliocidaris* occupies a somewhat isolated position; its globiferous pedicellariæ are not so much developed as those of the other genera, it reminds to a rather high degree of *Sterechinus Neumayeri*, but especially of *Pseudechinus albocinctus*; several things favour the belief that *Pseudechinus* is really a transitional form between *Sterechinus* and *Heliocidaris*, and the latter leads on again to *Toxocidaris*, *Echinometra* etc. Thus we have here a very fine series of development where, together with the peculiar development of the globiferous pedicellariæ, a marked tendency to obliquity is seen, reaching the climax in the genera *Heterocentrotus* and *Colobocentrotus*. There seems to be no occasion to separate these two genera as a special group on account of their longitudinal axis not being placed in the same direction as in *Echinometra*, because their pedicellariæ and spicules are exactly agreeing with those of *Echinometra*. It is constantly seen that spicules and pedicellariæ are the most important systematic characters, so that there is no reason for suddenly following a new principle here. The genera *Pseudechinus*, *Heliocidaris*, and *Echinostrephus* must then be interpreted as more or less primitive oligopore Echinometrids.

Stomopneustes occupies a quite isolated position; its globiferous pedicellariæ and spicules are so peculiar and so different from what is found in the other forms mentioned here, that there can be no question of classing it with any of them; it forms a special group.

The relation between these forms may most easily be surveyed in the following diagram. For safety's sake I shall expressly remark, however, that I do not mean it to be regarded as a phylogenetic one. I will in no way maintain that our *Parechinus* is the ancestral form of *Echinus* etc., but only express my opinion that it shows the simplest structure of the organs most important with regard to classification. We may in the recent forms scarcely find more than an indication of the way the development seems to have taken. Now there is unfortunately only a small chance of finding these fine structures in the fossil forms, so we shall hardly get so far as to be able with certainty to point out the ancestral forms. Otherwise this survey of the relations of the forms shows clearly that here is everywhere a tendency to increase the number of tube feet, a development from oligopore to polypore forms. The most original feature, no doubt, is that all the ambulacral plates are well developed with primary spine and three tube feet; then the primary spines disappear from every other ambulacral plate, and these plates become much narrower than the others, but keep their three tube feet. This development is carried on in *Tripneustes* and *Heliocidaris*, where the primary spine is wanting in more ambulacral plates after each other. By this development there is made room for far more tube feet than when all the ambulacral plates are typically developed and provided with a primary tubercle; but there are constantly only three tube feet for each compound ambulacral plate. The same end is reached by the fact that the ambulacral plates are made to consist of more than three primary plates, that they become polypore. In almost all the groups both oligopore and polypore forms prove to be found; only *Parasalenia* has no polypore relation, and in the *Strongylocentrotus*-group an oligopore form is still wanting. It may not be thought unreasonable to expect that such a one will be found; it is no far cry from *Str. pulcherrimus* where only four pairs of pores are found.

Pseudocentrotus
Pseudoboletia
Anthocidaris Strongylocentrotus Sphærechinus Colobocentrotus
Tripneustes Heterocentrotus
Toxopneustes Echinometra
Gymnechinus Toxocidaris
Parasalenia Psammechinus Echinostrephus
Heliocidaris
Pseudechinus
Paracentrotus

Sterechinus
Echinus
Loxechinus
Stomopneustes Parechinus

The result of the studies of *Echinometradæ* and *Triplechinidæ* represented here, is expressed in the following system.

Fam. **Stomopneustidæ** n. fam.

The spicules irregular, more or less tubular fenestrated plates. The globiferous pedicellariæ without end-tooth[1]) The stalk compact.

Only one genus known.

Stomopneustes Ag.

The pores trigeminate. Only every fourth or fifth ambulacral plate with primary tubercle, but this tubercle is large and spreads over several ambulacral plates. The spines long and thick; small spines on the buccal plates. The buccal membrane with numerous fine fenestrated plates, quite imbedded in the skin. The gills with numerous three-radiate spicules. A deep furrow along the median line in the interambulacral areas.

[1]) Perhaps here may be found, besides the large globiferous pedicellariæ without end-tooth (and without poison gland?), a smaller form of globiferous pedicellariæ of the common structure. (See above p. 126).

Species: *St. variolaris* (Lamk.), *atropurpurea* Woods (?).

Distribution: Indian Ocean, Australia. Littoral forms.

Fam. **Echinidæ** Ag. (emend.)

Spicules bihamate. The globiferous pedicellariæ with end-tooth and one or more lateral teeth on either side; no neck; the stalk consists of long, thin, loosely connected calcareous threads. Mouth slits small.

Subfam. **Parechininæ** n. subfam.

In the globiferous pedicellariæ the edges of the blade are fine, not thickened, and project into two or more teeth on either side. No cross-beams connect the edges across the inside of the blade.

Genera: *Parechinus*, *Loxechinus*.

Parechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates; they may be very large and thick, or finer and hidden in the skin. The globiferous pedicellariæ without neck. Numerous short, greenish spines.

Species: *Parech. miliaris* (Müll.), *microtuberculatus* (Blv.), *angulosus* (Leske).

Distribution: In the Atlantic Ocean at the European coasts, the Mediterranean; the southern and eastern coasts of Africa; the Indian Archipelago, Australia. Littoral forms.

Loxechinus Desor (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates. The globiferous pedicellariæ with a short neck only containing longitudinal muscles. Numerous short, greenish spines.

Species: *L. albus* (Mol.), *gibbosus* (Val.), *bullatus* (Bell).

Distribution: The southern and western coasts of South America, the Galapagos Islands[1]). Littoral forms.

Subfam. **Echininæ** n. subfam.

In the globiferous pedicellariæ the edges of the blade are thickened and commonly connected by cross-beams across the inside of the blade. One or more lateral teeth on either side.

Genera: *Echinus*, *Sterechinus*, *Paracentrotus*.

Echinus Rond. (emend.)

Pores trigeminate; primary tubercle on every or only on every other ambulacral plate. No ocular plate reaches to the periproct. The buccal membrane with numerous fenestrated plates imbedded in the skin both outside and inside of the buccal plates. The spines upon the whole long and strong; the actinal primary spines not curved at the point. Globiferous pedicellariæ generally with the edges connected across the inside of the blade. The large, generally long and narrow, tridentate pedicellariæ with thick edge upon which numerous small teeth are placed in transverse series or irregularly.

[1]) The occurrence of *L. albus* at the Philippines and of *gibbosus* at the Fiji Islands needs corroboration.

Species: *Ech. esculentus* L., *acutus* Lamk., *melo* Lamk., *elegans* Düb. Kor., *gracilis* Ag., *Alexandri* Dan. Kor., *lucidus* Döderl., *affinis* n. sp., *atlanticus* n. sp.

Distribution: The Atlantic Ocean, the Mediterranean, the Pacific Ocean. Littoral-archibenthal forms.

Sterechinus Koehler (emend.).

Pores trigeminate; primary tubercle on every or only on every other ambulacral plate. The buccal membrane most frequently with numerous fenestrated plates inside of the buccal plates, outside of these it is almost or quite naked. Generally one or more (all) of the ocular plates reach to the periproct. The secondary spines often fine, silky; the actinal primary spines curved at the point (always?). The globiferous pedicellariæ generally with the edges connected across the inside of the blade. The tridentate pedicellariæ broad, leaf-shaped; the edge not thickened, only with a single series of teeth.

Species: *Sterech. margaritaceus* (Lamk.), *horridus* (Ag.), *Neumayeri* (Meissn.), *magellanicus* (Phil.).

Distribution: The southern and western coasts of South America, the Antartic Seas. Littoral-archibenthal forms.

Paracentrotus n. g.

Pores multigeminate. Primary tubercle on all the ambulacral plates. The buccal membrane with fenestrated plates both inside and outside of the buccal plates (outside, however, rather few). None or 1—2 ocular plates reach to the periproct. The spines long and rather thick; the actinal ones not curved at the point. In the globiferous pedicellariæ the edges are not connected by cross-beams across the inside of the blade. The tridentate pedicellariæ long, narrow, without transverse series of small teeth.

Species: *Paracentr. lividus* (Lamk.), *Gaimardi* (Blainv.).

Distribution: The Mediterranean and the adjoining Atlantic coasts. Brazil. — Littoral forms.

Fam. **Toxopneustidæ** Troschel (emend.).

The globiferous pedicellariæ with end-tooth, but without lateral teeth; the edges of the blade quite coalesced on the inside, so that the blade is tubular. Peculiar dumb-bell-shaped or somewhat branched spicules are generally found in the globiferous pedicellariæ and often also in the tube feet; bihamate spicules are generally also found; in one form (*Strongylocentrotus pulcherrimus*) only bihamate spicules are known. Generally 1—2 ocular plates reach the periproct.

Subfam. **Schizechininæ** Pomel (emend).

The spicules in the globiferous pedicellariæ dumb-bell-shaped or small bows not pointed at the ends. Generally deep slits in the test. The globiferous pedicellariæ without neck; mostly with glands on the stalk. The stalk compact.

Genera: *Psammechinus*, *Gymnechinus*, *Toxopneustes*, *Tripneustes*, *Sphærechinus*, *Pseudoboletia*, *Pseudocentrotus*.

Psammechinus Ag. (emend.)

(Synonyms: *Lytechinus* Ag., *Psilechinus* Ltk., *Schizechinus* Pomel.)

Pores trigeminate; primary tubercle on all the ambulacral plates. Slits of the test rather deep. The buccal membrane with numerous plates forming a more or less distinct plate-covering. In the globiferous pedicellariæ the blade is not much lengthened. The spicules dumb-bell-shaped, form no border round the globiferous pedicellariæ. The spicules of the tube feet bihamate, not branched. The spines of a middle length, greenish.

Species: *Psammech. variegatus* (Lamk.), *semituberculatus* (Val.), *verruculatus* Ltk.

Distribution: The eastern and western coasts of tropical America; the Indian Ocean. Littoral forms.

Gymnechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. Slits of the test small. The buccal membrane, with the exception of the buccal plates, contains no fenestrated plates at all. Inmost in the edge of the mouth more or fewer irregular, needle-shaped spicules are found; also numerous bihamate spicules are found, especially nearest to the edge of the mouth and the outer edge. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ arcuate or slightly dumb-bell-shaped, form no border. Smaller, short-spined forms.

Species: *Gymnech. Robillardi* (Loriol), *darnleyensis* (Woods)[1].

Distribution: Mauritius, Australia. Littoral forms.

Toxopneustes Ag. (emend.).

(Synonym: *Boletia* Desor.)

Pores trigeminate; primary tubercle only on every other ambulacral plate. Slits of the test deep. The buccal membrane with numerous fenestrated plates most of which are quite imbedded in the skin. In the globiferous pedicellariæ the blade is much lengthened. The spicules in the globiferous pedicellariæ are typically dumb-bell-shaped and form a thick, white border round the outer edge of the valves; in the tube feet branched, bihamate spicules are found. Large, flat, short-spined forms.

Species: *T. pileolus* (Lamk.), *roseus* Ag., *elegans* Döderl.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Tripneustes Ag. (emend.)

(Synonym: *Hipponoë* Gray.)

Pores trigeminate; primary tubercle only on every third or fourth ambulacral plate. The pore areas very broad, so that the pores form three separated vertical series; in the small individuals the pores are placed in the usual manner in short arcs. The buccal membrane with numerous fenestrated plates most of which are quite imbedded in the skin. Slits of the test rather deep. In the globiferous pedicellariæ the blade is not much lengthened; the pedicellariæ upon the whole small and darkly pigmented. The spicules in the globiferous pedicellariæ are typically dumb-bell-shaped; they form no border. The bihamate spicules in the tube feet are not branched. Large, high, short-spined forms.

[1] Comp. above p. 110.

Species: *Tripn. esculentus* (Leske), *depressus* Ag., *gratilla* (L.).

Distribution: Cosmopolitan in the warm zone. Littoral forms.

Sphærechinus Desor (emend.).

Pores multigeminate (generally four in each arc); primary tubercle on all the ambulacral plates[1]). Slits of the test rather deep; the buccal membrane with rather numerous fenestrated plates; no spines on these or on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ small bows, not pointed at the ends; they form no border. In the tube feet branched, bihamate spicules are found. Large, short-spined forms, almost globular.

Species: *Sphærech. granularis* (Lamk.), *roseus* Russo, *australiæ* Ag.

Distribution: The Mediterranean and the adjoining Atlantic coasts, Australia. Littoral forms.

Pseudoboletia Troschel (emend.).

Pores multigeminate (four in each arc); primary tubercle on all the ambulacral plates. Slits of the test rather deep. The buccal membrane with rather numerous plates carrying both spines and pedicellariæ; spines are likewise found on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ small bows, not pointed at the ends; they form no border. The bihamate spicules in the tube feet are not branched. Large, high, rather short-spined forms.

Species: *Ps. indiana* (Mich.), *maculata* Trosch.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Pseudocentrotus n. g.

Pores multigeminate; primary tubercle on all the ambulacral plates. The pore areas somewhat petaloid on the actinal side. Slits of the test rather small. The buccal membrane with numerous fine fenestrated plates; no spines on these or on the buccal plates. In the globiferous pedicellariæ the blade is not much lengthened. The spicules of the globiferous pedicellariæ bow-shaped, not pointed at the ends; they form no border. The bihamate spicules in the tube feet are branched. The spines rather long and strong; the test rather flat.

Only one species known: *Ps. depressus* (Ag.).

Distribution: Japan. Littoral form.

Subfam. **Strongylocentrotinæ** n. subfam.

The spicules of the globiferous pedicellariæ bihamate (always?), generally branched at the ends; no dumb-bell-shaped spicules, nor such as are not pointed at the ends. The globiferous pedicellariæ with well developed neck with longitudinal and circular muscles; tubular stalk.

Genera: *Strongylocentrotus*, *Anthocidaris*.

Strongylocentrotus Brandt (emend.).

Pores multigeminate; the pore areas not petaloid on the actinal side. Primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates most of

[1]) Not examined in *Sph. australiæ*.

which are quite hidden in the skin. The spicules bihamate, branched or unbranched. The test more or less flattened. The spines very different, from short and fine to long and coarse ones.

Species: *Str. chlorocentrotus* Brandt, *pulcherrimus* (Barn.), *intermedius* (Barn.), *drobachiensis* (O. F. Müll.), *purpuratus* Stimps., *franciscanus* (Ag.).

Distribution: The Northern Atlantic, the Arctic Ocean (*drobachiensis*); the Northern Pacific Ocean (all the species). Littoral forms.

Anthocidaris Lütken (emend.).

Pores multigeminate; the pore areas somewhat petaloid on the actinal side. Primary tubercle on all the ambulacral areas. The buccal membrane with numerous fine fenestrated plates most of which are quite hidden in the skin. The spicules in the tube feet biacerate, a little curved, with a rather strong point in the middle of the convex side. The test somewhat flattened, the spines rather long and strong.

Only one species known: *A. homalostoma* Ltk.

Distribution: Japan, China. Littoral form.

Subfam. **Parasaleninæ** n. subfam.

The spicules of the globiferous pedicellariæ bihamate, unbranched; those in the tube feet biacerate with a couple of small processes on the concave side. The globiferous pedicellariæ without neck; the stalk compact. Slits of the test small [1].

Only one genus known: *Parasalenia*.

Parasalenia Ag.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates; no spines on the buccal plates. The periproct covered by four large plates. The test oblong. The spines long and strong.

Species: *P. gratiosa* Ag., *Pöhlii* Pfeffer.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Fam. Echinometridæ Gray (emend.) [2].

The globiferous pedicellariæ with end-tooth and one unpaired, strong lateral tooth; the edges of the blade almost always connected by cross-beams across the inside; no neck. Only bihamate spicules are found. Slits of the test small. The stalk of the pedicellariæ compact.

Genera: *Pseudechinus*, *Heliocidaris*, *Echinostrephus*, *Toxocidaris*, *Echinometra*, *Colobocentrotus*, *Heterocentrotus*.

Pseudechinus n. g.

Pores trigeminate; primary tubercle on all the ambulacral plates. The buccal membrane quite naked with the exception of the buccal plates. The spines of a middle length, slender. The form of the test regular, *Echinus*-like.

[1]) *Parasalenia Pöhlii* not examined.
[2]) The name of *Echinometradæ* is linguistically incorrect (Bell).

Only one species: *Pseudech. albocinctus* (Hutton).

Distribution: New Zealand. Littoral form.

Heliocidaris Desml. (emend.)

(Synonym: *Evechinus* Verr.)

Pores trigeminate; primary tubercle only on every second or third ambulacral plate. The buccal membrane with numerous fine fenestrated plates hidden in the skin. No spines on the buccal plates. The triphyllous pedicellariæ with peculiar, digitate processes from the apophysis (in all the other genera the triphyllous pedicellariæ are constructed in the usual way). The spines short, strong, greenish; the secondary spines club-shaped. The form of the test regular, *Echinus*-like.

Species: *H. chloroticus* (Val.), *raritubercnlatus* (Bell), *australiæ* Woods (? — not examined).

Distribution: New Zealand, Australia. Littoral forms.

Echinostrephus Ag. (emend.)

Pores trigeminate, more rarely quadrigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates, most of which carry pedicellariæ. No spines on the buccal plates. The form of the test very peculiar, flat and broad above, narrow below. The spines rather thin, black; those of the upper side long, directed straight upward.

Species: *Ech. molare* (Blv.), *pentagonus* Yosh. (? — not examined).

Distribution: The Indo-Pacific Ocean. Littoral forms.

Toxocidaris Ag. (emend.)

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with rather few plates most of which carry pedicellariæ; no spines on the buccal plates. The form of the test regular, *Echinus*-like. The spines rather long and thick.

Species: *T. tuberculatus* (Lamk.), *erythrogrammus* (Val.), *armiger* (Ag.).

Distribution: Australia. Littoral forms.

Echinometra Rond. (emend.)

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fine fenestrated plates hidden in the skin, of which only a few carry pedicellariæ. Spines on the buccal plates. The form of the test more or less oblong. The spines rather long and thick.

Species: *Ech. lucunter* (L.), *viridis* Ag., *Mathaei* (Blv.), *oblonga* (Blv.), *van Brunti* Ag., *macrostoma* (Ltk.) (?).

Distribution: Cosmopolitan in the warm zone. Littoral forms.

Heterocentrotus Brandt (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The buccal membrane with numerous fenestrated plates, partly hidden in the skin. Spines both on the buccal plates and on some of the plates outside of these. The test oblong. The primary spines exceedingly large and thick, mostly edged; the secondary ones short, truncate.

Species: *H. mamillatus* (Klein), *trigonarius* (Lamk.).

Distribution: The Indo-Pacific Ocean. Littoral forms.

Colobocentrotus Brandt (emend.).

Pores multigeminate; primary tubercle on all the ambulacral plates. The pore areas on the actinal side petaloid. The buccal membrane with numerous fenestrated plates, partly hidden in the skin. Spines both on the buccal plates, and on some of the plates outside of these. The test oblong, flat. The spines very short, thick, truncate, form a dense mosaic on the abactinal side. The spines on the ambitus longer, flat; those on the actinal side of the common form.

Species: *C. atratus* (L.), *Mertensii* Brandt.

Distribution: The Indo-Pacific Ocean. Littoral forms.

Incertæ sedis:

Echinus multicolor Yoshiwara.

Toxopneustes maculatus (Lamk.).

Strongylocentrotus mexicanus (Ag.).

— *nudus* (Ag.).

— *globulosus* (Ag.).

The system given here is, I think, in all essentials an expression of the natural relation of these forms. To be sure, we must a priori hesitate before building up a system chiefly on so minute things as pedicellariæ and spicules. But the result is the best possible one: no undoubtedly connected forms are separated; on the other hand, forms hitherto placed very far from each other in spite of their great similarity as to habitus, are now put together (*Parechinus* and *Loxechinus*). That the boundary line in one place is somewhat arbitrary is no important objection to the system — this will be the fact everywhere, where transitional forms are found. The genus *Pseudechinus* is here referred to the *Echinometridæ*; but there can scarcely be any doubt that it is also closely allied to the *Echinidæ*, it seems especiallyto be a near relation of *Sterechinus magellanicus*. Here it has been referred to the *Echinometridæ* especially for practical reasons, it being then possible to give a quite certain character of these two families: in one teeth on either side of the blade of the globiferous pedicellariæ, in the other only one unpaired lateral tooth. *Pseudechinus* forms the connecting link between the two families, and it is especially worthy of notice that in this genus may sometimes be found an indication of a lateral tooth also on the other side of the blade of the globiferous pedicellariæ.

The family *Toxopneustidæ* is sharply limited from the other two families, without transitional forms. Objections can scarcely be raised against the subfamily *Schizechininæ* — all the genera referred thither, are evidently closely allied. Less sure are the subfamilies *Parasaleninæ* and *Strongylocentrotinæ*. Possibly the feature whether the globiferous pedicellariæ have a neck or not, is not of so great importance, as has here been supposed; but I think it impossible to decide this fact with certainty, as long as only so few forms belonging here are known.

That no other outer characters are found in these forms, which may be used in the classification, I think to be certain; both the test and the spines have been studied rather thoroughly, so that anything new of importance is scarcely to be expected here. It is hardly probable that the inner anatomical structure will yield systematic characters of any greater importance, but this question, at all events, deserves a closer examination. There is, however, one feature left, from which important contributions to the classification may be expected, viz. the larval forms. As almost all the species belonging here, are littoral forms, they may all be supposed to have pelagic larvæ, and they will, no doubt, show a great richness in forms. That the larva of *Sphærechinus* is so different from those of *Echinus*[1]) indicates, at all events, that very interesting things may be found here.

Fam. **Echinidæ.**

Subfam. **Parechininæ.**

11. **Parechinus miliaris** (Müll.).

Pl. II. Fig. 7. Pl. XV. Figs. 6—7, 11. Pl. XVI. Fig. 15. Pl. XVII. Figs. 1—2, 7—8, 10—11, 14—15, 22—28.

Principal synonyms: *Echinus miliaris* Müll.
Psammechinus miliaris (Lamk.).
Echinus saxatilis O. F. Müll.
— *virens* Düb. Kor.

Principal literature: Düben & Koren: Öfversigt af Skandinaviens Echinodermer. p. 274. — Agassiz: Revision of Echini. p. 495. — Hoyle: Revised List of Brit. Echinoidea (202). p. 417. — Bell: Catalogue of Brit. Echinoderms. p. 150. With regard to the other extensive literature the reader is especially referred to Bell's Catalogue.

It is not necessary to give a thorough description of this well known species, I shall only refer to the works cited above. On Pl. II. Fig. 7 is given a coloured figure of the animal; with regard to the test I shall refer to Pl. XV. Figs. 6—7, 11, where the apical area, an ambulacral and an interambulacral area are represented. From these figures it is clearly seen that the secondary tubercles form no regular longitudinal or transverse series, and that a primary tubercle is found on all the ambulacral plates. The buccal membrane is richly provided with large, thick, irregular plates, between which the naked skin is seen, especially on dried specimens; they are constructed as usual (Pl. XVI. Fig. 15; the figure represents one of the simplest plates from the outer edge of the peristome), contrary to what is the fact in *P. microtuberculatus* (Pl. XVI. Fig. 14) where they consist of a compact, greenish calcareous mass with funnel-shaped holes. The plates inside of the buccal plates are somewhat smaller than those outside and constructed in a far simpler way; they consist only of one layer with some knobs on the upper side. The buccal plates carry numerous pedicellariæ, but no spines. The gills contain small irregular calcareous plates.

The pedicellariæ. The globiferous pedicellariæ (Pl. XVII. Figs. 1, 7, 23—24) are generally exceedingly numerous, and form, as it were, a dense, white flue, especially on the abactinal side. The blade is rather broad and flat, and the edges not connected by cross-beams across the inside. The edges are not thickened, and project into — generally — 7—8 long, somewhat irregular indentations; the number may vary between 5 and 10. There are often some more on one side than on the other. The stalk

[1]) Th. Mortensen: Die Echinodermenlarven der Plankton-Expedition. Ergebn. d. Plankton-Exped. d. Humboldt-stiftung. II. J. 1898.

consists of long, thin calcareous threads connected by small cross-beams. — Perrier[1]) states that the valves of the globiferous pedicellariæ end in two hooks »situés sur le même plan«. This is absolutely wrong; I suppose he must have interpreted the edges of the poison canal as two separate teeth. The tridentate pedicellariæ (Pl. XVII. Figs. 2, 11, 22) with rather broad, not very deep blade; the outer part, where the valves join, is somewhat widened and sinuate in the edge. The whole edge is serrate, coarsely below, finely above, but there is only a single series of teeth, they form no transverse series as in the *Echinus*-species. The bottom of the blade is filled by a rather well developed net of meshes. The apophysis has 2—4 rather large indentations at the upper end. The valves are rather wide apart through the greater part of their length. In larger specimens tridentate pedicellariæ are also found on the buccal plates; they are smaller than the others, more spoon-shaped; the edge more straight, and there is no mesh-work at the bottom (Fig. 2). According to Perrier (loc. cit.) the apophysis of the tridentate pedicellariæ is »découpé en un nombre assez grand de dents pointues«; as stated above I have only found 2—4 teeth. The ophicephalous pedicellariæ show no marked peculiarities; the blade is rather narrow, with well developed mesh-work (Pl. XVII. Figs. 8, 28). The triphyllous pedicellariæ (Pl. XVII. Figs. 14, 25) are distinguished by the very finely rounded form of the blade. — The sphæridiæ (Pl. XVII. Figs. 26, 27) are quite smooth.

The spicules in the tube feet are very few, often quite wanting. They are bihamate, very small (Pl. XVII. Fig. 10); just below the sucking disk they may be a little irregular. The spicules figured by Perrier as belonging to this species, no doubt belong to *Strongylocentrotus drobachiensis*. — There are no bihamate spicules in the gills or the buccal membrane, nor in the pedicellariæ or in the skin at the base of the spines.

It is a small species; a specimen of a diameter of 35^{mm} is uncommonly large. It is very common in the Danish seas, quite down in the western part of the Baltic but not in the eastern part. Along the coasts of Norway it is common, at all events to Trondhjem; further it is found at Iceland and the Faroe Islands, but not at Greenland or North America. To the south it is found at the coasts of Great Britain and along the Atlantic coasts of Europe quite down to Morocco. Bell (Catalogue. p. 151) states that it is also found in the Mediterranean.

It is a pronounced littoral form, often found just at the beach; but it is common down to ca. 50 fathoms, and may be found on still greater depths. At the Faroe Islands I have taken a large specimen on a depth of 100 fathoms; this fact, however, is a little uncertain. The locality is a little range of the sound between Nolso and Ostnæs; it is not impossible that the dredge has got in on more shallow water at the edge of this deep hole, so that the animal may have been obtained there. It prefers hard, stony bottom.

Subfam. **Echininæ.**

12. **Echinus elegans** Düb. Kor.

Pl. I. Figs. 2—3. Pl. III. Fig. 4. Pl. XV. Fig. 4. Pl. XVI. Figs. 3, 19. Pl. XVIII. Figs. 2, 3, 22, 26. Pl. XIX. Figs. 10, 26. Pl. XX. Figs. 8, 9, 19, 22, 23.

Synonym: *Echinus Wallisi* Ag. (?)

Principal literature: Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 272. —

[1]) Recherches sur les Pédicellaires. p. 146. Pl. V.

Agassiz: Revision of Echini. p. 491. — Wyv. Thomson: Echinoidea of Porcupine (395) p. 744. — Hoyle: Rev. List of Brit. Echinoidea (202) p. 414. — Bell: Catalogue of Brit. Echinoderms. p. 154.

The form of the test rather varying, from evenly rounded to slightly conical, on the actinal side evenly rounded or almost flat (in the conical forms); the edge of the mouth always somewhat bent inward. The peristome rather large. The height of the test a little more than half the diameter; the contour round.

The ambulacral areas (Pl. XVI. Fig. 19) a little more than half as broad as the interambulacral ones, at the edge of the mouth generally a little broader than the latter. The number of ambulacral plates is rather constant, one third as great as that of the interambulacral plates. The boundaries between the primary plates generally somewhat indistinct; the boundary line between the areas not much sinuate. The arcs of pores rather steep; the pores reach quite to the edge. Sometimes four

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Periproct.	Ambulacral area.	I.-Ambulacral area.	Ambulacral area.	I.-Ambulacral area.	
51	27	17	5	11	20	27—28	17—18	
46	24	17	5·5	10·5	18	23—24	15—16	23 [1])
37	20	14·5	4·2	8·2	14·2	21—22	14—15	
35	21	13·3	4	7·8	14	21	14	
31	18	12	3·5					20
30	18	13	4·5	7	11	18—19	12—13	19 [2])

All the measures are in millimetres.

pairs of pores are found in an arc. The primary tubercles are rather large and strong, somewhat smaller than the interambulacral ones, and form a very conspicuous, uninterrupted longitudinal series, a primary tubercle being found on all the plates. They are placed very close together, the edges of their scrobicular areas join through almost the whole area only the very uppermost ones are separated. This fact of the tubercles being placed so close together gives to the test a very characteristic appearance. The secondary tubercles may form a short longitudinal series on the actinal side inside of the primary series, but this feature is not a constant one. On the abactinal side there are only few secondary tubercles; commonly there is one small tubercle between the pores and the primary tubercle. Miliary tubercles numerous and rather strong; together with the secondary ones they give the whole test a very rough and uneven appearance. (In the figures the miliary tubercles have been omitted.)

The interambulacral areas (Pl. XV. Fig. 4). Also here the primary tubercles form a very close series, the scrobicular areas, however, do not join above the ambitus. The secondary tubercles are very numerous on the actinal side; they are considerably smaller than the primary ones, and form no distinct longitudinal series neither inside nor outside of the primary ones.

The apical plates carry rather many tubercles (Pl. XVI. Fig. 3). The periproct is generally very small (in the figured one it was larger than is commonly the fact), covered by numerous, irregular

[1]) The specimen figured on Pl. I. Fig. 2.
[2]) The specimen figured on Pl. I. Fig. 3.

small plates; here and here a tubercle may be found on a somewhat larger plate. Nearest to the anal opening the small plates are a little lengthened.

The buccal membrane commonly richly provided with large, simple fenestrated plates as in *Ech. Alexandri*; those inside of the buccal plates also as in this species. Bihamate spicules may be found in rather great number among the fenestrated plates. A few of the plates outside of the buccal plates are larger and somewhat complicate, and carry pedicellariæ. No spines on the buccal plates.

The spines of a middle length, $^1/_2$—$^2/_3$ of the diameter of the test, rather strong; they are largest at the ambitus, but decrease generally only little towards the apical area. The actinal primary spines may be truncate and flat at the point (not constantly), not irregularly widened as in *Ech. acutus*.

The pedicellariæ are generally very numerous, especially the ophicephalous ones. The globiferous ones (Pl. XVIII. Figs. 2—3) have most frequently 2—3 teeth on either side of the blade, sometimes 3 or only one on one side, two on the other. The basal part has often a few indentations in the edge, but this is no constant feature. The stalk is rather strong and may at the upper end have some thorns directed downward (Pl. XX. Fig. 23). The tridentate pedicellariæ (Pl. XVIII. Figs. 22, 26. Pl. XX. Fig. 9): the valves rather broad, a little widened at the point, where they join; the edge is here rather sinuate, in the other part it is straight, thick, and set with small teeth forming somewhat irregular transverse series. There is a rather well developed mesh-work at the bottom of the blade. — Together with this form is often found a smaller one (Pl. XX. Fig. 9), where the blade is almost quite flat and rather abruptly truncate at the point, without mesh-work. In some specimens only this form is found. Transitional forms between this form and the larger one are found, so that it cannot be regarded as another kind than the larger form. — The ophicephalous (Pl. XIX. Fig. 10) and the triphyllous pedicellariæ (Pl. XX. Fig. 22) show no marked peculiarities. — The sphæridiæ (Pl. XIX. Fig. 26) are generally somewhat grooved and thorny; the grooves often form rather distinct longitudinal series. The spicules (Pl. XX. Fig. 8) are small and rather varying in form. They are pretty numerous in the tube feet and gills; in the skin round the base of the spines some spicules are generally found, and sometimes a few are found in the stalks of the pedicellariæ (the globiferous ones).

The typical coloration is as on Pl. III. Fig. 4: purple, white-tipped spines; the test white, slightly rosy round the apical area (Pl. I. Fig. 3). In some of the specimens in hand this colour, however, is only slightly indicated; some are quite white, others have only a slight yellowish red tint around the apical area or only at the base of some of the primary tubercles on the abactinal side. In one specimen the test is of a fine lilac colour (Pl. I. Fig. 2).

Ingolf	St. 1	(62° 30′ N. L.	8° 21′ W. L.	142 fathoms,	Sand, Shells.	Bottom temp.	7° 8).	1 spec.
—	— 47	(61° 32′ —	13° 40′ —	950 —	Mud.	—	3° 1).	3 —
—	— 52	(63° 57′ —	13° 32′ —	420 —	?	—	7° 2).	2 —
—	— 54	(63° 08′ —	15° 40′ —	691 —	?	—	4° 2).	6 —

This species is indigenous in the sublittoral-archibenthal zone of the northern Atlantic, both at the European and American side, as well as south of Iceland, and in the sea along Norway; it is found on ca. 50—950 fathoms. The statement that it goes down to 1350 fathoms (Challenger-

Echinoidea p. 115) is incorrect (see below). Agassiz (»Challenger«-Echinoidea p. 213) states that it is also found in the Mediterranean, off Tristan d'Acunha and Papua (more exactly: the Admiralty Islands), and these statements are adopted by Hoyle and Bell. I cannot dispute the occurrence in the Mediterranean, as I have not seen the specimens upon which the statement rests; on the other hand I must maintain that the other statements are incorrect, as I have examined the specimens from »Challenger« that Agassiz has determined as *Ech. elegans* (Chall. Ech. p. 115). The specimen from st. 46 (south of Nova Scotia, 1350 fathoms) is a large, fine specimen of *Ech. Alexandri.* Those from Tristan d'Acunha are likewise a large, fine form, very similar to *Ech. Alexandri* (the more long-spined forms). Its narrow tridentate pedicellariæ, however, show that it cannot be this species; presumably it is a new species, which seems to be most closely allied to *Ech. lucidus* Döderl. The specimens from st. 219 (the Admiralty Islands), on the other hand, are something widely different from *Ech. elegans.* There is an unpaired lateral tooth on the globiferous pedicellariæ, and according to my observations by the short examination during my stay at British Museum I feel inclined to think that it is nearly related to *Arbacina forbesiana*; at all events it is a sure fact that it has nothing to do with *Ech. elegans*, and upon the whole does not belong to the family *Echinidæ.*

Thus a great uncertainty is seen to have been prevailing with regard to the interpretation of this species. The description of *Ech. elegans* given by Agassiz in »Rev. of Ech.«, does not agree with this species, but with *Ech. norvegicus*, and the figure given (Pl. VII. a. Fig. 4) seems also to be *Ech. norvegicus*; it is not, however, to be seen with certainty, as the specimen has been less well preserved. — In conformity to this wrong interpretation of *Ech. elegans* Agassiz seems to have established a new species, *Ech. Wallisi*, for the real *Ech. elegans.* As mentioned above (p. 100) I have received a specimen from U. S. National Museum, determined as *Ech. Wallisi*, which is no doubt a large specimen of *Ech. elegans*, only a little more short-spined than is usually the case. But I think it must be regarded as a little doubtful, whether it is really *Ech. Wallisi.* It does not agree very well with the description of this species, especially must be pointed out that its pores are trigeminate as usual in *Echinus.* But, according to Agassiz *Ech. Wallisi* is distinguished by »the arrangement of the pairs of pores in sets of two« (»Blake«-Echini p. 39). — It is impossible for me to decide how the fact really is, but to judge by this specimen it is a sure fact that *Ech. elegans* is found off North America, and that *Ech. Wallisi* is either synonymous with it — but then its pores are trigeminate and not in »sets of two« — or that it is a separate species with the pores in »sets of two«, but then it is no *Echinus.* At all events it is to be regretted that Agassiz has given a so deficient description of a new species, and, moreover, has not given any figure of it at all.

Judging from the material of *Ech. elegans* we have from the Ingolf-Expedition, it is a very varying form. If we compare the test of a subconical and a higher form, we might be led to suppose them to be two separate species. But transitional forms are found, and especially no difference seems to be found in the pedicellariæ. For the present I must regard them all as one species, but the possibility is not excluded that by means of a larger material we may be able to distinguish different forms. It is, however, I think, more likely that it will show a richness in forms similar to that of *Echinus Alexandri*, in which case the Challenger-specimens from Tristan d'Acunha will perhaps nevertheless have to be referred to *Ech. elegans.*

13. **Echinus Alexandri** Dan. Kor.

Pl. V. Figs. 2—3, 5—7. Pl. XV. Figs. 13, 17. Pl. XVI. Fig. 8. Pl. XVIII. Figs. 9, 11, 19, 23, 25. Pl. XIX. Figs. 16, 31, 34, 38. Pl. XX. Figs. 1, 2, 27. Pl. XXI. Figs. 18—20, 27.

Literature: Danielssen & Koren (109). — Danielssen (110): Echinida. Norske Nordhavs-exped. p. 1. T. I. — Koehler (224—226): Echinodermes. Caudan. p. 92. Pl. I. fig. 4 Pl. II. fig. 18—19.

Of this large, fine species we have a very great material from the Ingolf, and as I have had the type specimen of Danielssen for examination, I have been able to identify it with certainty. Prof. Koehler has further sent me some of his specimens from Caudan, so that I am also able to corroborate the correctness of his determination. On the basis of this great material I shall then give a new description of the species.

The test is much flattened, the height generally a little less than half the diameter of the test; specimens of a middle size and smaller ones are quite flat above, the larger ones a little rounded. The actinal side is flat, not at all or very little curved inward at the edge of the mouth. The slits as usual small and rather indistinct.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.	
69	35	19·5	10	13	29	23—24	15—16	c. 50
68	35	19	9					c. 50
62	30	19	10	12	26	24—25	15—16	
45	21	15	6·5					22
45	24	14	5·5					43
38	17	13	5					25
34	15·5	12·5	?	7	13·5	16—17	12—13	
31	15	10·5	4·5	6·8	12	16—17	13—14	
30	14	11	5					34
30	14·5	10	4·5					22
19	9	8	3					15
14	6·5	5·5	2·5					14
13	5·5	6	3	3	5	11	9	

All the measures in millimetres.

The ambulacral areas (Pl. XV. Fig. 13) in large specimens scarcely half as broad as the interambulacral areas, in smaller specimens a little more than half this breadth; at the edge of the mouth the two areas are of about equal breadth. The number of compound plates in the ambulacral areas is only about $^{1}/_{2}$—$^{1}/_{3}$ time greater than that of the interambulacral areas, accordingly the ambulacral plates are rather high. The arcs of pores are not placed very obliquely, in small specimens they are almost perpendicular. In the type specimen the arcs of pores show a remarkable irregularity, as is seen in the figures of Danielssen. As no similar feature is seen in any of the Ingolf-specimens it is no doubt something abnormal. The pores reach quite to the edge of the plates. The boundaries between the small plates rather indistinct, the boundary line between the areas rather highly sinuate. The primary tubercles form a very conspicuous, dense longitudinal series; a primary tubercle is found on all the ambulacral plates. The scrobicular areas join on the actinal side as far as to the ambitus. On the abactinal side the primary tubercles decrease very much in size. The secondary tubercles form at the ambitus a tolerably distinct longitudinal series inside of the primary one, but they are considerably smaller than the primary tubercles. There are generally a couple of small tubercles just inside of each arc of pores. Besides numerous small tubercles are found on the actinal side, a few ones on the abactinal side.

The interambulacral areas (Pl. XV. Fig. 17). The primary tubercles form a strong, uninterrupted longitudinal series, but the scrobicular areas do not touch each other on the actinal side; on this side they are only little larger than the ambulacral primary tubercles, on the abactinal side considerably larger. In large specimens they decrease only very little in size towards the apical area, in smaller specimens, on the other hand, they decrease very much in size, so that the whole abactinal side gets a strikingly smooth and naked appearance, the secondary tubercles being here also very few. The actinal side is closely set with secondary tubercles forming a distinct longitudinal series inside of the primary one, and the tubercles of this series may be almost as large as the primary ones. Outside of the primary series the secondary tubercles are scattered, not placed in longitudinal series. The miliary tubercles are generally few in number and little conspicuous, so that they do not deprive the abactinal side of its smooth character.

The apical area (Pl. XVI. Fig. 8) is most frequently somewhat raised, especially the inner edge. The form of the apical plates show no peculiarities; there is generally a circle of tubercles along the inner edge. In some specimens two pores may be found in one or a couple of the genital plates. The periproct is rather large, covered by numerous small, irregular plates, among which the central plate may be distinct; the plates nearest to the anal opening are a little lengthened, thick, irregularly club-shaped. On specimens in alcohol only these knobs are seen nearest to the anal opening, so that it looks as if the other part of the periproct were naked (Koehler 226. p. 94); in dried specimens the whole area is distinctly seen to be covered with small plates. — In the description by Danielssen the curious expression occurs: »the membranous portion (periprocte) is closely covered with round calcareous vessels«; this, no doubt, is owing to the fact that an erratum in the Danish text, »Kalkkar« in stead of »Kalkkorn«, has passed into the English text, which has thus got the meaningless expression »calcareous vessels« in stead of »calcareous grains«.

The buccal membrane contains numerous large, thin, highly perforated calcareous plates (Pl. XXI. Fig. 27); those inside of the buccal plates are much smaller and almost without holes (Pl. XXI. Fig. 18. a). There is a slight indication of a radiate arrangement of the inmost plates. Very few or no bihamate spicules in the buccal membrane. No spines on the buccal plates; only in larger specimens a few pedicellariæ are found outside the buccal plates. The gills with the usual irregular calcareous plates and a few bihamate spicules.

The length of the spines is very varying, as is seen from the noted measures; thus in two specimens of a diameter of 45^{mm} the longest spines in one specimen are 22^{mm}, in the other 43^{mm}. In some specimens the spines are even longer than the diameter of the test, as is especially seen in the statements of Koehler. All the specimens of Koehler seem to have been long-spined; among those from the Ingolf only a few long-spined specimens are found (especially from st. 78), in most of them the spines are somewhat shorter than the diameter of the test, in some specimens even only half so long. In conformity to the size of the tubercles the spines on the ambulacral areas are a little shorter than those of the interambulacral areas. The actinal spines are blunt, a little flat, but not widened at the point. In the more long-spined specimens the primary spines decrease only little in length towards the apical area, in the specimens with shorter spines those at the ambitus are considerably longer than the others.

The pedicellariæ are most frequently rather few, especially the globiferous and tridentate ones, sometimes one or the other, or even both of these forms are quite wanting in large specimens. The globiferous pedicellariæ (Pl. XVIII. Figs. 9, 11) have commonly 3—4 teeth on either side of the blade; the number is, however, varying from 2—5 teeth, and there is often an unequal number on the two sides. The edges of the blade are commonly connected by some cross-beams, but sometimes they are not connected at all, as in the type specimen (Fig. 9). That this feature can be of no greater importance here, so that it might be used as a specific character, is sure enough, as in the same pedicellaria one valve may be found with the edges of the blade connected by cross-beams, while in the others the edges are not connected. Generally, however, the edges are connected, as shown in Fig. 11. The basal part may be finely rounded, or with a single indentation in the edge; the apophysis is most commonly a little serrate in the edge. In the type specimen the upper end of the apophysis has a peculiar form which I have not found quite similar in other specimens.

The tridentate pedicellariæ (Pl. XVIII. Figs. 23, 25. Pl. XIX. Figs. 34, 38. Pl. XX. Fig. 1. Pl. XXI. Fig. 20) are very different from those of the other *Echinus*-species. The valves are broad, rather flat, without mesh-work at the bottom (except just at the end of the apophysis); they are full of holes regularly arranged in beautiful arcs. The edges are often somewhat bent inward in the lower part, where the valves are apart (Pl. XVIII. Fig. 23); in the outer part, where the valves join, the edge is rather coarsely sinuate. The edges are thick, set with transverse series of small teeth; in the outer part these small teeth are numerous and not placed in transverse series (Pl. XXI. Fig. 20). Generally these pedicellariæ are rather large, up to 2·5^{mm}, but quite small forms may also be found, as the one figured on Pl. XIX. Fig. 38. — Danielssen has not found the tridentate pedicellariæ in the type specimen; the figure with regard to which Koehler supposes that it might be a tridentate pedicellaria (Fig. 9), is a globiferous one, and even a tolerably good figure (Koehler has found no globiferous pedicellariæ in his specimens). The tridentate pedicellariæ are, however, also found in the type specimen; I have found a few ones, all rather small; on Pl. XIX. Fig. 34 is figured a valve of one of these pedicellariæ. They are broad and flat as in the other specimens, only the edge is not curved inward in the lower part; this feature, however, is of no great importance, as in the same specimen some pedicellariæ may be found with inward bent, others with straight edge. As such broad, tridentate pedicellariæ are not found in any other *Echinus*-species, they are of great importance for the determination of this species. Unfortunately they are not rarely wanting.

The ophicephalous pedicellariæ (Pl. XIX. Fig. 16) are generally very sinuate in the edge; the mesh-work in the blade is not much developed. In some specimens together with this common form another larger, more lengthened form is found with many serrations in the edge and well developed mesh-work in the blade (Pl. XX. Fig. 27); they may be almost as large as the tridentate pedicellariæ.

All transitional forms are found between this large form and the small, common form, and the specimens in which they are found, agree otherwise exactly with the other specimens, so that there can be no question of interpreting them as a separate species, not even as a separate variety.

In the triphyllous pedicellariæ (Pl. XVIII. Fig. 19) the upper edge of the apophysis is most frequently a little arched over the blade, which is somewhat broader than usual; this feature is, however, scarcely to be regarded as a constant, reliable character. — The sphæridiæ (Pl. XIX. Fig. 31) have some small spines at the end, no grooves. Spicules (Pl. XX. Fig. 2) of the common form. — With regard to the colour I may refer to the beautiful figure by Koehler (226. Pl. I. Fig. 4).

«Ingolf» st.	7 (63° 13′ N. L.	15° 42′ W. L.	597 fathoms.	Hard clay.	Bot. temp. 4° 9).	8 specs.		
—	- 42 (61° 41′ —	10° 17′ —	625 —	Sand	— 1°).	5	—	(1 doubtf.)[1]
—	- 43 (61° 42′ —	10° 11′ —	645 —	—	— 0° 7).	11	—	
—	- 44 (61° 42′ —	9° 36′ —	545 —	Hard bottom.	— 5° 4).	15	—	
—	- 46 (61° 32′ —	11° 35′ —	720 —	Gray mud with stones.	— 2° 3).	40	—	(6 doubtf.)
—	- 47 (61° 32′ —	13° 40′ —	950 —	Mud with Globigerina.	— 3° 1).	80	—	(40 —)
—	- 49 (62° 07′ —	15° 08′ —	1120 —	?	— 3° 3).	4	—	
—	- 52 (63° 57′ —	13° 32′ —	420 —	?	— 7° 2).	14	—	
—	- 53 (63° 15′ —	15° 07′ —	795 —	?	— 3° 0).	68	—	(45 doubtf.)
—	- 54 (63° 08′ —	15° 40′ —	691 —	?	— 4° 2).	10	—	
—	- 64 (62° 06′ —	19° 00′ —	1041 —	?	— 3° 1).	4	—	(1 doubtf.)
—	- 65 (61° 33′ —	19° 00′ —	1089 —	Mud.	— 3° 3).	13	—	(2 —)
—	- 78 (60° 37′ —	27° 52′ —	799 —	—	— 4° 1).	3	—	
—	- 93 (64° 36′ —	34° 50′ —	767 —	?	— 1° 3).	1	—	
—	- 95 (65° 14′ —	30° 39′ —	752 —	?	— 1° 7).	6	—	
—	- 96 (65° 24′ —	29° 00′ —	735 —	?	— 0° 9).	3	—	

From previous collections we have further a few specimens from 65° 39′ N. L. 28° 25′ W. L. 553 fathoms (Ryder), and from 60° 32′ N. L. 4° 20′ W. L. 525 fathoms (Wandel). — It has further been taken by «Challenger» off Cape Cod and the Bay of Maine, 1350 fathoms (st. 46), one specimen from this locality, by Agassiz referred to *Ech. elegans* (Chall. Ech. p. 115), proving to be this species. By «Caudan» it has been taken in the Bay of Biscay. Thus there can be no doubt that this species is found in the archibenthal zone of the whole northern Atlantic; that it has not been mentioned before is, doubtless, not owing to its not having been found there by the earlier expeditions, but to the fact that it has been confounded with other species, *elegans* and, presumably, especially with *norvegicus*. — Otherwise the ridge between Iceland and the Faroe Islands does not form the northern boundary of this species, any more than of *Ech. elegans*. To be sure only one specimen is known from the Norwegian Sea, but this is, moreover, taken on a place, where the bottom temperature was negative (st. 176. Norwegian North-Sea Exped. 69° 18′ N. L. 14° 33′ E. L. 536 fathoms. Bottom temperature ÷ 0·2). This, however, is certainly an exception; the mentioned station is just at the edge of the large, cold depth of the Norwegian Sea. It is, no doubt, distributed on the smaller depths along the coast of Norway, but in the cold area it certainly is not found.

[1]) The specimens here noted as «doubtful», are young ones, not yet showing the specific characters so distinctly developed, that it can be decided with certainty, whether they belong to this species or to *E. affinis* (see below p. 152).

14. Echinus affinis n. sp.

Pl. V. Figs. 4, 8. Pl. XV. Figs. 3, 10. Pl. XVI. Figs. 6, 20. Pl. XVIII. Figs. 4, 16, 28. Pl. XIX. Fig. 27. Pl. XX. Figs. 17, 21.

This species resembles much *Ech. Alexandri*, together with which it is often found; a closer examination shows, however, that several good characters are found distinguishing it from this species. The test is generally evenly rounded on the abactinal side, but it may be almost as flattened as in *Alexandri*. The actinal side is generally less flat than in the latter species; the edge somewhat curved inwardly; the peristome rather large.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.	
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.
38	22	12	5·5	8	16	20—21	14—15
36	21	12	5·2	8	15	19—20	14—15
26	13	9	5	5·1	10·2	17—18	12—13
24	13	8·8	4	5	10	16—17	12—13

All the measures in millimetres.

The ambulacral areas (Pl. XV. Fig. 10. Pl. XVI. Fig. 20) generally half as broad as the interambulacral ones; at the edge of the mouth they are of equal breadth. There are $^1/_3$—$^1/_2$ time as many ambulacral as interambulacral plates; in proportion to the size the number is a little larger than in *Alexandri*. The arcs of pores are rather erect, they do not always reach quite to the edge of the area. The boundaries between the small plates rather indistinct, the boundary line between the areas somewhat sinuate. A primary tubercle is found on all the ambulacral plates, but they show a very peculiar arrangement. In some specimens the two series are about equally strong, but then they are both very irregular, large and small primary tubercles occurring among each other without any order (Pl. XV. Fig. 10). It reminds much of *Ech. norvegicus* (Pl. XV. Fig. 16); but in the latter the principal series is formed by both primary and secondary tubercles, while in *Ech. affinis* it is formed by primary tubercles alone, as is sufficiently shown by their position. In other specimens the tubercles decrease evenly in size towards the peristome and the apical area, but then the two series of the same area are of very different size (Pl. XVI. Fig. 20). The largest primary tubercles are not much smaller than those of the interambulacral areas. The secondary tubercles are very few and almost only found on the actinal side; they are small and form no longitudinal series.

The interambulacral areas (Pl. XV. Fig. 3). The primary tubercles are large and strong; they decrease almost not at all in size towards the apical area, but in the common way down towards the mouth. The scrobicular areas scarcely touch each other on the actinal side, on the abactinal side the distance between them is considerable, the plates being rather high. The secondary tubercles are very few on the abactinal side, which has a similar naked appearance as in *Ech. Alexandri*. On the actinal side they are numerous, but form no regular longitudinal series inside or outside of the primary series, and they are far from equalling the primary tubercles as to size. The miliary tubercles are generally little numerous; in some specimens, however, they may be so conspicuous as to deprive the test of its smooth appearance.

The apical area (Pl. XVI. Fig. 6) is generally somewhat raised, but otherwise of the common form; also here sometimes two pores may be found in one genital plate, as in the figure. Only 2—3 tubercles on each genital plate, one or none on the ocular plates. The periproct rather large, covered by numerous small, more or less knob-shaped plates assuming towards the anus a somewhat lengthened form. No distinct central plate.

The buccal membrane with numerous fine fenestrated plates of the same form as in *Ech. Alexandri*, sometimes also with rather many bihamate spicules. There are no spines on the buccal plates, and none or very few pedicellariæ outside of these. The gills with the usual irregular fenestrated plates and most frequently rather numerous bihamate spicules.

The spines are long and strong, but hardly so much varying in length as in *Ech. Alexandri*; exact informations of this fact cannot be given, as the spines are broken on the specimens in hand (when they are not quite rubbed away). The actinal spines are not broad and flat at the point.

The pedicellariæ are generally not numerous, especially the tridentate and globiferous ones, and as in the preceding species one or other of these forms may be quite wanting. The globiferous pedicellariæ (Pl. XVIII. Fig. 16) have generally 2—2 lateral teeth, more rarely 3 teeth; sometimes only one tooth is found on one side. Otherwise they show no constant difference from those of *Ech. Alexandri*. Rather numerous cross-beams seem always to be found between the edges of the blade. The tridentate pedicellariæ (Pl. XVIII. Figs. 4, 28) are very different from those of the preceding species; the blade is very long, narrow, and deep with a rather well developed system of beams at the bottom. The apophysis at its upper end spreads into a large perforated plate; most frequently a narrow, irregular prolongation passes from it some way into the blade, being placed a little deeper than the plate. The edge is as usual provided with transverse series of small teeth, perhaps a little less numerous than in *Ech. Alexandri*. The valves are very wide apart, only joining for a little way at the point, which is a little obliquely cut off; in this part the edge is slightly sinuate. The length of the head up to 2·2^{mm}. The ophicephalous pedicellariæ chiefly of the same form as in the preceding species, only the indentations being perhaps a little less developed; the peculiar lengthened form that may be found in *Ech. Alexandri*, I have not found in this species. The triphyllous pedicellariæ (Pl. XX. Fig. 21) of the common form. The sphæridiæ (Pl. XIX. Fig. 27) as in the preceding species, but with fewer spines at the point, often quite smooth. The spicules (Pl. XX. Fig. 17) are pretty varying in form; they are rather numerous in tube feet and gills, and sometimes in the buccal membrane; at the base of the spines no spicules are found.

I can give no information of the natural colour of this species; all the specimens in hand are quite bleached both on the test and the spines. It reaches scarcely to so considerable a size as *Ech. Alexandri*.

»Ingolf»	st. 46	(61° 32′ N. L.	11° 35′ W. L.	720 fms.	Gray mud with stones.	Bottom temp.	2° 8).	8 specms.
—	- 47	(61° 32′ —	13° 40′ —	950 —	Mud with Globigerina.	—	3° 1).	31 —
—	- 49	(62° 07′ —	15° 08′ —	1120 —	?	—	3° 3).	7 —
—	- 50	(62° 43′ —	15° 07′ —	1020 —	Mud.	—	3° 0).	3 —
—	- 52	(63° 57′ —	13° 32′ —	420 —	?	—	7° 2).	2 —
—	- 53	(63° 15′ —	15° 07′ —	795 —	?	—	3° 0).	2 —
—	- 64	(62° 06′ —	19° 00′ —	1041 —	?	—	3° 1).	10 —
—	- 65	(61° 33′ —	19° 00′ —	1089 —	Mud.	—	3° 3).	26 —

Accordingly the species has been taken in considerable numbers and on many localities, and so it would be a remarkable fact, if it had not been taken before by any deep-sea Expedition. It has also been taken, and surely numbers of times; it has only been confounded with other species. I am able to substantiate the following instances: From U. S. Fish Commission (Smithsonian Institution) our museum has received 4 specimens under the name of *Echinus norvegicus*; they are typical *Ech. affinis*. («Albatross». 1884. 39° 35' N. L. 71° 24' W. L. 1043 fathoms.) In «Challenger»-Echinoidea *Ech. norvegicus* is mentioned from sts. 46 and 47 (eastern coast of North America, off Cape Cod); it is also *Ech. affinis*. (On st. 46 it is taken together with *Ech. Alexandri*, comp. p. 149). Accordingly there can be no doubt that this species like *Ech. Alexandri* is found throughout the archibenthal zone of the northern Atlantic, and possibly it is still wider distributed. In «Challenger»-Echinoidea *Echinus acutus* is mentioned from st. 170, off the Kermadec Islands in the Pacific Ocean. After having examined the specimen from this station in British Museum, I must positively assert that it is no *Ech. acutus*; on the contrary it agrees with *Ech. affinis* with regard to the tubercles of the ambulacral areas and the pedicellariæ, and I have found no character, by which it might be distinguished from *Ech. affinis*. Accordingly I must regard it as a rather sure fact that it is *Ech. affinis*; a more thorough examination will, however, be necessary in order to establish the fact definitively. — North of the ridges between the Faroe Islands and Iceland, and between Iceland and Greenland it has not been found, and at all events it is surely not found in the cold depth of the Norwegian Sea.

The species *Ech. Alexandri* and *affinis*, no doubt, are closely allied. As they are most frequently found together, it is an obvious thought that they might possibly be one species with a marked difference of sex, although such a difference is otherwise very unusual in the Echinids. Of this, however, there can be no question, as I have found both ♀ and ♂ among specimens of *affinis*. There can be no doubt that they are two well distinguished species. The form of the test, the tubercles on the ambulacral areas, and especially the tridentate pedicellariæ yield excellent criterions of them. But on the other hand it may be very difficult or quite impossible to distinguish quite young individuals of the two species, the more important specific characters being not yet typically developed. From the «Ingolf» we have thus a rather great number of small specimens, which I am not able with certainty to refer to one or the other of the two species. They are badly preserved, so that no tridentate pedicellariæ are to be found. These pedicellariæ are otherwise early developed, and give then all desirable certainty in the determination. The tridentate pedicellariæ seem not rarely to be quite wanting in larger individuals, as may also be the case in *Ech. Alexandri*; the determination of such specimens will, however, scarcely cause any difficulty, as especially the arrangement of the tubercles in the ambulacral areas then will be a sufficient criterion.

15. **Echinus acutus** Lamk.

Pl. I. Figs. 4, 7—8. Pl. II. Figs. 1—2, 6, 8. Pl. XV. Figs. 2, 14—16. Pl. XVI. Figs. 2, 5, 10, 16, 18, 22. Pl. XVIII. Figs. 1, 5—7, 14, 24. Pl. XIX. Figs. 32, 36. Pl. XXI. Figs. 25—26.

Principal synonyms: *Echinus Flemingii* Forb.
— *norvegicus* Düb. Kor.
— *depressus* G. O. Sars.

Echinus rarispinus G. O. Sars.
— *microstoma* Wyv. Thoms.

Principal literature: Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 266, 268. M. Sars: Norges Echinodermer. p. 92. Middelhavets Littoral-Fauna. p. 111. — G. O. Sars: Nye Echinodermer fra den norske Kyst (Vidensk. Selsk. Forhandl. Kristiania. 1871. p. 23). Bidrag til Kundskaben om Dyrelivet paa vore Havbanker. Ibid. 1872. p. 104. — Agassiz: Revision of Echini. p. 296, 489. 6. p. 77. Blake Echini (9). p. 39. — Wyv. Thomson: Porcupine Echinoidea (395). p. 744. — Danielssen: Echinida. Norske Nordh. Exped. (110). p. 3. — E. v. Marenzeller: 269. p. 13. 270. p. 20. — Koehler: 217. p. 121. Notes échinologiques (221). p. 20. 229. p. 23. — Prouho: 327. p. 8. — Hoyle: Revised List of Brit. Echinoidea (202). p. 413, 415. — Bell: Catalogue of Brit. Echinoderms. p. 146—49. With regard to the other literature the reader is referred to Revison of Echini, Bell's Catalogue, and Ludwig's Die Echinodermen des Mittelmeeres (256).

This species, I think, is the one that has caused most difficulties to the systematists. As shown by the synonyms enumerated above, a whole series of species has been established on more or less distinct forms of it; some of these, however, are now commonly regarded as synonyms, while others (*norvegicus*, *microstoma*, and partly *Flemingii*) are constantly mentioned as independent species, although expressions as critical species (Wyv. Thomson. Op. cit.), it seems almost hopeless to attempt to distinguish the species of *Echinus* known as *E. elegans*[1]), *E. norvegicus*, *E. melo*, and *E. Flemingii* (Agassiz 9. p. 39) sufficiently show the difficulty of distinguishing between them. The best founded of these species is, no doubt, *norvegicus*, and so long as I had only examined the material from the Ingolf-Expedition, and what was otherwise found in our museum of this form, I also felt persuaded that it was a distinct species. After having collected a considerable material at the Faroe Islands during the summer of 1899, and especially after having received a considerable number of specimens of all sizes from the Mediterranean from Prof. E. v. Marenzeller, I have got to the result, however, that the whole can only be interpreted as one very varying species, among the numerous forms of which three tolerably distinct varieties may, however, be distinguished: var. *mediterranea*, *Flemingii*, and *norvegicus*.

The northern specimens are generally easily referred to respectively *norvegicus* or *Flemingii*; especially it seems that at the Norwegian coasts specimens are rather seldom found, which are only with difficulty decidedly to be referred to one or the other of the mentioned forms. Most of the mentioned specimens from the Faroe Islands, on the other hand, it was impossible with certainty to refer to one or the other variety. In the Mediterranean a third, very large form occurs, which I have called var. *mediterranea*; it does not seem to be found in the northern Atlantic, but in return var. *Flemingii* is apparently not found in the Mediterranean. On the other hand var. *norvegicus* occurs in both seas. But in the Mediterranean this latter scarcely occurs as a marked variety; in the material received from Prof. v. Marenzeller, at all events, all possible transitions were found between the genuine *norvegicus* and var. *mediterranea*. In the first of the essays quoted above v. Marenzeller has referred the specimens before him to *E. norvegicus* after a comparison with northern specimens of this form; in the latter he has, on the basis of a greater material, referred the whole to *Ech. acutus*. I must

[1]) That *E. elegans* is mentioned in this connection is owing to a wrong interpretation of this species (comp. pp. 99, 145).

decidedly follow v. Marenzeller in this, and further draw the consequence of it (what has not expressly been done by v. Marenzeller), viz. that *Ech. norvegicus* becomes synonymous with *Ech. acutus*.

I shall here give the characters of the three most marked forms or varieties; but it is expressly to be observed that all possible transitional forms are found, so that it will often be impossible to decide, to which of these varieties some particular specimens are to be referred.

Var. *mediterranea* (Pl. II. Fig. 8. Pl. XV. Figs. 14—15. Pl. XVIII. Figs. 5—6. Pl. XIX. Fig. 36). The test high, conical, or more globular, somewhat flat, however, on the actinal side. The peristome rather small, with the edge somewhat curved inward. The tubercles very small, considerably smaller than in var. *Flemingii* (comp. Pl. XV. Fig. 15 with Pl. XVI. Fig. 2; both figures are drawn in natural size, the former [var. *mediterranea*] accordingly from a much larger specimen than the latter [var. *Flemingii*]). As usual they are largest at the ambitus, and decrease evenly in size towards the mouth and the apical area. The primary tubercles of the ambulacral areas form regular longitudinal series, but, apart from some smaller irregularities, they are only found on every other ambulacral plate; the secondary tubercles form no distinct longitudinal series. In a considerable part of the middle of the test the pores recede not a little from the outer edge of the area, leaving a very distinct naked space between the pores and the edge, generally quite without spines. The primary tubercles of the interambulacral areas are somewhat larger than the ambulacral ones; also here they are not rarely wanting on every other plate for a longer or shorter way on the abactinal side. The secondary tubercles are small and rather few; on the actinal side some of them are almost as large as the primary ones, and form a tolerably distinct longitudinal series inside of the primary series, and in the largest specimen in hand one more series is indicated inside of these. The tubercles outside of the primary series are placed quite irregularly.

The spines on the abactinal side are rather few, short, and thin, those at the ambitus, however, being longer and stronger; the latter are directed downwards like those on the actinal side, and they are of such a length, that all the spines on the lower side reach equally far down with the point so as to produce a quite even ambulatory surface (Pl. II. Fig. 8); they are truncate, flat, and widened at the point. The colour of the test is reddish, with more or less distinct, white stripes between the series of tubercles; the actinal side white. The spines on the abactinal side are most frequently red or reddish brown at the base, and white in the other part; of the actinal spines the outer ones are also red at the base, and then white for a greater or smaller part, but thereupon a greater part of the point is deep red, which gives to the animal a very peculiar appearance (Pl. II. Fig. 8). The innermost ones, nearest the mouth, are quite white.

Var. *Flemingii* (Pl. I. Fig. 7. Pl. II. Fig. 1. Pl. XVI. Figs. 2, 10, 16, 18. Pl. XVIII. Fig. 14. Pl. XIX. Fig. 32. Pl. XXI. Figs. 25—26). The test most frequently somewhat conical, sometimes more flat; the actinal side rather flat, the edge of the mouth only slightly bent inward; the peristome rather large.

The tubercles large and strong. A primary tubercle is only found on every other ambulacral plate; the plates where it is wanting, have generally two strong secondary tubercles, one out at the pores, and one nearer the median end, accordingly one on either side of the primary series of tubercles. Most frequently every other plate is regularly wanting a primary tubercle, but it may be wanting in

2—3 or still more plates in succession. This, however, does not make the primary series look very irregular. The secondary tubercles are very few; on the actinal side the largest ones form a rather regular longitudinal series on either side inside of the primary series; here they almost equal the primary tubercles in size. The pores reach quite to the edge of the area.

The primary tubercles of the interambulacral areas are considerably larger than the ambulacral ones; they form very conspicuous longitudinal series. The tubercles are largest at the ambitus, but often they decrease only very little in size towards the apical area, but in the common way towards the peristome. Most frequently a primary tubercle is wanting on a few or more plates near the apical area; in the latter case, the plates, as in the ambulacral areas. are placed alternately with plates provided with a primary tubercle. The secondary tubercles are rather few on the abactinal side, and averagely much smaller than the primary ones; on the actinal side they are more numerous, and the largest are of about the same size as the primary tubercles; they form a rather regular longitudinal series inside of the primary one, and on large specimens one more series may be found inside, along the very median line of the area, not, however, very regular. The tubercles outside of the primary series form no longitudinal series. The miliary tubercles are rather numerous, but very small, so that the test looks rather smooth.

The spines are not very numerous, nor very close-set, but upon the whole long and strong — considerable variation is found, however, with regard to the size. The longest ones are found a little above the ambitus; in some individuals they decrease only very little in size towards the apical area, so that the uppermost spines are of about the same length as those at the ambitus, which gives to the animal a very peculiar appearance. On the actinal side the ends of the spines, as in var. *mediterranea*, form an even ambulatory surface; they are likewise flat, almost all of them, truncate, and a little widened at the point.

The colour of the test is white with a more or less broad, reddish brown band down the middle of each series of plates (Pl. I. Fig. 7). The lower side most frequently quite white. The spines are red, reddish brown, or greenish brown for a smaller part at the base, the rest white; the actinal spines are quite white. In younger specimens the red colour may reach almost to the point of the spines.

Var. *norvegicus* (Pl. I. Figs. 4, 8. Pl. II. Figs. 2, 6. Pl. XV. Figs. 2, 16. Pl. XVI. Figs. 5, 22. Pl. XVIII. Figs. 1, 7, 24). The test generally much flattened, in larger specimens slightly conical. The peristome highly varying in size, sometimes very small; the edge of the peristome generally much bent inward. The tubercles rather large and strong.

The ambulacral areas are very characteristic (Pl. XV. Fig. 16. Pl. XVI. Fig. 22). The primary tubercles form no continuous series; between every two plates with a primary tubercle one or more (up to 4, most frequently 2) plates are found without such a tubercle. On these latter plates (those above the ambitus) generally only one secondary tubercle is found, placed a little outside of the primary series, and this secondary tubercle is most frequently rather large, almost as large as the nearest primary tubercles. As a consequence of this feature the primary and secondary tubercles form together one longitudinal series, which is very irregular, partly because the tubercles do not decrease evenly in size upward, partly because they are not placed in a straight line. On the actinal side the primary tubercles form a more regular series, the secondary tubercles being here considerably smaller than the primary ones, so that they here only to a smaller degree or not at all contribute to the formation of the series of tubercles, and here often more plates in succession have a primary tubercle. The pores reach quite to the edge of the area.

The primary tubercles of the interambulacral areas (Pl. XV. Fig. 2) form a very conspicuous longitudinal series, in large specimens sometimes with a few interruptions near the apical area. The secondary tubercles are very few and small on the abactinal side; on the actinal side, as usual, they are more numerous, and some of them become almost as large as the primary tubercles. In larger specimens they often, but not always, form a longitudinal series inside of the primary one; generally they are much larger in one series of plates than in the other. Those outside of the primary series are, as usual, smaller, but more numerous; in smaller specimens they are generally arranged in a rather distinct longitudinal series, in larger specimens most frequently irregularly placed.

The spines are on the abactinal side rather few; they are long and pointed, especially in small specimens, the interambulacral ones considerably longer than the ambulacral ones, corresponding to the mutual relation of the sizes of the tubercles. On the actinal side they are, as usual, more close-set, and, as in the two other forms, they are flat and widened at the point. The primary spines on the abactinal side decrease only little in length towards the apical area; on the actinal side they decrease very much in length towards the peristome; they do not, however, here form so fine, even an ambulatory surface as in the two other forms.

The colour of the test is in small specimens often very characteristic (Pl. I. Fig. 8. Pl. II. Fig. 6). There are 5 large, red spots on the interambulacral areas, and 5 narrow ones on the ambulacral areas, the boundaries between the areas are white. The spots reach to the ambitus, the actinal side is white. On the apical area there is most frequently a rather regular, white pentagon whose corners are formed by the ocular plates; thus the genital plates are white in the inner part, red in the outer part (with the genital pore). The periproct generally slightly reddish (this coloration of the apical area occurs also often in var. *Flemingii*). In larger specimens (Pl. I. Fig. 4) the red spots often spread over the whole abactinal side and some way down on the actinal side. The spines (Pl. II. Fig. 2) are generally red or reddish brown on a larger or smaller part at the base; this colour passes evenly into a greenish, at last slightly yellowish green colour. Often the spines are red in their whole length, especially the ambulacral ones. On the actinal side the spines are more whitish or quite white; in small specimens (Pl. II. Fig. 6) the spines are only slightly coloured.

Beyond the features described here scarcely any character of greater importance for the distinguishing of the three forms can be mentioned. Therefore I shall treat the other features together.

The apical area (Pl. XVI. Figs. 5, 10) without marked peculiarities; in larger specimens rather numerous tubercles are most frequently found, arranged circularly along the inner edge of the genital plates. The periproct covered by numerous small plates the largest of which carry a small tubercle.

The size of the peristome is very varying, especially in var. *norvegicus*. The buccal membrane is smooth, but contains rather numerous simple fenestrated plates among which more or fewer bihamate spicules may be found; the plates inside of the buccal plates are smaller, a little more complicate (Pl. XVI. Fig. 16), and the innost ones show a radiate arrangement. There are no spines on the buccal plates; a few pedicellariæ may be found on the buccal membrane, especially opposite to the gills.

The pedicellariæ. The globiferous pedicellariæ (Pl. XVIII. Figs. 6, 24) have one lateral tooth on either side, sometimes two teeth on one side, one tooth on the other; the blade is almost tubular, the edges being coalesced to such a degree, that only a series of small holes are left in the median line, and one larger hole just below the large end-tooth. The basal part is very varying in form, with more or less projecting outer corners or with quite rounded edge. The apophysis is narrow and often rather irregular in the edge with a larger, oblong or rhombic hole at the upper end. The size differs very much; especially in var. *Flemingii* quite small pedicellariæ may be found. In var. *norvegicus* numerous spicules are generally found in the stalk and head of the globiferous pedicellariæ (also in the neck of the other pedicellariæ). The tridentate pedicellariæ (Pl. XVIII. Figs. 1, 5, 7). The valves long, narrow, and deep; the upper end of the apophysis spreads somewhat, and forms a little mesh-work in the lower end of the blade; a few narrow cross-beams cross the inside of the blade for a shorter or longer way. The edge is straight, thick, and set with numerous small teeth, placed in transverse series (Pl. XXI. Fig. 25); in the short part at the point where the valves join, the edge is more or less coarsely serrate. They may be very long, up to $2{\cdot}5^{mm}$ (the length of the head). The ophicephalous pedicellariæ (Pl. XIX. Fig. 36) as well as the triphyllous ones without any characteristic peculiarities. — The sphæridiæ (Pl. XIX. Fig. 32) rather much grooved at the point. — The spicules (Pl. XVIII. Fig. 14) of the common form, numerous, especially in the abactinal tube feet; they are also found in rather great numbers in the skin round the base of the spines, and even some way out on the spines, in the gills, and in the buccal membrane: in the gills together with the common irregular fenestrated plates. Also in the pedicellariæ they may be found, especially in var. *norvegicus*. Sometimes a few S-shaped spicules may be found among the common bihamate ones.

Synonymous with this species are *Echinus rarispinus* G. O. Sars, *depressus* G. O. Sars, and *microstoma* Wyv. Thomson. The two former have already in Rev. of Ech. by Agassiz correctly been referred to *Ech. norvegicus*. Of *Ech. rarispinus* Danielssen (110. p. 4) says that if it be no distinct species it is at all events a well-marked variety that seems to work its way up to an independent species . By the kindness of Prof. Collett I have from the museum of Christiania got some typical specimens of *Ech. rarispinus* for examination; I can see no other thing but that they are large specimens of var. *norvegicus*. Pl. II. Fig. 2 may so far be taken as an *Ech. rarispinus* , but there is no reason to keep up this form as a special variety. Neither can I feel quite persuaded that the small specimens with the characteristic red spots (Pl. II. Fig. 6) may be said to be representatives of a dwarfish variety degenerated by its confined life in the fjords (Danielssen loc. cit.), as it is a fact that it is not confined to the fjords, but is also found in the midst of the Cattegat and Skager Rack; also from the Mediterranean and from the Bay of Biscay I have seen quite typical specimens. They are scarcely anything else than young specimens of *Ech. acutus*. It is, however, to be observed that such small specimens of a diameter of ca. $^1/_2$" may be sexually ripe, as pointed out by G. O. Sars[1]), and as I have also substantiated on specimens from the Cattegat. We have no proof that these small,

[1]) Forhandl. i Vidensk. Selsk. Christiania. 1872. p. 106.

sexually ripe individuals later grow to become large *Ech. acutus* of one or another form. Upon the whole we know next to nothing of the biology of these animals.

Echinus microstoma Wyv. Thomson (395. p. 744), of which Prof. Bell has sent me a couple of specimens, is only by its uncommonly small peristome distinguished from *Ech. acutus* var. *norvegicus*, in all the other respects it agrees completely with this latter. As there is, however, great variation with regard to the size of the peristome in *norvegicus*, I can in *Ech. microstoma* see nothing but a good *norvegicus*. The strong red colour and the thinness of the test, pointed out by Wyv. Thomson and Bell (Catalogue p. 149) as characters of *Ech. microstoma*, are as well found in typical *norvegicus*.

Whether *Ech. melo* can be kept up as a distinct species, I do not venture to say with certainty, as I have only had a slight material of it for examination; but I am inclined also to regard this form as a mere variety of *Ech. acutus*. Large specimens, to be sure, are very characteristic; but this holds also good with regard to *Ech. acutus* var. *mediterranea*, and I think it to be very doubtful, whether the smaller specimens may be distinguished with certainty. Koehler (221) has exactly enumerated the characters by which *Ech. acutus* and *melo* are distinguished. The most important one is the fact that in *melo* only every other interambulacral plate above the ambitus has a primary tubercle, while in *acutus* they have all such a tubercle — with the exception of the part near the apical area, where it is also wanting on every other plate; in some specimens the latter arrangement may even reach down almost to the ambitus. Thus this character is rather unreliable. Koehler finds another character of importance in the tridentate pedicellariæ, the edge of which is in *melo* highly serrate, in *acutus* almost smooth. According to my examinations, however, this feature is not at all constant; they may be thorny also in *acutus* and smooth in *melo*. (The thorns are in reality transverse series of small teeth, as usual in the *Echinus*-species). The other characters pointed out by Koehler, seem to me to be of slight importance. I may further mention that the globiferous pedicellariæ (Pl. XVIII. Fig. 18) are most frequently distinguished by the apophysis being peculiarly rugged or spinous above, and that the spicules are somewhat larger than usual (Pl. XVIII. Fig. 8). As in *acutus* a primary tubercle is only found on every other ambulacral plate, in several places even on every third plate only, and as in *Ech. acutus* var. *mediterranea* the pores are rather much removed from the edge of the ambulacral area. — Thus I can see no one character by which *Ech. melo* is decidedly distinguished from *acutus*, and accordingly it can scarcely be maintained as a distinct species, but only as a variety of *acutus*, characterized by its almost globular form, its green spines, and the peculiar coloration of the test.

Of *Ech. acutus* we have a rather great number of specimens, all of var. *norvegicus*, or at all events more nearly belonging to this variety, from the following stations (on the southern and western side of Iceland, the Denmark Strait):

St.	8	(63° 56′ N. L.	24° 40′ W. L.	136 fms.	Bottom	temp. 6°4).	1	specimen.
—	9	(64° 18′ —	27° 00′ —	295 —	—	6°2).	2	—
—	16	(65° 28′ —	27° 05′ —	250 —	—	6°4).	1	—
—	52	(63° 57′ —	13° 32′ —	420 —	—	7°2).	2	—
—	54	(63° 08′ —	15° 40′ —	691 —	—	4°2).	23	—
—	85	(63° 22′ —	25° 21′ —	170 —	—	?).	1	—
—	87	(65° 02′ —	23° 58′ —	110 —	—	?).	1	—
—	98	(65° 37′ —	26° 27′ —	138 —	—	6°2).	1	—

Further it has been taken on 63° 30′ N. L. 13° 39′ W. L. 92 fathoms (Wandel. 1890).

Otherwise this species occurs in the North-European seas up to north of Norway, at the British coasts, along South Europe into the Mediterranean; whether it is also found at the Azores is for the present uncertain (Koehler. 229. p. 23). It is found on depths between ca. 20—ca. 700 fathoms. Although in the Norwegian North Sea Expedition it is noted from a couple of stations with negative bottom temperature, its home must doubtless be said to be the warmer regions with positive bottom temperature. It does not occur in the cold area of the Norwegian Sea.

According to the statements given in the literature it is much wider distributed, is cosmopolitan, and ranges to a depth of 2435 fathoms (Chall. Ech. p. 213—14). As has already repeatedly been shown above, many of these statements are founded on wrong determinations, and to judge by these there is all probability that also the other statements, according to which *Ech. acutus* (or *norvegicus*) is said to occur outside of the territory stated above, are founded on wrong determinations. The places from which it is mentioned are: the eastern coast of North America to Florida, Ascension, the western coast of Patagonia, the Kermadec Islands, and Japan. As to the occurrence at the Atlantic coasts of North America, I cannot, of course, control the numerous statements of *Ech. norvegicus* being found there; but the specimens that our museum has received from U. S. National Museum under the name of *Ech. norvegicus*, at all events, are not this species, but *Ech. affinis*, and the statements in Chall. Ech. p. 117 that *Ech. norvegicus* has been taken on sts. 46 and 47 (off Cape Cod) are also founded on wrong determinations, what I have had occasion to substantiate during my stay at British Museum — these specimens are also *Ech. affinis*. Also *Ech. acutus* is in Chall. Ech. (p. 115) mentioned from the same place (st. 46); to be sure, I have not seen the specimens upon which this statement is founded, but considering how it is with *Ech. norvegicus* from the same station, and as the statement of *Ech. elegans* being found at the same place is also founded on a wrong determination (it is *Ech. Alexandri*), I think it best to remain sceptical with regard to *Ech. acutus* from st. 46 — and upon the whole with regard to all statements of the occurrence of this species off North America. The specimens from Ascension (Chall. st. 343) referred by Agassiz to *Ech. acutus* belong to another, new species, described above (p. 100) by the name of *Ech. atlanticus*.

From the western coast of Patagonia (Chall. st. 308) Agassiz mentions *Ech. norvegicus*; in British Museum I have seen the specimens upon which this statement is founded; they are two different species, viz. *Sterechinus magellanicus* and an *Echinus*-species, probably a new one, but at all events closely allied to *Ech. elegans*, accordingly belonging to another group of species than *Ech. acutus*. From the Kermadec Islands (Chall. st. 170) *Ech. acutus* is mentioned; it is a large, fine specimen of *Ech. affinis*, as far as I was able to decide by a short examination; at all events it has nothing to do with *Ech. acutus*. With regard to the occurrence of this species at Japan, finally, *Ech. norvegicus* is in Chall. Ech. (p. 117) mentioned from this locality (sts. 232 and 235); I have seen two specimens from st. 232, which are, no doubt, *Ech. lucidus* Döderl. No more than all the above mentioned specimens they have anything to do with *Ech. norvegicus*. I have not seen the specimens from st. 235, but there can, I think, scarcely be any doubt that they are the same species as those from st. 232. With this I think that the pretended enormous distribution of *Ech. acutus* is refuted. As far as we hitherto know, it occurs only in the North-European seas and the Mediterranean.

16. Echinus esculentus L.

Pl. I. Fig. 9. Pl. III. Fig. 3. Pl. XV. Figs. 1, 5. Pl. XVI. Figs. 7, 12. Pl. XVIII. Figs. 12, 13, 20. Pl. XIX. Figs. 24, 28, 30. Pl. XX. Figs. 24, 30.

Principal synonyms: *Echinus sphæra* O. F. Müller.
— *Schwartzii* Nilsson & Holst.

Principal literature: Sv. Nilsson & A. L. Holst: Collectanea Zoologiæ scandinavicæ. Lund. 1817. p. 7. — Düben & Koren: Öfvers. af Skandinaviens Echinodermer. p. 264. — Sars: Norges Echinodermer. p. 93. — Agassiz: Revision of Echini. p. 491. — Lovén: Echinoidea descr. by Linnæus (252). p. 61. — Hoyle: Rev. List of Brit. Echinoidea (202) p. 411. — Bell: Catalogue of Brit. Echinoderms. p. 152.

With regard to the other synonyms and the other literature I shall refer to Rev. of Ech. and Bell's Catalogue. — I shall not here give any thorough description of this well known and easily recognizable species, but only mention a few features which have hitherto been overlooked or not clearly described.

The primary tubercles are very small, both in the ambulacral and the interambulacral areas, so that they are only by a closer inspection seen also in this species to form regular longitudinal series in the interambulacral areas, even in the largest specimens (Pl. XV. Fig. 5). In small specimens, on the other hand, the primary tubercles form very conspicuous longitudinal series, both in the ambulacral and the interambulacral areas (Pl. I. Fig. 9), secondary tubercles being almost not yet found here. The series of primary tubercles in the ambulacral areas is in large specimens very indistinct (Pl. XV. Fig. 1); a primary tubercle is only found on every other ambulacral plate, below (and in young specimens) the alternation of the tubercles, however, is most frequently very irregular, and above the ambitus also 2—3 plates without primary tubercle may follow each other, sometimes also a couple of plates with primary tubercle. The secondary tubercles on the plates wanting primary tubercle are placed rather irregularly, the most common arrangement, however, being that a larger tubercle is found near the median edge of the plate, and a small one outside of the primary series, quite at the pores. On the uppermost ambulacral plates are found no secondary tubercles at all. — According to Bell (Catalogue. p. 153) "the irregularity may be further increased by absorption of some of the tubercles". That an absorption of tubercles (and spines) once formed, may take place, I must doubt; it is, at all events, not the reason why primary tubercles are here wanting on every other (or still more) ambulacral plates, the fact being that they have never been formed on these plates. — The miliary tubercles are very little conspicuous, being of the same deep red colour as the test, while the other tubercles just are so conspicuous on account of their white colour.

The close-set spines are short and thick, rarely longer than 14—15^{mm}; in small specimens the spines are comparatively longer than in the large ones, scarcely, however, in any instance more than half the length of the diameter of the test. The spines on the actinal side are generally somewhat flat, but not widened at the point; the end is most frequently somewhat blunt, worn, I suppose, by the walk. Under higher magnifying powers the surface of the spines is seen to have a peculiar appearance, being finely, irregularly striped longitudinally on the ribs (Pl. XX. Fig. 30); this holds otherwise also good with regard to the other *Echinus*-species, as well as *Strongylocentrotus* and

Parechinus, although it is not equally marked in all of them. On the buccal plates and on a few of the other plates in the buccal membrane some small, club-shaped spines of a length of a couple of mm. are found (Pl. XX. Fig. 24). As these spines are found in no other genuine *Echinus*-species [1]), they are an excellent distinguishing character of this species; they are, however, not found in quite small individuals, until these have reached a diameter of ca. 15^{mm}.

The buccal membrane contains numerous, more or less complicate fenestrated plates (Pl. XVI. Fig. 12); in larger specimens some of these are so large and thick, that they are seen as small knobs on the dried buccal membrane. Inside of the buccal plates they are more numerous and smaller, and are arranged in radiate series. A few bihamate spicules are rarely seen in the buccal membrane. In the gills they are found in larger numbers together with the common irregular fenestrated plates.

The pedicellariæ. The globiferous pedicellariæ (Pl. XIX. Fig. 24) with 1—1, sometimes 1—2 lateral teeth, otherwise without marked peculiarities. The tridentate pedicellariæ (Pl. XVIII. Figs. 13, 20) have a long, narrow, rather deep blade; from the upper end of the apophysis some mesh-work reaches a longer or shorter way into the blade; in small pedicellariæ no such mesh-work is found (Fig. 13). Only at the point, where the valves join, the edge is somewhat serrate; in the other part it is straight, but set with small teeth placed in transverse series as in the other *Echinus*-species. The ophicephalous and triphyllous pedicellariæ of the common form; sometimes, however, may be found a few large, elongate ophicephalous pedicellariæ, quite as those described above in *Ech. Alexandri*. The sphæridiæ (Pl. XIX. Figs. 28, 30) with few grooves, sometimes a little thorny. Spicules (Pl. XVIII. Fig. 12) of the common form.

By the "Ingolf"-Expedition this species has been taken on the following stations:

St. 6	(63° 43' N. L.	14° 34' W. L.	90 fms.	Bottom temp.	7° 5).	2 specimens.
— 54	(63° 08' —	15° 40' —	691 —	—	4° 2).	2 —
— 86	(65° 04' —	23° 48' —	76 —	—	?).	1 —
— 89	(64° 45' —	27° 20' —	310 —	—	8° 0).	1 —

Otherwise it is found along the European coasts from Britany to Spitzbergen and Iceland. Hoyle (op. cit.) mentions it also from the coasts of Spain and Portugal and from the Mediterranean, and Bell (Catalogue) further notes it from Port Natal and Brazil. The two last statements I must suppose to be incorrect, whether they are owing to wrong determinations or wrong labelling. A so wide distribution of a littoral species would be something quite exceptional, and if this large, conspicuous species were really found on the coasts of South Africa and Brazil, we should certainly have sufficient statements of this fact. I must also regard its occurrence in the Mediterranean as doubtful, probably owing to a confounding with other species (*acutus*?). When Hoyle cites Carus as an authority for its being found in the Mediterranean, it must be owing to a misapprehension. Carus, in his "Prodromus Faunæ mediterraneæ", does not mention this species, but only *Ech. esculentus* Lamk. (not L.) as a synonym of *Sphærech. granularis*. Sluiter (371) also mentions a specimen of *Ech. esculentus* L. from the Mediterranean, but I cannot regard this museum-statement as quite reliable either.

[1]) In the description of *Ech. lucidus* by Döderlein (114) it is said: "Das Buccalfeld ist glatt bis auf 10 mässig grosse Plättchen, deren jedes einen grösseren Tuberkel und einige Pedicellarien trägt". This might indicate that also in this species spines may be found on the buccal plates. On the specimen I have examined, I have not, however, seen any such spines.

The greatest depth hitherto given for *Ech. esculentus* is 110 fathoms. Now it has been taken by the Ingolf on 310 and 691 fathoms. Certainly, however, it is not common on so great depths; it properly belongs to the littoral zone.

This species is not very varying. A peculiar form with especially fine spines and high test is by Norman[1]) denoted as var. *tenuispina*; it seems only to occur on greater depths. Hoyle further establishes a couple of varieties: *α*. «with red test and spines», and *β*. «with brownish-red spines» (op. cit. p. 412), there is, however, I suppose, only slight reason to distinguish that kind of colour-varieties. A couple of specimens of a middle size from the North Sea (40 fathoms) found in the collection of our museum, have a very peculiar appearance, being very similar to *Ech. elegans*. The spines are uncommonly long and quite red, and the test not so high as usual. But the spines on the buccal plates and the fact that only every other ambulacral plate has a primary tubercle, leave no doubt of their being *esculentus*. These specimens perhaps correspond to Hoyle's var. *α*. A couple of larger, naked tests from Norway, also found in the museum of Copenhagen, combine to a curious degree the characters of both *E. esculentus* and *acutus*, var. *Flemingii*, so that it is quite impossible to decide with certainty to which of these species they belong, and the supposition of their being hybrids between the two species seems very obvious.

It seems that the species *Ech. Schwartzii* described by Nilsson & Holst, can be no other thing than a young *E. esculentus*; there is nothing in the description that will not agree with this species, and other Echinids with red test are not found at the Norwegian coast on the rocks at the very edge of the water; otherwise the type specimen is no longer found in the museum of Lund.

Fam. **Toxopneustidæ.**

Subfam. **Strongylocentrotinæ.**

17. **Strongylocentrotus drobachiensis** (O. F. Müll.).

Pl. I. Figs. 5–6. Pl. II. Figs. 3–5. Pl. XVI. Figs. 4, 9, 11, 13, 17, 21, 23. Pl. XX. Figs. 3–6, 12–13, 16, 18, 20, 25–26, 29.

Principal synonyms: *Echinus neglectus* Lamk.
— *granularis* Say.
— *granulatus* Gould.
Toxopneustes pictus Norman.
— *pallidus* G. O. Sars.

Principal literature: Düben & Koren: Öfvers. Skand. Ech. p. 277. — Lütken: Oversigt over Grønlands Echinodermata. 1857. p. 24. — G. O. Sars: Nye Ech. fra den norske Kyst. Forh. Vidensk. Selsk. Christiania 1871. p. 25. — Agassiz: Revision of Echini. p. 277. — Duncan & Sladen: Mem. Ech. Artic Sea (135). p. 19. — Hoyle: Revised List of Brit. Echinoidea (202). p. 408. — Bell: Catalogue of Brit. Echinoderms. p. 156.

[1]) On the Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Hydrozoa and Porifera. Shetland Final Dredging Report. II. Rep. Brit. Assoc. 1868. p. 314.

With regard to the other synonyms and the immense number of places in the literature where this species is mentioned or more thoroughly treated, the reader is referred to Rev. of Ech. and Bell's Catalogue. — As it has been treated so many times, I shall only here mention a few features that have not before been described with sufficient clearness.

With regard to the provision of the test with tubercles very great variation is found. On Pl. XVI. Figs. 17 and 23 is represented an ambulacral and an interambulacral area of a specimen with comparatively few tubercles (Sars's *Str. pallidus*), Figs. 11 and 21 represent the same of a specimen with numerous tubercles (*granularis* Say). The difference is here very conspicuous, and nevertheless the represented forms are by no means extreme ones. All transitional forms between these may be found. The number of the pores varies between 4—7, but most commonly 5 or 6 are found. Generally two ocular plates reach to the periproct (Pl. XVI. Fig. 9), sometimes three, more rarely one. On Pl. XVI. Fig. 4 is figured the apical area of a specimen with two pores in one of the genital plates.

The buccal membrane contains rather numerous fenestrated plates some of which are large, very complicated, and carry pedicellariæ; those inside of the buccal plates are, as usual, smaller (Pl. XVI. Fig. 13). Very few bihamate spicules in the buccal membrane and the gills, which latter otherwise contain the usual irregular fenestrated plates.

The pedicellariæ. It was the pedicellariæ of this species which were figured by O. F. Müller in Zoologia danica; among the later authors only Perrier[1]) has studied them more thoroughly and figured some of the skeletal parts. Also Agassiz gives some figures (Rev. of Ech. Pl. X), but they are too small to show the interesting features found here. — The globiferous pedicellariæ (Pl. XX. Figs. 16, 25, 26, and 29) are highly characteristic and widely different from those of all the other Echinids occurring in the northern Atlantic. The head is not, as in those, placed directly on the stalk, but connected with it by a long, muscular neck, provided with as well longitudinal as circular muscles, so that it may be stretched out and retracted, and the head may be moved freely in all directions. The blade is tubular, without lateral teeth, only with a more or less marked obliquity above. Perrier's figure (Pl. V. Fig. 7. a) of such a valve is rather unfortunate, as it seems to show two end-teeth. The form of the basal part is rather varying, as the outer corners may be more or less conspicuous or bent somewhat inward. Most frequently some spicules are found in the head, arranged in a narrow band along the edge of the valves (Fig. 29). The stalk is a hollow tube peculiarly furrowed above. (Also the stalks of the other pedicellariæ are hollow.) The globiferous pedicellariæ are generally large and strong; they are sometimes found in so great numbers as to be almost more conspicuous than the spines (on the abactinal side). Sometimes they are quite light, sometimes quite dark from pigment; the more pigmented they are, the fewer spicules they seem to contain; they may also quite want spicules.

The tridentate pedicellariæ are of very different forms (Pl. XX. Figs. 4, 6, 20); the blade may be long and narrow, or short and broad, deep with almost adjoining edges, or flat and broad; now there is a strong mesh-work, now almost none. The ophicephalous and triphyllous pedicellariæ (Pl. XX. Figs. 3, 5) without marked peculiarities. — The spicules (Pl. XX. Fig. 12) are branched at the ends, but

1) Recherches sur les Pedicellaires. p. 152.

also really bihamate spicules are found, although only in small numbers. The sphæridiæ (Pl. XX. Figs. 13, 18) quite smooth or a little thorny, sometimes also a little grooved.

By the »Ingolf«-Expedition it has been taken on the following stations:

St. 2	(63° 04' N. L.	9° 22' W. L.	262 fms.	Clay, gravel.	Bottom temp.	5° 9).	2	spec.
— 4	(64° 07' —	11° 12' —	237 —	Stones.	—	3°).	2	—
— 6	(63° 43' —	14° 34' —	90 —	Sand.	—	7° 5).	2	—
— 15	(66° 18' —	25° 59' —	330 —	?	—	÷ 0° 35).	3	—
— 16	(65° 28' —	27° 05' —	250 —	?	—	6° 4).	1	—
— 29	(65° 34' —	54° 31' —	68 —	Sand.	—	0° 5).	8	—
— 31	(66° 43' —	55° 57' —	88 —	?	—	2° 0).	6	—
— 32	(66° 35' —	56° 38' —	318 —	Mud.	—	4° 2).	1	—
— 33	(67° 57' —	55° 30' —	35 —	Coarse sand.	—	1° 4).	1	—
— 34	(65° 17' —	54° 17' —	55 —	Sand.	—	0° 9).	5	—
— 52	(63° 57' —	13° 32' —	420 —	?	—	7° 2).	1	—
— 86	(65° 04' —	23° 48' —	76 —	?	—	?).	1	—
— 87	(65° 02' —	23° 58' —	110 —	?	—	?).	46	—
— 98	(65° 37' —	26° 27' —	138 —	?	—	6° 2).	3	—
— 115	(70° 50' —	8° 29' —	86 —	Mud.	—	0° 4).	1	—
— 127	(66° 33' —	20° 05' —	44 —	Sand.	—	5° 9).	34	—

It is very widely distributed being found in all the arctic seas, and passing far to the south, both in the Atlantic (to the English Channel and Massachusetts Bay) and in the Pacific (to Vancouver Island and Korea). It is a littoral form, but goes rather deep; by the »Ingolf« it has been taken on a depth of 420 fathoms, and Verrill even mentions it from 640 fathoms (426. p. 540.)

It is no wonder that a so widely distributed species is very varying; a whole series of »species« has also been established on more or less marked forms of it. I completely agree with Agassiz, Bell, a. o. that it is quite impossible to keep the forms described under the name of *pallidus*, *granularis*, *pictus*, and *carnosus*[1]) distinct from the typical *drobachiensis* or from each other. Forms are not rarely found, to be sure, which may easily be referred to these forms, but most frequently such a referring will be impossible. I have examined several hundreds of specimens and found all possible transitional forms. Marked local forms seem not to be found; but as a general thing it may be said that in the Danish seas a more long-spined form is the most common one, at the Faroe Islands a form with numerous short, strong spines and almost without spicules in the globiferous pedicellariæ seems to be predominant (most nearly the form *granularis*); the Icelandic and East-Greenland specimens seem upon the whole to have very numerous spicules in the globiferous pedicellariæ, and the Pacific specimens may often be referred to the form *carnosus*; quite typical *drobachiensis* are, however, found so far down as Korea (after specimens in the museum of Copenhagen). These forms may so far be kept up as distinct varieties, but I do not see that we gain anything by it. Most specimens it will certainly be impossible to refer to any decided one of these varieties, and the separate varieties may often be found together. Neither can any difference be pointed out between the forms from shallow water and those from deep water.

Also the colour is very varying; most common is a grayish white or a somewhat greenish colour,

[1]) With regard to *Str. chlorocentrotus* see above p. 120.

but frequent are the reddish or dark, almost black specimens; a fine violet specimen may now and then be found (Pl. I. Figs. 5—6. Pl. II. Figs. 3—5).

Rodger (333. p. 163) speaks of an »extraordinary variety of *Str. drobachiensis*, with enormous pedicellariæ». It must decidedly be asserted that a variety cannot be established characterized by especially large pedicellariæ; the size of the globiferous pedicellariæ (and they are certainly meant) is so very varying, that it would be a quite absurd thing to distinguish different forms by this feature; the difference in size is, moreover, increased by the neck of the pedicellariæ being now stretched out, now retracted. We might with more probability expect to find a difference of importance in the tridentate pedicellariæ, but the different varieties cannot be distinguished by means of those either. A »Var. with slender, reddish spines«, mentioned by Verrill (416. p. 504), is scarcely better characterized than the other varieties.

There are in the literature a few statements of other regular Echinids from the North-European seas. Agassiz (10) enumerates *Echinus melo* among Echinids from the Faroe-Channel, but adds: »there is nothing new». Here must, I think, be some mistake, and I must quite agree with Bell (Catal. p. 155) that *Ech. melo* cannot on this basis be included in the fauna of the North-European seas — quite apart from the question, whether *Ech. melo* can upon the whole be kept up as a distinct species.

Dalla Torre (108. p. 92) mentions *Strongylocentrotus lividus* from Helgoland; this is, no doubt, a confounding with *Str. drobachiensis*, which latter is not named. Further Herdmann (194. p. 89) mentions *Str. lividus* from Norway without further informations; this is surely also a mistake. The Norwegian coast-fauna has been so excellently examined by so many eminent Norwegian naturalists, that it is quite inconceivable that this large, fine Echinid should have been overlooked. Finally Sluiter (371. p. 70) states to have a specimen of *Sphærechinus granularis* from Denmark. Unfortunately we must relinquish our claim to the joy of having this beautiful and interesting Echinid in our seas; the northermost locality, from which it is known, is the Channel Isles. (Bell. Catalogue. p. 106).

Table of the Echinids of the Families Echinidæ and Toxopneustidæ[1]) occurring in the northern Atlantic and the Mediterranean.

1. The spicules simply bihamate, the globiferous pedicellariæ with 1—more lateral teeth on either side	2.
The spicules branched at the ends or dumb-bell-shaped, the globiferous pedicellariæ without lateral teeth	13.
2. The pores trigeminate	3.
— multigeminate	*Paracentrotus lividus* (Lamk.).
3. The globiferous pedicellariæ with the edges of the blade fine, projecting into several large indentations on either side; no cross-beams connect the edges across the inside	4.

[1]) In this table the species *Echinus gracilis*, *atlanticus*, and *lucidus* have been included, so that it comprises all sure *Echinus*-species.

The globiferous pedicellariæ with the edges of the blade thickened, connected by cross-beams across the inside (in *Ech. Alexandri*, however, sometimes without such cross-beams) .... 5.

4. The plates on the buccal membrane thick, greenish, of a peculiar structure (a compact calcareous mass with deep, funnel-shaped holes); they form a dense covering......... *Parechinus microtuberculatus* (Blv.).

The plates on the buccal membrane not greenish, of the common structure; they form no quite dense covering, naked skin is seen between them........................ *Parechinus miliaris* (Müll.).

5. Primary tubercle on all the ambulacral plates............ 6.

— — only on every other ambulacral plate... 11.

6. The tridentate pedicellariæ with the blade broad and rather flat; the globiferous pedicellariæ generally with 3—4 teeth on either side of the blade.............................. *Echinus Alexandri* Dan. Kor.

The tridentate pedicellariæ with the blade narrow and deep; the globiferous pedicellariæ with 1—2 teeth on either side of the blade.. 7.

7. The primary tubercles on the ambulacral areas of very unequal size, or, if the size decreases regularly towards the apical area and the peristome, the two series in each ambulacral area of very different size.................... *Echinus affinis* Mrtsn.

The primary tubercles on the ambulacral areas decrease regularly in size towards the apical area and the peristome; both series of equal size................................ 8.

8. The test high.. 9.

— rather flat... 10.

9. Finely red; the ophicephalous pedicellariæ with uncommonly long blade... *Echinus atlanticus* Mrtsn.

With a fine green coloration; the ophicephalous pedicellariæ of the common form............................ *Echinus gracilis* Ag.

10. The globiferous pedicellariæ generally with 2—2 lateral teeth; the test and the spines generally finely red and white, more rarely the test violet........................ *Echinus elegans* Düb. Kor.

The globiferous pedicellariæ generally with 1—1 lateral tooth; the test and the spines white...................... *Echinus lucidus* Döderl.

11. Spines on the buccal plates; the primary spines short, thick, not distinctly longer than the secondary ones...... *Echinus esculentus* L.

No spines on the buccal plates; the primary spines considerably longer than the secondary ones............ 12.

12. Only every other interambulacral plate above the ambitus with a primary tubercle; the primary spines rather short, greenish; the form of the test almost globular........... *Echinus melo* Lamk.

Only a few interambulacral plates nearest to the apical area want primary tubercle; the primary spines most frequently rather long, reddish; the test high or more or less flat *Echinus acutus*[1]) Lamk.

13. The spicules branched in the ends, none dumb-bell-shaped; the globiferous pedicellariæ with long, muscular neck; no glands on the stalk. The pores multigeminate........... *Strongylocentrotus drobachiensis* (Müll.)

The spicules of the pedicellariæ dumb-bell-shaped, those of the tube feet branched in the ends; the globiferous pedicellariæ without neck, with glands on the stalk. The pores multigeminate.................................... *Sphærechinus granularis*[2]) (Lamk.).

Several results of importance to the study of the geographical distribution will appear from the present researches. A complete representation of these results must, however, be delayed, till the irregular Echinids have been treated. Here I shall only briefly mention one feature of greater interest, viz. the resemblance between the arctic-subarctic and the antarctic-subantarctic Echinid-fauna, as this resemblance is chiefly based on the regular Echinids.

Meissner (285) gives a comparison of the Echinid-fauna of the two regions after the statements in the literature: one species occurs in both these regions, is »bipolar«, viz. *Echinus norvegicus*. The following species represent each other: *Cidaris canaliculata* and *papillata*, *Echinus magellanicus* and *miliaris*, *E. margaritaceus* and *elegans*, *Strongylocentrotus albus* and *drobachiensis*, *Schizaster Philippii* and *fragilis*. I shall express no opinion with regard to the two *Schizaster*-species, but all the other points of resemblance between the two faunas are quite illusory. I have shown above that *Echinus norvegicus* is not bipolar. The statement originates from Agassiz (»Challenger« Echinoidea p. 117), but is wrong. The specimens (from st. 308) that have been referred to *Ech. norvegicus*, are partly *Sterechinus magellanicus*, partly an *Echinus*-species that has nothing to do with *norvegicus*; it belongs to the species with primary tubercle on all the ambulacral plates; it is perhaps a new species. — »*Cidaris*« *canaliculata* and *papillata* can in no way be said to correspond to each other, they belong to two different genera, *Stereocidaris* and *Dorocidaris*; any two other Cidarids might as justly be said to represent each other. *Echinus magellanicus* and *miliaris*, to be sure, are rather similar with regard to habitus, but as they belong, not only to two different genera, but to two different sub-

[1]) With regard to var. *mediterranea*, *Flemingii*, and *norvegicus* I must refer to the description above (pp. 154—155).

[2]) I cannot give the characters of *Sphærechinus roseus* more particularly, as I have not seen this species; the reader is referred to Russo's description of it (347).

families, they cannot be said to correspond very exactly to each other. *Echinus margaritaceus* and *elegans* must be referred to two different genera, *Sterechinus* and *Echinus*, so that these species can not be placed as substitutes for each other either. Upon the whole it is worthy of notice that it proves necessary to refer all the antarctic »*Echinus*«-species to another genus (*Sterechinus*) than the northern species. It seems to be rather gratuitous to place the separate species of these two genera against each other as substitutes. With regard finally to *Strongylocentrotus drobachiensis* and *albus*, they, to be sure, have some resemblance as to habitus — nevertheless they belong to two different families. — With this I suppose it to be sufficiently proved that there is no special resemblance between the arctic-subarctic and the antarctic-subantarctic Echinid-fauna.

APPENDIX.

By an assistance received from the Carlsberg Fond, for which I here render my best thanks, I was enabled to go abroad for a longer time during the summer of 1902 to visit several of the most important museums, especially British Museum and the Museum of Paris. By this I have been enabled to decide many of the questions which in the preceding work I had been obliged to leave undecided. As the printing of the work had already gone so far, that nothing could be corrected or added, these informations are here given in an appendix. Neither was it possible to insert any reference to the appendix in the places concerned of the text.

I beg leave to offer my best thanks to Messrs. Prof. Pfeffer, Sluiter, Bell, Perrier, de Loriol, Döderlein, and Möbius, as well as to Dr. Meissner for the liberality they have shown especially by giving me free admission to examine the type specimens, which are of so very great importance.

The treatment of the pedicellariæ (pp. 10, 55). For the isolation of the skeletal parts it is more convenient to use hypochlorite of sodium (Na OCl.) (Eau de Javelle); it acts very quickly, and has not to be heated as the solution of potash. Especially by the treating of very small forms of pedicellariæ hypochlorite of sodium is absolutely to be preferred, as the skeletal parts are by this means easily isolated on the objectglass. Prof. Döderlein has drawn my attention to this very practical manner of proceeding.

"*Globiferæ*" Hamann (pp. 10, 55). As I had had no occasion to examine these organs myself, I supposed them really to be globiferous pedicellariæ, whose peculiar appearance was due to the highly developed glands on the stalk and the reduction of the head. In his preliminary report of the Echinids of the Siboga-Expedition[1]), de Mejere has given the information that they are really ophicephalous pedicellariæ. Having now had the occasion to examine these peculiar pedicellariæ myself I must corroborate the correctness of the statement of de Mejere; in *Centrostephanus longispinus*, to be sure, they are somewhat different from the ophicephalous pedicellariæ where glands are wanting on the stalk, but in *Aspidodiadema* they are constructed in quite the same manner as these. Accordingly it is absolutely inadmissible to use the name of "Globiferæ" of these pedicellariæ, they are morphologically highly different from the globiferous pedicellariæ. If a special name is needed for them, they must be called "claviform" pedicellariæ, which name has been proposed by Foettinger (155) what

[1]) Vorläufige Beschreibung der neuen, durch die Siboga-Expedition gesammelten Echiniden. Tijdschr. d. Nederl. Dierk. Vereen. (2) VIII. 1902. p. 16.

Hamann has overlooked, though be repeatedly quotes the paper by Foettinger. The name of Globiferæ must then be rejected for these pedicellariæ in the *Diadematidæ* on account of priority as well as morphology. In *Sphærechinus* the case is quite different; here they are evidently (rudimentary) globiferous pedicellariæ; the name of «claviform» pedicellariæ cannot be applied to them.

Dorocidaris papillata. The arrangement of the tubercles in the ambulacral areas described p. 32 (Pl. IV. Fig. 8) is no constant feature. In some specimens from the Shetland Islands brought home by Cand. mag. A. S. Jensen, the secondary tubercles are sometimes placed opposite to those in the primary series, sometimes alternating with these (as in *Cidaris affinis*), sometimes there is a tubercle both opposite to the primary one and one down in the inner corner of the ambulacral plate.

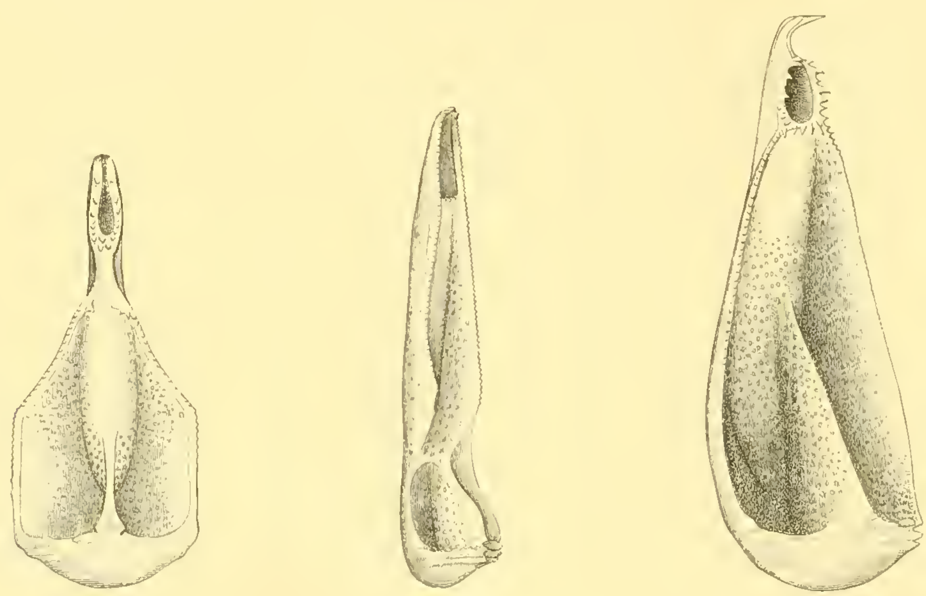


Fig. 7. Fig. 8. Fig. 9.

Fig. 7. Valve of a large globiferous pedicellaria of *Stereocidaris Lorioli.* Obj. AA. Oc. III. (Zeiss).
— 8. — - small — — - *Stereocidaris Lorioli.* Obj. AA. Oc. III. (Zeiss).
— 9. — - large — — - *Dorocidaris nuda.* Obj. AA. Oc. III. (Zeiss).

With regard to the hitherto uncontrolled statements of the occurrence of *D. papillata* (p. 35) I am now able to give the following informations: the specimen from St. Pauls Rock (Challenger) is a *D. papillata.* This locality is the southernmost one, from which the species is known, — the specimens (2) from the still more southern locality, «Challenger» st. 320 (off the mouth of the River Plate) being no *D. papillata*, but a species hitherto not described. The spines resemble those of *D. papillata*, have a slightly reddish, rather long neck; there are about 18 longitudinal ribs, serrate as in *C. affinis*; between the ribs slightly branched «hairs» are found, so that a transverse section of the spines gives a quite similar figure as in *D. papillata.* In the smaller specimen the spines are a little more thorny. No ampullæ on the secondary spines. The large globiferous pedicellariæ (Fig. 7) without end tooth, the blade a little prolonged. The mouth is long and narrow, surrounded by rather strong teeth. They are rather varying in size, the figured one is among the smaller. In the larger ones the lateral corners are less conspicuous or even not indicated at all. The mouth may also be somewhat shorter, so that the whole valve reminds of the form peculiar of the genus *Cidaris*. The small globiferous pedicellariæ (Fig. 8) are of a quite different form, flat and broad, the lower limit little conspicuous; they are also very varying in size, and the larger specimens are very similar to tridentate pedicellariæ. Real tridentate pedicellariæ I have not found. The spicules of the common form. This species, no doubt, is to be referred to the genus *Stereocidaris*; I propose the name of **St. Lorioli** n. sp.

The specimens from Chall. st. 24 (Culebra Island) and from Gomera (The Canary Islands) I have not seen — they are not found in British Museum — and so I can give no informations of them.

Of the specimen of *D. papillata* mentioned by Studer (386), from 4° 40′ N. L. 9° 10′ E. L., 59 fathoms (the Gazelle -Expedition) (the mentioned locality is not, as Studer says, the Cape Verd Islands, but quite innermost in the Gulf of Guinea) I have (pp. 35, 37) expressed the supposition that it might be *Cidaris affinis*. This is not correct; it is a new *Dorocidaris*-species, very different from *D. papillata* as to habitus. The secondary spines are rather few, and, with the exception of the primary series in the ambulacral areas and a single circle round each radiole, very small, by which fact the whole test, but specially the apical area, gets a strikingly naked appearance. In the ambulacral areas a double series of spines is found in the median line, so small, that they do not reach to the base of those in the primary series. No ampullæ seem to be found. The secondary spines are reddish brown; according to Studer they are purple (on living individuals?); the colour of the test white. The radioles are likewise reddish brown, but of a lighter shade than the secondary spines; they are about 1½—2 times as long as the diameter of the test, only a little tapering towards the point, ending in a little widening. There are ca. 9—11 more or less coarsely serrate, rather conspicuous longitudinal ridges; the hairs on the outer layer between the longitudinal ridges as in *D. papillata*, so that a transverse section of the spines gives the same picture as in the latter species. The actinal radioles not much serrate in the edge, upon the whole only little different from the others, excepting with regard to the length. The areoles comparatively very large, but not especially deep; they occupy almost the whole space, so that there is only room left for a few secondary spines outside of the single circle nearest to the radiole. No naked median line in the interambulacral areas or between the plates; no transverse furrows in the edge of the interambulacral areas as in *papillata*. The inner tubercles in the ambulacral areas are placed opposite to or a little below those in the primary series. — The mouth of the large globiferous pedicellariæ (Fig. 9) is regularly limited below, often by a straight line; it is surrounded by rather strong teeth. The dorsal side of the blade is less highly perforated than in *D. papillata*; the small globiferous pedicellariæ as in this species. The tridentate pedicellariæ are not so irregularly serrate in the edge and upon the whole less complicate in the lower part of the blade than in *D. papillata*. The spicules as in *papillata* and arranged as in this species. — This species, for which I propose the name of **Dorocidaris nuda** n. sp., I have also found in the museum of Paris, from „Talisman", st. 109, 70 m., and st. 110, 450 m., near Cape Verd, called *Dorocid. hystrix*, by which name it has been mentioned by Bernard (78).

It is still to be noted that the specimen of *D. papillata* mentioned in Rev. of Ech. p. 105, from Guadeloupe (Duchassaing), does not belong to this species; it is a *Cidaris* sp., probably *C. affinis*.

Thus I have established the fact that no less than 8 different species, of which, moreover, only one belongs to the genus *Dorocidaris*, have in the literature been wrongly referred to *D. papillata*, viz. *Dorocidaris nuda*, *Tretocidaris annulata*, *spinosa*, *Cidaris affinis*, *baculosa* and another *Cidaris*-species (Chall. st. 204), *Stereocidaris Lorioli*, and another *Stereocidaris*-species (Chall. st. 210) — a fine demonstration of the trustworthiness of the statements hitherto found in the literature with regard to the occurrence and distribution of these animals.

Cidaris Thouarsii. The type specimen has a short limb on the stalk of the pedicellariæ; I suppose then, that the specimens, in which I have found a long limb (p. 17), do not belong to this species. The main point, however, is that *C. Thouarsii* as well as its close relation *C. Galapagensis*, belong to the genus *Cidaris*. I shall not here trench on the question whether *galapagensis* can really be kept up as a separate species.

Cidaris annulifera (pp. 19—20, 28). Having examined the type specimen of Lamarck in the museum of Paris I am able definitively to decide the question of this species. It is the species figured by de Loriol (243) under this name, and it is doubtless synonymous with *C. baculosa*, while it has nothing to do with *C. bispinosa* and the genus *Stephanocidaris*. The representation of these species given by Döderlein in «Bericht über die von Herrn Prof. Semon bei Amboina und Thursday Island gesammelten Echinoidea» (Semon. Zool. Forschungsreisen in Australien und dem Malayischen Archipel. V. 1902. — Jen. Denkschr. VIII[1]) is completely correct. The type specimen of *C. annulifera* is a naked test filled with wax, on which the radioles are fixed with needles. Secondary spines, pedicellariæ, and tube feet are completely wanting, but the red spots on the neck of the radioles leave no doubt that it is a form of *C. baculosa*. As *baculosa* is named first by Lamarck, the name of *annulifera* must be rejected as a specific name, can only be kept as the name of a variety of *baculosa*, as has been done by Döderlein. — On the other hand I cannot agree with Döderlein, when he adopts the name of *pistillaris* Lamk. instead of *baculosa*, because Lamarck names *pistillaris* as the first name. It would, no doubt, be correct if we could prove with certainty that *C. pistillaris* and *baculosa* are one species, but this we cannot do, as the type specimen seems to be existing no more. It is not found in the museum in «Jardin des plantes», and it cannot be decided, whether a specimen found under this name in «École des mines» in Paris, is a type specimen. It is to be noted, however, that this specimen has the red spots on the neck of the spines. Lamarck does not name «École des mines» under this species, neither is it in «Catalogue raisonné» mentioned from this collection. Two specimens from the Seychelles (Rousseau 1841) found in the museum in «Jardin des plantes» under the name of *pistillaris* do exactly want the red spots on the neck of the spines, but have close, bluish red streaks. Probably they are genuine *Cidaris*, perhaps only a variety of *baculosa*, but as I could find no large globiferous pedicellariæ on the specimens, I cannot decide it with certainty. Döderlein (op. cit. p. 693) says that «selten fliessen die Tüpfel in Längsstreifen zusammen»; I cannot see, however, that he has proved the specimens with these longitudinal streaks to be the same species as the typical *baculosa* — if individuals with both forms of spines might be found, it might be taken to be certain. — For the present I must regard this form with the longitudinal streaks (presumably the *C. pistillaris* of Lamarck) as a separate species or, at all events, a distinct variety of *C. baculosa* which is so very rich in forms.

[1]) This very important and excellent work did not appear till the printing of the present work was begun, so I have not been able to take it into consideration. It does not, however, overthrow any of my results.

To adopt the name of *pistillaris* in stead of *baculosa* I must, for the reasons given above, regard as unwarranted.

Schleinitzia crenularis (p. 20). — The specimen figured by Studer cannot be identified any longer with certainty in the museum of Berlin; a dried specimen without label resembles the figure rather much, but not quite — it is *C. baculosa* var. *annulifera*. Two other specimens in alcohol are *Stephanocid. bispinosa*, a form with little thorny spines as in var. *ramsayi* Döderl. (op. cit. p. 697). In the glass together with one of these specimens is found a loose spine of *C. baculosa* var. *annulifera*. No more specimens are found in the museum of Berlin. Thus *Schleinitzia crenularis* is = *Cidaris baculosa* var. *annulifera* and *Stephanoc. bispinosa*.

Acanthocidaris curvatispinis (p. 21). Of this species I found a specimen, also from Mauritius, in the museum of Paris, called *Dorocidaris?* The globiferous pedicellariæ are quite as in the type specimen: sometimes the two outmost teeth at the mouth may be united at the point and thus form an apparent end tooth. Tridentate pedicellariæ were not found on this specimen.

Histocidaris elegans (pp. 21—22). By a renewed examination of all the specimens in British Museum I have not been able to find any globiferous pedicellariæ; accordingly the valve figured on Pl. IX. Fig. 2, with two end-teeth is evidently an abnormity having nothing to do with this species. The genus *Histocidaris* then seems only to have tridentate pedicellariæ.

Stereocidaris nutrix (*Gonioc. membranipora* Studer) (p. 26). I have examined all the specimens of this species in the museum of Berlin; none of them have young ones on the periproct, but two have young ones round the mouth, quite as described by Wyv. Thomson. The remark by Studer quoted on p. 26 is thus incorrect, it must apply to his *G. vivipara*. No specimen of this species in the museum of Berlin carries any longer young ones, but some young are lying in a couple of small glasses together with them. Accordingly my interpretation of *Stereoc. nutrix* and *canaliculata* is no doubt correct.

Porocidaris purpurata. A couple of large, fine specimens in the museum of Paris (Talisman Riv. Ouro. 1439 m.) differ from the common form by the fact that in the uppermost (1—2) radioles of each series the neck is swollen in a fusiform manner and of a fine violet colour; the other spines are quite cylindric. Otherwise it agrees with *purpurata*, also the pedicellariæ are quite as in this species. I suppose it to be a separate species, but as I can give no other characters of it, I shall only designate it as a variety of *P. purpurata* under the name of var. **Talismani** n. var.

Dorocidaris tiara. Of this species I have examined a specimen from Calcutta in the collection of de Loriol. With regard to spines and pedicellariæ it agrees exactly with *Stephanoc. bracteata* (Ag.), and so it is evidently a synonym of this species.

Phormosoma placenta. After the printing of the section of the Echinothurids, a glass was found with some small young ones of this species from st. 25; the smallest ones have only a diameter of 3^{mm}, and are thus considerably smaller than the youngest stages of Echinothurids hitherto known[1]). Thus it will be of great interest to get information of these younger stages. Agassiz has, in Blake -Echini, given some informations of the development of *Phormosoma*, but as the youngest of

[1]) The specimen of *Asthenosoma hystrix* of $3{,}1^{mm}$, mentioned and figured in Rev. of Ech. p. 273 (Pl. II. c.) is scarcely an Echinothurid; at all events there is neither in the description nor in the figures anything showing it.

his specimens had a diameter of 8^{mm}, he has not, of course, been able to give all the necessary informations. To this is to be added that I must decidedly contest the correctness of several of the most important statements of Agassiz.

The form of the test is in specimens of a diameter of 3^{mm} as in a common *Echinus*, not flattened, and the plates are not yet imbricated; already in specimens of a diameter of 5^{mm} the test is a little flattened. In the smallest specimens the peristome is quite covered by the 10 large buccal plates; only inside of these, nearest to the mouth, a few small, irregular plates are seen. All the 10 buccal tube feet are well developed and of equal size; spines are not yet found on the buccal plates. In a specimen of a diameter of 5^{mm} there are 5 spines on the buccal plates, one for each pair of tube feet; here ambulacral plates have begun to appear on the buccal membrane outside of the buccal plates. A specimen of a diameter of 7^{mm} has 10 spines on the buccal plates alternating regularly with the tube feet, so that spines and tube feet together form a regular circle; here also 5 spines have appeared outside of the first circle, one opposite to each ambulacrum. According to Agassiz the buccal plates in *Phormosoma placenta* should not differ in size from the other plates on the peristome, so that the Echinid features of the actinostome did not seem to occur in this species. This is incorrect; in the youngest stages the buccal plates are easily recognised by their size — but it is to be admitted that this difference in size soon disappears, the other plates of the peristome reaching about the same size. Of these plates in the peristome Agassiz (op. cit. p. 32) says that they »are developed ... independently of the coronal plates; new plates forming on the distal surface of the actinostome, which are intercalated between the old plates and the coronal plates«. This is absolutely incorrect; the plates of the peristome are ambulacral plates displaced adorally (Lovén); on a contrary supposition beginnings of them and quite small plates must be found outermost in the peristome, but this is not the case — on the contrary the outermost plates are the largest. In »Challenger«-Echinoidea p. 73 Agassiz also says that these plates »are formed by becoming detached from the ambulacral zones«.

In the smallest of the specimens in hand there are as yet only ca. 7 pairs of tube feet, besides the buccal ones. There is no distinct difference between the primary and the accessory ambulacral plates; only in a specimen of a diameter of 7^{mm} the primary one begins to grow larger than the others, and it carries now 1—2 tubercles, while the small ones have at most a small miliary tubercle. In specimens of this size the areoles begin to be deepened, so that the difference between the actinal and abactinal side is now already indicated. — Auriculæ are already distinct in individuals of a diameter of 6^{mm}, but are as yet only a pair of small processes, not connected above. The gills do not appear till later; in individuals of a diameter of 10^{mm} they are not yet to be seen. A few triphyllous pedicellariæ, of the same form as in the adult, and a few sphæridiæ are already found in the smallest specimens. — The apical area is in all essentials as in the youngest stage figured (Pl. IV. Fig. 2). The periproct is, even in the smallest specimens, covered by a number of small, irregular plates, with no larger plate between. So a central plate seems never to be found here. The genital plates join for a long space, so that the ocular plates are widely separated from the periproct; these plates are much lengthened, reach down quite to the middle of the test, and here the pore is placed, which, in accordance with its morphological signification as the opening of the terminal feeler (the point of the radiary canal), is found from the earliest stages, and not, as stated by Agassiz (op. cit. p. 35), only formed, when the animal has reached a size of 20mm.

Of the formation of the interambulacral plates the following very remarkable statement is found in Agassiz (op. cit. p. 32): On the abactinal system ... while the plates of the genital ring are well defined and seem to be distinctly separated from the coronal plates, yet new interambulacral plates are not added independently as in the ambulacral system and in the interambulacral system of other young Echinids where the genital ring remains permanently closed. The new interambulacral plates are found to be pushing out from the plates of the anal system on each side of the genital plates. As the ocular and genital plates of the genital ring become separated with increasing size, the additional anal plates formed in the intervening spaces are pushed out, and become a part of the abactinal portion of the interambulacral area .... This shows a far closer relationship between the young of some of the Sea-urchins of the present day with Starfishes and Ophiurans on the one side and Holothurians on the other, than had been suspected formerly. — This statement is completely incorrect. The interambulacral plates are formed in *Ph. placenta* as in other Echinids, not by the anal plates. The genital ring, at all events, is closed, until the animal has reached a size of 17mm in diameter, and so far accordingly the interambulacral plates must necessarily be formed in the common way, as may also easily be substantiated. In a specimen of a diameter of 30mm a couple of ocular and genital plates are still joining, and here the case is quite the same. That a new mode of formation of the interambulacral plates, otherwise quite unknown among the Echinids, should then suddenly occur, is very improbable — and, above all, Agassiz has not at all proved it; all that may be seen in the larger specimens, is that the small anal plates directly adjoin the uppermost interambulacral plates. Thus the more close relation between Asterids, Ophiurids, Holothurids, and some of the Sea-urchins of the present day, which Agassiz derived from this feature, is quite illusory.

Calveria gracilis. — The parasitic Copepod from the spines of this species, mentioned on p. 51, has been described by Dr. H. J. Hansen in Vidensk. Medd. fra Naturh. Foren. Kobenhavn 1902 by the name of *Echinocheres globosus.*

Aræosoma fenestratum. In a well preserved specimen from Blake 1880 (with no more precise locality) found in the museum of Paris, I have found the tetradactylous pedicellariæ together with as well the large as the small form of tridentate pedicellariæ. If still some doubt might be left of the correctness of my interpretation of this species, no doubt will hereafter be possible.

Through Prof. Bell I have from Department in the course of fishing investigations received some specimens of an Echinothurid from west of Ireland (Porcupine Bank, 199 fathoms) which prove to be closely allied to *A. fenestratum*, but are, no doubt, nevertheless to be interpreted as a separate species. The structure of the test differs somewhat from that of *A. fenestratum.* In the latter the interambulacral plates are lower in the middle, and widened in both ends, in the former most of the plates are not widened at all in the outer end. (This character, however, is scarcely very reliable — comp. Bell (72)). The primary tubercles of the ambulacral areas form on the actinal side a rather regular longitudinal series out at the tube feet, in *fenestratum* they are arranged more irregularly. Otherwise no difference is found in the arrangement of the tubercles between this species and *fenestratum*, only, perhaps, the secondary spines are somewhat more numerous in the new species.

— Tetradactylous pedicellariæ I have not found. The tridentate and triphyllous pedicellariæ as in *fenestratum*; the large form of tridentate pedicellariæ is found in very different sizes, but also the small ones are of the typical structure, so that they cannot be confounded with the other form. Besides the forms of the second kind of tridentate pedicellariæ mentioned and figured for *fenestratum*, a form is also found here where the blade is not at all involved below (Fig. 10). I have, however, once found this form in *A. fenestratum* (in a specimen from Barbados, in British Museum), and so it can be no specific character. The spicules, perhaps, are a little smaller than in *fenestratum*, but this difference is too little marked to be used as a specific character. The best character is the colour, which in the preserved specimens is deeply dark violet, while all the specimens of *fenestratum* I have seen, are quite bleached in alcohol: also in the living animals the colour is quite different — comp. the description by Wyv. Thomson. The primary spines on the actinal side are dark with a rather large, white hoof, very conspicuous on the dark ground-colour. — The organs of Stewart are very large; the longitudinal muscles powerful. — For this species, the place of which is evidently between *A. fenestratum* and *coriaceum*, I propose the name of **Aræosoma violaceum** n. sp.

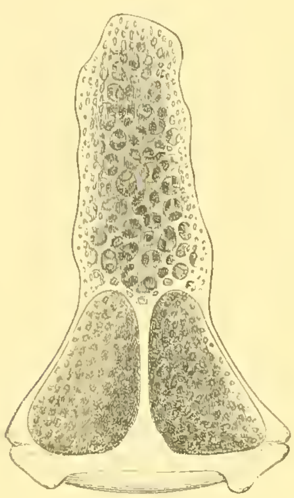


Fig. 10.

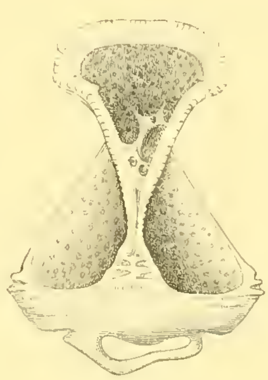


Fig. 11.

Fig. 10. Valve of tridentate pedicellaria of *Aræosoma violaceum*. Obj. AA. Oc. II. (Zeiss).
Fig. 11. Valve of ophicephalous pedicellaria of *Hygrosoma Petersii*. Obj. AA. Oc. I. (Zeiss).

Echinosoma uranus (p. 57). A couple of specimens of this species (Talisman Sahara, 938 m.) I have seen in the museum of Paris. All the primary spines on the actinal side were broken, but some of the spines round the mouth had a little hoof; after this there can be no doubt that the primary spines on the actinal side end in a hoof as in *E. tenue*. The large tridentate pedicellariæ are quite similar to the one of *E tenue* figured on Pl. XII. Fig. 35, with the exception that here the apophysis does not continue into the blade as a crest.

Hygrosoma Petersii (p. 59). In a specimen of this species (the Azores, 1258 m. Talisman. The museum of Paris) was found a pedicellaria (Fig. 11) forming a transition between the ophicephalous pedicellariæ in *Tromikosoma Koehleri* and the short, thick pedicellariæ of *H. luculentum*. After this there can be no doubt that *luculentum* is really to be classed together with *H. Petersii*, and it may well be supposed that this form of pedicellariæ will also be found in *H. hoplacantha* — in other words that it is one of the characters of the genus *Hygrosoma*. Whether it is then to be regarded as an ophicephalous or a transformed tridentate pedicellaria is so far of no consequence; I think it, however, most correct to regard it as an ophicephalous one, although in *luculentum* it is not of the typical structure. — The form of pedicellariæ in *H. luculentum* (Chall. Pl. XLIV. Fig. 27) mentioned on p. 60, I have not been able to find by a renewed examination of the specimen from st. 200, although this specimen is rather well preserved. — If thus ophicephalous pedicellariæ are found in the genus

Hygrosoma, the difference between the latter and the genus *Tromikosoma* becomes rather more slight than stated in the diagnoses. Then there is only any difference of importance in the form of the tridentate pedicellariæ; but this difference is so great, that I, at all events for the present (until transitional forms become known), must regard the genus *Tromikosoma* as a legitimate one.

Kamptosoma asterias (p. 60). All the three specimens from Chall. st. 272 which Agassiz has determined as *Phormosoma tenue?*, are *K. asterias*. After a renewed examination I must regard it as unjustified to establish a separate species of this genus on them. — It is the primary spines on the actinal side that are flat and widened at the point (Pl. XIV. Fig. 29); below they are round, tubular, and then they become evenly flattened towards the point. They are a little curved; a hoof is scarcely found. The spines nearest to the mouth are surrounded by a rather thick bag of skin, not widened at the point. The small, accessory ambulacral plates are really wanting, only nearest to the peristome a single one may be found. For each ambulacral plate here are as usual three branches from the radial canals, but two of them are quite thin and their ampullæ rudimentary, and their tube feet are not developed at all.

Sperosoma Grimaldii (p. 75). Of this species I have found ca. 20 specimens in the museum of Paris ("Talisman", the Azores, Morocco, 300—1257 m.), determined partly as *Phormosoma uranus*, partly as *Asthenosoma hystrix*. Our museum has further received some specimens of different sizes from the Faroe Channel (59° 29′ N. L. 7° 51′ W. L. 580—689 fathoms. "Michael Sars". Ad. S. Jensen), a corroboration of the supposition with regard to its geographical distribution expressed above. — Rather great variation proves to be found in the mutual relation of the size of the abactinal ambulacral plates; accordingly there cannot be laid much stress on the deviations in this respect from the type specimen of Koehler described above, and there can be no doubt that the large specimen figured on Pl. IV. Fig. 3, is a real *Sp. Grimaldii*.

Prionechinus sagittiger (p. 84). As far as can be seen on the type specimen preserved in alcohol (st. 218), no grooves are found in the test; to be able to state this fact with certainty, it will, however, be necessary to examine a dried specimen.

Echinus lucidus (pp. 100, 105) has calcareous plates in the buccal membrane as the other genuine *Echinus*-species; they are simple fenestrated plates as in *Ech. Alexandri*. There are no spines on the buccal plates (p. 161, note).

Sterechinus margaritaceus (pp. 101—102). De Loriol has called my attention to the fact that the figures of *Ech. margaritaceus* given in "Voyage de la Frégate Venus". Zoophytes Pl. VI. 1, do not agree with Koehler's description of *St. antarcticus*, especially as all the ocular plates in *margaritaceus* are shut off from the periproct. Trusting to the interpretation by Agassiz of *Ech. margaritaceus* as the correct one, I had omitted to examine this question more closely. According to a kind information from Dr. Gravier the type specimen is no more found in Paris. But to judge by the figures in "Voyage de Venus" there can scarcely be any doubt that Agassiz's (and my) interpretation of *Ech. margaritaceus* is incorrect; besides the ocular plates being shut off from the periproct, it seems also to appear from these figures that there is a primary tubercle on all the ambulacral plates. But then I do not see how *St. magellanicus* is to be distinguished from *margaritaceus*, and it is an obvious supposition that they are really one species; if this be the case the name of *magellanicus* will only be a synonym of *margaritaceus*. The species described above as *margaritaceus*, will, if *margaritaceus* and *magellanicus* really be identical, get the name of *Sterech. diadema* (Studer), in which species *Sterech. antarcticus* (Koehler) is to be included as a synonym. With regard to the geographical distribution it will, I suppose, be proved that *St. diadema* (*margaritaceus*?) only occurs in the seas round Kerguelen, *St. margaritaceus* (*magellanicus*) round Patagonia — analogous with *Stereocidaris nutrix* and *canaliculata*. The statements of *diadema* (under the name of *margaritaceus*) from Patagonia, I think will have to be referred to *horridus*, which is, as to habitus, very similar to this species[1]). It is still to be observed that *St. diadema* has a distinct genital papilla.

Sterechinus horridus (p. 102). There are no plates in the buccal membrane outside of the buccal plates, which carry spines. The actinal primary spines are not curved. The character pointed out in the diagnosis of the genus *Sterechinus* (p. 135), that the buccal membrane is almost or quite naked outside of the buccal plates, is thus correct.

Pseudechinus albocinctus (p. 104). One of the anal plates is somewhat larger than the others, and carries a larger tubercle. No spines on the buccal plates.

Parechinus microtuberculatus (p. 107). The type specimen of this species is the common Mediterranean form; the statement of Blainville that it has 6 pairs of pores in each arc, is thus incorrect.

Sphærechinus australiæ (p. 117). Has a primary tubercle on all the ambulacral plates. Otherwise the specimen examined by me, is so very similar to *Sph. granularis*, that I should not be surprised, if it proved to be this species (— and in this case it is surely not from Australia —); perhaps I have then not seen the real *Sph. australiæ* at all.

Strongylocentrotus intermedius and *chlorocentrotus* (pp. 120—121). What I have hitherto regarded as *Str. intermedius* is not this species, but *Str. pulcherrimus* (comp. my supposition expressed on p. 121 that *pulcherrimus*, *intermedius*, and *chlorocentrotus* (?) might be one species). The real *intermedius*, which I got to know from Prof. Döderlein, is as to habitus very similar to *drobachiensis*, also with regard to pedicellariæ and spicules, but is — according to Döderlein's (not published) examinations — distinguished from this by having a considerably larger number of plates in both areas, and a rather smaller apical area than specimens of *drobachiensis* of the same size. At all events the two species are very closely allied.

Strongylocentrotus gibbosus (p. 123). The examination of the pedicellariæ of one of the type specimens in Paris shows that this species is an Echinometrid, I suppose of the genus *Toxocidaris*, or perhaps a new genus. With the genus *Loxechinus* this species has nothing to do; the specimen (Chall. st. 304), by which I referred *gibbosus* to this genus, is thus wrongly determined (what I had a slight impression of — comp. the incongruity in the relation of the ocular plates mentioned loc. cit.). Besides the two type specimens (Expedition de la Bonite. M. Gaudichaud. 1837) two specimens are found in

[1]) When the remarks above were printed, I received from the museum in »Jardin des Plantes« a specimen called *Ech. margaritaceus* from Cape Horn, 1894 (Coll. Cotteau). As to habitus it resembles *diadema*, the secondary spines, however, being somewhat coarser. All the ocular plates are shut off from the periproct; distinct central plate, as in *diadema*. Primary tubercle on every other ambulacral plate — somewhat indistinct towards the apical area. Primary spines round the mouth curved at the point; a few spines on the buccal plates. The pedicellariæ as in *diadema*. — Thus this specimen agrees neither with *diadema*, *horridus*, nor *Neumayeri*; nevertheless it seems rather irrational to interpret it as a separate species. The supposition that *diadema*, *horridus*, and *Neumayeri* are all together only one very varying species, seems to me to be rather obvious. But to decide this question a great material will be necessary.

the museum of Paris called *Str. gibbosus* Val. (I. Galapagos. M. Rousseau. 1846). They are *Sphærechinus granularis* (or, if they be really from Galapagos, another *Sphærechinus*-species (*australiæ*?)). On the back of the label is written »acheté à Londres« — thus the locality cannot be regarded as reliable.

Paracentrotus Gaimardi (p. 124). On a specimen of this species in the museum of Paris (the type specimen of *Ech. aciculatus* Hupé, which is a synonym of *Gaimardi*) I have found a small tridentate pedicellaria; it was somewhat broken, but showed nevertheless sufficiently that it is similar to those of *P. lividus*, so that a specific character is scarcely to be found in it.

Anthocidaris homalostoma (p. 125). The type specimens of *Ech. homalostoma* Val. are two naked tests that are really very similar to *Anthocidaris*; but it cannot be decided by the naked tests whether they are the same species. The locality (New Zealand) tells against the identity. I have above (loc. cit.) said that the name of *homalostoma* would have to be used whether they be identical or not. According to the opinion of Döderlein expressed to me, this is incorrect, and I shall readily submit to his authority. Then the species will get the name of *Anthocidaris crassispina* (Ag.).

Strongylocentrotus nudus (pp. 126, 140). A specimen of this species (from Hakodadi — Japan) I have examined in Strassburg. No globiferous pedicellariæ were found on it, but the spicules show it to be a genuine *Strongylocentrotus*. The tridentate pedicellariæ occur in three different forms, as in *drobachiensis*; a short, broad one (1·5^{mm}) resembling that figured on Pl. XX. Fig. 20; a long, narrow one (2^{mm}) resembling that figured on Pl. XX. Fig. 6, only more serrate below; and finally a small one (ca. 0·5^{mm}), more particularly corresponding to the third form in *drobachiensis* (Pl. XX. Fig. 4); it is simply leaf-shaped with quite straight edge, without marked indentations. The other pedicellariæ show no peculiarities.

Strongylocentrotus mexicanus (pp. 126, 140). The specimens from Chili mentioned by Sluiter (371), are Echinometrids — but whether they be really *Str. mexicanus*, is perhaps not quite sure, so the systematic position of this species must continue to be regarded as doubtful.

Echinus elegans (p. 145). The specimens from Cape Verd (»Gazelle«) noted by Studer as *Ech. elegans?*, are two small naked tests; one is doubtless *Genocidaris maculata*, the other I suppose to be a *Parechinus*, but it cannot be decided with certainty.

Echinus affinis (p. 152). For this species I can add one more locality, having found in the museum of Paris some specimens from 39° 38′ N. L. 70° 56′ W. L. 1241 fathoms (»Blake«); they were called *Ech. norvegicus*.

Echinus acutus, var. *norvegicus* (p. 155). Some small specimens from the Faroe Channel (»Michael Sars« 150—217 fathoms, Ad. S. Jensen) have a primary tubercle on all the ambulacral plates and upon the whole in regular series; they are only irregular as to size, especially a few ones at the ambitus being disproportionately large. Upon the whole the ambulacral areas have here quite the same appearance as in some specimens of *Ech. affinis*. They are then to be distinguished from this species by the colour and the globiferous pedicellariæ, the latter having in *affinis* 2—2 (more rarely 2—3) lateral teeth, while in *norvegicus* they have 1—1 or 1—2 lateral teeth. The tridentate pedicellariæ of the two species are so similar, that no distinguishing character can be found in this feature. On the other hand the spicules of the stalk of the pedicellariæ is a good character of *norvegicus* — when they are found, but they are no constant feature. — Evidently *Ech. affinis* is more particularly allied to var. *norvegicus*, and they represent both of them transitional forms between the species with primary tubercle on every ambulacral plate and those with primary tubercle only on every other ambulacral plate. — The specimens of *norvegicus* mentioned here, have a specially small peristome, accordingly they belong to the form *microstoma*.

Echinus esculentus (p. 161). The specimens of this species from the Mediterranean found in Amsterdam and in British Museum, are correctly determined, but have been got from older collections, or bought from dealers in natural objects; consequently the locality is unreliable, and, as we have no other statements of the occurrence of this species in the Mediterranean, evidently wrong. This holds also good with regard to the specimens stated to be from Port Natal. The specimen after which the species is noted from the coasts of Spain and Portugal by Bell and Hoyle, is *Parechinus miliaris*. The specimen of *Ech. esculentus* (Talisman. Cape Spartel, 717 m.) mentioned by Bernard, is *Ech. elegans*. — The determinations by Bernard of the *Echinus* species, are otherwise quite confused: »*melo*« is *acutus*, »*norvegicus*« is *Alexandri*, »*acutus*« is a typical var. *norvegicus*. — The specimen from Brazil (John Adam's Bank) is stated to have been obtained by the Herald-Expedition; it is correctly determined, with a label within it; accordingly there can apparently be no doubt of the correctness. As we have not, however, other statements of the occurrence of the species off Brazil, I must for the present remain sceptical with regard to this statement. The other distribution of the species does not indicate that it should really be found off Brazil.

Through Prof. Bell I have received a new *Echinus*-species (from Department in the course of fishing investigations), taken west of Ireland (»Porcupine«-bank, 91 fathoms), 2 specimens.

Diameter.	Height.	Diameter.		Largest breadth.		Number of plates.		Longest spines.
		Peristome.	Apical area.	Ambulacral area.	Interambulacral area.	Ambulacral area.	Interambulacral area.	
57	45	20	12	13	20	c. 38	18	13
33	23	14	8	7	12	22—23	14	?

All the measures are in millimetres.

The test is almost globular, especially in the large specimen; the edge of the mouth not curved invard. There are spines on the buccal plates; numerous, rather thick plates in the buccal membrane. No ocular plates reach to the periproct. Only every other ambulacral plate has a primary tubercle; on the other plates there is a rather large secondary tubercle in the inner end and one a little outside of the primary series, near the pores; otherwise there are almost no tubercles in the ambulacral area. The pores reach quite to the edge of the area. Each interambulacral plate has a primary tubercle and moreover ca. 4—6 secondary ones, which are, however, far from filling the plate, so that the test looks rather naked. The primary series are distinct. Miliary tubercles numerous. On the actinal side the tubercles are placed much more closely. Here the spines are rather long, directed straight downward, not flat or widened at the point; the abactinal spines short and fine. Pedicellariæ and spicules quite as in *Ech. esculentus*. The colour of the preserved specimens white. — After a communication from the Rev. Canon A. M. Norman it is this species he has described as *Ech.*

esculentus var. *tenuispina* (p. 162), and so it gets the name of **Echinus tenuispinus** n. sp. It is, as seen by Norman, closely allied to *esculentus*, with which it agrees in the most important characters: primary tubercle only on every other ambulacral plate, and spines on the buccal plates; it is easily distinguished from the latter by having far fewer tubercles, among which the primary series are very distinct, and by its white colour — *esculentus* seems always to keep the colour in spirit. I am decidedly of opinion that it must be regarded as an independent species, not only as a variety of *esculentus*. It differs considerably as to habitus from this species, among whose forms I know no specimens with which it may be confounded. What I, above (p. 162), have interpreted as var. *tenuispinus*, is a peculiar form with short, fine spines, but with the usual colour of the test (from the Faroe Islands); accordingly it is not identical with Norman's var. *tenuispinus*.

Fig. 12. *Echinus tenuispinus* n. sp. Natural size. (From a photograph.)

Strongylocentrolus lividus (p. 165) is by Sluiter (371) mentioned from Dogger Bank — it is *Str. drobachiensis*.

Finally I shall call attention to the fact that no single regular Echinid belongs to the large cold depth north of Iceland. The account of the geographical distribution must otherwise be put off until the whole Echinid-material has been examined.

BIBLIOGRAPHY.

List of the works, which have appeared since 1872, containing systematic descriptions of and notes on recent Echinids or remarks on their geographical distribution. Of other works on Echinids, anatomical, histological or embrylogical, only those have been named which seemed to be of importance for this work, thus especially works in which the pedicellariæ are treated. — A few works from 1871—72, which are not named in the bibliography in »Revision of Echini« are also contained in this list. Those few works, which I have not seen myself, are marked with *.

1. **A. Agassiz:** The Homologies of Pedicellariæ. Americ. Naturalist. VII. 1873. p. 398-406. (Also in »Rev. of Echini«. Part IV. p. 659 seq.)
2. — The Echini collected on the Hassler Expedition. Bull. Mus. Comp. Zool. III. 1873. p. 187-90.
3. — On viviparous Echini from Kerguelen Islands. Proc. Amer. Acad. of Arts & Sc. N. Ser. III. 1876. p. 231-36.
4. — Reports on the Results of Dredging ...... in the Gulf of Mexico by the U. S. Coast Survey Steamer »Blake«. II. Report on the Echini. Bull. Mus. Comp. Zool. V. 1878, p. 185-94. Pl. I-V.
5. — Preliminary Report on the Echini of the exploring Expedition of H. M. S. »Challenger«. Proc. Amer. Acad. Arts & Sc. XIV (N. Ser. VI). 1879. p. 190-212.
6. — Reports on the Results of Dredging ..... in the Caribbean Sea 1878-79 and along the Atlantic Coast of the U. S. during the Summer of 1880, by the U. S. Coast Survey Steamer »Blake«. IX. Preliminary Report on the Echini. Bull. Mus. Comp. Zool. VIII. 1880. p. 69-84.
7. — Note on some points in the History of the Synonymy of the Echini. Proc. Zool. Soc. London. 1880. p. 33-38.
8. — Report on the scientific results of the Voyage of H. M. S. »Challenger«. Zoology. Vol. III. Report on the Echinoidea. 1881.
9. — Reports on the results of Dredging in the Gulf of Mexico (1877-78), in the Caribbean Sea (1878-79) and along the Atlantic coast of the United States (1880) by the U. S. Coast Survey Steamer »Blake«. XXIV. Part I. Report on the Echini. 32 Pl. Mem. Mus. Comp. Zool. Vol. X. 1883.
10. — Echinoidea of the Faroe Channel (Exploration of the Faroe Channel during the Summer of 1880 in H. M. hired Ship »Knight Errant«). Proc. R. Soc. Edinburgh. XI. 1882. p. 697-98.
11. — Three Cruises of the U. S. Coast and Geodætic Survey Steamer »Blake«. Vol. II. Bull. Mus. Comp. Zool. XV. 1888. (Echinids. p. 88-101).
12. — Reports on the Dredging operations off the West Coast of Central America to the Galapagos .... by the U. S. Fish Comm. Steamer »Albatross« during 1891. II. General Sketch of the Expedition of the »Albatross«. Ibid. XXIII. 1892. p. 80-82. »Comparison of the Deep-Water Echini obtained in the Panamic and Caribbean district.»
13. **A. Agassiz:** Reports on the Dredging Operations .... by the U. S. Fish Comm. Steamer »Albatross« 1891. XXIII. Preliminary Report on the Echini. Ibid. XXXII. 1898. p. 71-86. Pl. I-XIII.
14. — & **L. F. de Pourtalès:** Zoological results of the Hassler Expedition. I. Echini, Crinoids and Corals. Illustr. Catalogue. Mus. Comp. Zool. No. VIII. 1874. Echini. p. 1-24. Pl. I-IV.
15. **A. Alcock:** Natural History Notes from H. M. Indian marine Survey Steamer »Investigator«. Ser. II. No. 9. An account of the Deep-Sea collection made during the Season of 1892-93. Journ. Asiatic Soc. Bengal. LXII. 1893. p. 169-84. Pl. 8-9.
16. — Illustrations of the Zoology of the Royal Indian marine Survey steamer »Investigator«. Echinoderma. Part II. 1895.

— see **Wood-Mason.**

17. **E. I. Allen:** On the Fauna and bottom deposits near the thirty fathom line from the Eddystone Grounds to the Start Point. Journ. Marine Biol. Assoc. of the United Kingdom. V. 1899. p. 365-542. Distribution and habits of Echinids. p. 472-76.
18. **A. R. S. Anderson:** Natural History Notes from H. M. Indian marine Survey Steamer »Investigator«. Ser. II. No. 16. On the Echinoidea collected during the season 1893-94. Journ. Asiatic Soc. Bengal. LXIII. 1894. p. 188-95.
19. — Report of the Surgeon Naturalist for the season ending 31 March 1898. Report of the Marine Survey of India. 1897-98. p. 5-12.
20. **H. J. van Ankum:** Kalklichaampjes bij Echinometra lucunter Ag. Tijdschr. Nederl. Dierk. Vereenig. I. 1876. p. 188-96. Pl. 9-10.
21. **Anonym:** Anthozoa and Echinodermata of the Gulf Stream Slope of the New England Coast (U. S. Fish Commission). American Naturalist XXIV. 1890. p. 183-86.
22. — »A moving Grove«. Natural Science. V. 1894. p. 169-70.
23. **A. Appellöf:** Om Bergensfjordens faunistiske Præg. Bergens Mus. Årsberetn. 1891. 14 pp.
24. — Faunistiske Undersøgelser i Herløfjorden. Bergens Mus. Årbog. 1894-95. 11 pp.
25. — Faunistiske Undersøgelser i Osterfjorden. Ibid. 1896.
26. **C. W. S. Aurivillius:** Hafsevertebrater från nordligaste Tromsö Amt och Vest Finmarken. Bihang till Svenska Vet. Akad. Handl. XI. 1887. 4. 56 pp. Echinoidea. p. 48.

27. **H. Ayers:** On the Structure and Function of the Sphæridia of the Echinoidea. Quart. Journ. Micr. Sc. N. Ser. XXVI. 1885. p. 39-52. Pl. 5.

28. **J. Barrois:** Note sur une nouvelle forme Parasite des Firoles. Journ. de l'Anat. et de la Physiol. XXIII. 1887. p. 1-17. Pl. I-II. (comp. **Ludwig** 261.)

29. **Th. Barrois:** Catalogue des Crustacés podophthalmaires et des Echinodermes recueillis à Concarneau. Lille 1882. 8⁰. p. 34-59. Pl. 1-3.

30. — Liste des Echinodermes recueillis aux Açores durant les mois d'Août et Septembre 1887. Revue biol. du Nord de la France. I. 1888.

31. **W. Bateson:** Materials for the study of variation, treated with especial regard to discontinuity in the origin of species. London 1884. 8⁰. Chapter XVII. Echinodermata; p. 441-47. Variation in number of radii in Echinids.

32. **F. A. Bather:** Evolution of a protective habit in Sea-Urchins. Nat. Science. VI. 1895. p. 72.

33. — Echinoidea, in The scientific results of the Challenger Expedition. Ibid. VII. 1895. p. 44—46.

34. **Bavay:** Préparation des Echinides à sec. Feuille des jeunes Naturalistes. XXIII. 1893. N⁰ 267. p. 43—44. (Comp. 93.)

Beddard see **Geddes.**

35. **F. P. Bedford:** On Echinoderms from Singapore and Malacca. Proc. Zool. Soc. London. 1900. p. 271-99. Pl. 21-24.

36. **Ch. E. Beecher:** The origin and significance of spines: a Study in Evolution. Amer. Journ. Sc. 4. Ser. VI. 1898. p. 1-20, 125-36, 249-68, 329-59.

37. **F. Jeffr. Bell:** Observations on the Characters of the Echinoidea. I. On the species of the Genus Brissus and on the allied forms Meoma and Metalia. Proc. Zool. Soc. London. 1879. p. 249-55.

38. — Observations etc. II. On the species of the Genus Tripneustes. Agass. Ibid. 1879. p. 655-62. pl. 49.

39. — Observations etc. III. On some genera and species of the Temnopleuridæ. Ibid. 1880. p. 422-40. pl. 41.

40. — Observations etc. IV. The Echinometridæ, their affinities and systematic position. Ibid. 1881. p. 410-33.

41. — Note on the number of anal plates in Echinocidaris. Ibid. 1879. p. 436-37.

42. — On Palæolampas, a new genus of Echinoidea. Ibid. 1880. p. 43-49. pl. 4.

43. — On the names applied to certain Echinoidea. Ibid. 1880. p. 220-22.

44. — Exhibition of an immature Echinid. Ibid. 1880. p. 356-58.

45. — Note on an abnormal (quadriradiate) specimen of Amblypneustes formosus. Journ. Linn. Soc. London. Zoology. XV. 1880. p. 126-29. pl. 5.

46. — Account of the zoological collections made during the Survey of H. M. S. Alert in the straits of Magellan and on the coast of Patagonia. IX. Echinodermata. Proc. Zool. Soc. London. 1881. p. 87-101. pl. 8-9.

47. — Description of a new species of the Genus Mespilia. Ibid. 1881. p. 433-35.

48. — On the apparent retention of a suranal plate by a young Echinometra. Journ. Linn. Soc. London. Zoology. XV. 1881. p. 318-20.

49. — Report on a collection made by Mr. T. Conry in Ascension Island. Echinodermata. Ann. Mag. Nat. Hist. 5. Ser. VIII. 1881. p. 436-38.

50. **F. Jeffr. Bell:** Note on the Spicules found in the ambulacral tubes of the regular Echinoidea. Journ. R. Microsc. Soc. 2. Ser. II. 1882. p. 297-99. pl. 5.

51. — Note on the Echinoderm Fauna of the Island of Ceylon, together with some observations on Heteractinism. Ann. Mag. Nat. Hist. 5. Ser. X. 1882. p. 218-25.

52. — Observations on the generic and specific Characters of the Laganidæ. Ibid. 5. Ser. XI. 1883. p. 130—36.

53. — On the species of Pseudoboletia. Ibid. 5. Ser. XIII. 1884. p. 108-11.

54. — Report on the Echinodermata collected by Mr. F. Day in H. M. S. Triton off the eastern Coast of Scotland in July 1882. Journ. Linn. Soc. London. Zoology. XVII. 1884. p. 102-4.

55. — Report on the zoological collection made in the Indo-pacific Ocean during the voyage of H. M. S. Alert. 1881-82. London. 1884. Echinodermata. p. 117-77, 509-12. pl. 8-17& 45.

56. — On the generic position and relations of Echinanthus tumidus Woods. Proc. Zool. Soc. London. 1884. p. 40-43. pl. 2.

57. — Notes on the structural Characters of the spines of Echinoidea (Cidarida). Journ. R. microsc. Soc. 2. Ser. IV. 1884. p. 846-50. pl. 13.

58. — Report on a Collection of Echinodermata from Australia. Proc. Linn. Soc. N. S. Wales. IX. 1884. p. 496-511.

59. — On the Echinoderm Fauna of the Island of Ceylon. Rep. Brit. Ass. f. Adv. of Science. 1885. p. 1065.

60. — On a species of Echinocardium from the Channel Islands. Ann. Mag. Nat. Hist. 5. Ser. XVII. 1886. p. 516-17.

61. — A new species of Nucleolites, with remarks on the subdivisions of the genus. Ibid. 5. Ser. XX. 1887. p. 125-27.

62. — Description of a new species of Evechinus. Ibid. 5. Ser. XX. 1887. p. 403-5. pl. 17. 7-8.

63. — Report on a collection of Echinodermata from the Andaman Islands. Proc. Zool. Soc. London. 1887. p. 139-45. pl. 16.

64. — The Echinoderm Fauna of the Island of Ceylon. Scientif. Transact. R. Dublin Soc. 2. Ser. III. 1887. p. 643-58. pl. 39-40.

65. — On the Echinodermata of the Sea of Bengal. Rep. Brit. Assoc. f. Adv. of Sc. 1888. p. 718.

66. — Notes on the Echinoderms collected at Port Philip by Mr. I. Bracebridge Wilson. Ann. Mag. Nat. Hist. 6. Ser. II. 1888. p. 401-7.

67. — Report on a collection of Echinoderms made at Tuticorin, Madras, by Mr. Edgar Thurston. Proc. Zool. Soc. London. 1888. p. 383-89.

68. — Note on the relative claims to recognition of the generic names Arbacia Gray and Echinocidaris Des Moulins. Ann. Mag. Nat. Hist. 6. Ser. III. 1889. p. 290.

69. — Report on a deep-sea trawling Cruise off the S. W. Coast of Ireland, under the direction of Rev. W. Spotswood Green. Echinodermata. Ibid. 6. Ser. IV. 1889. p. 432-35. pl. 18-19.

70. — Note on the Echinoderms collected by Mr. Bourne in Deep Water off the South West of Ireland in H. M. S. Research. Journ. Mar. biol. Assoc. of the United Kingdom. N. Ser. I. 18. p. 324-27.

71. — On the arrangement and interrelations of the Classes of the Echinodermata. Ann. Mag. Nat. Hist. 6. Ser. VIII. 1891. p. 206-15.

72. — On the Echinoderms collected by the S.s. «Fingal» in 1890 and by the S.s. Harlequin in 1891 off the West

Coast of Ireland. Scientif. Proc. R. Dublin Soc. N. Ser. VII. 1891-92. p. 520-29. pl. 23-25.
73. **F. Jeffr. Bell**: Catalogue of the British Echinoderms in the British Museum. London 1892. 202 pp. 16 pl.
74. — Description of a remarkable new Sea-Urchin of the genus Cidaris from Mauritius. Transact. Zool. Soc. London. XIII. 1893. p. 303-4. pl. 38.
75. — On the Echinoderms collected during the voyage of H. M. S. »Penguin» and by H. M. S. »Egeria» when surveying Macclesfield Bank. Proc. Zool. Soc. London. 1894, p. 392-413. pl. 23-27.
76. — On the Actinogonidiate Echinoderms collected by Mr. I. Stanley Gardiner at Funafuti and Rotuma. Ibid. 1898. p. 849-50.
77. — Report on the Echinoderms (other than Holothurians) collected by Dr. Willey. **A. Willey.** Zoological Results. Part II. Cambridge. 1899. p. 133-40.
— see **Haddon.**
78. **F. Bernard**: Liste des Echinides recueillis pendant les croisières du »Travailleur» et du »Talisman». Bull. Mus. Paris. 1895. p. 207-9.
79. — Echinides recueillis par l'expédition du Cap Horn. 1882 -83. Ibid. 1895. p. 272-74.
80. **O. Bidenkap**: Undersøgelser over Lyngenfjordens Evertebratfauna. I. Storfjorden. Tromsø Mus. Årshefter. 20. 1897. p. 81-103.
81. — Tromsøsundets Echinodermer. Ibid. p. 104-12.
82. **H. Bolau**: Die Spatangiden des Hamburger Museums. Program der Realschule des Johanneums. Hamburg. 1873. 23 pp. 1 Pl.
83. — Neue Spatangiden des Hamburger Museums. Arch. f. Naturgesch. 40. 1874. p. 175-78. Pl. 6.
84. **L. Boutan**: Voyage dans la mer Rouge. Rev. biol. du Nord de France. IV-V. 1892. IV. p. 173-83, 210-23, 266-72, 351 -62, 403-10, 463-68, 502-10; V. p. 40-44, 53-69. Pl. VII-X. Pl. VII.
85. **M. Braun**: Verzeichniss der Echinodermen des Hafens von Mahon, Menorca. Sitzungsber. d. Naturf. Gesellsch. d. Univ. Dorpat. VII. 1886. p. 307-10.
86. **R. Broom**: Exhibit of Rotula Rumphii from Sierra Leone. Proc. Nat. Hist. Soc. of Glasgow. N. Ser. II. 1890. p. 34.
87. **L. Camerano**: Osservazioni intorno al Dimorfismo sessuale degli Echinodermi. Boll. dei Musei di Zool. ed Anat. Comp. d. R. Univ. di Torino. V. 1890. No. 91.
88. — **& Lessona**: Compendio della Fauna italica. Torino. 1885. p. 297-300.
89. **I. V. Carus**: Prodromus Faunæ mediterraneæ. I. p. 85-111. Stuttgart. 1884. 8°.
90. **H. C. Chadwick**: Second Report on the Echinodermata of the L. M. B. C. District. Proc. Liverpool Biol. Soc. III. 1889. p. 174-80.
91. — Note on a tetramerous specimen of Echinus esculentus. Proc. & Transact. Liverpool. Biol. Soc. XII. 1898. p. 288 -90. pl. 17.
92. — Memoirs on typical British marine plants and animals. Ed. by W. A. Herdman. III. Echinus. Liverpool marine biol. Committee. 1900. (Also Proc. & Transact. Liverpool Biol. Soc. XIV.)
93. **E. Chevreux**: Préparation des Echinides à sec. Feuille d. jeunes Naturalistes. XXIII. 1893. p. 78. (Comp. 34.)
94. **C. Chun**: Aus den Tiefen des Weltmeeres. Schilderungen von der deutschen Tiefsee-Expedition. Jena. 1900.
95. **H. Lym. Clark**: Zoological Jamaica. Nat. Science. XIII. 1898. p. 161-71.
96. — The Echinoids and Asteroids of Jamaica. Johns Hopkins Univ. Circ. 18. 1898. No. 137.
97. — Notes on the Echinoderms of Bermuda. Ann. New York Acad. XI. 1898. p. 407-13.
98. — Further notes on the Echinoderms of Bermuda. Ibid. XII. 1899. p. 117-38. 1 pl.
98a. — Echinoderms from Puget Sound: Observations on the Echinoderms collected by the parties from Columbia University, in Puget Sound, in 1896 and 1897. Proc. Boston Soc. Nat. Hist. XXIX. 1901. p. 323-34. 4 Pl.
98b. — Bermudan Echinoderms. A report on observations and collections made in 1899. Ibid. XXIX. 1901. p. 339-44.
A. Collin see **Meissner.**
99. **Jonas Collin**: Limfjordens marine Fauna. Kobenhavn. 1884. 8°. Echinodermer. p. 23.
100. **G. Cotteau**: Note sur un nouveau genre d'Echinide vivant. Bull. Soc. Zool. de France. XIV. 1889. p. 15.
101. — Echinides recueillis par M. Jullien sur les côtes de Guinée. Ibid. XIV. 1889. p. 340 -42.
102. — Description de trois Echinides vivants recueillis par le Dr. I. Jullien, sur les côtes de Guinée (Libéria). Congrès Internat. de Zool. Compte-rendu des scéances. Paris. 1889. p. 281-92. pl. 2-5.
103. — Note sur le groupe des Clypéastrides. Comptes Rendus de l'Assoc. Franc. pour l'Avanc. d. Sciences. XIX. 1891. p. 390-96.
104. **E. Coues & H. C. Yarrow**: Notes on the natural History of Fort Mahon, N. C., and vicinity. Proc. Ac. Nat Sc. Philadelphia. 1878. p. 297-315.
105. **P. Couteaud**: Rapport sommaire sur les collections d'histoire naturelle faites pendant la campagne de la »Manche» à l'île Jan Mayen et au Spitzberg. Arch. d. Missions scientif. V. 1893. p. 145-54.
106. **H. Coutière**: Notes sur les récifs madréporiques de Djibouti. Bull. Mus. d'hist. nat. Paris. 1898. p. 87-90. 155-57.
107. — Observations sur quelques animaux des récifs madréporiques de Djibouti. Ibid. 1898. p. 238-40.
Cuénot see **Janet.**
108. **K. W. v. Dalla Torre**: Fauna von Helgoland. Zool. Jahrb. Abth. f. System. Suppl. H. 2. 1889.
109. **D. C. Danielssen & T. Koren**: Fra den norske Nordhavsexpedition. Nyt Magaz. f. Naturvidensk. XXVII. 1883. p. 267-99. 4 Pl.
110. — Echinida. Norske Nordhavsexpedition. Zoologi. XXI. 1892. 2 pp. 1 Pl.
111. **C. B. Davenport**: The Fauna and Flora about Coldspring Harbour. Science. N. Ser. VIII. 1898. p. 685-89.
*112. **P. Dautzenberg**: Atlas de poche des coquilles des côtes de France (Manche, Océan, Méditerranée) communes, pittoresques ou comestibles. Suivi d'un appendice sur les Crustacés, Oursins etc. les plus communes par **V. de Clèves**: Paris. 1897. 16°. 153 pp. 72 pl.
113. **A. Dendy**: Notes on a remarkable collection of marine animals lately found on the New Brighton Beach, near Christchurch, New Zealand. Transact. & Proc. New Zealand. Inst. XXX. 1898. p. 320-26.
114. **L. Döderlein**: Seeigel von Japan und den Liu-Kiu Inseln. Arch. f. Naturgesch. 51. I. 1885. p. 73-112.
115. — Eine recente »Cidaris buchi«. Neues Jahrb. f. Mineral., Geol. u. Palæont. 1886. I. p. 192-94.

116. **L. Döderlein:** Die japanischen Seeigel. I. Familien Cidaridæ und Saleniidæ. Stuttgartt. 1887. 4°. 59 pp. 11 pl.
117. — Echinodermen von Ceylon. Bericht über die von den Herren Dres **Sarasin** gesammelten Asteroidea, Ophiuroidea und Echinoidea. Zool. Jahrb. Abth. f. Syst. III. 1888. p. 821-46. pl. 31-33.
118. — Diagnosen einiger von der Valdivia-Expedition gesammelter Seeigel-Arten aus dem Indischen Ocean. Zool. Anzeiger. XXIII. 1901. Nr. 633. p. 19-23.
119. — Zoologische Ergebnisse einer Untersuchungsfahrt des deutschen Seefischerei-Vereins nach den Bäreninsel und Westspitzbergen, ausgeführt im Sommer 1898 auf S. M. S. »Olga«. Die Echinodermen. Wissensch. Meeresuntersuch., herausgeg. v. d. Komm. z. Unters. d. deutschen Meere in Kiel und d. biol. Anstalt auf Helgoland. N. F. IV. Abth. Helgoland. H. 2. 1900. p. 195-235. pl. IV-X. p. 236-48.
120. **A. Dohrn:** Mittheilungen aus und über die zoologische Station von Neapel. Offenes Sendschreiben an Prof. Dr. C. Th. v. Siebold. Zeitschr. f. wiss. Zoologie. XXV. 1875.
121. **I. E. Duerden:** Notes on the marine Zoology of Kingston Harbour. Journ. Inst. Jamaica. II. 1896. p. 282-85.
122. **P. M. Duncan:** On the Saleniidæ Wright. Observations on the morphology of recent Saleniæ and description of a new species. Ann. Mag. Nat. Hist. 4. Ser. XX. 1877. p. 70-73, 245-57. Pl. II. B, VII.
123. — On the Saleniidæ Wright. Part III. On a third form of recent Saleniæ and on the Saleniæ from the Tertiary deposits. Ibid. 5. Ser. II. 1878. p. 59-67.
124. — On some points in the morphology of the test of the Temnopleuridæ. Journ. Linn. Soc. London. Zoology. XVI. 1882. p. 343-58. pl. 8.
125. — On the genus Pleurechinus L. Agass., its classificatory position and alliances. Ibid. XVI. 1882. p. 447-54.
126. — On the Anatomy of the Ambulacra of the recent Diadematidæ. Ibid. XIX. 1885. p. 95-114. pl. 5.
127. — On the classificatory position of Hemiaster elongatus. Ann. Mag. Nat. Hist. 5. Ser. XV. 1885. p. 72.
128. — On the »Tag« of Coelopleurus Maillardi Mich. Ibid. 5. Ser. XVI. 1885. p. 88-89.
129. — On the perignathic girdle of the Echinoidea. Journ. Linn. Soc. London. Zoology. XIX. 1885. p. 179-212. pl. 30-31.
130. — Remarks on Dr. Hamann's researches in the morphology of the Echinoidea. Ann. Mag. Nat. Hist. 5. Ser. XVIII. 1886. p. 66-69.
131. — On some points in the Anatomy of the Temnopleuridæ. Ibid. 6. Ser. I. 1888. p. 109-31. pl. XI.
132. — A revision of the genera and great groups of the Echinoidea. Journ. Linn. Soc. London. Zoology. XXIII. 1889. p. 1-311.
133. — & **W. P. Sladen:** Report on the Echinodermata collected during the arctic expedition 1875—76. Ann. Mag. Nat. Hist. 4. Ser. XX. 1877. p. 449-70.
134. — — Echinodermata in: **Nares'** Narrative of a voyage to the Polar Sea during 1875-76 in H. M. S. »Alert« and »Discovery« with notes on the natural History. (8°). Vol. II. 1878. p. 260-80.
135. — — A memoir on the Echinodermata of the Arctic Sea to the West of Greenland. 1881. (4°). 82 pp. 6 pl.
136. — — The classificatory position of Hemiaster elongatus D. & S., a reply to a criticism by Prof. Sven Lovén. Ann. Mag. Nat. Hist. 5. Ser. XIV. 1884. p. 225-42.
137. **P. M. Duncan & W. P. Sladen:** On the Family Arbaciadæ Gray, Part I. The morphology of the test in the genera Coelopleurus and Arbacia. Journ. Linn. Soc. London. Zoology. XIX. 1885. p. 25-57. pl. 1-2.
138. — — On some points in the Morphology and classification of the Saleniidæ Agass. Ann. Mag. Nat. Hist. 5. Ser. XIX. 1887. p. 117-37.
139. — — On the Echinoidea of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson. Journ. Linn. Soc. London. Zoology. XXI. 1889. p. 316-19.
140. **Ebert:** Über die Gattung Spatangus. Zeitschr. d. deutschen geol. Gesellsch. 39. 1887. p. 229-30.
141. **M. Efisio:** Saggio d'un Catalogo metodico dei principali e piu communi animali invertebrati della Sardegna. Boll. della Soc. Rom. Stud. Zool. I. 1893. p. 246-81.
142. **R. P. F. Casto de Elera:** Catalogo sistematico de toda la Fauna de Filipinas. III. Molluscos y Radiados. 4°. Manila. 1896. Equinodermos. p. 820-38.
143. **R. Etheridge jun.:** On the relationship existing between the Echinothuridæ and the Perischoechinidæ. Quart. Journ. Geol. Soc. London. 1874. p. 307-16. pl. 24.
I. C. Ewart se **I. Romanes.**
144. **H. Farquhar:** Notes on New Zealand Echinoderms. Transact. New Zealand Inst. XXVII. 1894. p. 194-208. pl. 10-13.
145. — A Contribution to the history of New Zealand Echinoderms. Journ. Linn. Soc. London. Zoology. XXVI. 1897. p. 186-98. pl. 13-14.
146. — On the Echinoderm Fauna of New Zealand. Proc. Linn. Soc. N. S. Wales. 1898. p. 300-27.
147. **I. W. Fewkes:** Excavating habits of our common Sea-Urchin. Americ. Naturalist. XXIII. 1889. p. 728-30.
148. — On excavations made by Sea-Urchins. Ibid. XXIV. 1890. p. 1-21. Pl. I-II.
149. — Sea-Urchin excavations at Guaymas, Mexico. Ibid. XXIV. 1890. p. 478-80.
150. **G. W. Field:** Notes on the Echinoderms of Kingston Harbour, Jamaica. Johns Hopkins Univ. Circulars. 1892. Nr. 97.
151. **H. Filhol:** Recherches zoologiques, botaniques et géologiques faites à l'île Campbell et en Nouvelle-Zélande. Zoologie, Chap. X. Echinodermes. Recueil de mémoires, rapports et documents relatifs à l'observation du passage de Vénus sur le Soleil. III. (2.) 1885. p. 572-73.
152. **F. Fischer:** Die Echinodermen von Jan Mayen. Die internationale Polarforschung. Die österreichische Polarstation Jan Mayen. III. 1886. p. 29-38.
153. **P. Fischer:** Echinodermes des côtes de la Gironde et du Sud-ouest de la France. Actes de la Soc. Linn. de Bordeaux. XXVII. 1872. p. 358-76.
154. — & **Folin:** Exploration bathymétrique de la fosse du Cap Breton. Comptes Rendus de l'Acad. d. Sc. 76. 1873. p. 582-85.
155. **A. Foettinger:** Sur la structure des Pédicellaires gemmiformes de Sphærechinus granularis et d'autres Echinides. Arch. de Biologie. II. 1881. p. 455-96. pl. 26-28.
156. **C. Forstrand:** Methoder för preparering och konservering af Hafsdjur, samt några biologiska Iakttagelser från Bermudas Korallfauna. Biol. Föreningens Förhandl. Stockholm. II. 1890. p. 108-11.

157. **W. F. Ganong:** The Echinodermata of New Brunswick. Bull. Nat. Hist. Soc. New Brunswick. VII. 1888. p. 12-68.

158. — Zoological Notes. Report of the Committee on marine Invertebrate Zoology. Ibid. IX. 1890. p. 46-59.

159. **F. Gasco:** Descrizione di alcuni Echinodermi nuovi o per la prima volta trovati nel mediterraneo. Rendiconti della R. Acad. d. Scienze fis. e matem. di Napoli. XV. 2. 1877. p. 9-11. 1 pl.

160. **V. Gauthier:** Sur les Echinides, qui vivent aux environs de Marseille. Comptes Rendus de l'Acad. d. Sc. 79. 1874. p. 401-4.

161. — Une nouvelle classification des Echinides. Bull. Soc. d. Sc. hist. et nat. de l'Yonne. 38. 1885. p. 176-94.

162. — Contribution à l'étude des Echinides fossiles. Bull. Soc. géol. de France. 3. Ser. XXV. 1897. p. 831-41. pl. 24.

163. **P. Geddes & F. E. Beddard:** On the histology of the Pedicellariæ and of the muscles of Echinus sphæra. Transact. R. Soc. Edinburgh. 30. I. 1881. p. 383-95. pl. 3. (Ann. Mag. Nat. Hist. 5. Ser. VII. 1881. p. 275-77. Comptes Rendus de l'Acad. d. Sc. 92. 1881. p. 308-10.)

164. **A. Giard:** On an Amphipod (Urothoë marina), a commensal of Echinocardium cordatum. Ann. Mag. Nat. Hist. 4. Ser. XVII. 1876. p. 261—62.

165. **Giebel:** Echinothrix desori. Zeitschr. f. d. gesammten Naturwiss. 50. (3. Folge. II.) 1877. p. 319-20.

166. — Seeigel der Gattung Phyllacanthus. Ibid. 51. (3. Folge, III.) 1878. p. 863-64.

167. **E. Graeffe:** Übersicht über die Seethierfauna des Golfes von Triest. I. Echinodermen. Arb. a. d. zool. Inst. Wien. III. 1881. p. 333-44.

168. **I. E. Gray:** List of Echinoderms collected by Rob. M'Andrew in the Gulf of Suez in the Red Sea. Ann. Mag. Nat. Hist. 4. Ser. X. 1872. p. 115-24.

169. **R. Greeff:** Echinodermen, beobachtet auf einer Reise nach der Guinea-Insel São Thomé. Zool. Anzeiger. V. 1882. p. 114-20, 135-39, 156-59.

S. W. Green see **Haddon.**

170. **I. W. Gregory:** On the affinities of the Echinothuridæ, and on Pedinothuria and Helikodiadema, two new genera of Echinoidea. Quarterl. Journ. Geol. Soc. London. 53. 1897. p. 112-22.

171. **J. Grieg:** Undersogelser over Dyrelivet i de vestlandske Fjorde. II. Echinodermer, Annelider etc. Bergens Mus. Årsberetn. 1888. Nr. 2. p. 1-76. 2. pl.

172. — Echinodermfaunaen i de Vestlandske Fjorde. Bergens Mus. Årbog. 1894-95. Nr. 12. 13 pp.

173. — Om Bukkenfjordens Echinodermer og Mollusker. Stavanger Mus. Årsberetn. 1896. p. 34-46.

174. — Skrabninger i Vågsfjorden og Ulvesund, ytre Nordfjord. Bergens Mus. Årbog. 1897. Nr. 16. 28 pp.

175. **T. T. Groom:** On some new features in Pelanechinus corallinus. Quarterl. Journ. Geol. Soc. London. 43. 1887. p. 703-14. pl. 28.

176. **R. I. L. Guppy:** Observations upon the physical conditions and Fauna of the Gulf of Paria. Proc. Inst. Trinidad. 1895. p. 105-15. pl. 2.

177. **W. Haacke:** Zur Morphologie der Seeigelschale. Zool. Anzeiger. VIII. p. 490-93.

178. — Seeigelgewohnheiten, Tiefseefauna und Palæontologie. Biol. Centralblatt. VI. 1886-87. p. 641-47.

179. — Die Radiärthiernatur der Seeigel. Ibid. VII. 1887. p. 289-94.

180. **A. C. Haddon:** Preliminary Report on the Fauna of Dublin Bay. Proc. R. Irish Acad. 2. Ser. IV. 1885. p. 523-31.

181. — **& F. Jeffr. Bell:** First Report on the marine Fauna off the South West of Ireland. Echinodermata. Ibid. p. 618-21.

182. — **& S. W. Green:** Second Report .... do. Ibid. 3. Ser. I. 1889. p. 29-56.

183. **P. Hallez:** Dragages effectués dans le Pas-de-Calais. IV. La bassure de Baas. Rev. biol. du Nord de France. IV. 1893. p. 273-78.

184. **O. Hamann:** Beiträge zur Histologie der Echinodermen. III. Jenaische Zeitschr. f. Naturwiss. XXI. 1887. p. 87-266. pl. 6-18.

185. **W. Heape:** Preliminary Report upon the Fauna and Flora of Plymouth Sound. Journ. Mar. biol. Assoc. Un. Kingdom. II. 1888. p. 167-68.

186. **C. Hedley:** Summary of the Fauna of Funafuti. Mem. Austral. Mus. III. 1899. p. 511-35.

187. **A. Heilprin:** Contributions to the Natural History of the Bermuda Islands. Proc. Acad. Nat. Sc. Philadelphia. 1888. Echinodermata. p. 309-18.

188. — The Bermuda Islands. Philadelphia. 1889. 8⁰. Echinoidea. p. 144-45.

189. **I. R. Henderson:** The Echinodermata of the Firth of Clyde. Proc. R. Phys. Soc. Edinburgh. IX. 1887. p. 328-37.

190. **W. A. Herdman:** On the Invertebrate Fauna of Lamlash Bay. Proc. R. Phys. Soc. Edinburgh. V. 1880. p. 193-219.

191. — Additional Notes on .... do. Ibid. VI. 1881. p. 17-30.

192. — Report upon the Crinoidea, Asteroidea, Echinoidea and Holothurioidea of the L. M. B. C. District. Fauna of Liverpool Bay. I. Proc. literary & philos. Soc. of Liverpool. XL. 1886. p. 131-39.

193. — The biological results of the Cruise of S. Y. Argo round the West Coast of Ireland in August 1890. Proc. Liverpool Biol. Soc. V. 1891. p. 181-212.

194. — Notes on the Collections made during the Cruise of S. Y. Argo up the West Coast of Norway in July 1891. Proc. Liverpool Biol. Soc. VI. 1892. p. 70-93. pl. 6-7.

195. — The marine Zoology, Botany and Geology of the Irish Sea. Fourth and final Report of the Committee. Rep. Brit. Assoc. 1896. p. 417-50.

— see **Leslie.**

195a. **E. Hesse:** Die Mikrostructur der fossilen Echinoideenstacheln und deren systematische Bedeutung. Neues Jahrb. f. Mineral., Geol. und Palæontol. XIII. Beil. Bd. 1899-1901. p. 185-264. T. XII-XIII.

196. **C. K. Hoffmann:** Echinodermes in: Recherches sur la Faune de Madagascar et de ses dépendances, d'après les découvertes de F. P. L. Pollen & D. C. v. Dam. V. Partie. 1877. p. 45-56. Pl. X.

197. — Die Echinodermen gesammelt während den Fahrten des Willem Barents. (1878-79.) Niederl. Arch. f. Zool. Suppl. I. 1882. 20 pp. 1 Pl.

198. **D. Honeyman:** Nova Scotia Echinodermata. Proc. Nova Scotian Inst. VII. 1889. p. 253-59.

199. — Two Cable Hauls of marine Invertebrates .... by Cable Steamer Minia. Ibid. p. 260-72.

200. **R. Horst:** Naamlijst der tot de Nederlandsche Fauna behoorende Echinodermata. Tijdschr. Nederl. Dierk. Vereenig. 2. Ser. I. 1885. p. 69-76.

201. **W. E. Hoyle:** On the deep-water Fauna of the Clyde Sea-area. Echinodermata. Journ. Linn. Soc. London. Zoology. XX. 1890. p. 442-72 1 pl.

202. **W. E. Hoyle:** A revised list of British Echinoidea. Proc. R. Phys. Soc. Edinburgh. X. 1891. p. 398-436.

203. **F. W. Hutton:** Catalogue of the Echinodermata of New Zealand. Colonial Museum and Geological Survey Department. Wellington. 1872.

204. — Notes on some New Zealand Echinodermata, with descriptions of new species. Trans. & Proc. New Zealand Inst. XI. 1880. p. 305-8.

205. **Hyatt:** To prepare sections of spines of Echinus for microslides. Journ. of Microscopy and Nat. Sc. (N. Ser.) II. 1889. p. 156.

206. **H. v. Ihering:** A Ilha de S. Sebastião. Revista Mus. Paulista. II. 1897. p. 129-70. Pl. II.

207. **I. E. Ives:** Echinoderms from the Northern Coast of Yucatan and the Harbour of Vera Cruz. Proc. Acad. Nat. Sc. Philadelphia. 1890. p. 317-40. pl. 8.

208. — Echinoderms and Arthropods from Japan. Ibid. 1891. p. 210-23. pl. 7-12.

209. — Echinoderms from the Bahama Islands. Ibid. p. 337-41. pl. 16.

210. — Echinoderms and Crustaceans collected by the West-Greenland Expedition of 1891. Ibid. p. 479-81.

211. **Ch. Janet:** Sur pores génitaux et madréporiques multiples dans quelques Échinoides, et sur les homologies des plaques calycinales. Suivi d'observations de Munier-Chalmas. Bull. Soc. Géol. de France. 3. Ser. XIX. 1891. p. XXXVIII-XLI.

212. — **& L. Cuénot:** Note sur les orifices génitaux multiples, sur l'extension des pores madréporiques hors du madréporite, et sur la terminologie de l'appareil apical chez les Oursins. Ibid. p. 295-304.

213. **G. John:** Über bohrende Seeigel. Arch. f. Naturgesch. 1889. I. (55. Jahrg.) p. 268-302. pl. 15.

214. **W. Saville Kent:** The Great Barrier Reef of Australia, its Products and Potentialities. London. 1893. 4⁰. 388 pp. 64 Pl.

215. **C. Kerbert:** Echinodermes de l'Escaut de l'Est. (Echinodermen van de Oosterschelde). Tijdschr. Nederl. Dierk. Vereenig. Suppl. Deel. I. 1884. p. 558-69.

216. **H. Gadeau de Kerville:** Recherches sur les Faunes marine et maritime de la Normandie. 2. Voyage. Région de Grandcamp-les-bains (Calvados) et îles Saint-Marcouf (Manche). Bull. Soc. des Amis d. Sc. nat. Rouen. 1897. p. 309-452. pl. 1-12.

217. **R. Koehler:** Recherches sur les Échinides des côtes de Provence. Annales du Mus. d'hist. nat. de Marseille. I. 1883. 167 pp. 7 pl.

218. — Contribution à l'étude de la faune littorale des îles Anglo-Normandes. Ann. Sc. nat. Zoologie. 6. Ser. XX. 1885. (Bull. Soc. Sc. Nancy. 2. Ser. VII. 1884.)

219. — Une excursion zoologique à Cette. Lyon. 1894. 8 pp.

220. — Échinodermes recueillis à la Ciotat pendant l'été 1894. Mém. Soc. Zool. de France. 1894. p. 405-26.

221. — Notes échinologiques. Revue biologique du Nord de France. VII. 1894-95. p. 317-42. pl. 9.

222. — Catalogue raisonné des Échinodermes recueillis par M. Korotnev aux îles de la Sonde. Mém. Soc. Zool. de France. VIII. 1895. p. 374-423. pl. 9.

223. — Note préliminaire sur les Échinides recueillis pendant les campagnes de l' Hirondelle. Bull. Soc. Zool. de France. XX. 1895. p. 223-27.

224. — Note préliminaire sur les Échinides des premières campagnes de la »Princesse Alice«. Ibid. p. 227-33.

225. **R. Koehler:** Dragages profonds executés à bord du »Caudan« dans le Golfe de Gascogne. Août-Septembre 1895. Rapport préliminaire sur les Échinodermes. Rev. biol. du Nord de France. VII. 1895. p. 439-96.

226. — Résultats scientifiques de la campagne du »Caudan« dans le Golfe de Gascogne. Échinodermes. Ann. de l'Université de Lyon. XXVI. 1896. p. 33-127. pl. 1-4.

227. — Résultats scientifiques de la campagne du »Caudan«. Liste par nature de dragage des animaux. Ibid. p. 711-40.

228. — Sperosoma Grimaldii Koehler. Nouveau genre d'Échinothurides. Zool. Anzeiger. 1897. p. 302-7.

229. — Échinides et Ophiures provenant des campagnes du yacht l' Hirondelle (Golfe de Gascogne, Açores, Terre-Neuve). Résultats des campagnes scientifiques accomplies sur son yacht par Albert I^er^. Prince de Monaco. Fasc. XII. 1898.

230. — Sur la présence en Méditerranée de l'Asterias rubens Linné et de l'Échinocardium pennatifidum Norman. Zool. Anzeiger. XXI. 1898. p. 471-74.

231. — Sur les Échinocardium de la Méditerranée, et principalement sur les Éch. flavescens et mediterraneum. Revue Suisse de Zoologie. VI. 1899. p. 173-87. pl. 4.

232. — Note préliminaire sur les Échinides et les Ophiures de l'Éxpedition antarctique Belge. (1.) Bull. de l'Acad. roy. de Belgique (Classe d. sc.). 1900. p. 814-20.

233. — Les Échinides et les Ophiures de l'Expédition antarctique Belge. Comptes Rendus de l'Acad. d. Sc. 1900.

233a. — Résultats du Voyage du S. Y. »Belgica« en 1897-99. Zoologie. Échinides et Ophiures. Anvers. 1901. 42 pp. 8 pl.

233b. — Note préliminaire sur les Échinides, Ophiures et Crinoides recueillis en 1898 et 1899 par la »Princesse Alice« dans les regions arctiques. Bull. Soc. Zool. de France. 1901. p. 98-103.

Koren see **Danielssen.**

234. **W. Kükenthal:** Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo. I. Reisebericht. Abh. Senckenb. Gesellsch. XXII. 1896. 321 pp. 63 pl.

235. **A. Lafont:** Note pour servir à la Faune de la Gironde. Act. Soc. Linn. Bordeaux. XXVIII. 1872. Échinodermes. p. 278-79.

236. **F. Lahille:** Variabilité et affinités du Monophora Darwini. Revista del Museo de la Plata. VII. 1896. p. 409-44. pl. 1-5.

237. **I. Lambert:** Note sur le genre Echinocyamus. Bull. Soc. géol. de France. 3. Ser. XIX. 1891. p. 749-52.

238. — Études morphologiques sur le plastron des Spatangides. Bul. Soc. de l'Yonne. 46. II. 1893. p. 55-99. 1 Pl.

238a. — Études sur quelques Échinides de l'Infra-Lias. Ibid. 53. II. 1900. p. 3—57. pl. I.

239. **Leslie & Herdman:** Echinodermata of Firth of Forth. Proc. R. Phys. Soc. Edinburgh. VI. 1881. p. 86-95.

240. **G. M. R. Levinsen:** Kara-Havets Echinodermata. »Dijmphna«-Togtets zoologisk-botaniske Udbytte. Kobenhavn. 1886. p. 383-418. 2 Pl.

241. **Lockington:** List of Echinidæ now in the collection of the Californian Academy of Natural Sciences. Proc. Californ. Acad. Sc. VI. 1875. p. 152-59.

242. **E. Lönnberg:** Undersökningar rörande Öresunds Djurlif. Medd. från Kgl. Landtbruksstyrelsen. 1898. No. 1 (No. 43).

243. **P. de Loriol**: Description de trois espèces d'Échinides appartenant à la Famille des Cidaridées. Mém. Soc. Sc. nat. Neuchatel. V. 1873. p. 21-36. Pl. 3-5.
244. — Note sur quelques espèces nouvelles appartenant à la classe des Échinodermes. Mem. Soc. de Phys. et d'hist. nat. Génève. XXIV. 1876. p. 1-17. pl. 1-2.
245. — Catalogue raisonné des Échinodermes recueillis par M. V. de Robillard à l'île Maurice. Ibid. XXVIII. 1883. 64 pp. 6 pl.
246. — Échinodermes de la Baie d'Amboine. Voyage de MM. M. Bedot et C. Pictet dans l'Archipel Malais. Revue Suisse de Zoologie. I. 1893. p. 359-426. Pl. 13-15.
247. — Supplément aux Échinodermes de la Baie d'Amboine. Ibid. III. 1895. p. 365-66. pl. 10-11.
248. — Notes pour servir à l'étude des Échinodermes. Fasc. IX. Genève. 1901.
249. **S. Lovén**: Om Echinoideernes byggnad. Öfvers. kgl. Vetensk. Akad. Förhandl. 1871. p. 1—47. pl. 19.
250. Études sur les Échinoidées. Kgl. Svenska Vetensk. Akad. Handl. XI. 1875. 91 pp. 53 pl.
251. — On Pourtalesia, a genus of Échinoids. Ibid. XIX. 1884. 95 pp. 21 pl.
252. On the species of Echinoidea described by Linnæus in his Work Museum Ludovicæ Ulricæ. Bihang kgl. Svenska Vetensk. Akad. Handl. XIII. 1887. Afd. IV. No. 5. 185 pp. 9 pl.
253. — On a recent form of Echinoconidæ. Ibid. XIII. 1887. Afd. IV. No. 10. 25 pp. 2. pl.
254. Echinologica. Ibid. XVIII. 1892. Afd. IV. No. 1. 74 pp. 12 pl.
255. **H. Ludwig**: Über bewegliche Schalenplatten bei Echinoideen. Zeitschr. f. wiss. Zool. XXIX. 1877. (Morphologische Studien an Echinodermen. I. 3. p. 131-40. 1 pl.).
256. — Die Echinodermen des Mittelmeeres. Prodromus einer monographischen Bearbeitung derselben. Mitth. a. d. Zool. Stat. Neapel. I. 1879. p. 523-80.
257. — Über Asthenosoma varium Grube, und über ein neues Organ bei den Cidariden. Z. f. wiss. Zool. 34. 1880. p. 70-86. pl. 2-3. (Morphol. Studien an Echinodermen. II. 2. p. 17-33).
258. — Echinodermata in: **R. Kossmann's**: Zoologische Ergebnisse einer im Auftrage d. kgl. Akad. d. Wissensch. zu Berlin ausgeführten Reise in die Küstengebiete des Rothen Meeres. 1880. 7 pp.
259. Verzeichniss der von Prof. E. van Beneden an der Küste von Brasilien gesammelten Echinodermen. Mém. couronnés des savants étrangers, publ. par l'Acad. R. d. Sc. de Belgique. 44. 1882. 26 pp.
260. — Die Echinodermen des Beringsmeeres. Zool. Jahrb. I. 1886. p. 275-96. pl. 6.
261. — Über den angeblichen neuen Parasiten der Firoliden, Trichælina paradoxa Barrois. Zool. Anzeiger. X. 1887. p. 296-98. (Jf. **Barrois** 28.)
262. — Echinodermen des Sansibargebietes. Abh. Senckenb. Nat. Gesellsch. XXI. 1899. p. 535-63.
263. **H. W. Mackintosh**: On a malformed corona of Echinus esculentus. Proc. R. Irish Acad. 2. Ser. II. 1875. p. 206-8. pl. 21-22.
264. — Researches on the structure of the spines of the Diadematidæ. Transact. R. Irish Acad. XXV. 1875. p. 519-58. pl. XXXI^a-XXXIII.
265. — Report on the Acanthology of the Desmosticha Haeckel. I. Ibid. XXVI. 1878. p. 475-90. pl. 9-11. II-III. Ibid. XXVIII. 1883. p. 241-66. pl. 5-10.
266. **R. T. Maitland**: Prodrome de la Faune des Pays Bas et de la Belgique Flamande, ou énumération systématique de tous les animaux y observés depuis 1679-1897, excepté les Araignées et les Insectes. Lejde. 1897. 8⁰. 62 pp.
267. **P. Marchisio**: Echinodermi del Golfo di Rapallo. Boll. Mus. Torino. XI. 1896. No. 227.
268. **E. v. Marenzeller**: Die Coelenteraten, Echinodermen und Würmer der k. k. österreichisch-ungarischen Nordpol-Expedition. Denkschr. d. k. Akad. d. Wiss. Wien. XXXV. 1877. p. 357-98. pl. 1-4.
269. — Zoologische Ergebnisse. I. Echinodermen, gesammelt 1890, 1891 und 1892. Berichte d. Comm. f. Erforschung des östlichen Mittelmeeres. V. Denkschr. d. k. Akad. d. Wiss. Wien (math.-naturw. Classe). LX. 1894. p. 1-24. pl. 1-4.
270. — Zoologische Ergebnisse. V. Echinodermen, gesammelt 1893 u. 1894. Berichte d. Commission f. Tiefsee-forschung. XVI. Ibid. LXII. 1895. p. 123-48. 1 Pl.
271. **E. v. Martens**: Echinodermen aus Neu Guinea. Sitz.ber. d. Gesellsch. Naturf. Freunde Berlin. 1889. p. 183-85.
272. **A. F. Marion**: Dragages au large de Marseille. Ann. d. Sc. nat. Zoologie. 6. Ser. VIII. 1879. 18 pp. 4 Pl.
273. Notes sur la Faune des Dardanelles et du Bosphore. Bull. Mus. Marseille. (2.) I. Fasc. I. 1898. p. 163-82.
274. — Ésquisse d'une Topographie zoologique du Golfe de Marseille. Ann. Mus. d'hist. nat. Marseille. I. 1883. I.
275. — Considérations sur les faunes profondes de la Méditerranée. Ibid. I. 1883. II.
276. **G. Mazzetti**: Echini del Mar Rosso dragati nella campagna idrografica della R. nave Scilla nel 1891-92. Atti d. Soc. dei Naturalisti di Modena. 3. Ser. XII. 1893. p. 100.
277. — Catalogo degli Echini del Mar Rosso e descrizione di sp. n. Ibid. p. 238-43.
278. — Gli Echinidi del Mar Rosso. Mem. della Regia Acad. di Scienze di Modena. 2. Ser. X. 1894. p. 211-28.
279. **F. Mc. Coy**: Prodromus of the Zoology of Victoria. I. 1885. Decade X. p. 33-35. Pl. 100.
280. **W. C. Mc. Intosh**: On the Invertebrate marine Fauna and Fishes of St. Andrews. Echinodermata. Ann. Mag. Nat. Hist. 4. Ser. XIV. 1874. p. 68-75.
281. — The coloration of marine animals. Ibid. 7. Ser. VII. 1901. p. 221-40.
282. **M. Meissner**: Über die von Herrn Marine-Stabarzt Dr. Sander heimgebrachten Seeigel. Sitz.ber. d. Ges. Naturf. Freunde Berlin. 1892. p. 183-85.
283. — Über Parasalenia gratiosa A. Ag. von Madagascar. Ibid. p. 185-86.
284. — Die von Dr. Plate aus Chile heimgebrachten See-Igel. Arch. f. Naturgesch. 62. I. 1896. p. 83-90.
285. — Echinoïden der Hamburger Magelhaensische Sammelreise. Hamburg. 1900. 18 pp.
286. — & **A. Collin**: Beiträge zur Fauna der südöstlichen und östlichen Nordsee. II. Echinodermen. Wiss. Meeresunters., herausg. v. d. Biol. Stat. Helgoland. Neue Folge. I. 1894. p. 329-45.
287. **K. Möbius**: Die wirbellosen Thiere der Ostsee. Bericht über die Expedition zur physikalisch-chemischen u. biologischen Untersuchung der Ostsee im Sommer 1871 auf S. M. Avisodampfer Pommerania. Jahresber. d. Commission z. wiss. Unters. d. deutschen Meere in Kiel. I. 1873. p. 97-144. Echinodermen. p. 103.

288. K. Möbius: Die auf der Fahrt nach Arendal gefangenen Echinodermen. Ibid. I. p. 147-54.
288a. — Mollusken, Würmer, Echinodermen und Coelenteraten. Die zweite deutsche Nordpolfahrt in den Jahren 1869 und 1870. Bd. II. 1874. p. 258-260.
289. — Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen. Berlin. 1880. 4°. Echinodermen. p. 46-50.
290. — Über die Thiere der schleswig-holsteinischen Austernbänke, ihre physikalischen und biologischen Lebensverhältnisse. Sitz.ber. d. k. Preuss. Akad. d. Wiss. Berlin. 1893. I. p. 67-92.
291. — & O. Bütschli: Zoologische Ergebnisse der Nordseefahrt. IV. Echinodermata. Jahresber. d. Comm. z. wiss. Unters. d. deutschen Meere in Kiel. II. 1875. p. 143-52.
292. R. Arango y Molina: Radiados de la Isla de Cuba. (Equinodermos.) Ann. Acad. Habana. XIV. 1878. p. 312-18.
293. Th. Mortensen: Smaa faunistiske og biologiske Meddelelser. Vidensk. Medd. Naturh. Foren. Kobenhavn. 1897. p. 311-31.
294. A. Morton: Notes on a recent dredging trip in the Derwent. Papers & Proc. & Reports of the R. Soc. of Tasmania. 1890. p. 185-87.
295. John Murdoch: Marine Invertebrates, in: Report of the international Polar Expedition to Point Barrow, Alaska. Washington. 1885. Echinodermata. p. 156-62.
296. J. Murray: On the deep and shallow water marine Fauna of the Kerguelen Region of the great Southern Ocean. Transact. R. Soc. Edinburgh. XXXVIII. 1897. p. 343-500.
297. H. F. Nachtrieb: Preliminary notes on the Echinoderms of Beaufort. Johns Hopkins Univ. Circ. 4. 1885. p. 67-68. (Ann. Mag. Nat. Hist. 5. Ser. XV. p. 421-25.)
298. — Notes on Echinoderms obtained at Beaufort. Stud. from the Biol. Laborat. of the Johns Hopkins Univ. IV. 1887. p. 81-82.
299. M. Neumayr: Über Palaeechinus, Typhlechinus und die Echinothuriden. Neues Jahrb. f. Mineral., Geol. u. Palaeontol. 1890. I. p. 84-87.
300. O. Nordgaard: Enkelte Træk af Beitstadfjordens Evertebratfauna. Bergens Mus. Aarbog. 1892. No. 2. 11 pp.
301. A. M. Norman: Crustacea, Tunicata, Polyzoa, Echinodermata, Actinozoa, Foraminifera, Polycystina and Spongida of the Valorous Cruise. Proc. Royal Soc. London. XXV. 1876. p. 202-15.
302. — Notes on the French exploring voyage of Le Travailleur in the Bay of Biscay. Ann. Mag. Nat. Hist. 5. Ser. VI. 1880. p. 430-36.
303. — The Abysses of the Ocean; with Appendix A-C. (A. The first dredging in the great Abyss. B. The fauna of the Great Abysses of all Oceans. C. The Fauna as far as yet known, which lives in the North Atlantic Ocean at greater depths than one Thousand fathoms). Nat. Hist. Transact. Northumberland, Durham and Newcastle-on-Tyne. VIII. 1884-89. p. 91-134.
304. — A month on the Trondhjem Fjord. I. Ann. Mag. Nat. Hist. 6. Ser. XII. 1893. p. 341-67.
305. H. L. Osborn: A case of variation in the number of Ambulacral systems in Arbacia punctulata. Americ. Naturalist. XXXII. 1898. p. 259-61.
*306. — Variations in the apical plates of Arbacia punctulata from Woods Holl Mass. Science. N. Ser. XIII. 1901. p. 938-40. 20 fig.
307. A. Ostroumow: Comptes rendus des dragages et du Plankton de l'expédition de »Selânik«. Bull. de l'Acad. d. sc. de St. Pétersbourg. 5. Sér. V. 1896. p. 33-92. (Russisk.)
*308. A. S. Packard: The Labrador Coast. New York & London. 1891. (List of Echinoderms. p. 370-71.)
309. P. Pallary: Énumération des Oursins vivants dans le golfe d'Oran. Feuille d. jeunes Naturalistes. 3. Sér. 28. 1898. p. 151-53.
310. — Les coquilles marines du littoral oranais. Journal de Conchyliologie. 1900. No. 3.
311. E. Parfitt: The Fauna of Devon. VIII. Echinodermata. Rep. & Transact. Devonshire Assoc. V. 1872. p. 352-70.
312. C. G. Joh. Petersen: Det videnskabelige Udbytte af Kanonbaaden Hauch's Togter i de danske Farvande indenfor Skagen i Aarene 1883-86. Kobenhavn. 1893. Echinodermata. p. 35-52.
313. G. Pfeffer: Die Clypeastriden des Hamburger Museums. Verhandl. d. naturwiss. Vereins Hamburg-Altona. (2). 5. Jahrg. 1881.
314. — Zoologische Kleinigkeiten. VII. Über die Rechtschreibung des Wortes »Echinoderma«. VIII. Über Abweichung von der Fünfzahl bei Echinodermen. IX. Über Parasalenia gratiosa (A. Ag.) und P. Pöhlii n. sp. Verhandl. d. Vereins f. naturwiss. Unterhaltung Hamburg. VI. 1887. p. 107-13.
315. — Mollusken, Krebse und Echinodermen von Cumberland-Sund. Jahrb. d. Hamburgischen wissensch. Anstalten. III. 1887. p. 49.
316. — Zur Fauna von Süd-Georgien. Ibid. VI. 1889. (Echini. p. 49.)
317. — Die Fauna der Insel Jeretik, Port Wladimir, an der Murman-Küste, nach den Sammlungen des Herrn Kapitän Horn. Ibid. VII. 1889. p. 63-96.
318. — Fische, Mollusken und Echinodermen von Spitzbergen, gesammelt von Herrn Prof. W. Kükenthal im Jahre 1886. Ibid. VIII. p. 91-99.
319. — Echinodermen von Ost-Spitzbergen, nach der Ausbeute der Herren Prof. W. Kükenthal und Dr. A. Walter im Jahre 1889. Zool. Jahrbücher. Abth. f. Syst. VIII. 1895. p. 100-127.
320. — Niedere Thierwelt des antarktischen Ufergebietes. 1890. Ergebnisse der deutschen Polar-Expedition. Allgemeiner Theil. Bd. II. 17. 120 pp.
321. — Ostafrikanische Echiniden, Asteriden und Ophiuriden, gesammelt von Herrn Dr. F. Stuhlmann im Jahre 1888 und 1889. Mitth. Mus. Hamburg. XIII. 1896. p. 43-48.
322. — Echinodermen von Ternate. Echiniden, Asteriden, Ophiuriden und Comatuliden. (Kükenthal: Zoologische Forschungsreise. III. 1.) Abh. d. Senckenb. Naturf. Gesellsch. XXV. 1900. p. 83-85.
323. R. A. Philippi: Über die chilenischen Seeigel. Verhandl. d. deutschen wissensch. Vereins zu Santiago in Chile. II. 1892. p. 246-47.
324. A. Pomel: Paléontologie de l'Algérie. Échinodermes. 1. Livraison: Classification méthodique et Genera des Échinides vivants et fossiles. Alger. 1883. 4°. 120 pp. 1 Pl. (II. Livr. 1887; Descriptions of fossil species.)
325. — Notes d'Échinologie synonymique. Bull. Soc. géol. de France. 3. Sér. XVI. 1888. p. 441-53.
326. Edith M. Pratt: Contribution to our knowledge of the marine Fauna of the Falkland Islands. Mem. Man-

chester literary & philos. Soc. 42. 1898. No. 13. p. 1-26. pl. V.
327. **H. Prouho:** Recherches sur le Dorocidaris papillata et quelques autres Échinides de la Méditerranée. Arch. d. Zool. expér. et génér. 2. Sér. V. 1887. p. 213-380. pl. 14-26.
328. — Du rôle des Pédicellaires gemmiformes chez les Oursins. Comptes Rendus de l'Acad. d. sc. CXI. 1890. p. 62-64.
329. **G. Pruvot:** Coup d'œil sur la distribution générale des invertébrés dans la région de Banyuls (Golfe du Lyon). Arch. Zool. expér. & génér. 3. Sér. III. 1895. p. 629-58. pl. 30.
330. — Essai sur les fonds et la faune de la Manche occidentale (côtes de Brétagne), comparés à ceux du Golfe du Lion (avec catalogue des Invertébrés benthiques du Golfe du Lion et de la Manche occidentale avec leur habitat. Ibid. 3. Sér. V. 1897. p. 511-660. pl. 21-26.
331. **E. P. Ramsay:** Catalogue of the Echinodermata in the Australian Museum. Part I. Echini. Sydney. 1885. 54 pp. 3 Pl. II. Ed. 1891. 60 pp. 4 Pl.
332. — Specimens obtained in a dredging trip in Port Jackson. 1890. Records of the Australian Mus. IV. 1890. p. 84-88.
332a. **W. M. Rankin:** Echinoderms collected off the West Coast of Greenland by the Princeton Arctic Expedition of 1899. Proc. Acad. Nat. Sc. Philad. 1901. p. 169-81.
333. **R. Rathbun:** Additions to the Echinoid Fauna of Brazil. Amer. Journ. of Arts & Sc. 3. Ser. XV. 1878. p. 82-84.
334. — A List of the Brazilian Echinoderms with notes on their distribution. Transact. Connecticut Acad. of Sc. V. 1879. p. 139-58.
335. — Report upon the Echini collected by the U. S. Fish Commission Steamer Albatross in the Carribean Sea and Gulf of Mexico. Jan.-May. 1884. Proc. U. S. National Museum. VIII. 1885. p. 83-89.
336. — Report upon the Echini collected by the U. S. Fish Commission Steamer Albatross in the Gulf of Mexico from Jan.-March 1885. Ibid. p. 606-20.
337. — Catalogue of the collection of recent Echini in the United States National Museum. Ibid. IX. 1886. p. 255-93.
338. **H. Rauff:** On Pourtalesia, a genus of Echinoidea by Sven Lovén. Sitz.ber. d. naturhist. Vereins d. preuss. Rheinl. u. Westphalen. 42. 1885. p. 93-118.
339. **I. Rein:** Japan, nach Reisen und Studien dargestellt. 1881. I. p. 238-40. Echinodermen.
340. **H. N. Ridley:** Notes on the Zoology of Fernando Noronha. Journ. Linn. Soc. Zoology. XX. 1890. p. 473-570. pl. 30. List of Echinoderms (determ. by **I. Jeffr. Bell**). p. 559-60.
341. **D. Robertson:** Amphidotus cordatus. Transact. Nat. Hist. Soc. Glasgow. N. Ser. I. 1887. p. 290-93.
342. — Jottings from my Notebook. On Amphidotus cordatus Penn. Ibid. N. Ser. IV. 1897. p. 333-34.
343. **A. de Rochebrune:** Materiaux pour la Faune de l'Archipel du Cap Vert. Nouv. Arch. d. Musée d'hist. nat. Paris. 2. Sér. IV. 1881. Echinodermata. p. 321-29.
344. **A. Rodger:** Preliminary account of natural history collections made on a voyage to the Gulf of St. Lawrence and Davis Straits. Proc. R. Soc. Edinburgh. XX. 1894. p. 154-63.
345. **I. Romanes & J. C. Ewart:** Observations on the Locomotor System of Echinodermata. Phil. Transact. 172. 1881. p. 829-85. pl. 79-85.
346. **A. Rothpletz:** Über die Diadematiden-Stachel und Haploporella fasciculata aus dem Oligocän von Astrupp. Neues Jahrb. f. Mineral., Geol. u. Palaeontol. 1891. I. p. 285-90.
347. **A. Russo:** Specie di Echinodermi poco conosciuti e nuovi viventi nel Golfo di Napoli. Atti d. R. Acad. di Sc. fis. e matem. di Napoli. VI. 1894. 1. 9 pp. 1 Pl.
348. — Echinodermi raccolti nel Mar Rosso degli Ufficiale della R. marina italiana. Boll. Soc. Nat. Napoli. VII. 1893. p. 159-63.
349. **C. F. & P. B. Sarasin:** Über einen mit zusammengesetzten Augen bedeckten Seeigel. Zool. Anzeiger. VIII. 1885. p. 715-20.
350. — — Über einen Lederigel aus dem Hafen von Trincomalie (Ceylon) und seinem Giftapparat. Ibid. IX. 1886. p. 80-82.
351. — — Die Augen und das Integument der Diadematiden. Ergebnisse naturwiss. Forschungen aus Ceylon. I. 1887. p. 1-17. Pl. 1-3.
352. — — Über die Anatomie der Echinothuriden und die Phylogenie der Echinodermen. Ibid. I. p. 81-154. pl. X-XVII. (Neues Jahrb. f. Mineral., Geol. u. Palaeont. 1889. II. p. 54-59.)
353. **H. E. Sauvage:** Contribution à la connaissance de la Faune du Pas-de-Calais et des parties voisines de la mer du Nord et de la Manche. Bull. Scientif. de France et de la Belgique. 22. 1890. p. 243-48.
354. **F. E. Schulze:** Präparate von Echinodermskeletten. Sitz.-ber. Gesellsch. naturf. Freunde Berlin. 1887. p. 30-31.
355. **Th. Scott:** Notes on some Scottish Echinodermata. Ann. Scott. Nat. Hist. 1892. p. 49-51. pl. II.
356. — Notes on a collection of Echinoderms and Molluscan Shells from the Moray Firth district. Proc. R. Phys. Soc. Edinburgh. XI. 1891. p. 81-84.
357. — Report on a collection of marine dredgings and other natural history materials made on the West Coast of Scotland by the late George Brook. Ibid. XIII. 1896. p. 166-93. 1 Pl.
358. — The marine Fishes and Invertebrates of Loch Fyne. Rep. Fishery Board Scotland. 15. III. 1897. p. 107-74. pl. 1-3.
359. **W. Sharp:** The Sea-Urchin. Rep. Guernsey Soc. 1890. p. 61-64.
360. **G. Sim:** Preliminary Reports on the natural history of the district of the Union (E. Scotland Societies). VII. Crustacea and Echinodermata. Proc. East Scotl. Union of Naturalists Soc. 1884. p. 42-45.
361. — Echinus acutus Lamk. on the East Coast of Scotland. Ann. Scott. Nat. Hist. 1895. p. 255.
362. — Echinus acutus Lamk. off the Aberdeenshire Coast. Ibid. 1896. p. 62.
363. **I. Simpson:** Echinus norvegicus in Scottish Seas. Science Gossip. (N. S.) II. 1896. p. 305.
364. **H. Simroth:** Zur Kenntniss der Azorenfauna. Echinodermata. Arch. f. Naturgesch. 1888. I. p. 231-34.
365. **W. P. Sladen:** On the Asteroidea and Echinoidea of the Korean Seas. Journ. Linn. Soc. London. Zoology. XIV. 1879. p. 424-45. pl. 8.
366. — On a remarkable form of Pedicellaria and the functions performed thereby; together with general observations on the allied forms of this organ in the Echinidae. Ann. Mag. Nat. Hist. 5. Ser. VI p. 101-13. pl. 12-13.

367. **W. P. Sladen:** Report on a collection of Echinodermata from the S. W. Coast of Ireland, dredged in 1888 by a Committee, appointed by the Royal Irish Academy. Proc. R. Irish Acad. 3. Ser. I. 1891. p. 687-704. pl. 25-29.

368. — Report on the Echinodermata, in: Notes on Rockall Island and Bank. Transact. R. Irish Acad. of Sc. XXXI. 1897. p. 78.

— see **Duncan.**

369. **C. Ph. Sluiter:** Die Evertebraten aus der Sammlung des königlichen naturwissenschaftlichen Vereins in Niederländisch Indien in Batavia. Die Echinodermen. II. Echinoidea. Naturkundig Tijdschr. vor Nederl. Indie (Batavia). 48. 1889. p. 285-96.

370. — Nachträgliches über die Echinodermen-Fauna des Java-Meeres. Ibid. 49. 1890. p. 105-10. 1 Pl.

371. — Die Echiniden-Sammlung des Museums zu Amsterdam. Bijdr. tot de Dierk. 17. 1895. p. 65-74.

372. **E. A. Smith:** Description of a new species of Spatangidæ. Ann. Mag. Nat. Hist. 5. Ser. I. p. 67-70.

373. — An account of the Petrological, Botanical and Zoological Collections made in Kerguelen's Land and Rodriguez during the Transit of Venus-Expeditions in the years 1874-75. Echinodermata (from Kerguelen Island). Philos. Transact. 168. 1879. p. 270-81. pl. 16-17.

374. — Do. Echinodermata (from Rodriguez). Ibid. p. 564-68. pl. 51. Fig. 1-3.

375. **W. A. Smith:** The West Coast Fauna of the »Garland« Expedition. Rep. Fishery Board Scotland. IX. III. 1891. p. 297-99.

376. — The West Coast Expedition of the »Garland« during July and August 1892. Ibid. XI. III. 1893. p. 167-71.

377. **A. Sommerville:** Dredging off Portincross, Ayrshire. Proc. Nat. Hist. Soc. Glasgow. N. Ser. II. 1890. p. 189-93.

378. **C. Stewart:** Note on the calcareous parts of the sucking feet of an Echinus (Podophora atrata). Monthly Microsc. Journ. London. IX. 1873. p. 55-56. Pl. 7.

379. — On certain Organs of the Cidaridæ. Transact. Linn. Soc. 2. Ser. I. 1879. p. 569-72. pl. 70.

380. — Note on an abnormal Amblypneustes griseus. Journ. Linn. Soc. London. Zoology. XV. 1881. p. 130. pl. 5. 4-6.

381. — On some structural features of Echinostrephus molaris, Parasalenia gratiosa and Stomopneustes variolaris. Journ. R. micros. Soc. III. 1880. p. 909-12. pl. 20.

382. **M. Stossich:** Breve sunto sulle produzzioni marine del Golfo di Trieste. Boll. dell. Soc. Adriatica di Sc. nat. (Triest). 1876.

383. — Prospetto della fauna del mare Adriatico. Part V. Echinodermata. Ibid. VIII. 1884. p. 90—110.

384. **Th. Studer:** Über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln, gesammelt auf der Reise S. M. S. »Gazelle« um die Erde. Monatsber. d. Berliner Akad. 1876. p. 452-65.

385. — Über Geschlechtsdimorphismus bei Echinodermen. Zool. Anzeiger. 1880. No. 67 & 68.

386. — Übersicht über die während der Reise S. M. Corvette »Gazelle« um die Erde 1874-76 gesammelten Echinoiden. Monatsber. d. Akad. Berlin. 1880. p. 861-85. 2 pl.

387. — Die Forschungsreise S. M. S. »Gazelle« in den Jahren 1874-76. III. Zoologie und Geologie. Berlin. 1889. 4^0. p. 1-322. 33 pl.

388. **A. Stuxberg:** Echinodermer från Novaja Zemljas Haf samlade under Nordenskjöldska Expeditionerna, 1875-76. Öfvers. kgl. Svenska Vetensk. Akad. Förhandl. 1878. III. p. 27-40. pl. 6.

389. — Evertebratfaunan i Sibiriens Ishaf. Vega-Expeditionens vetenskapliga Iakttagelser. I. 1882. p. 677-812.

390. **I. C. Sumner:** On the Echinodermfauna of Plymouth. Rep. British Assoc. 1895. p. 471-72.

391. **R. Tate:** List of Recent Echini of South Australia. Trans. R. Soc. S. Australia. V. 1882. p. 74-75.

392. **W. d'Arcy Thompson:** On a supposed resemblance between the marine faunas of the arctic and antarctic Regions. Proc. R. Soc. Edinburgh. 22. 1899. p. 311-49.

393. **Wyville Thomson:** Notice of a new Family of the Echinodermata. Ibid. 1871-72. p. 615-17.

394. — On the Echinoidea of the »Porcupine« Deep-sea Dredging Expeditions. Ibid. VIII. 1873. p. 491-97. (Ann. Mag. Nat. Hist. 4. Ser. X. p. 300-6.)

395. — On the Echinoidea of the »Porcupine« Deep-sea Dredging-Expeditions. Philos. Transact. 164. 1875. p. 719-56. pl. 59-71.

396. — Voyage of the »Challenger«. The Atlantic. A preliminary account of the general results of the exploring voyage of H. M. S. »Challenger« during the year 1873 and the early part of the year 1876. I-II. 1877.

397. — Notice of some peculiarities in the mode of propagation of certain Echinoderms of the Southern Sea. Journ. Linn. Soc. London. Zoology. XIII. 1878. p. 55-79.

398. **E. Thurston:** Preliminary Report on the marine Fauna of Rámésvaram and the neighbouring Islands. Government Central Museum. Madras. Science. Ser. I. 1887. 41 pp. 6 pl. 8^0.

399. — Notes on the Pearl and Chank Fisheries and Marine Fauna of the Gulf of Manaar. Government Central Mus. Madras. 1890.

400. — Rámésvaram Island and Fauna of the Gulf of Manaar. Madras. Government Museum. Bull. No. 3. 1895.

401. **W. L. Tower:** An abnormal Clypeastrid Echinoid. Zool. Anzeiger. 1901. No. 640. p. 188-91.

402. **G. F. Tregelles:** Notes on the Echinodermata of Mounts Bay. Transact. Penzanze Nat. Hist. Soc. N. Ser. IV. 1884-88. p. 368-76.

403. **F. H. Troschel:** Die Familie der Echinocidariden. I. Archiv f. Naturgesch. 1872. p. 293-356. II. Ibid. 1873. p. 308-56.

404. — Rhabdocidaris recens sp. n. Archiv f. Naturgesch. 43. 1877. p. 127-34. pl. 8. Nachträgliche Bemerkung über Rh. recens. Ibid. p. 260.

405. — Über Rhabdocidaris recens. Sitz.ber. d. Niederrhein. Gesellsch. (Phys. Sect.). 1877.

406. **I. v. Uexküll:** Die Physiologie der Pedicellarien. Zeitsch. f. Biologie. 37. 1899. p. 334-403. 2 pl.

407. — Die Physiologie des Seeigelstachels. Ibid. 39. 1900. p. 73-112.

408. **W. S. M. d'Urban:** The Zoology of Barents' Sea. Ann. Mag. Nat. Hist. 5. Ser. 6. 1880. p. 253-77.

409. **E. Vanhöffen:** Die Fauna und Flora Grönlands, in: Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin 1891-93, unter Leitung von E. v. Drygalski. II. 1. 1897. Echinodermen. p. 234-43.

410. **E. A. Verrill:** Contributions to Zoology from the Museum of Yale College. XXII. On the radiata from the Coast of North Carolina. Americ. Journ. Sc. & Arts. 3. Ser. III. 1872. p. 436-38.

411. **E. A. Verrill:** Contributions etc. XXIII. Results of recent Dredging Expeditions on the Coast of New-England. Ibid. 3. Ser. V. 1873. p. 1-16.
412. — Contributions. XXIV. Do. Continuation. Ibid. p. 98-106.
413. — Contributions. XXVI. Do. Continuation. Ibid. 3. Ser. VII. 1874. p. 38.
414. — Contributions. XXVII. Do. Continuation. Ibid. p. 131.
415. — Contributions. XXVIII. Do. Continuation. Ibid. p. 405.
416. — Contributions. XXIX. Do. Continuation. Ibid. p. 498.
417. — Contributions. XLVII. Notice of the remarkable marine Fauna occupying the outer banks off the Southern Coast of New England. Ibid. 3. Ser. XX. 1880. p. 390-403.
418. — Contributions. XLIX. Do. Continuation. Ibid. XXIII. 1882. p. 135.
419. — Contributions. L. Continuation. Ibid. p. 216.
420. — Contributions. LIII. Continuation. Ibid. XXIV. 1882. p. 360.
421. — Contributions. LVI. Continuation. Ibid. XXVIII. 1884. p. 378-84.
422. — On the marine Fauna of Eastport. Bull. Essex Instit. III. 1871. p. 2-6.
423. — Explorations of Casco Bay by the U. S. Fish Commission in 1873. Proceed. Amer. Assoc. f. Adv. of Science. XXII. 1873. p. 340-95.
424. — Notice of some dredgings made near Salem by Dr. A. S. Packard and C. Cooke. 6th annual Report of the Trustees of the Peabody Acad. of Science. 1873. p. 58-60.
425. — Radiates, in: Contribution to the natural History of Arctic America, made in connection with the Howgate Polar-Expedition 1877-78, by Ludwig Kumlien. Bull. U. S. National Museum II. 1882. (Smithson. Miscell. Collections. XXIII. 1882. Art. V. p. 151.)
426. — Results of the Explorations made by the Steamer „Albatross" off the northern Coast of the United States in 1883. (Ann. Rep. of the Commissioner of Fish and Fisheries for 1883). 1885.
427. — Additions to the Echinoderms of the Bermudas. Transact. Connect. Acad. Arts & Sc. X. 1900. p. 583-87.
428. — & **S. I. Smith:** Report upon the invertebrate animals of Vineyard Sound and adjacent waters, with an account of the physical features of the Region. Washington. 1874. (Report of the Commissioner of Fish and Fisheries, on the condition of the sea-Fisheries of the South Coast of New England in 1871 and 1872).
429. **A. Walter:** Ceylons Echinodermen. Jenaische Zeitschr. f. Naturwiss. XVIII. 1885. p. 365-84.
430. **J. Walther:** Die Lebensweise der Meeresthiere. Beobachtungen über das Leben der geologisch wichtigen Thiere. Zweiter Theil einer Einleitung in die Geologie als historische Wissenschaft. Jena. 1893. Echinoidea. p. 312-28.
431. **I. F. Whiteaves:** Notes on deep-sea dredging round the Island of Anticosti in the Gulf of St. Lawrence. Ann. Mag. Nat. hist. 4. Ser. X. 1872. Echinoderms. p. 346.
432. **I. F. Whiteaves:** On recent deep-sea dredging expeditions in the Gulf of St. Lawrence. Amer. Journ. Sc. & Arts. 3. Ser. VII. 1874. p. 210-19.
433. — On some marine Invertebrata dredged or otherwise collected by Dr. G. M. Dawson in 1885. Proceed. Transact. R. Soc. Canada. IV. 1887. p. 111-137.
434. — Notes on some marine Invertebrata from the Coast of British Columbia. Ottawa Naturalist. VII. 1893. p. 133-37. pl. I.
435. — Catalogue of the marine Invertebrata of Eastern Canada. Geological Survey of Canada. Ottawa. 1901. Echinoderms. p. 43-63.
436. **Th. Whitelegge:** List of the marine and Freshwater Invertebrate Fauna of Port Jackson and the Neighbourhood. Journ. R. Soc. N. S. Wales. XXIII. 1889. p. 163-323.
437. — The Echinodermata of Funafuti. Memoirs of the Austral. Mus. III. 1897. p. 155-62.
438. **R. N. Wolfenden:** Radiography in Marine Zoology. The British Echinodermata. Suppl. to the „Arch. Roentgen Ray". 4°. 6 pp. 15 pl. 1897.
439. **H. V. Wilson:** Marine Biology at Beaufort. Americ. Naturalist. XXXIV. 1900. p. 339-60. 4 pl.
440. **I. Wood-Mason & A. Alcock:** Natural History notes from H. M. Indian marine survey steamer „Investigator". No. 21. Ann. Mag. Nat. Hist. 6. Ser. VII. 1891. p. 1-19.
441. — Do. Ser. II. No. 1. On the results of deep-sea dredging during the season 1890-91. Ibid. 6. Ser. VIII. 1891. Echinoderms. p. 427-43. pl. XVII.
442. **I. E. Tenison Woods:** The Echini of Australia (including those of the Chevert Expedition). Proc. Linn. Soc. N. S. Wales. II. 1878. p. 145-76; 342-44 (supplemental note).
443. — On some new Australian Echini. Ibid. IV. 1880. p. 282-91. pl. 13-14.
444. — On some of the littoral marine fauna of North-East Australia. Ibid. V. 1881. p. 106-31.
445. — On the habits of some Australian Echini. Ibid. V. 1881. p. 193-204.
446. — On a young specimen of a Temnopleurus. Ibid. V. 1881. p. 493-94.
447. — On a new species of Stomopneustes and a new variety of Hipponoë variegata. Ibid. VII. 1883. p. 93-94.
448. **S. Yoshiwara:** On two new species of Asthenosoma from the Sea of Sagami. Annot. Zoologicæ Japonenses. I. 1897. p. 5-11. pl. 2.
449. — Preliminary notice of new Japanese Echinoids. Ibid. II. 1898. p. 57-61.
450. **Hj. Östergren:** Über die von der schwedischen zoologischen Polarexpedition 1900 eingesammelten Asteroidea, Echinoidea, Holothuroidea und Crinoidea. Zool. Anzeiger. XXIV. 1901. (No. 642.) p. 252-53. (Naturvet. Studentsällsk. Upsala.)

The coloured figures are made from preserved specimens; nevertheless they give an excellent picture also of the living animals, the Echinids, as is well known (at all events with regard to a great number of species), being possessed of the excellent quality often to keep their colour completely in alcohol. — I have had occasion myself to see a great many living Echinids, so that I may have a well-founded opinion of this fact. — Only of *Calveria hystrix* I have had a coloured sketch, made from the living animal onboard of the "Ingolf"; the preserved animal proved to have lost next to nothing of the intensity of its colour. There is therefore good sense in making coloured figures from preserved specimens, especially as we have most frequently to do with preserved specimens by the determinations. I have accordingly thought it very important to have these figures made, and I must here take the opportunity to thank my friend, the artist painter, Mr. Bentzen-Bilkvist, most heartily for the excellent execution as well of the original figures as of the lithographic reproduction of these and of all the other plates. Also the uncoloured habitus figures are drawn by Mr. Bentzen-Bilkvist; all the detail figures are drawn by the author.

With regard to the enlargement (Obj. and Oc.) of the separate figures it must be noted that where nothing else is stated, a Seibert's microscope has been used; when a Zeiss's microscope has been used, it is specially stated.

Plate I.

Fig. 1. *Cidaris affinis.*

— 2—3. *Echinus elegans.*

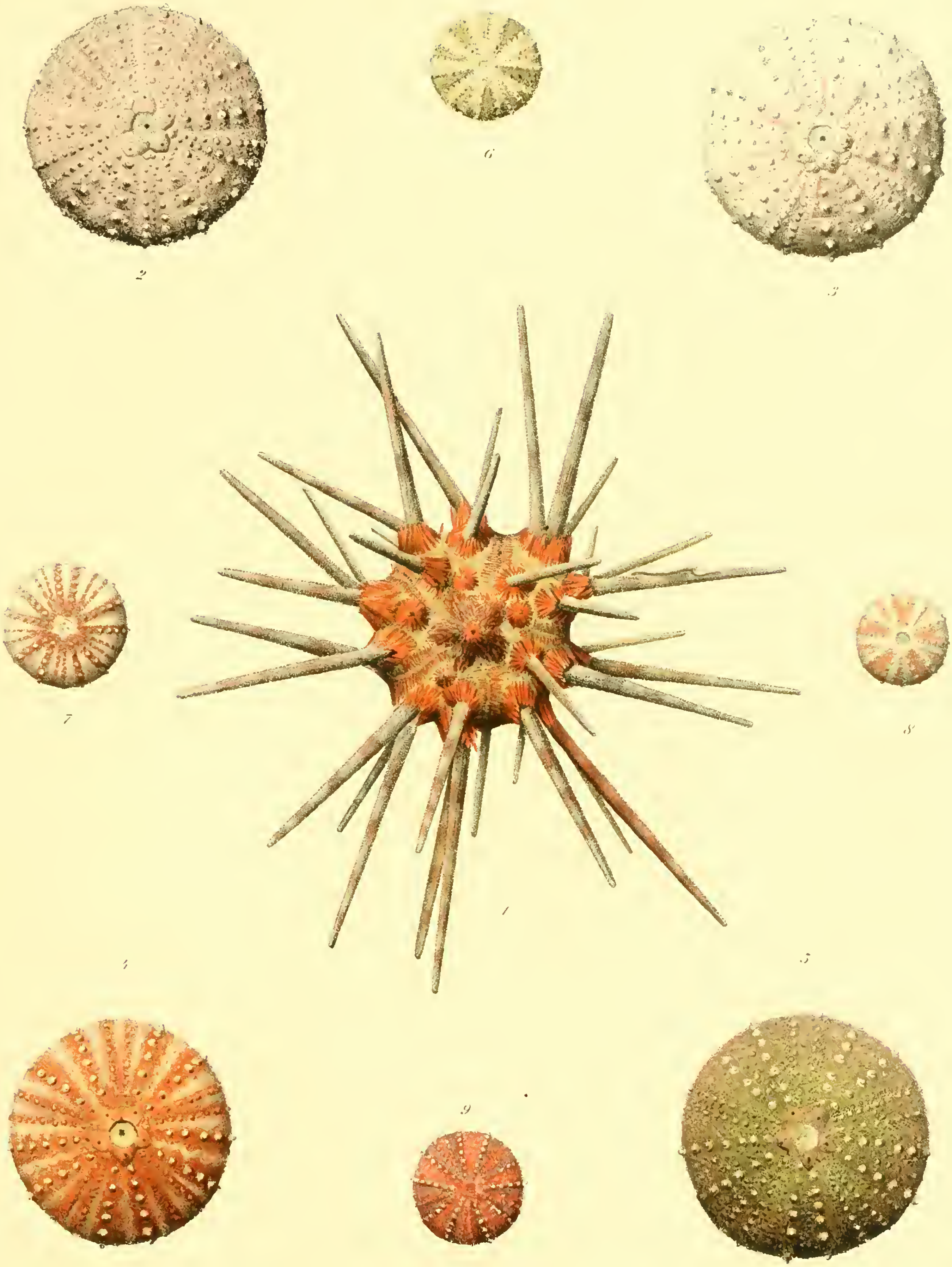
— 4. *Echinus acutus*, var. *norvegicus.*

— 5—6. *Strongylocentrotus drobachiensis.*

— 7. *Echinus acutus*, var. *Flemingii.*

— 8. *Echinus acutus*, var. *norvegicus.*

— 9. *Echinus esculentus*, young specimen.



1. Cidaris affinis Phil. 2-3. Echinus elegans D.K. 4. 8 Ech. norvegicus D.K. 5. 6 Str. drobachiensis (O.F.M.)
7 Ech. Flemingii Forb. 9 Ech. esculentus L.

Plate II.

Fig. 1. *Echinus acutus*, var. *Flemingii.*

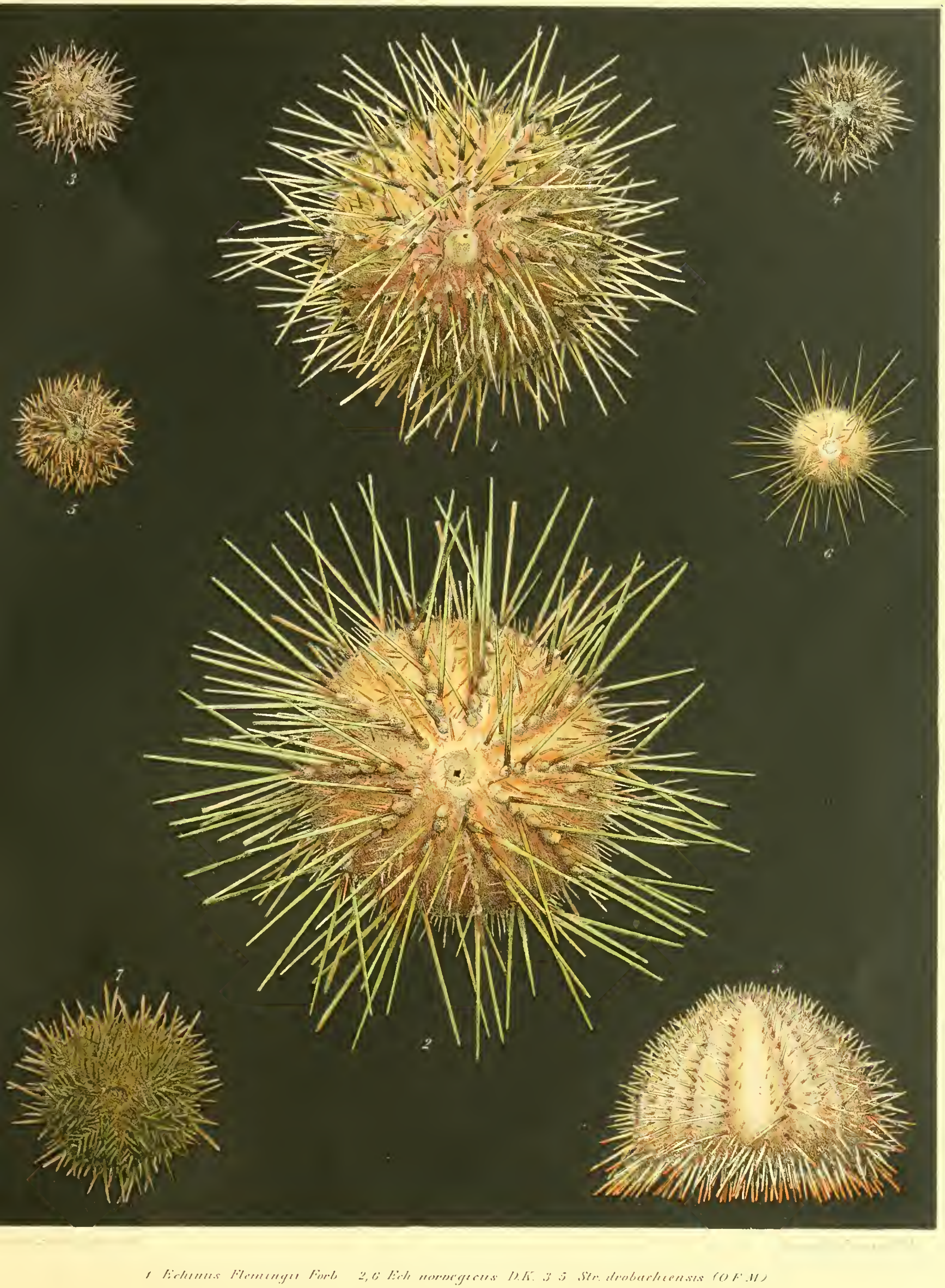
— 2. — — var. *norvegicus*, large specimen.

— 3—5. *Strongylocentrotus drøbachiensis.*

— 6. *Echinus acutus*, var. *norvegicus*, small specimen.

— 7. *Parechinus miliaris* (on the plate wrongly called *Psammechinus*).

— 8. *Echinus acutus*, var. *mediterranea.*



1 Echinus Flemingii Forb. 2, 6 Ech. norvegicus D.K. 3, 5 Str. drobachiensis (O.F.M.)
7 Psammech. miliaris (Müll.) 8. Ech. acutus Lam.

Plate III.

Fig. 1—2. *Calveria hystrix*, 1. abactinal side, 2. actinal side. (On the plate wrongly called *Asthenosoma*.)

— 3. *Echinus esculentus.*

— 4. — *elegans.*

1. 2. Asthenosoma hystrix (W.Th.) 3. Echinus esculentus L.
4. Ech. elegans D.K.

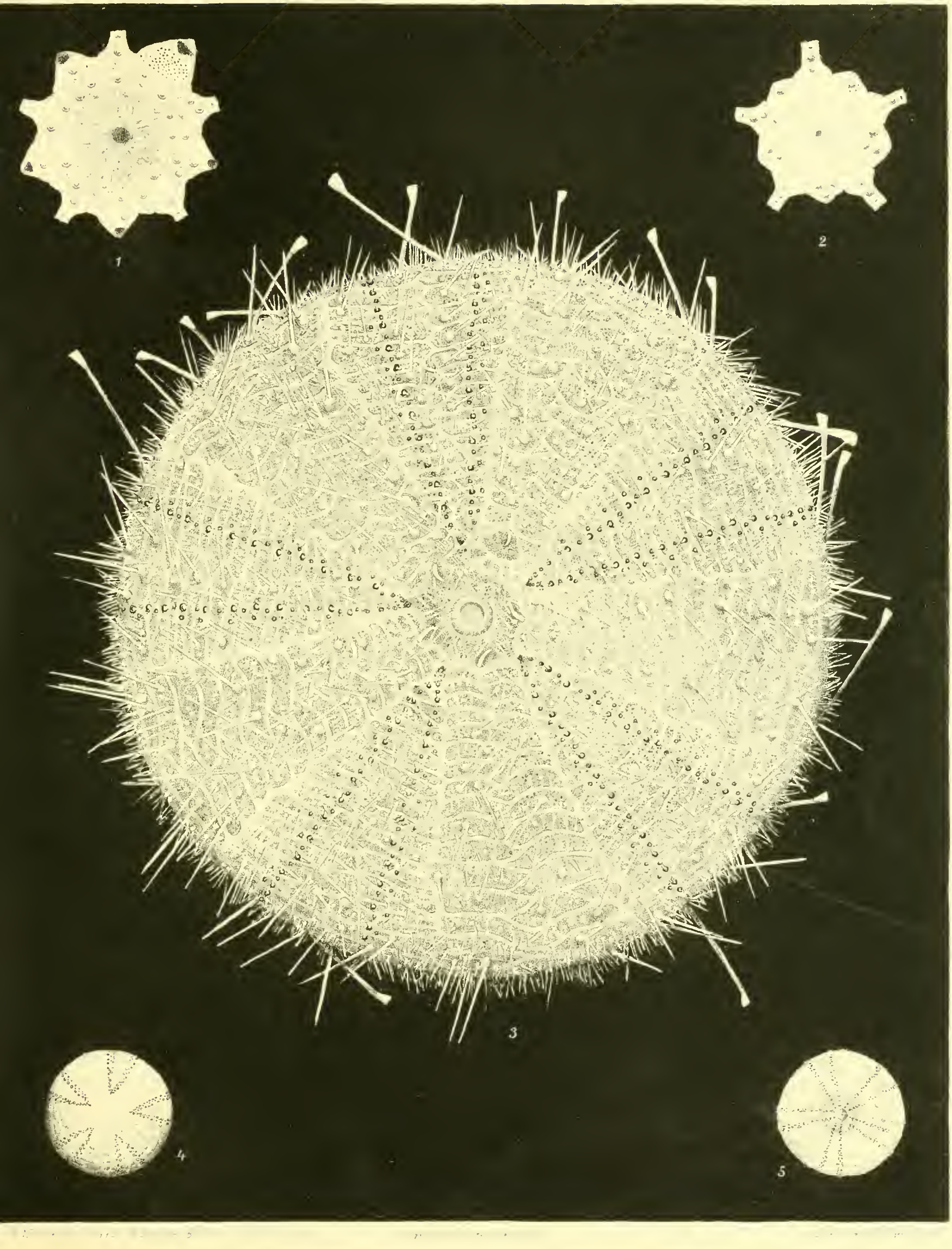
Plate IV.

Fig. 1. Apical area of *Phormosoma placenta*, diameter 37^{mm}. $^4/_1$.

— 2. — — — — — 7^{mm}. $^8/_1$.

— 3. *Sperosoma Grimaldii*, abactinal side.

— 4—5. — — young specimen; 4. abactinal side, 5. actinal side.



1 2. Phormosoma placenta W. Th. 3 5. Sperosoma Grimaldii Koehler

Plate V.

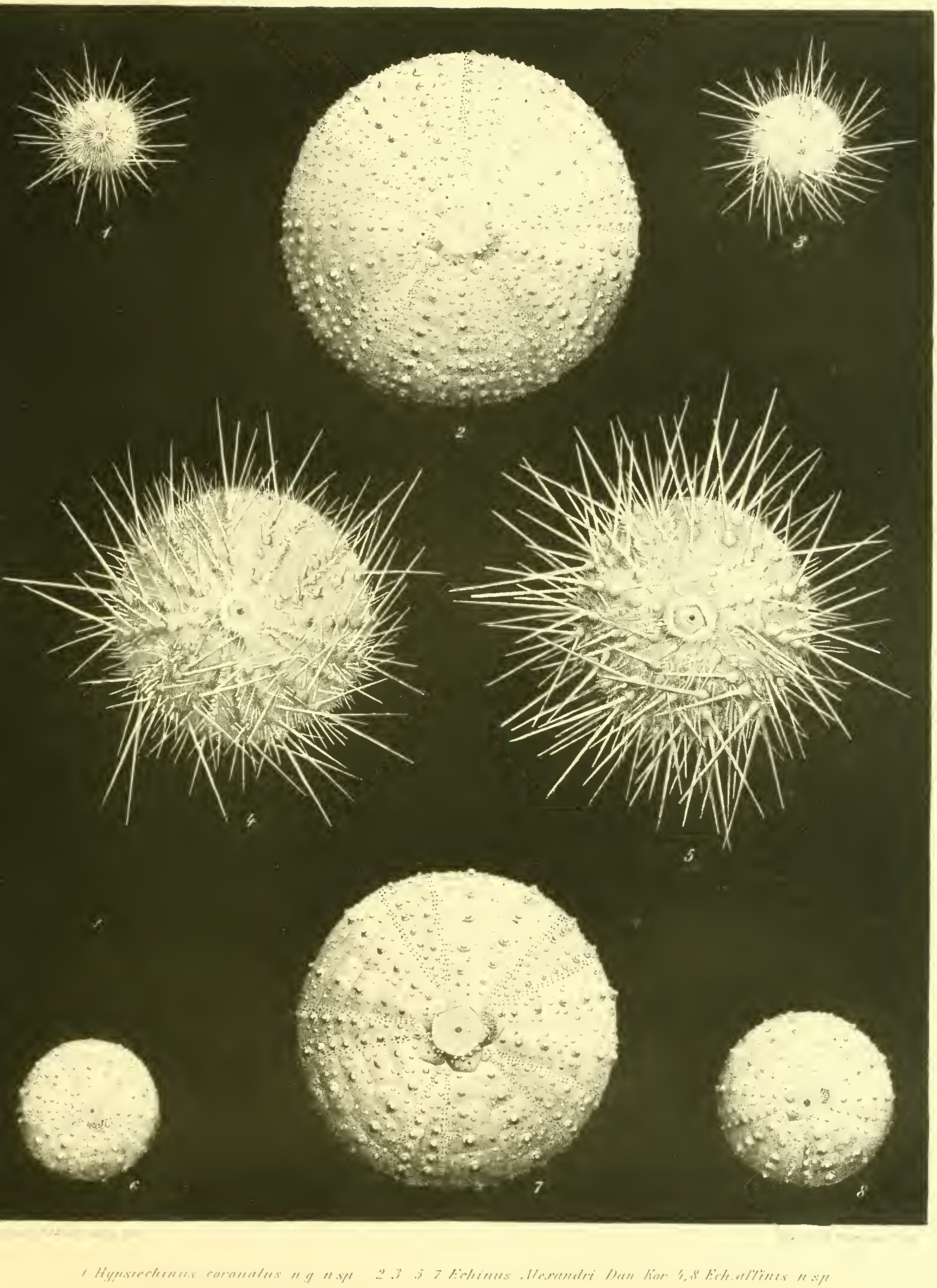
Fig. 1. *Hypsiechinus coronatus.* $^{2}/_{1}$.

— 2—3. *Echinus Alexandri.* $^{1}/_{1}$.

— 4. — *affinis.* $^{1}/_{1}$.

— 5—7. — *Alexandri.* $^{1}/_{1}$.

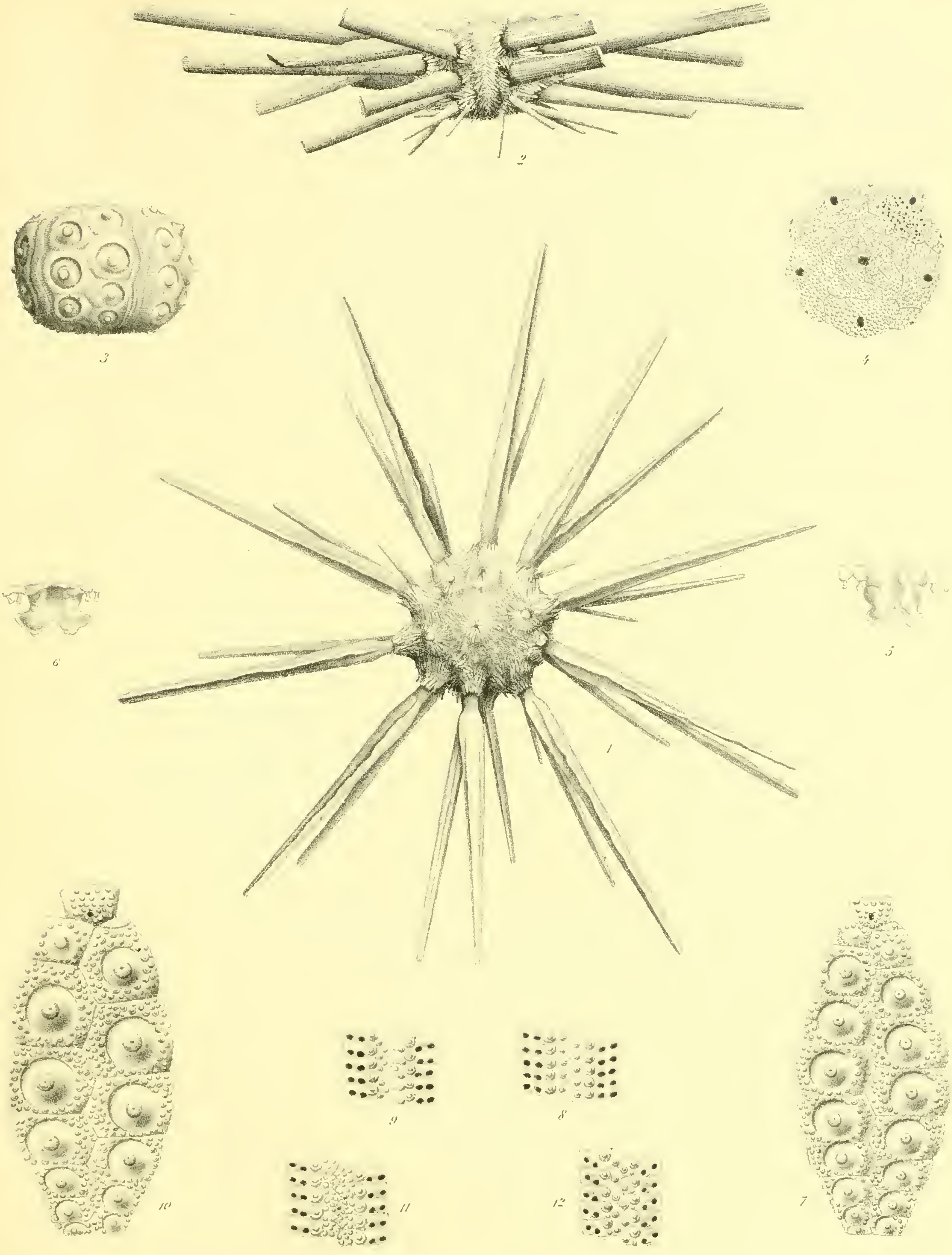
— 8. — *affinis.* $^{1}/_{1}$.



1 Hypsiechinus coronatus n. g. n. sp. 2, 3, 5, 7 Echinus Alexandri Dan. Kor. 4, 8 Ech. affinis n. sp.

Plate VI.

Fig. 1. *Stereocidaris ingolfiana*, from above. $^1/_1$.
— 2. — — - the side. $^1/_1$.
— 3. Test of *Stereocidaris ingolfiana*. $^1/_1$.
— 4. Apical area of — — $^2/_1$.
— 5. Ambulacral-processes of *Stereocidaris ingolfiana*. $^1/_1$.
— 6. — - *Dorocidaris papillata*. $^1/_1$.
— 7. Interambulacral area - — — $^1/_1$.
8. Piece of ambulacral area of *Dorocidaris papillata*. $^4/_1$.
— 9. — - — - *Cidaris affinis*. $^4/_1$.
— 10. Interambulacral area of *Cidaris affinis*. $^2/_1$.
— 11. Piece of ambulacral area of *Stereocidaris ingolfiana*. $^4/_1$.
— 12. — - — - *Porocidaris purpurata*. $^4/_1$.



1–5, 11 Stereocidaris ingolfiana n. sp. 6–8 Dorocidaris papillata (Leske) 9–10 Cidaris affinis Phil. 12 Porocidaris purpurata W. Th.

Plate VII.

Fig. 1—20. *Hypsiechinus coronatus.*

— 1. Test of ♀. $^4/_1$.

— 2—4. Test of ♀. $^1/_1$.

— 5. Specimen with young. $^3/_1$.

— 6—8. Three developmental stages, the more important skeletal parts begun. Obj. II. Oc. I.

— 9. Apical area of ♂. $^4/_1$.

— 10. Piece of the rosette. Obj. II. Oc. III.

— 11. Plate from the buccal membrane. Obj. II. Oc. I.

— 12. Spicules from the gills. Obj. II. Oc. I.

— 13. Spicules from tube feet. Obj. II. Oc. I.

— 14. Anal plate of a young one. Obj. II. Oc. III.

— 15. Calcareous plates from the buccal membrane, inside of the buccal plates. Obj. II. Oc. I.

— 16. Valve of triphylious pedicellaria. Obj. II. Oc. III.

— 17. Sphæridia. Obj. II. Oc. III.

— 18. Valve of ophicephalous pedicellaria. Obj. II. Oc. III.

— 19. — - globiferous pedicellaria, from the inside. Obj. II. Oc. III.

— 20. — - — — — - side. Obj. II. Oc. III.

— 21. — - tridentate pedicellaria of *Prionechinus sagittiger.* Obj. II. Oc. I.

— 22. — - — — - *Arbacina forbesiana.* Obj. II. Oc. I.

— 23. — - triphylious — - *Trigonocidaris albida.* Obj. II. Oc. III.

— 24. — - — — - *Genocidaris maculata.* Obj. II. Oc. III.

— 25. — - — — - *Prionechinus sagittiger.* Obj. II. Oc. III.

— 26. — - — — - *Arbacina forbesiana.* Obj. II. Oc. III.

— 27. Spicules from tube foot of *Trigonocidaris monolini.* Obj. V. Oc. o.

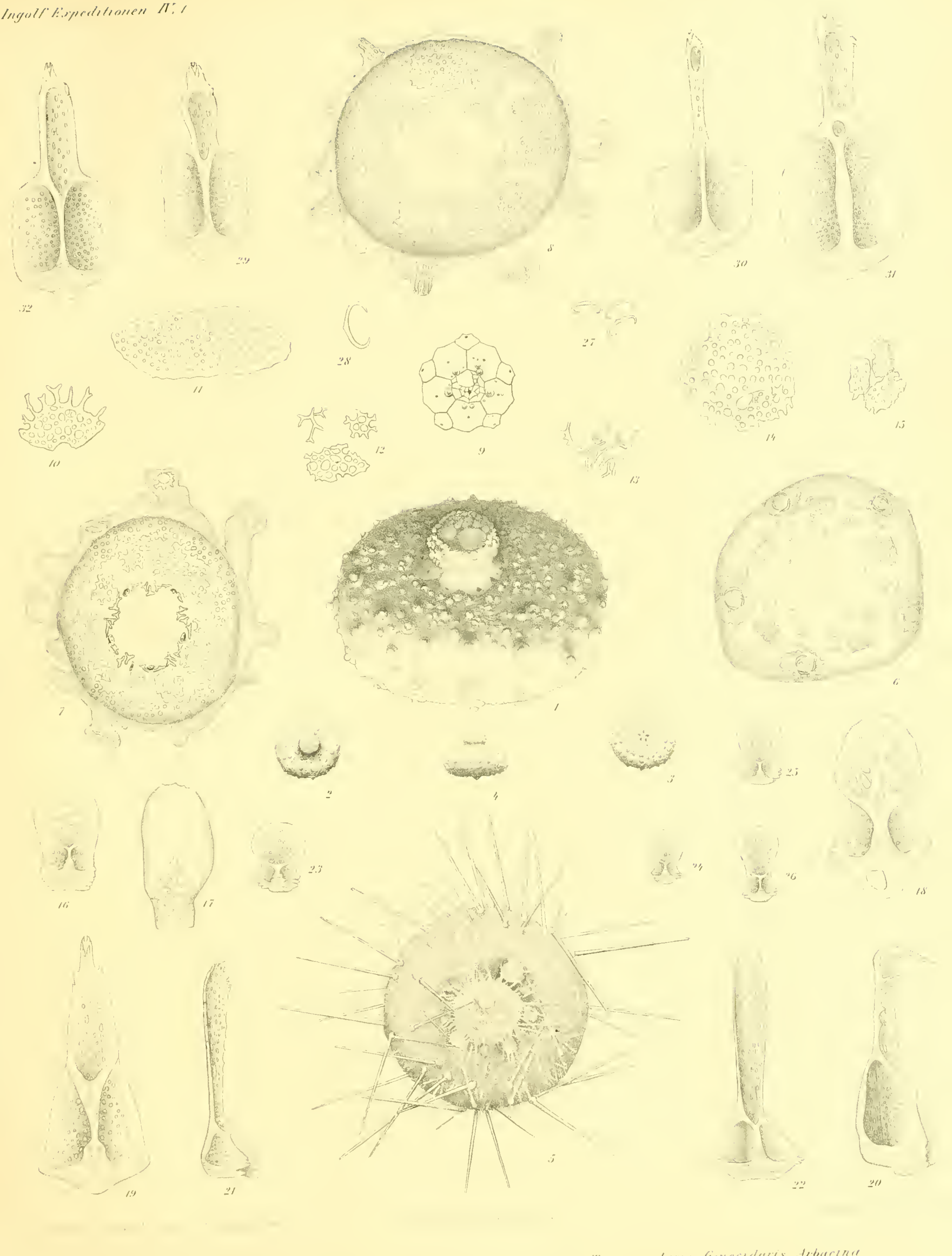
— 28. — - — — - — *albida.* Obj. V. Oc. o.

— 29. Valve of globiferous pedicellaria of *Prionechinus sagittiger.* Obj. II. Oc. III.

— 30. — - — — - *Genocidaris maculata.* Obj. II. Oc. III.

— 31. — - — — - *Trigonocidaris albida.* Obj. II. Oc. III.

— 32. — - — — - *Arbacina forbesiana.* Obj. II. Oc. III.



1-20 Hypsiechinus coronatus n. g. n. sp. 21-32 Prionechinus, Trigonocidaris, Genocidaris, Arbacina

Plate VIII.

Fig. 1. Tube foot of *Dorocidaris papillata*, shows the arrangement of the spicules. Obj. o. Oc. o.

— 2. a. b. Spines of *Cidaris affinis* (U. S. F. C.); a. primary actinal spine, $^3/_1$. b. primary abactinal spine, $^1/_1$.

— 3. Actinal primary spine of *Dorocidaris papillata*. $^1/_1$.

— 4. — — - - *Stereocidaris ingolfiana*. $^2/_1$.

— 5. Secondary abactinal spine of *Hypsiechinus coronatus*. Obj. II. Oc. o.

— 6. Valve of a small globiferous pedicellaria of *Stereocidaris canaliculata*, from the side. Obj. II. Oc. I.

— 7. Globiferous pedicellaria of *Genocidaris maculata*; shows the double poison gland. Obj. II. Oc. I.

— 8. Valve of a large globiferous pedicellaria of *Stereocidaris canaliculata*, from the side. Obj. II. Oc. I.

— 9. Point of a primary abactinal spine of *Hypsiechinus coronatus*. Obj. II. Oc. o.

— 10. Primary abactinal spine of *Stereocidaris ingolfiana*. $^1/_1$.

— 11. Valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*, from the side. Obj. II. Oc. I.

— 12. Spine from the peristome of *Dorocid. papillata*. Obj. oo. Oc. o.

— 13. — - — - — — from the side. Obj. oo. Oc. o.

— 14. Secondary spine with ampulla from the abactinal side of *Dorocid. papillata*. Obj. o. Oc. o.

— 15. Piece of an actinal spine of *Hypsiech. coronatus*. Obj. II. Oc. III.

— 16. Large globiferous pedicellaria of *Stereocidaris ingolfiana*. Obj. II. Oc. o.

— 17. Actinal spine of *Hypsiech. coronatus*. Obj. o. Oc. o.

— 18. Piece of an abactinal primary spine of *Hypsiech. coronatus*. Obj. II. Oc. o.

— 19. Secondary spine of *Stereocidaris ingolfiana*. Obj. oo. Oc. o.

— 20. Spine from the peristome of — — Obj. o. Oc. o.

— 21. Point of a valve of a small globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. V. Oc. I.

— 22. — - — — pedicellaria of *Porocidaris purpurata*. Obj. V. Oc. o.

— 23. — - — — small globiferous pedicellaria of *Sterocid. ingolfiana*. The two outermost teeth coalesced in the point. Obj. V. Oc. III.

— 24—25. Ambulacral and interambulacral area of *Hypsiechinus coronatus*. $^4/_1$. The sutures of the ambulacral area are not so distinct in the animal, as here in the figure.

— 26. Point of a valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. V. Oc. o.

— 27. — - — - — — — - *Dorocid. papillata*. Obj. V. Oc. o.

28. Small globiferous pedicellaria of *Stereocid. ingolfiana*. Obj. II. Oc. o.

— 29. Valve of a large globiferous pedicellaria of *Stereocid. ingolfiana*, from the inside. Obj. II. Oc. I.

— 30. — - - small — — - — — — - side. Obj. II. Oc. I. (comp. Fig. 21.)

31. Valve of a globiferous pedicellaria of *Stereocidaris incerta*. Obj. A A. Oc. III. (Zeiss.)

— 32. — - - large globiferous pedicellaria of *Stereocid. canaliculata*, from the inside. Obj. II. Oc. I.

— 33. Tridentate pedicellaria of *Arbacina forbesiana*. Obj. II. Oc. I.

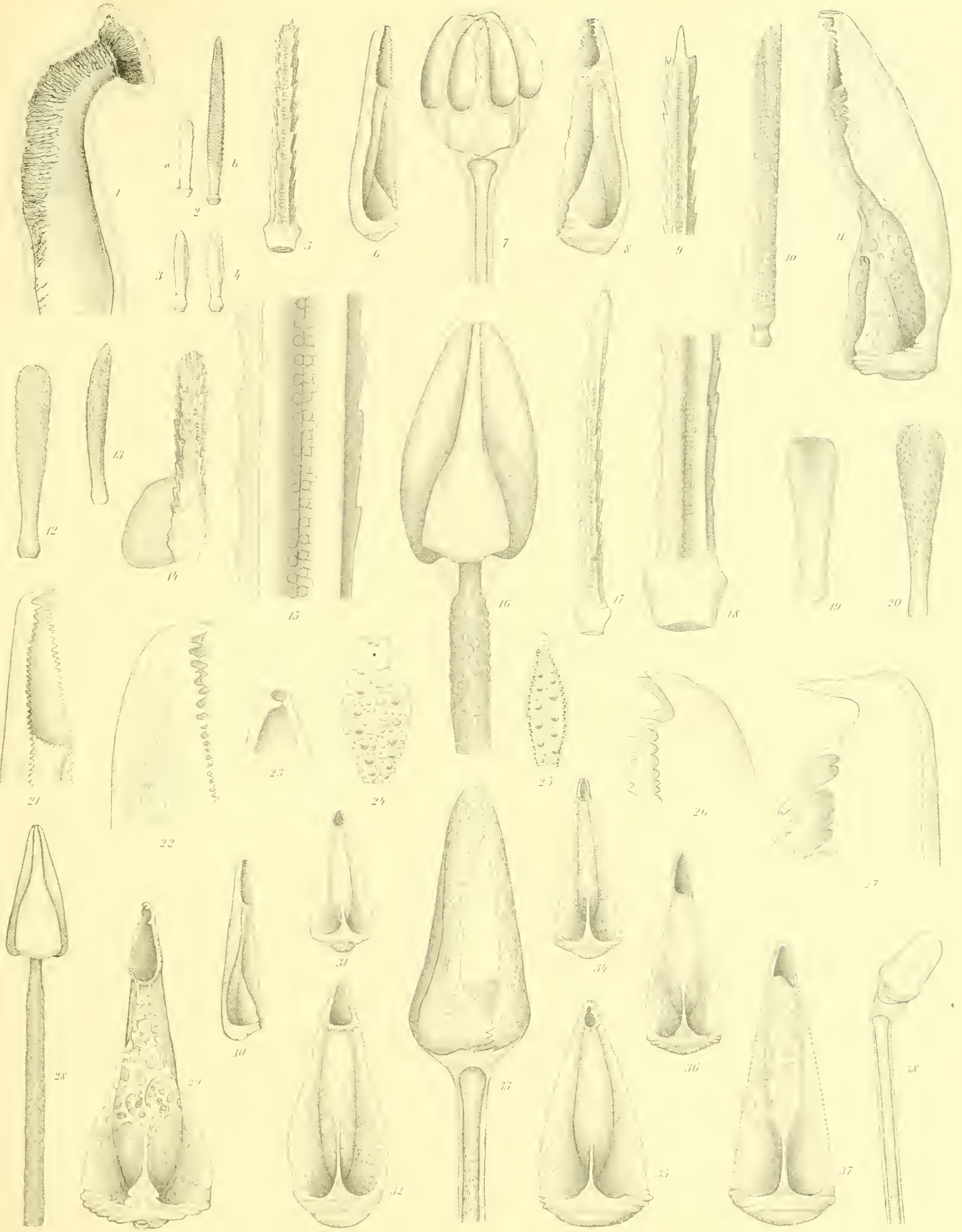
— 34. Valve of small globiferous pedicellaria of *Stereocid. Mortenseni*, from the inside. A A. Oc. I. (Zeiss.)

— 35. — - large — — - — sp., from the inside. (Challenger. St. 156. comp. p. 26.) Obj. II. Oc. o.

— 36. Valve of small globiferous pedicellaria of *Stereocid. ingolfiana*, from the inside. Obj. II. Oc. I.

— 37. — - large — — - *Acanthocidaris curvatispinis*, from the inside. Obj. II. Oc. I.

— 38. Ophicephalous pedicellaria of *Hypsiechinus coronatus*. Obj. II. Oc. o.



Cidaridæ. Temnopleuridæ.

Plate IX.

Fig. 1. Valve of tridentate pedicellaria of *Cidaris affinis*, from the side. Obj. II. Oc. III.

— 2. — - small globiferous pedicellaria of *Histocidaris elegans* (?), from the side. Obj. II. Oc. I. (See Appendix.)

— 3. Valve of large globiferous — - *Dorocidaris papillata*, - — Obj. II. Oc. o.

— 4. Stalk - — — — - *Tretocidaris annulata*. Obj. II. Oc. o.

— 5. Valve - — — — - *Dorocid. papillata*, from the inside. Obj. II. Oc. o.

— 6. — - small — — - *Phyllacanthus imperialis*, from the side. Obj. II. Oc. III.

— 7. Valve of tridentate — - *Dorocid. papillata*, from the side. Obj. II. Oc. o.

— 8. — - small globiferous — - *Cidaris affinis* (U. S. F. C.), from the inside Obj. II. Oc. III.

— 9. Valve of large — — - — — from the side. Obj. II. Oc. I.

— 10. — - small — — - *Goniocidaris biserialis*, from the side. Obj. II. Oc. III.

— 11. — - — — — - *Cidaris affinis* (U. S. F. C.), from the side. Obj. II. Oc. III.

— 12. Stalk of large — — - — — Obj. II. Oc. I.

— 13. Valve - small — — - *Dorocid. papillata*, from the side. Obj. II. Oc. I. (Comp. Fig. 20.)

— 14. Valve of small — — - — — f. *abyssicola*, from the inside. Obj. AA. Oc. III. (Zeiss.)

— 15. Valve of small globiferous — - — — from the inside. Obj. II. Oc. III.

— 16. — - large — — - — *Blakei*, from the inside. Obj. II. Oc. o.

— 17. Point of a valve of a small globiferous pedicellaria of *Cidaris affinis* (U. S. F. C.). Obj. V. Oc. I.

— 18. Valve of tridentate pedicellaria of *Cidaris affinis* (U. S. F. C.), from the inside. Obj. II. Oc. I.

— 19. — - — — - — — — - the side. Obj. II. Oc. I.

— 20. Point of a valve of a small globiferous pedicellaria of *Dorocid. papillata*. Obj. V. Oc. o.

— 21. Tridentate pedicellaria of *Cidaris affinis* (U. S. F. C.). Obj. II. Oc. o.

— 22. Valve of a large globiferous pedicellaria of *Cidaris affinis*, from the inside. Obj. II. Oc. I.

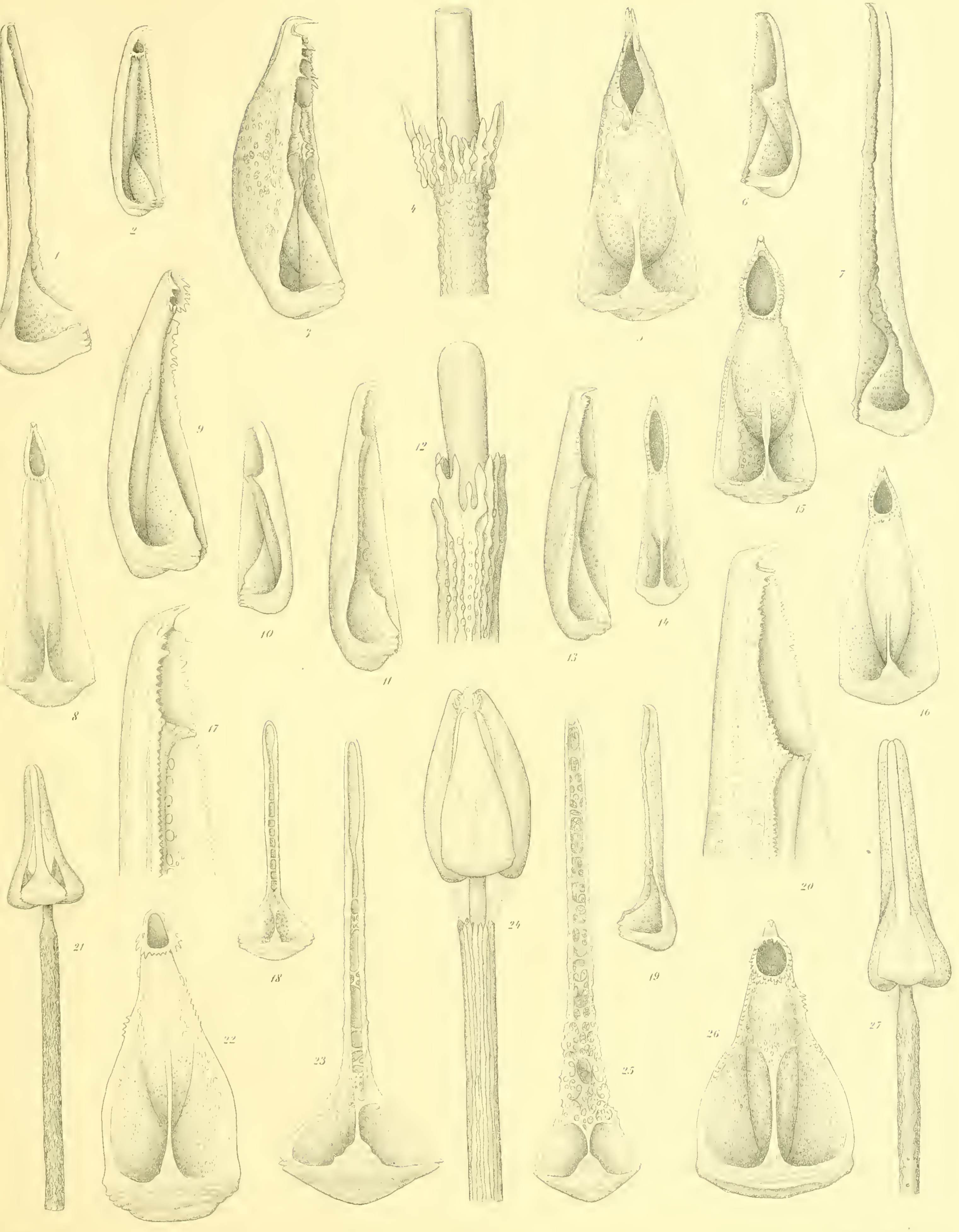
— 23. — - tridentate — - — — - — Obj. II. Oc. III.

— 24. Large globiferous pedicellaria of *Cidaris affinis*. Obj. o. Oc. I.

— 25. Valve of tridentate pedicellaria of *Dorocid. papillata*, from the inside. Obj. II. Oc. o.

— 26. — - large globiferous pedicellaria of *Dorocid.* (?) *micans*, from the inside. Obj. II. Oc. o.

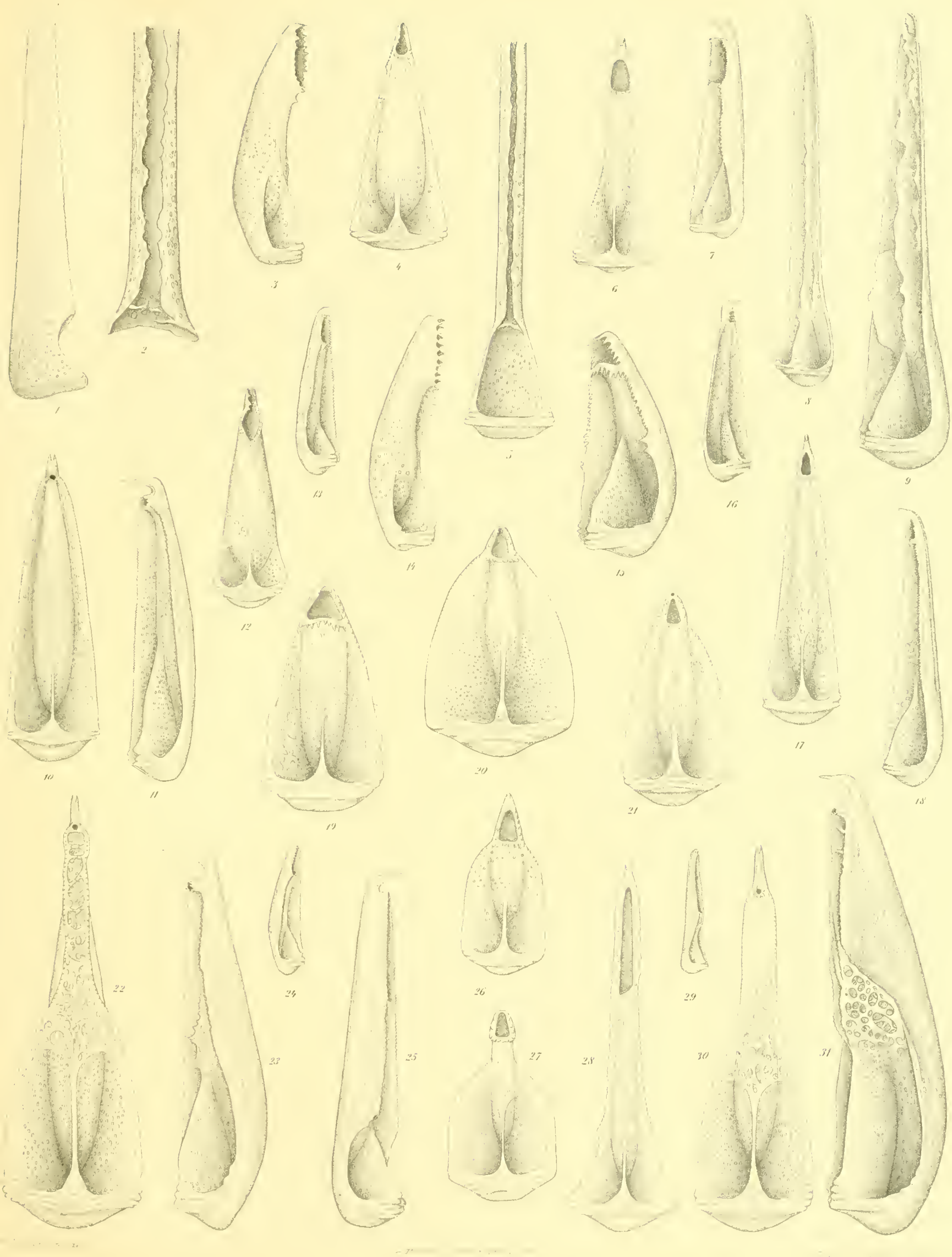
— 27. Tridentate pedicellaria of *Dorocid. papillata*. Obj. o. Oc. I.



Cidarida

Plate X.

Fig. 1. Valve of pedicellaria of *Porocidaris purpurata*, from the side. Obj. II. Oc. o.
— 2. Piece of the same, from the inside. Obj. V. Oc. o.
— 3. Valve of a large globiferous pedicellaria of *Stereocidaris nutrix*, from the side. Obj. II. Oc. o.
— 4. — — — — — - — — - the inside. Obj. II. Oc. o.
— 5. — of pedicellaria of *Porocidaris purpurata*, from the inside, the lower part. Obj. II. Oc. o.
— 6. — - globiferous pedicellaria of *Discocidaris* (?) *serrata*, from the inside. Obj. II. Oc. III.
— 7. — - — — - — — - the side. Obj. II. Oc. III.
— 8. — - tridentate — - *Phyllacanthus imperialis*, from the side. Obj. A A. Oc. I (Zeiss.)
— 9. Valve of tridentate — - *Acanthocidaris curvatispinis*, from the side. Obj. A A. Oc. I. (Zeiss.)
— 10. Valve of a large globiferous pedicellaria (a smaller specimen) of *Tretocidaris spinosa*, from the inside. Obj. II. Oc. o.
— 11. Valve of a large globiferous — of *Tretocidaris spinosa*, from the side. Obj. II. Oc. o.
— 12. — — — — — - *Stereocidaris nutrix*, - the inside. Obj. II. Oc. o.
— 13. — — small — — - *Goniocidaris umbraculum*, from the side. Obj. II. Oc. I.
— 14. — — large — — - *Stereocidaris nutrix*, from the side. Obj. II. Oc. o.
— 15. — — — — — - *Chondrocidaris gigantea*, from the side. Obj. II. Oc. I.
— 16. — — small — — - *Tretocidaris spinosa*, from the side. Obj. II. Oc. o.
— 17. — — large — — - *Stephanocidaris bispinosa* (see Appendix), from the inside. Obj. II. Oc. o.
— 18. Valve of a large globiferous — - *Stephanocidaris bracteata*, from the side. Obj. II. Oc. I.
— 19. — — — — — - *Chondrocidaris gigantea*, from the inside. Obj. II. Oc. I.
— 20. — — — — — - *Goniocidaris tubaria*, - — Obj. II. Oc. I.
— 21. — — — — — - — *umbraculum*, - — Obj. II. Oc. I.
— 22. — — — — — - *Tretocidaris annulata*, - — Obj. II. Oc. o.
— 23. — — — — — - — *Bartletti*, from the side. Obj. A A. Oc. VI. (Zeiss.)
— 24. Valve of a small — — - *Stereocidaris nutrix*, - — Obj. A A. Oc. III. (Zeiss.)
— 25. Valve of a large — — - *Schizocidaris assimilis*, - — Obj. II. Oc. III.
— 26. — — small — — - *Chondrocidaris gigantea*, from the inside. Obj. AA. Oc. VI. (Zeiss.)
— 27. Valve of a large — — - *Petalocidaris florigera*, - — Obj. A A. Oc. VI. (Zeiss.)
— 28. Valve of a large — — - *Schizocidaris assimilis*, - — Obj. II. Oc. III.
— 29. Valve of a small — — - *Petalocidaris florigera*, from the inside. Obj. II. Oc. I.
— 30. — — large — — - *Tretocidaris Bartletti*, — — Obj. A A. Oc. VI. (Zeiss.)
— 31. Valve of a large — — - — *annulata*, — the side. Obj. II. Oc. o.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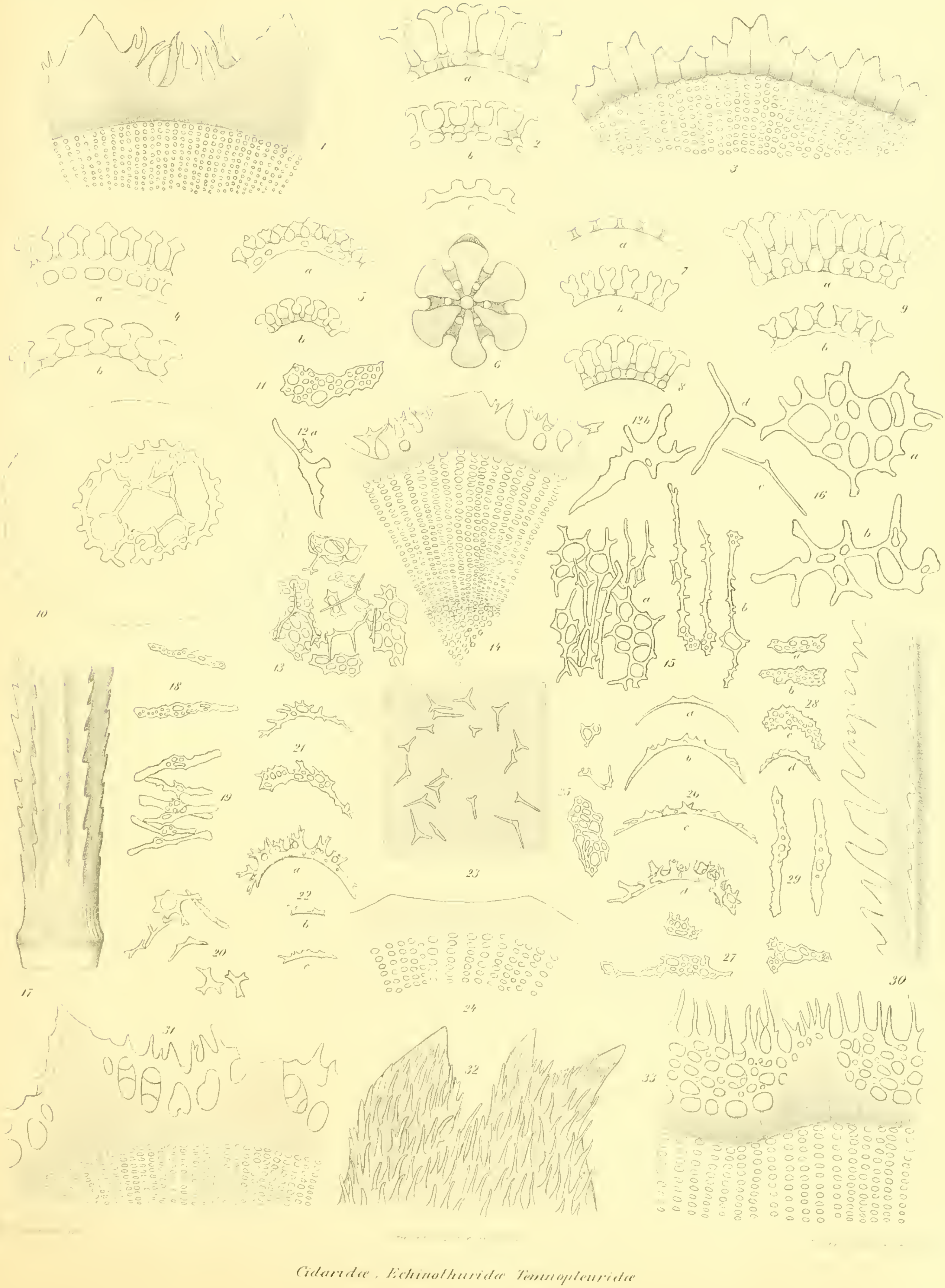
Cidaridæ

Plate XI.

Fig. 1. Piece of transverse section of a primary spine of *Cidaris affinis*. Obj. II. Oc. o.
— 2. — - — — - spines of *Tromikosoma Koehleri*; a—b. sections of primary actinal spines, c. of an abactinal spine. Obj. II. Oc. I.
— 3. Piece of transverse section of a primary spine of *Porocidaris purpurata*. Obj. II. Oc. I.
— 4. — - — — - spines of *Hygrosoma Petersii*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 5. Piece of transverse section of spines of *Calveria hystrix*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 6. Transverse section of a primary spine of *Hypsiechinus coronatus*. Obj. II. Oc. III.
— 7. Piece of transverse section of spines of *Phormosoma placenta*; a. section of an abactinal spine, b. of a primary actinal spine, lower part. Obj. II. Oc. I.
— 8. Piece of transverse section of a primary spine of *Aræosoma fenestratum*. Obj. II. Oc. I.
— 9. — - — — - spines of *Sperosoma Grimaldii*; a. section of a primary actinal spine, b. of an abactinal spine. Obj. II. Oc. I.
— 10. Transverse section of a primary actinal spine of *Phormosoma placenta*, outer part. The outline indicates the circumference of the bag of skin. Obj. II. Oc. I.
— 11. Spicule of a tube foot of *Aræosoma tesselatum*. Obj. II. Oc. III.
— 12. a. b. Spicules from the organs of Stewart of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 13. Spicules of a tube foot of *Tromikosoma Koehleri*. Obj. II. Oc. I.
— 14. Piece of transverse section of a primary spine of *Dorocidaris papillata*, young specimen. Obj. II. Oc. o.
— 15. Spicules of a tube foot of *Aræosoma coriaceum*; a. from [the outer, b. from the lower part Obj. II. Oc. III.
— 16. a—d. Spicules of the genital organs of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 17. Piece of a primary spine of a young *Stereocidaris ingolfiana*. Obj. oo. Oc. o.
— 18. Spicules of a tube foot, lower part, of *Kamptosoma asterias* (*Ph. tenue*). Chall. St. 272). Obj. II. Oc. I.
— 19. Spicules of a tube foot of *Hapalosoma pellucidum*. Obj. II. Oc. III.
— 20. — — — - *Asthenosoma varium*. Obj. II. Oc. III.
— 21. — — — - *Porocidaris purpurata*. Obj. II. Oc. I.
— 22. — — — - *Cidaris affinis*; a. from the outer, b—c. from the lower part. Obj. II. Oc. I.
— 23. Piece of the intestine, with imbedded spicules, of *Stereocidaris ingolfiana*. Obj. II. Oc. I.
— 24. — - transverse section of a primary spine of *Dorocidaris* (?) *micans*. Obj. II. Oc. I.
— 25. Spicules of an abactinal tube foot of *Phormosoma placenta*. Obj. II. Oc. I.
— 26. a—d. — of a tube foot of *Dorocidaris papillata*. Obj. II. Oc. III.
— 27. — — — - *Hygrosoma Petersii*. Obj. II. Oc. I.
— 28. a—d. — — — - *Stereocidaris ingolfiana*. Obj. II. Oc. III.
— 29. — — — - *Calveria hystrix*. Obj. II. Oc. III.
— 30. Piece of a primary spine with the crest of a young *Stereocidaris ingolfiana*. Obj. oo. Oc. o.
— 31. — - transverse section of a primary spine of *Dorocidaris papillata*, larger specimen. Obj. II. Oc. o.
— 32. Piece of the crest of a primary spine of *Stereocidaris ingolfiana*. Obj. II. Oc. o.
— 33. — - transverse section of a primary spine of *Stereocidaris ingolfiana*. Obj. II. Oc. I.



Cidaridæ, Echinothuridæ, Temnopleuridæ

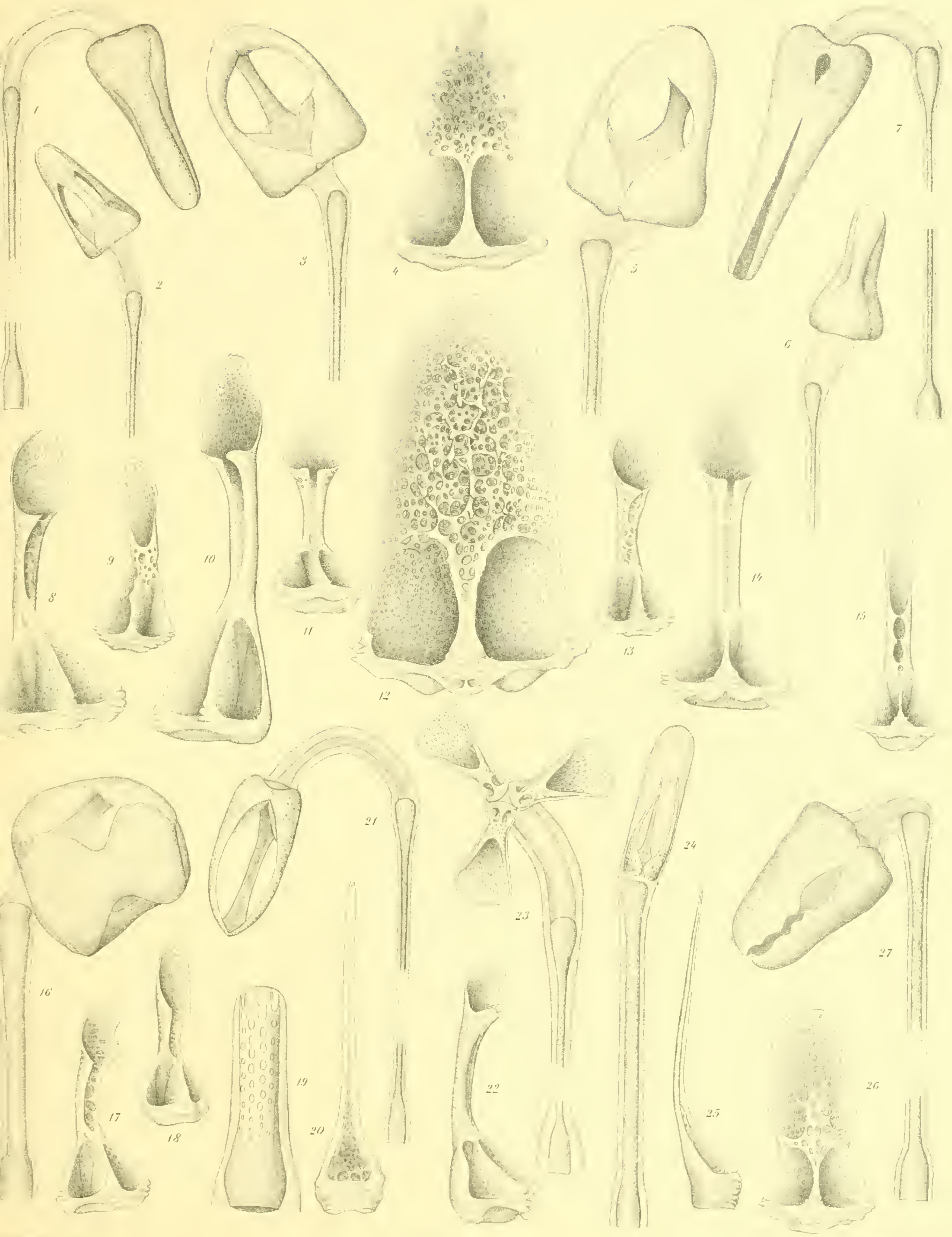
Plate XII.

Fig. 1. Valve of tridentate pedicellaria of *Phormosoma bursarium.* Obj. II. Oc. I.
— 2. — - — — - — *placenta*, from the Davis Strait. Obj. II. Oc. o.
— 3. — - — — - — — —. the Gulf of Mexico. Obj. II. Oc. o.
— 4. Developmental stage of a large tridentate pedicellaria of *Phormosoma placenta.* Obj. II. Oc. o.
— 5. Valve of a half developed — — — - — — Obj. II. Oc. o.
— 6. — — tridentate pedicellaria of *Phormosoma rigidum.* Obj. II. Oc. I.
— 7. — — — — - — *placenta* (Ingolf. St. 40). Obj. II. Oc. o.
— 8—10. Transverse sections of the head of a globiferous pedicellaria of *Hapalosoma pellucidum* 8. nearest to the basis, 10. in the middle, 9. at the point. Obj. II. Oc. III.
— 11. Actinal primary spine of *Phormosoma placenta*, the bag of skin removed. Obj. oo. Oc. o.
— 12. Valve of a triphyllous pedicellaria of *Kamptosoma asterias.* Obj. II. Oc. III.
— 13. — — — — - «*Asthenos. gracile*» (Chall. St. 219). Obj II. Oc. III.
— 14. — — — — - *Hapalosoma pellucidum.* Obj. II. Oc. III.
— 15. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta.* Obj. II. Oc. I.
— 16. Valve of a triphyllous pedicellaria of *Aperosoma Grimaldii.* Obj. II. Oc. I.
— 17. — — — — - *Echinosoma uranus.* Obj. II. Oc. I.
— 18. — — — — - *Asthenosoma varium.* Obj. II. Oc. III.
— 19. Spine from the peristome of *Phormosoma placenta*; with bag of skin. Obj. o. Oc. o.
— 20. Valve of a triphyllous pedicellaria of *Hygrosoma luculentum.* Obj. II. Oc. I.
— 21. — — — — - *Phormosoma placenta.* Obj II. Oc. I.
— 22. — — tridentate — small form, of *Tromikosoma Koehleri.* Obj. II. Oc. o.
— 23. Sphæridia of *Phormosoma placenta.* Obj. II. Oc. I.
— 24. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta.* Obj. II. Oc. I.
— 25. Sphæridia of *Phormosoma placenta.* Obj. II. Oc. I.
— 26. Valve of a small tridentate pedicellaria of *Phormosoma placenta.* Obj. II. Oc. o.
— 27. — — triphyllous pedicellaria of *Aræosoma coriaceum.* Obj. II. Oc. I.
— 28. — — — — - *Phormosoma bursarium.* Obj. II. Oc. I.
— 29. — — — — - *Aræosoma Belli.* Obj. II. Oc. I.
— 30. Developmental stage of a triphyllous pedicellaria of *Phormosoma placenta.* Obj. II. Oc. I.
— 31. Valve of a triphyllous pedicellaria of *Tromikosoma Koehleri.* Obj. II. Oc. I.
— 32. — — — — - *Kamptosoma asterias* («*Phormosoma tenue*», Chall. St. 272). Obj. II. Oc. III.
— 33. Valve of a triphyllous — - *Aræosoma fenestratum.* Obj. II. Oc. I.
— 34. — — — — - *Calveria hystrix.* Obj. II. Oc. III.
— 35. — — large tridentate pedicellaria of *Echinosoma tenue*, seen half from the side. Obj. o. Oc. o.
— 36. — — tridentate — - — *uranus.* Obj. II. Oc. I.
— 37 and 39. Valve of a small tridentate pedicellaria of *Phormosoma placenta.* Obj. II. Oc. o. The edge finely serrate, which cannot be seen under the magnifying powers used in the drawing.
— 38. Valve of a half developed triphyllous pedicellaria of *Phormosoma placenta.* Obj. II. Oc. I.
— 40. — — small tridentate pedicellaria of *Echinosoma tenue.* Obj. II. Oc. o.
— 41. — — large — — - *Tromikosoma Koehleri.* Obj. o. Oc. o.
— 42. — — triphyllous pedicellaria of *Hygrosoma Petersii.* Obj. II. Oc. I.

Echinothuridae

Plate XIII.

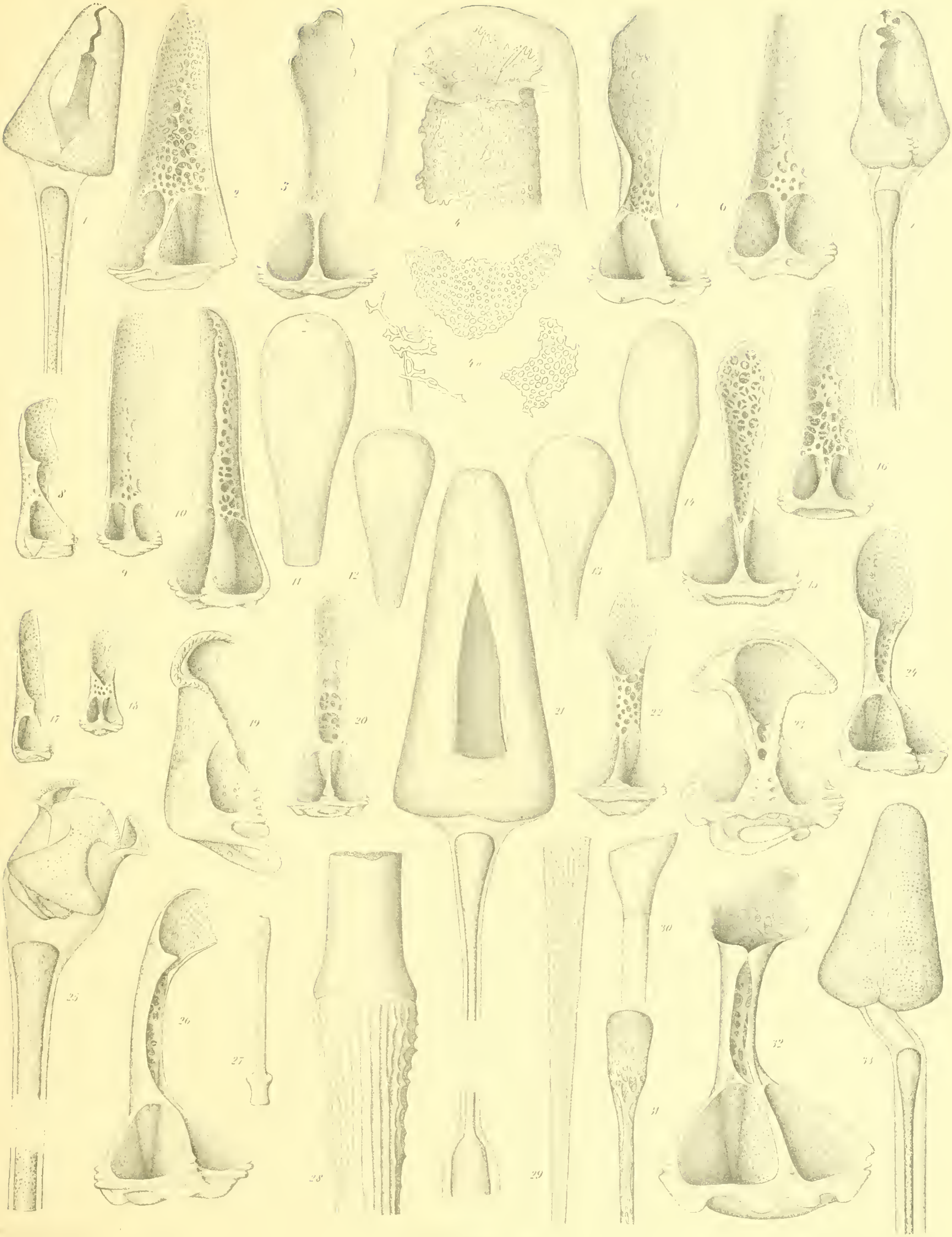
Fig. 1. Tridentate pedicellaria, small form, of *Asthenosoma varium*. Obj. o. Oc. I.
— 2. — — — — - *Hygrosoma luculentum*. Obj. o. Oc. o.
— 3. — — large — - *Calveria gracilis*. Obj. o. Oc. I.
— 4. Valve of a tridentate pedicellaria, short form, of *Asthenosoma varium*. Obj. o. Oc. I.
— 5. Tridentate pedicellaria, large form, of *Aræosoma tesselatum*. Obj. o. Oc. o.
— 6. — — small — - — — Obj. o. Oc. o.
— 7. — — long, narrow form of *Phormosoma placenta* (Ingolf. St. 40). Obj. o. Oc. o.
— 8. Valve of a large tridentate pedicellaria of *Hygrosoma Petersii*. Obj. II. Oc I.
— 9. — — — — — - *Kamptosoma asterias*. Obj. II. Oc. I.
— 10. — — — — — - *Aræosoma Belli*. Obj. o. Oc. I. The basal part was broken, is partly constructed, may be not quite correctly.
— 11. Valve of a small tridentate pedicellaria of *Aræosoma Belli*. Obj. II. Oc. I.
— 12. — — large — — - *Sperosoma Grimaldii*. Obj. o. Oc. I.
— 13. — — small — — - *Hygrosoma Petersii*. Obj. II. Oc. I.
— 14. — — large — — - — *luculentum*. Obj. II. Oc. I.
— 15. — — — — — - *Kamptosoma asterias* («*Phormos. tenue*». Chall. St. 272). Obj. II. Oc. I.
— 16. Tridentate pedicellaria, short form, of *Hygrosoma luculentum*. Obj. oo. Oc. I.
— 17—18. Valves of tridentate pedicellariæ of *Calveria hystrix*. Obj. II. Oc. o.
— 19. Developmental stage of a spine of *Phormosoma placenta*. Obj. II. Oc. I.
— 20. Valve of a globiferous pedicellaria of *Hapalosoma pellucidum*, from the inside. Obj. II. Oc. I.
— 21. Tridentate pedicellaria, larger form, of *Kamptosoma asterias* («*Phormos. tenue*». Chall. St. 272). Obj. o. Oc. I.
— 22. Valve of tridentate pedicellaria af *Aræosoma Belli*. Obj. II. Oc. o.
— 23. Triphyllous pedicellaria of *Sperosoma Grimaldii*. Obj. o. Oc. I.
— 24. Globiferous pedicellaria of *Hapalosoma pellucidum*. Obj. o. Oc. o.
— 25. Valve of globiferous pedicellaria of *Hapalosoma pellucidum*, from the side. Obj. II. Oc. I.
— 26. — - tridentate — - «*Asthenosoma gracile*» (Chall. St. 184). Obj. II. Oc. I.
— 27. Tridentate pedicellaria, short form, of *Asthenosoma Grubei*. Obj. o. Oc. o.



Echinothuridae

Plate XIV.

Fig. 1. Tridentate pedicellaria, smaller form, of *Aræosoma fenestratum.* Obj. o. Oc. o.
— 2. Valve of a larger tridentate pedicellaria of *Sperosoma Grimaldii.* Obj. o. Oc. I.
— 3. — — large — — - *Asthenosoma varium.* Obj. o. Oc. o.
— 4. The point of an actinal tube foot of *Sperosoma Grimaldii.* Obj. II. Oc. I.
— 4. a. Spicules of tube feet of *Sperosoma Grimaldii*; the two large ones from an actinal tube foot, the small ones from an abactinal tube foot. Obj. II. Oc. I.
— 5. Valve of a large tridentate pedicellaria of *Aræosoma coriaceum.* Obj. o. Oc. o.
— 6. — — smaller — — - *Sperosoma Grimaldii.* Obj. II. Oc. I.
— 7. Tridentate pedicellaria, large form, of *Asthenosoma Grubei.* Obj. oo. Oc. o.
— 8. Valve of a tridentate pedicellaria, smaller form, of *Aræosoma fenestratum.* Obj. II. Oc. o.
— 9. — — — — — — - *Hapalosoma pellucidum*; the edge finely serrate. Obj. II. Oc. o.
— 10. Valve of a tridentate pedicellaria, small — - *Asthenosoma varium.* Obj. II. Oc. o.
— 11. Sphæridia of *Sperosoma Grimaldii.* Obj. II. Oc. I.
— 12. — - *Tromikosoma Koehleri.* Obj. II. Oc. o.
— 13. — - *Calveria hystrix.* Obj. II. Oc. I.
— 14. — - *Aræosoma fenestratum.* Obj. II. Oc. I.
— 15. Valve of a tridentate pedicellaria of *Aræosoma tesselatum.* Obj. II. Oc. o.
— 16. — — — — - *Tromikosoma Koehleri*, small form. Obj. II. Oc. o.
— 17—18. Valves of tridentate pedicellariæ of *Aræosoma fenestratum*, small forms. Obj. II. Oc. o.
— 19. Valve of an ophicephalous pedicellaria of *Tromikosoma Koehleri*, from the side. Obj. II. Oc. I.
— 20. — - a tridentate — - *Asthenosoma gracile*, Chall. St. 219. Obj. II. Oc. I.
— 21. Tridentate pedicellaria, large form, of *Tromikosoma Koehleri.* Obj. o. Oc. o.
— 22. Valve of a tridentate pedicellaria, smaller form, of *Kamptosoma asterias* (*Phormosoma tenue*», Chall. St. 272). Obj. II. Oc. I.
— 23. Valve of an ophicephalous pedicellaria of *Tromikosoma Koehleri*, from the inside. Obj. II. Oc. I.
— 24. — - a tridentate — - *Aræosoma fenestratum*, smaller form. Obj. II. Oc. o.
— 25. Ophicephalous pedicellaria of *Tromikosoma Koehleri.* Obj. o. Oc. I.
— 26. Valve of a large tridentate pedicellaria of *Calveria hystrix.* Obj. II. Oc. o.
— 27. Spine with a parasitic Copepod, of *Calveria gracilis.* $^4/_1$.
— 28. The point of a spine from the peristome of *Tromikosoma Koehleri.* Obj. o. Oc. o.
— 29. Piece of a spine of *Kamptosoma asterias.* Obj. o. Oc. o.
— 30. The point of a primary actinal spine of *Tromikosoma Koehleri.* $^4/_1$.
— 31. Outer end of the stalk of a triphyllous pedicellaria of *Sperosoma Grimaldii.* Obj. II. Oc. I.
— 32. Valve of a large tridentate pedicellaria of *Aræosoma fenestratum.* Obj. II. Oc. o.
— 33. Tridentate pedicellaria of *Sperosoma Grimaldii.* Obj. o. Oc. o.



Echinothuridæ.

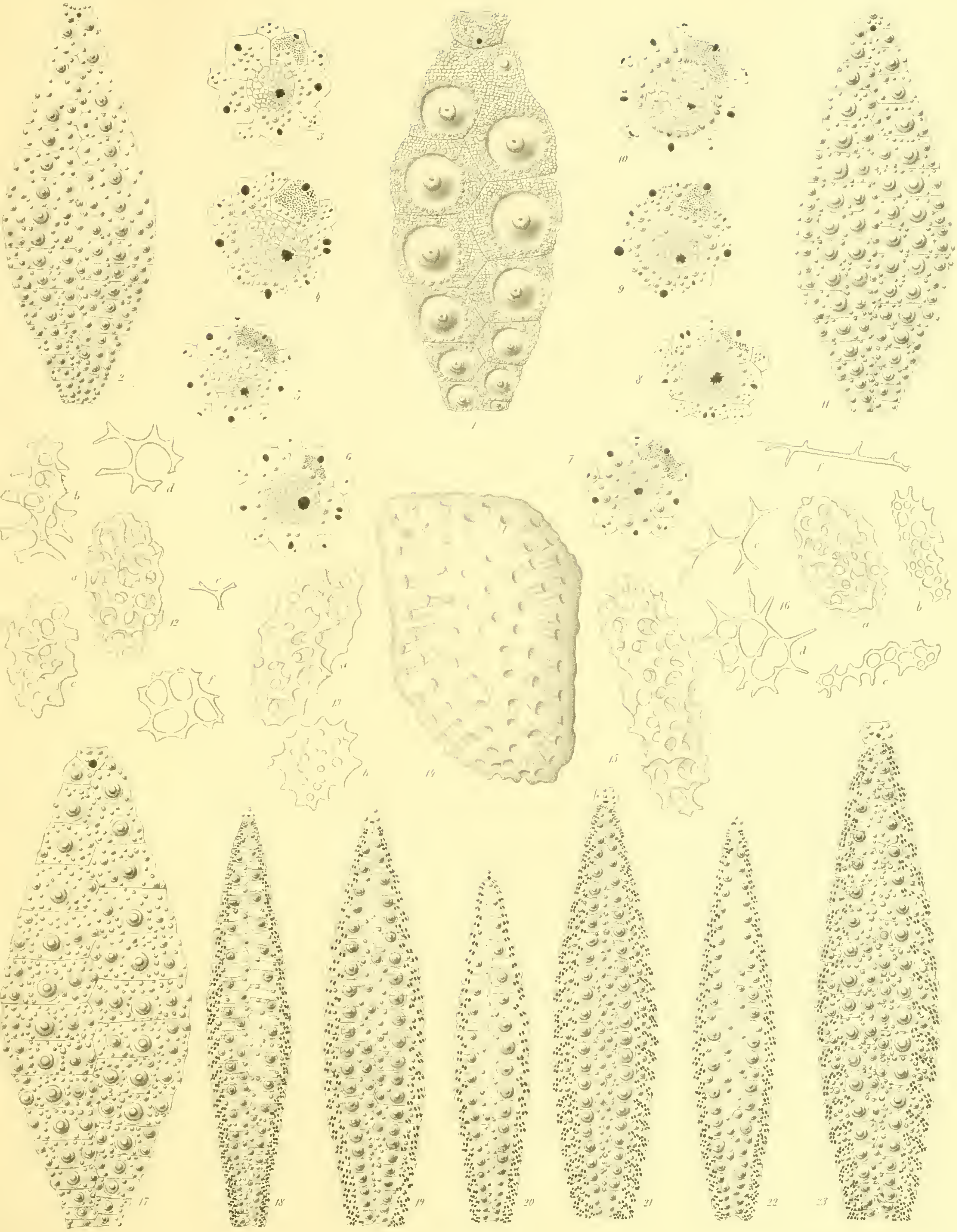
Plate XV.

Fig. 1. Ambulacral area of *Echinus esculentus.* $^1/_1$.
— 2. Interambulacral area of *Echinus acutus*, var. *norvegicus.* $^2/_1$.
— 3. — — - — *affinis.* $^2/_1$.
— 4. — — - — *elegans.* $^2/_1$.
— 5. — — - — *esculentus.* $^1/_1$.
— 6. Apical area of *Parechinus miliaris.* $^2/_1$.
— 7. Ambulacral area of *Parechinus miliaris.* $^2/_1$.
— 8. — — - — *microtuberculatus.* $^2/_1$.
— 9. Interambulacral area of *Parechinus microtuberculatus.* $^2/_1$.
— 10. Ambulacral area of *Echinus affinis.* $^2/_1$ (young specimen).
— 11. Interambulacral area of *Parechinus miliaris.* $^2/_1$.
— 12. Apical area of *Parechinus microtuberculatus.* $^2/_1$.
— 13. Ambulacral area of *Echinus Alexandri.* $^2/_1$.
— 14. — — - — *acutus*, var. *mediterranea.* $^1/_1$.
— 15. Interambulacral area of *Echinus acutus*, var. *mediterranea.* $^1/_1$.
— 16. Ambulacral area of *Echinus acutus*, var. *norvegicus.* $^2/_1$.
— 17. Interambulacral area of *Echinus Alexandri.* $^2/_1$.

Echinus, Parechinus.

Plate XVI.

Fig. 1. Interambulacral area of *Stereocidaris ingolfiana.* $^2/_1$.
— 2. — — - *Echinus acutus*, var. *Flemingii.* $^1/_1$.
— 3. Apical area of *Echinus elegans.* $^2/_1$.
— 4. — — - *Strongylocentrotus drøbachiensis.* $^2/_1$.
— 5. — — - *Echinus acutus*, var. *norvegicus.* $^2/_1$.
— 6. — — - — *affinis.* $^2/_1$. With two pores in one of the genital plates.
— 7. — — - — *esculentus.* $^2/_1$.
— 8. — — - — *Alexandri.* $^2/_1$. With two pores in two of the genital plates.
— 9. — — - *Strongylocentrotus drøbachiensis.* $^2/_1$.
— 10. — — - *Echinus acutus*, var. *Flemingii.* $^2/_1$.
— 11. Interambulacral area of *Strongylocentrotus drøbachiensis*, f. *granularis.* $^2/_1$.
— 12. Plates from the buccal membrane and the gills of *Echinus esculentus.* a. b. from the buccal membrane outside the buccal plates, c. from inside the buccal plates, d. e. f. from the gills. Obj. II. Oc. III.
— 13. Plates from the buccal membrane of *Strongylocentrotus drøbachiensis.* a. outside, b. inside the buccal plates. Obj. II. Oc. III.
— 14. Plate from the buccal membrane of *Parechinus microtuberculatus.* Obj. II. Oc. III.
— 15. — — — — - — *miliaris.* Obj. II. Oc. III.
— 16. Plates from the buccal membrane and the gills of *Echinus acutus*, var. *Flemingii.* a. b. from the buccal membrane outside the buccal plates, c. from inside the buccal plates, d. e. f. from the gills. a. b. Obj. II. Oc. I., c.—f. Obj. II. Oc. III.
— 17. Interambulacral area of *Strongylocentrotus drøbachiensis*, f. *pallidus.* $^2/_1$.
— 18. Ambulacral area of *Echinus acutus*, var. *Flemingii.* $^1/_1$.
— 19. — — - — *elegans.* $^2/_1$.
— 20. — — - — *affinis.* $^2/_1$.
— 21. — — - *Strongylocentrotus drøbachiensis*, f. *granularis.* $^2/_1$.
— 22. — — - *Echinus acutus*, var. *norvegicus.* $^2/_1$.
— 23. — — - *Strongylocentrotus drøbachiensis*, f. *pallidus.* $^2/_1$.



Stereocidaris, Parechinus, Echinus, Strongylocentrotus

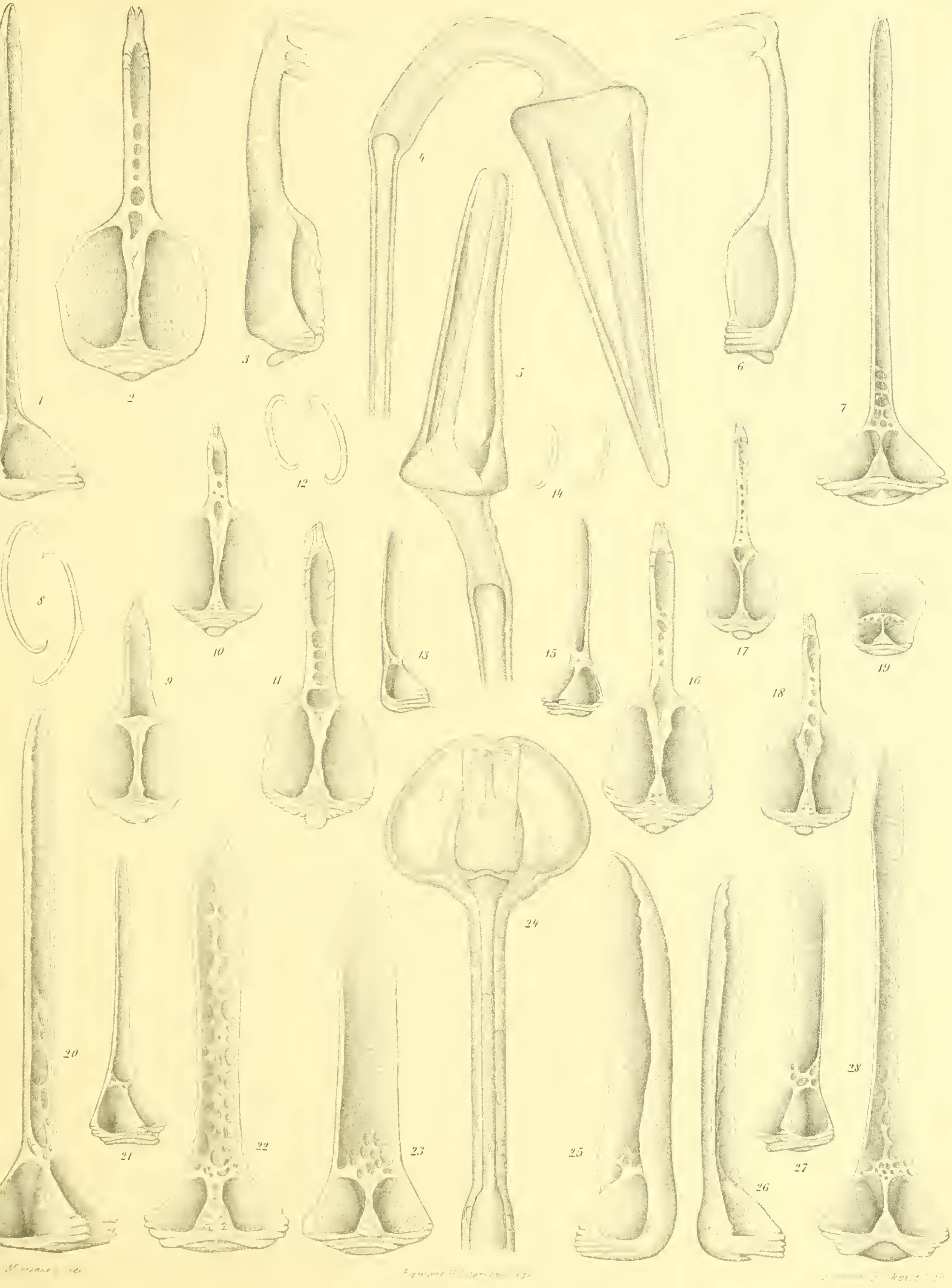
Plate XVII.

Fig. 1. Valve of a globiferous pedicellaria of *Parechinus miliaris*, from the side. Obj. V. Oc. o.
2. — — tridentate — from the buccal membrane of *Parechinus miliaris*. Obj. II. Oc. III.
— 3. — — ophicephalous — of *Parechinus angulosus*. Obj. II. Oc. I.
— 4. — — triphyllous — - *Stomopneustes variolaris*. Obj. D. Oc. III. (Zeiss.)
— 5. — — globiferous — - *Loxechinus albus*. Obj. II. Oc. I.
— 6. — — tridentate — large form, of *Parechinus angulosus*. Obj. II. Oc. o.
— 7. — — globiferous — from the inside, of *Parechinus miliaris*. Obj. V. Oc. o.
— 8. — — ophicephalous — of *Parechinus miliaris*. Obj. II. Oc. I.
— 9. — — tridentate — small form, of *Parechinus angulosus*. Obj. II. Oc. I.
— 10. Spicules of *Parechinus miliaris*. Obj. V. Oc. I.
— 11. Valve of a tridentate pedicellaria of *Parechinus miliaris*. Obj. II. Oc. III.
— 12. — — — — - *Loxechinus gibbosus*. Obj. II. Oc. I.
— 13. Spicules from the gills of *Stomopneustes variolaris*. Obj. D. Oc. I. (Zeiss.)
— 14. Valve of a triphyllous pedicellaria of *Parechinus miliaris*. Obj. V. Oc. o.
— 15. End-tooth of a globiferous pedicellaria of *Parechinus miliaris*. Obj. V. Oc. III.
— 16. Valve of a tridentate pedicellaria of *Stomopneustes variolaris*. Obj. D. Oc. II. (Zeiss.)
— 17. — — globiferous — - — — Obj. D. Oc. I. (Zeiss.)
— 18. — — tridentate — - *Loxechinus albus*. Obj. II. Oc. o.
— 19. — — globiferous — - *Paracentrotus lividus*. Obj. II. Oc. I.
— 20. — — tridentate — - *Stomopneustes variolaris*; from the inside. Obj. D. Oc. II. (Zeiss.)
— 21. — — — — - *Paracentrotus lividus*. Obj. o. Oc. I.
— 22. Tridentate pedicellaria of *Parechinus miliaris*. Obj. II. Oc. I.
— 23. Globiferous — - — — open. Obj. II. Oc. I.
— 24. — — - — — shut. Obj. II. Oc. I.
— 25. Triphyllous - — — Obj. II. Oc. I.
— 26—27. Sphæridiæ of *Parechinus miliaris*. Obj. II. Oc. III.
— 28. Ophicephalous pedicellaria of *Parechinus miliaris*. Obj. II. Oc. I.

Parechinus, Lorechinus, Paracentrotus, Stomopneustes.

Plate XVIII.

Fig. 1. Valve of a tridentate pedicellaria of *Echinus acutus*, var. *norvegicus*, from the side. Obj. II. Oc. I.
— 2. — — globiferous — - — *elegans*, from the inside. Obj. II. Oc. I.
— 3. — — — - — — - - side. Obj. II. Oc. I.
— 4. Tridentate pedicellaria of *Echinus affinis*. Obj. o. Oc. o.
— 5. — — - — *acutus*. Obj. o. Oc. o.
— 6. Valve of a globiferous pedicellaria of *Echinus acutus*, from the side. Obj. II. Oc. I.
— 7. — — tridentate — - — — var. *norvegicus*, from the inside. Obj. II. Oc. I.
— 8. Spicules of *Echinus melo*. Obj. V. Oc. I.
— 9. Valve of a globiferous pedicellaria of *Echinus Alexandri* (The type-specimen). Obj. II. Oc. o.
— 10. — — — — - — *gracilis*. Obj. II. Oc. I.
— 11. — — — — - — *Alexandri*. Obj. II. Oc. I.
— 12. Spicules of *Echinus esculentus*. Obj. V. Oc. I.
— 13. Valve of a tridentate pedicellaria, small form, of *Echinus esculentus*. Obj. II. Oc. o.
— 14. Spicules of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. I.
— 15. Valve of a tridentate pedicellaria, small form, of *Echinus gracilis*. Obj. II. Oc. I.
— 16. — — globiferous — of *Echinus affinis*. Obj. II. Oc. I.
— 17. — — — — - — *atlanticus*. Obj. II. Oc. o.
— 18. — — — — - — *melo*. Obj. II. Oc. o.
— 19. — — triphyllous — - — *Alexandri* (type-specimen). Obj. II. Oc. I.
— 20. — — tridentate — - — *esculentus*. Obj. II. Oc. o.
— 21. — — — — - — *gracilis*, large form. Obj. II. Oc. o.
— 22. — — — — - — *elegans*, from the inside. Obj. II. Oc. o.
— 23. — — — — - — *Alexandri*, from the inside. Obj. o. Oc. I.
— 24. Globiferous pedicellaria of *Echinus acutus*, var. *norvegicus*. Obj. o. Oc. I.
— 25. Valve of a tridentate pedicellaria of *Echinus Alexandri*, from the side. Obj. II. Oc. I.
— 26. — — — — - — *elegans*, from the side. Obj. II. Oc. I.
— 27. — — — — - — *lucidus*. Obj. II. Oc. I.
— 28. — — — — - — *affinis*. Obj. o. Oc. I.



Echinus.

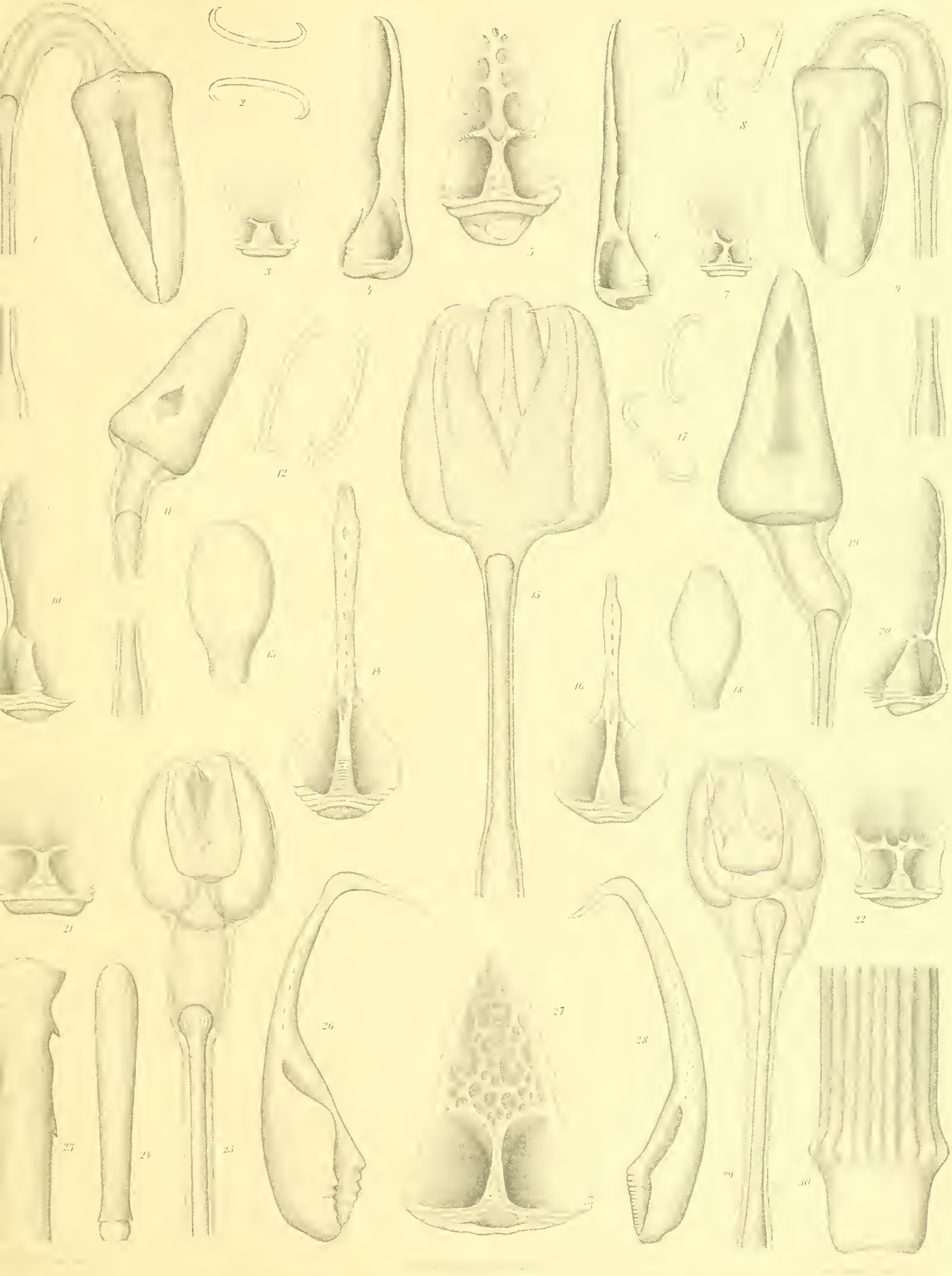
Plate XIX.

Fig. 1. Valve of a tridentate pedicellaria of *Colobocentrotus atratus.* Obj. II. Oc. I.
— 2. — — — — - *Sterechinus horridus.* Obj. II. Oc. I.
— 3. — — — — - — *margaritaceus.* Obj. II. Oc. o.
— 4. — — globiferous — - *Toxocidaris tuberculatus*, from the side. Obj. II. Oc. I.
— 5. — — — — - *Colobocentrotus atratus.* Obj. AA. Oc. III. (Zeiss.)
— 6. — — — — - *Heliocidaris chloroticus*, from the side. Obj. II. Oc. I.
— 7. — — tridentate — - — *rarit		uberculatus.* Obj. II. Oc. I.
— 8. — — — — - *Toxocidaris tuberculatus.* Obj. o. Oc. I.
— 9. — — — — - — — broad form. Obj. II. Oc. I.
— 10. — — ophicephalous — - *Echinus elegans.* Obj. II. Oc. I.
— 11. — — tridentate — - *Sterechinus magellanicus*, from the inside. Obj. II. Oc. III.
— 12. — — globiferous — - *Heliocidaris chloroticus*, from the inside. Obj. II. Oc. I.
— 13. — — — — - *Toxocidaris tuberculatus*, from the inside. Obj. II. Oc. I.
— 14. — — — — - *Sterechinus Neumayeri.* Obj. II. Oc. I.
— 15. — — tridentate — - *Heterocentrotus mamillatus.* Obj. AA. Oc. III. (Zeiss.)
— 16. — — ophicephalous — - *Echinus Alexandri.* Obj. II. Oc. III.
— 17. — — tridentate — - *Sterechinus magellanicus*, from the side. Obj. II. Oc. III.
— 18. — — globiferous — - *Echinus lucidus.* Obj. II. Oc. I.
— 19. — — — — - *Pseudechinus albocinctus.* Obj. II. Oc. I.
— 20. — — — — - *Sterechinus margaritaceus.* Obj. II. Oc. I.
— 21. — — tridentate — - *Echinometra van Brunti.* Obj. AA. Oc. I. (Zeiss.)
— 22. — — globiferous — - *Sterechinus horridus.* Obj. II. Oc. I.
— 23. — — — — - — *magellanicus.* Obj. II. Oc. I.
— 24. — — — — - *Echinus esculentus.* Obj. II. Oc. I.
— 25. — — tridentate — - *Pseudechinus albocinctus.* Obj. II. Oc. I.
— 26. Sphæridia of *Echinus elegans.* Obj. II. Oc. III.
— 27. — - — *affinis.* Obj. II. Oc. III.
— 28. — - — *esculentus.* Obj. II. Oc. III.
— 29. Valve of a triphyllous pedicellaria of *Heliocidaris chloroticus.* Obj. II. Oc. III.
— 30. Sphæridia of *Echinus esculentus.* Obj. II. Oc. III.
— 31. — - — *Alexandri.* Obj. II. Oc. III.
— 32. — - — *acutus*, var. *Flemingii.* Obj. II. Oc. III.
— 33. Valve of a tridentate pedicellaria of *Sterechinus margaritaceus.* Obj. II. Oc. o.
— 34. — — — — - *Echinus Alexandri* (Type-specimen). Obj. II. Oc. o.
— 35. — — — — - *Heterocentrotus trigonarius.* Obj. AA. Oc. II. (Zeiss.)
— 36. Two valves of an ophicephalous pedicellaria, in connection, of *Echinus acutus.* Obj. II. Oc. I.
— 37. Valve of an ophicephalous pedicellaria of *Echinus atlanticus.* Obj. II. Oc. o.
— 38. — — tridentate — - — *Alexandri*, very small form (of a small specimen). Obj. II. Oc. III.
— 39. Valve of a tridentate pedicellaria of *Heliocidaris chloroticus.* Obj. II. Oc. I.

Echinidæ, Echinometridæ.

Plate XX.

Fig. 1. Tridentate pedicellaria of *Echinus Alexandri*. Obj. o. Oc. I.
— 2. Spicules of *Echinus Alexandri*. Obj. V. Oc. I.
— 3. Valve of a triphyllous pedicellaria of *Strongylocentrotus drøbachiensis*. Obj. II. Oc. III.
— 4. — — tridentate — - — — f. *granulatus*. Obj. o. Oc. I.
— 5. — - ophicephalous - — — Obj. II. Oc. III.
— 6. — — tridentate — - — Obj. o. Oc. I.
— 7. — - triphyllous — - *Sterechinus Neumayeri*. Obj. II. Oc. III.
— 8. Spicules of *Echinus elegans*. Obj. V. Oc. I.
— 9. Tridentate pedicellaria, small form, of *Echinus elegans*. Obj. II. Oc. o.
— 10. Valve of a tridentate pedicellaria of *Strongylocentrotus pulcherrimus*. Obj. II. Oc. o.
— 11. Tridentate pedicellaria of *Sterechinus Neumayeri*. Obj. o. Oc. I.
— 12. Spicules of *Strongylocentrotus drøbachiensis*. Obj. V. Oc. I.
— 13. Sphæridia of — — Obj. II. Oc. III.
— 14. Valve of a globiferous pedicellaria of *Strongylocentrotus purpuratus*, from the inside. Obj. II. Oc. o.
— 15. Globiferous pedicellaria of *Psammechinus variegatus*. Obj. II. Oc. o. The skin full of spicules.
— 16. Valve of a globiferous pedicellaria of *Strongylocentrotus drøbachiensis*, from the inside. Obj. II. Oc. I.
— 17. Spicules of *Echinus affinis*. Obj. V. Oc. I.
— 18. Sphæridia of *Strongylocentrotus drøbachiensis*. Obj. II. Oc. III.
— 19. Tridentate pedicellaria, large form, of *Echinus elegans*. Obj. o. Oc. o.
— 20. Valve of a tridentate pedicellaria of *Strongylocentrotus drøbachiensis*. Obj. o. Oc. I.
— 21. — — triphyllous — - *Echinus affinis*. Obj. II. Oc. III.
— 22. — — — — - — *elegans*. Obj. II. Oc. III.
— 23. Stalk of a globiferous pedicellaria of *Echinus elegans*. Obj. II. Oc. I.
— 24. Spine from the buccal plates of *Echinus esculentus*. Obj. o. Oc. o.
— 25. Globiferous pedicellaria, the neck protruded, of *Strongylocentrotus drøbachiensis*. The spicules are drawn only on the upper side of the head. Obj. o. Oc. I.
— 26. Valve of a globiferous pedicellaria of *Strongylocentrotus drøbachiensis*, from the side. Obj. II. Oc. I.
— 27. — — ophicephalous — large form, of *Echinus Alexandri*. Obj. II. Oc. o.
— 28. — — globiferous — of *Strongylocentrotus purpuratus*, from the side. Obj. II. Oc. o.
— 29. Globiferous pedicellaria, the neck retracted, of *Strongyloc. drøbachiensis*. Obj. o. Oc. III.
— 30. Spine of *Echinus esculentus*, the basal part. Obj. o. Oc. o.



Echinus, Sterechinus, Psammechinus, Strongylocentrotus.

Plate XXI.

Fig. 1. Valve of a tridentate pedicellaria of *Pseudoboletia maculata*. Obj. o. Oc. I.
— 2. — — — — - *Psammechinus verruculatus*. Obj. II. Oc. I.
— 3. — — — — - *Tripneustes esculentus*. Obj. II. Oc. o.
— 4. — — — — - *Gymnechinus Robillardi*, from the side. Obj. II. Oc. I.
— 5. — — ophicephalous — - *Pseudoboletia maculata*. Obj. II. Oc. I.
— 6. — — tridentate — - *Anthocidaris homalostoma*. Obj. II. Oc. o.
— 7. — — — — - *Gymnechinus darnleyensis*. Obj II. Oc. I.
— 8. — — — — - *Pseudocentrotus depressus*. Obj. o. Oc. o.
— 9. — — — — - — — Obj. II. Oc. o.
— 10. — — — — - *Psammechinus variegatus*. Obj. II. Oc. o.
— 11. — — — — - *Gymnechinus Robillardi*, from the inside. Obj. II. Oc. I.
— 12. Spicules of *Sphærechinus granularis*. Obj. V. Oc. III.
— 13. Valve of a globiferous pedicellaria of *Toxopneustes pileolus*. Obj. II. Oc. o.
— 14. Spicules of *Pseudocentrotus depressus*; a. from the tube feet, b. from the pedicellariæ. Obj. V. Oc. o.
— 15. Valve of a tridentate pedicellaria of *Pseudocentrotus depressus*. Obj. II. Oc. o.
— 16. — — — — - *Tripneustes esculentus*. Obj. II. Oc. o.
— 17. — — — — - *Pseudoboletia maculata*, small form. Obj. o. Oc. I.
— 18. Plates from the buccal membrane and the gills of *Echinus Alexandri*; a. from the buccal membrane inside of the buccal plates, b. c. from the gills. Obj. II. Oc. I.
— 19. Piece of the stalk of a pedicellaria of *Echinus Alexandri*. Obj. V. Oc. I.
— 20. — — edge of a tridentate pedicellaria of *Ech. Alexandri*. Obj. V. Oc. III.
— 21. Spicules of *Toxopneustes pileolus*; a. from globiferous pedicellariæ, b. from tube feet, c. from the buccal membrane. Obj. V. Oc. I.
— 22. Valve of an ophicephalous pedicellaria of *Tripneustes esculentus*. Obj. II. Oc. I.
— 23. Spicules from pedicellariæ of *Gymnechinus darnleyensis*. Obj. V. Oc. III.
— 24. — - *Gymnechinus Robillardi*; a. from pedicellariæ, Obj. V. Oc. I, b. from the buccal membrane. Obj. II. Oc. I.
— 25. Piece of the edge of a tridentate pedicellaria of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. III.
— 26. — — stalk of a pedicellaria of *Echinus acutus*, var. *Flemingii*. Obj. V. Oc. I.
— 27. Plate from the buccal membrane, outside of the buccal plates, of *Echinus Alexandri*. Obj. II. Oc. I.
— 28. Spicules from pedicellariæ of *Psammechinus verruculatus*. Obj. V. Oc. III.
— 29. — - — - *Pseudoboletia maculata*. Obj. V. Oc. I.
— 30. — - tube feet of *Anthocidaris homalostoma*. Obj. V. Oc. o.
— 31. — - globiferous pedicellaria of *Psammechinus variegatus*; a developmental series. Obj. V. Oc. III.
— 32. — - tube feet of *Parasalenia gratiosa*. Obj. V. Oc. I.
— 33. — of *Tripneustes esculentus*; a. from globiferous pedicellariæ, b. from tube feet, c. d. from the buccal membrane. Obj. V. Oc. I.
— 34. Valve of a tridentate pedicellaria of *Sphærechinus granularis*. Obj. o. Oc. I.
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— 37. — — — — - *Sphærechinus granularis*, from the inside. Obj. II. Oc. o.
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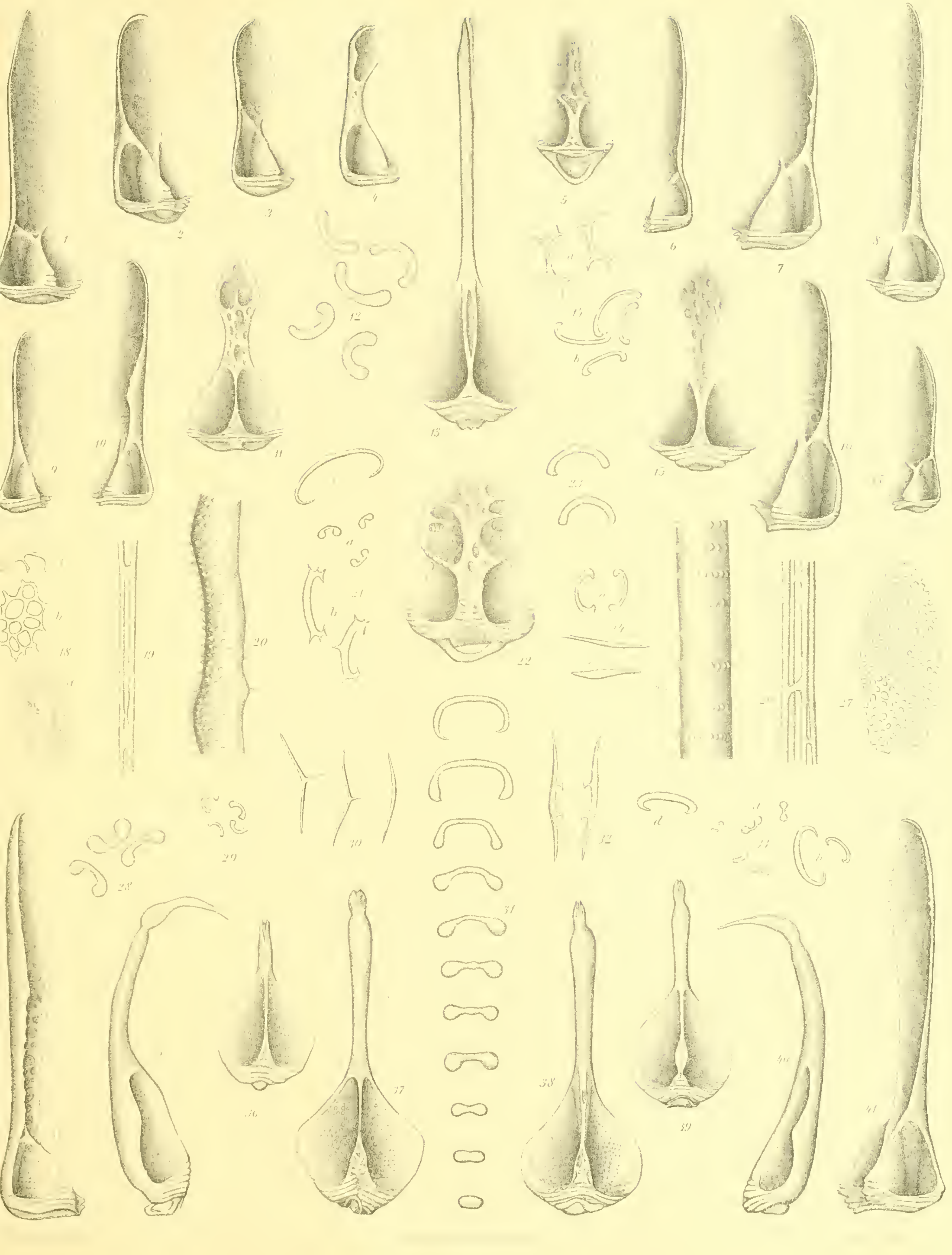
— 41. — — tridentate — - *Toxopneustes pileolus*. Obj o. Oc. o.



Echinidae. Toxopneustida

THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
1	62° 30'	8° 21'	132	7°2	24	63° 06'	56° 00'	1199	2°4	45	61° 32'	9° 43'	643	4°17
2	63° 04'	9° 22'	262	5°3	25	63° 30'	54° 25'	582	3°3	46	61° 32'	11° 36'	720	2°40
3	63° 35'	10° 24'	272	0°5		63° 51'	53° 03'	136		47	61° 32'	13° 40'	950	3°23
4	64° 07'	11° 12'	237	2°5	26	63° 57'	52° 41'	34	0°6	48	61° 32'	15° 11'	1150	3°17
5	64° 40'	12° 09'	155			64° 37'	54° 24'	109		49	62° 07'	15° 07'	1120	2°91
6	63° 43'	14° 34'	90	7°0	27	64° 54'	55° 10'	393	3°8	50	62° 43'	15° 07'	1020	3°13
7	63° 13'	15° 41'	600	4°5	28	65° 14'	55° 42'	420	305	51	64° 15'	14° 22'	68	7°32
8	63° 56'	24° 40'	136	6°0	29	65° 34'	54° 31'	68	0°2	52	63° 57'	13° 32'	420	7°87
9	64° 18'	27° 00'	295	5°8	30	66° 50'	54° 28'	22	1°05	53	63° 15'	15° 07'	795	3°08
10	64° 24'	28° 50'	788	3°5	31	66° 35'	55° 54'	88	1°6	54	63° 08'	15° 40'	691	3°9
11	64° 34'	31° 12'	1300	1°6	32	66° 35'	56° 38'	318	3°9	55	63° 33'	15° 02'	316	5°9
12	64° 38'	32° 37'	1040	0°3	33	67° 57'	55° 30'	35	0°8	56	64° 00'	15° 09'	68	7°57
13	64° 47'	34° 33'	622	3°0	34	65° 17'	54° 17'	55		57	63° 37'	13° 02'	350	3°4
14	64° 45'	35° 05'	176	4°4	35	65° 16'	55° 05'	362	3°6	58	64° 25'	12° 09'	211	0°8
15	66° 18'	25° 59'	330	—0°75	36	61° 50'	56° 21'	1435	1°5	59	65° 00'	11° 16'	310	—0°1
16	65° 43'	26° 58'	250	6°1	37	60° 17'	54° 05'	1715	1°4	60	65° 09'	12° 27'	124	0°9
17	62° 49'	26° 55'	745	3°4	38	59° 12'	51° 05'	1870	1°3	61	65° 03'	13° 06'	55	0°4
18	61° 44'	30° 29'	1135	3°0	39	62° 00'	22° 38'	865	2°9	62	63° 18'	19° 12'	72	7°92
19	60° 29'	34° 14'	1566	2°4	40	62° 00'	21° 36'	845	3°3	63	62° 40'	19° 05'	800	4°0
20	58° 20'	40° 48'	1695	1°5	41	61° 39'	17° 10'	1245	2°0	64	62° 06'	19° 00'	1041	3°1
21	58° 01'	44° 45'	1330	2°4	42	61° 41'	10° 17'	625	0°4	65	61° 33'	19° 00'	1089	3°0
22	58° 10'	48° 25'	1845	1°4	43	61° 42'	10° 11'	645	0°05	66	61° 33'	20° 43'	1128	3°3
23	60° 43'	56° 00'	Only the Plankton-Net used		44	61° 42'	9° 36'	545	4°8	67	61° 30'	22° 30'	975	3°0

Station Nr.	Long. W.	Lat. N.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	—0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	—0°6	130	63° 00′	20° 40′	338	6°5
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′6	23° 47′6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′3	23° 56′2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					

Jan Mayen
GRÖNLAND
ISLAND
Færöerne
Danmarks Stræde
Davis Strade
Godhavn
Egedesminde
Holstensborg
Sukkertoppen
Godthaab
Frederikshaab
Julianehaab
C. Farvel
Angmagsalik
Reykjavik
under (below) 0°
over (above) 0°
0 – 100 danske Favne (danish fathoms)
100 – 300
300 – 600
600 – 700
700 – 1000
over / above 1000
Grænselinie mellem koldt og varmt Bundvand
(Limit between cold and warm water at the bottom)
30° V f. Greenwich

With the Comp

THE DANISH INGOLF-EXPEDITION.

VOLUME IV.

2.

ECHINOIDEA.

(PART II.)

BY

TH. MORTENSEN.

WITH 19 PLATES AND 27 FIGURES IN THE TEXT.

COPENHAGEN.
PRINTED BY BIANCO LUNO.
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CONTENTS.

Echinoidea.

Echinoidea.

II

by

Th. Mortensen.

As in the Introduction to Part I of the Ingolf -Echinoidea I have the agreeable duty to tender my best thanks to several Colleagues, who have assisted me by sending material or otherwise. I beg to offer my sincerest thanks to Dr. F. A. Bather, Professor F. Jeffr. Bell, Prof. C. Chun, Prof. L. Döderlein, Dr. R. Fourtau, Prof. L. Joubin, Prof. R. Koehler, Dr. J. Lambert, Prof. H. Ludwig, Prof. E. v. Marenzeller, Dr. J. C. H. de Meijere, Dr. M. Meissner, Prof. G. Pfeffer, Prof. R. Rathbun, Miss M. J. Rathbun, Prof. Hj. Théel, Prof. A. E. Verrill, Prof. M. Weber. I am especially indebted to Professor Döderlein for sending me the proof sheets of his great work on the Echinoidea of the German Deep-Sea Expedition and thus enabling me to use this work, before it was published. — Of material importance for my study of the irregular Echinoids have been repeated visits to the British Museum, where Professor F. Jeffr. Bell with his usual great liberality gave me access to the extremely important collection of Echinoidea from the Challenger -Expedition as well as the other extensive collections of Echinoids in this Museum. Further, it was of the highest importance for me that I was, through the liberal grant of the Carlsberg Fund, enabled to visit those North American Museums in which more considerable collections of Echinoidea are preserved. It was, of course, rather a great disappointment for me that I could not get permission to make any studies of the large and extremely important collections in the Museum of Comparative Zoology at Harvard College; but, fortunately, I found in the U. S. National Museum, where I met the greatest liberality from Professor R. Rathbun and Miss M. J. Rathbun, almost all the types which I wanted especially to study; and the study of the rich collections from the Albatross preserved there also gave many important results. Likewise I had occasion to make several important observations in the Peabody Museum, Yale College, where Professor A. E. Verrill most liberally gave me access to the whole collection of the Museum.

Copenhagen, February 1907.

The Author.

Introduction.

Since the publication of the first Part of this work (1903) three great and highly important works on Echinoids have been published, viz. De Meijere: Die Echinoidea der Siboga-Expedition (1904. Siboga-Expeditie. XLIII), A. Agassiz: The Panamic Deep-Sea Echini (1904. Mem. Mus. Comp. Zool. XXXI) and L. Döderlein: Die Echinoiden der deutschen Tiefsee-Expedition (1906. Deutsche Tiefsee-Exped. 1898—99. Bd. V). De Meijere and Döderlein agree with me upon the whole in the views on the classification of the regular Echinoids and on the systematic importance of pedicellariæ and spicules set forth by me in the first part of this work and in my work on the Echinoidea (I) of the Danish Expedition to Siam 1899—1900 (Mém. Acad. Roy. d. Sc. et d. Lettres de Danemark. 7. Sér. I. 1904). De Meijere only reserves his opinion as to my classification of the Cidarids, though recognizing the importance of the differences in the structure of the pedicellariæ made known by me; his objections that my diagnoses of the genera do not correspond with some of his new species and that my classification leads to a great dismemberment of the system, I have replied to in my paper "On some Echinothurids from Japan and the Indian Ocean" (Ann. Nat. Hist. Ser. 7. Vol. XIV. 1904. p. 91—92). Döderlein after most careful and extensive researches states the general correctness of my views, though, as might be expected from his somewhat better material, he has been able to improve the classification in several respects. Above all his results as regards the classification of the *Cidaridæ* are highly important, and his arrangement of this family will doubtless prove correct, in any case for the very largest part of it; upon the whole, I think, Döderlein is quite right in the several corrections of my arrangement of genera and species of the regular Echinoids, though on this occasion I cannot enter on a further discussion thereof. (I must, however, reserve my opinion as to Döderlein's views of the species of *Sterechinus*, till I have made renewed studies on this group, which I intend to undertake in the works on the Echinoidea of the German and the Swedish South Polar Expeditions). On this occasion I can only express my admiration for the very clear and sound way in which Professor Döderlein in his Introduction sets forth the signification of such structures as the pedicellariæ in the classification of Echinoids and meets the different objections which have been or might be made against this use of them.

In marked contrast to these two authors Professor A. Agassiz practically rejects all my results, and expresses his contrary opinions in a way that seems to me not justified even by so great a renown as his. The objections set forth by the famous author I do not find very strong, except as regards the way in which they are expressed; but, of course, any criticism by so eminent an authority on the Echinoidea demands a careful and detailed consideration. It was my intention to publish a reply to the more personal criticisms of Professor Agassiz as a separate paper in some Periodical; but though I might well be entitled to have published in some American Journal a defence against an unjust accusation of gratuitous misrepresentation of facts set forth in one of the most prominent American Periodicals by one of the most famous American Naturalists, I could not succeed in getting it published and I must therefore publish the necessary remarks here.

In the introduction to his memoir Professor Agassiz states that I show but little appreciation of the work of my predecessors, and De Meijere is included under this accusation, since he agrees with me in regarding the minute microscopical structures of pedicellariæ and spicules as of considerable importance for classification. Dr. Mortensen, says Professor Agassiz, practically rejects all the work of his predecessors and challenges it as worthless because it is not based upon his methods for the solution of all Echinological problems. Like all classifications based upon a single character the results obtained culminate in such impossible associations that we are loath to follow his lead. — I must protest against the temper and style of criticism adopted by Dr. Mortensen; even if he were right, his assumption of omniscience is offensive to the utmost, and his personal remarks are entirely out of place in a scientific memoir. He concludes these very unrestrained remarks with the following quotation from a newspaper: The results should diminish the patronizing certainty of knowing it all which distinguishes Dr. Mortensen's work, and forbids us, his predecessors, to discuss matters of which we must be in the nature of the case, wholly ignorant.

First, as regards the temper and style of my criticism, I must confess my deep regret at having been so unhappy in my mode of expression. I always had and will have a very great respect for the author of that immense work The Revision of Echini, which must always remain the basis for the study of recent Echinoidea, even though its classification may prove untenable and the descriptions of genera and species more or less unsatisfactory. When my examination of the original material in the British Museum led me to publish several corrections of the same author's Report on the Challenger-Echinoidea, I always endeavoured to give them in the simplest way, stating only the facts without comment or reproach, but, I confess, also without praise. This procedure, dictated though it was by my respect for the author of the Revision of Echini, has had the unfortunate result that Professor Agassiz has taken it as an offensive assumption of omniscience; for it is, of course, unreasonable to suppose that the eminent author has been tempted to ascribe offensiveness to the mere demonstration of errors. Once again, I repeat my deep regret at this result and can only state that I tried my best to avoid expressions which could be regarded as offensive. If I have been unsuccessful in this respect, that may perhaps be partly ascribed to the circumstance that my work has been translated from Danish, in which language it was written by me. Probably I may not be quite aware of the full significance of all the English expressions used, so that more may sometimes have been said than I have meant to say. — That the errors found out had to be corrected, I think, everybody will agree; in any case I deem it the unconditional duty of every scientist to correct any erroneous statements he detects in literature, to prevent their going on and on in future literature, causing error on error, which will especially be the case with such statements occurring in the works of so famous an authority as Professor Agassiz.

As for the work of my predecessors, when Professor Agassiz states that I practically reject the whole of it, challenging it as worthless, because it is not based upon my methods for the solution of all echinological problems,» I venture to think that he does not do me justice. Setting aside for the moment the famous Report on the Challenger -Echinoidea, surely Professor Agassiz has observed that I regard, for instance, Wyville Thomson's work on the Porcupine -Echinoidea as one of the very best ever published on the recent forms, and that I have the most profound respect for Professor Döderlein's great work on the Cidarids, for the works of Professor Koehler, and for many others whom I might name. That I do not agree with these authors in all points, is far from implying a slight appreciation of their work. As for challenging it all as worthless because it is not based upon my (his) methods for the solution of all Echinological problems , can it really be necessary for me to express my conviction that any accurate and careful scientific research retains its worth, whatever method has been used? — If it be found, however, that some structure like the pedicellariæ is eminently important for classification, then consequently no species of which the test only has been described (however perfect that description may be) can be assigned to its definite position in the system before that special structure has been made known. This logical conclusion is far from being that implied by Professor Agassiz in the following remark (Op. cit. p. 19): The height of absurdity is finally reached when we are told that nothing can be said of the affinities of species of which pedicellariæ have not been examined (by him). The word nothing» as used by me, when taken in reasonable connection with the context, is seen to mean that one cannot say with certainty to which genus such a species belongs, e. g. *Goniocidaris Döderleini* (Part I. p. 28) or *Asthenosoma longispinum* (Ibid. p. 56), and in such places I have added the words with certainty. That in any case my proviso applies only to those families in which pedicellariæ are of prominent systematic importance should be self-evident, but it may not be superfluous to state the fact explicitly here. For the rest Professor Agassiz will probably himself admit that he was not justified in designating as an absurdity my view that species, whose most important systematic characters are unknown, cannot be assigned to their true position, seeing that Professor Döderlein, whom both Agassiz and I honour with the highest appreciation for his profound and elaborate works, now also puts aside as *incertæ sedis* such species as *Dorocidaris panamensis* A. Ag. and *Porocidaris Sharreri* A. Ag. on account of their pedicellariæ being unknown, though they are otherwise very carefully described. (Echinoiden d. deutsch. Tiefsee-Exped. p. 103.)

To turn to my personal remarks, which are characterised as being entirely out of place in a scientific memoir , I have already stated that I avoided personalities as far as possible, and in the whole of my work I can recall only two remarks to which Professor Agassiz might object on such grounds. The study of the Challenger Echinoids preserved in the British Museum has shown me that Professor Agassiz has in several cases put one or more notes of interrogation on the labels in the jars, but has omitted to mention in the text that the identification was doubtful. Without seeing the labels no one would imagine that the published statements are really doubtful. They appear in the work as certain facts and as such have been quoted by other authors with the consequent multiplication of insecurely based conclusions. On this subject I observed: this way of proceeding is very objectionable , and on p. 58: it cannot be considered to be correct to figure details of a specimen, referred with doubt to some species, without any reservation under the name of that species. I do not think these remarks out of place, where such facts are pointed out; but it is evidently these small reflections which have caused the above-cited remark of Professor Agassiz, as well as the following: Having stated in one part of the Challenger-Report that I considered some young specimens from Stations 184 and 219 as perhaps not belonging to *A(sthenosoma) gracilis.* I am corrected for not repeating this every time I mention *A. gracilis!* (Op. cit. p. 84) and Having made that statement (on *A. gracile*) I am taken to task by Dr. Mortensen for having made a statement in one place and not having repeated it somewhere else (Op. cit. p. 105). — Again Professor Agassiz writes: I have no doubt that in the mass of material collected by the Challenger which passed through my hands I must have failed to distinguish all the species. I was frequently in doubt as to the identification of certain specimens. That doubt was usually indicated on the labels accompanying them, but Dr. Mortensen has no words to express his horror at such a proceeding (Op. cit. p. 85). In the place to which Professor Agassiz refers here (Ingolf-Ech. p. 57) I have said: on the label was found a point of interrogation but of this doubt nothing is said in the text and St. 272 is given without any reservation as a locality of *Phormosoma tenue*. That is all. It is really too bad to credit me with such folly as to object to the marking of one's doubt on the labels when the identification of the specimens remains doubtful — a thing which every careful student of Echinoderms knows will occur now and then, especially when the material is not in the best state of preservation. Of course I have never thought of reproaching Professor Agassiz for doing this, but I do think that, when the identification is doubtful, some doubt should be indicated in giving the localities of the species. I hope Professor Agassiz will pardon me if I venture on a few instances:

Asthenosoma gracile. On p. 90 (Challenger-Echinoidea) is written: small specimens of *Asthenosoma* from Stations 184 and 219 are referred to this species with considerable doubt; on p. 91 are named the following localities for *A. gracile:* Stations 219, 200, 184 and 169. In my opinion Stations 184 and 219 ought not to have been mentioned here at all, but, if they were to be mentioned, a note of interrogation should certainly have been added. Again, it was incorrect to give Station 169 at this place, as may be seen from The Panamic Deep-Sea Echini p. 108, where Professor Agassiz writes: Among the specimens left at Cambridge, I had occasion to examine a specimen *(A. gracile?)* from Challenger Station 169, and am able to give some details and figures of this specimen, plainly showing that it is not an Asthenosoma but a new species of Phormosoma allied to *Ph. hispidum*. It thus appears that the original identification of this specimen was also doubtful though no hint of this was given in the text. This apparently trivial point is really one of much importance. By giving as certain what really is uncertain or even, as Professor Agassiz now admits, quite erroneous, the species *A. gracile* has been stated to occur at the Philippines, the Admiralty Islands, East of Torres Strait and East of New Zealand, at a depth of 150—1400 fathoms, whereas the species was at that time really known only from the Philippines from a depth of 255 fathoms. (Such erroneous statements are not excused even if it be found later that the species really occurs in such localities and depths.) In the lists concluding the Challenger Report the bathymetrical distribution of this species is said on p. 210 to be 150—255 fathoms, while on p. 268 are named Stations 169 (700 fathoms), 184 (1400 fathoms), 219 (150 fathoms) without any reservation. Any student of geographical distribution would naturally conclude from these statements that the bathymetrical distribution of *A. gracile* has been shown by Professor Agassiz in the Challenger Echinoidea to be from 150—1400 fathoms, for it can scarcely be expected of such students that they should study the descriptions of all the species they are dealing with, on the chance of finding out that their localities were not given correctly in a classical work written by the most celebrated authority.

In the preceding instance, it is true, careful perusal of the text might have raised a doubt in the mind of the student; but under *Phormosoma uranus* there is nothing said in the text about doubtful identification. On this case I have written (Part I. p. 58): In the description of *Phormosoma uranus* Agassiz uses the expression the only specimen collected, but nevertheless puts down for it two different localities, St. 6 and St. 78. This riddle I am able to solve. In (the) British Museum a quite small Echinothurid is found from Chall. St. 78 determined by Agassiz as *Ph. uranus*?? On this basis St. 78 is named without any reservation as a locality of *Ph.» uranus* (comp. *Calveria gracilis* and *Echinosoma tenue*). With regard to this specimen, it is otherwise very badly preserved, and not a single pedicellaria is kept. It is quite indeterminable, and consequently it cannot be considered to be correct to figure details of this specimen under the name of *Phormosoma uranus* (without any interrogation), as has been done by Agassiz (Chall. Ech. Pl. XVIII. c. fig. 12). I think it cannot be denied that my remark is quite true and very moderate and not entirely out of place. But I might have added that by this incorrect mention of Station 78 the bathymetrical distribution of the species becomes 1000—1525 fathoms, as, indeed, is definitely stated in the list on p. 311, whereas the species was then really known only from a depth of 1525 fathoms. — Since I merely wish here to justify my personal remarks I will not in this place allude to further instances of this kind to be found in the Report on the Challenger Echinoidea, but I cannot pass from this subject without suggesting that the personal remarks of Professor Agassiz, while not more moderate in their expression, are perhaps more out of place than mine.

To pass to another criticism by Professor Agassiz (Panamic Deep-Sea Echini p. 18): Dr. Mortensen harps on the fact that a great many species of Cidaris as well as other Echinoids have been proved by him to belong to other genera than those to which they were referred by others, and thus he constantly finds a fine demonstration of the trustworthiness of the statements hitherto found in the literature with regard to the occurrence and distribution of these animals! Once given his genera, the rest naturally follows, and we have nothing left of what has preceded. This again might seem very foolish in me, but the facts are really not quite those that might be inferred from this remark by Professor Agassiz. What I actually wrote in this connection is as follows (Part I. p. 171—172): Thus I have established the fact that no less than 8 different species, of which, moreover, only one belongs to the genus *Dorocidaris*, have in the literature been wrongly referred to *D. papillata*, viz. *Dorocidaris nuda*, *Tretocidaris annulata*, *spinosa*, *Cidaris affinis*, *baculosa* and another *Cidaris*-species (Chall. St. 204), *Stereocidaris Lorioli* and another *Stereocidaris*-species (Chall. St. 310) — a fine demonstration of the trustworthiness of the statements hitherto found in the literature etc. It will, I hope, be conceded that this remark is not quite so foolish as would appear from Professor Agassiz' presentation of it. The main thing in systematic reports, lists of collections etc. is, so far as I can see, the right identification of the species; whether the species be referred to one genus or another is thus far of secondary importance and may be a matter of discussion among specialists. But the species are the units with which science has to work. Wrong identifications of species must cause all later work founded on these identifications to be erroneous and, indeed, lost labour. As I have found that 8 different species had been wrongly mentioned in literature under the name of *Dorocidaris papillata*, I thought and still think my remark on the trustworthiness of such statements quite justified. If I had made that remark on account of the species *Dorocidaris papillata* having been referred to different genera, the above cited remark of Professor Agassiz would have been justified; but the case is really quite the reverse. It may not be superfluous to state that in consequence of the erroneous determinations in the case cited above of *Dorocidaris papillata*, this species is stated to occur at La Plata, the Philippines and in the Red Sea, whereas it is really known only from the Northern Atlantic (as far south as St. Paul rocks) and the Mediterranean. — A few other instances may be given:

Echinus norvegicus is stated (Chall. Echini p. 117) to have been taken by the »Challenger» at Cape Cod (St. 46 and 47), off the West coast of Patagonia (St. 308) and off Japan (St. 232 and 235). The alleged occurrence at Patagonia has proved of particular importance, causing this species to be ranged among »bipolar» animals. Examination of the specimens in the British Museum (except those from St. 235) gives the following result: The specimens from St. 46 and St. 47 are *Echinus affinis*, those from Patagonia (St. 308) are partly *Echinus magellanicus* and partly another species of *Echinus*, closely allied to *Ech. elegans*. (My examination does not enable me to state with certainty to which species the latter belong, but it shows clearly that they are not *Echinus norvegicus* (= *acutus*)). The specimens from St. 232 are probably *Echinus lucidus*, certainly not *E. norvegicus* and it seems a natural inference that those from St. 235 are not *E. norvegicus* either. It thus follows that there is not a single specimen of *E. norvegicus* among all the specimens referred to that species in the »Challenger» Report. Consequently, the almost cosmopolitan distribution of this species and its bipolar nature both of which have been deduced from the statements of that report can no longer be upheld.

For *Temnopleurus Hardwickii* the following localities are given in the »Challenger» Echinoidea (p. 107): Kobi, Japan; Arafura Sea; off Yokohama and St. 192 (at the Kei Islands). I have examined all the specimens in the British Museum and found them to be as follows: Kobi — *Temnopleurus toreumaticus*; Arafura Sea — a very young specimen, probably *T. toreumaticus*; St. 192 — a beautiful specimen representing a new species of the very interesting genus *Opechinus*, known hitherto only as fossil — one of the most interesting species taken by the »Challenger»[1]. — Thus it is only the specimens from Yokohama which are really *T. Hardwickii*[2].

The preceding instances are perhaps enough to justify the epithet »untrustworthy» as applied to the older identifications made without microscopical examination of pedicellariæ, spicules and other parts. If further justification is demanded, numerous other instances of wrong identification will be found pointed out in both parts of this work as well as in the work on the Siam-Echinoidea — from the works of Professor Agassiz as well as from other, less famous authors.

Professor Agassiz finds it »childish to be constantly lamenting, as do Dr. Mortensen and Dr. de Meijere, the loss of a specimen, if examined by the old method, necessary for the examination of the test, and of the actinal and abactinal systems. Surely we cannot welcome a method which deliberately saves a specimen in order to remain ignorant of its structure». (Op. cit. p. 19.) I fully agree with Professor Agassiz that it is the duty of the describer of new or imperfectly known species to elucidate as fully

[1] This species was described by me as *Opechinus spectabilis* in »The Danish Expedition to Siam 1899–1900. Zoological Results. II. Echinoidea. I. Mém. Acad. Sc. Copenhagen. 7. Ser. I. 1904, p. 94. Also, the *Pleurechinus variabilis* Döderlein proved to belong to the genus *Opechinus*.

[2] Op. cit. p. 62.

as possible all the structures known to be of classificatory importance, and Professor Agassiz will, I hope, recognize that I have done my duty in this respect. If I have characterised some new species mainly by the structure of their pedicellariæ, this is due to the fact that the specimens, being in the possession of foreign museums, were not at my full disposal. Moreover, I have established such new species only when convinced of having made known sufficient characters for their certain recognition. It does, however, seem to me that any method which enables one to determine the species of a rare specimen without destroying or damaging it, is to be welcomed. Such a method is presented in many cases, though certainly not in all, by the study of the pedicellariæ; if by adopting this method we can preserve some beautiful or rare specimen undamaged in a Museum, surely the destruction of such a specimen would be regrettable. Hence I have cited with approbation the remark of Stewart: that we may be enabled by the examination of even an ambulacral tube or pedicellaria etc. to determine a species without denudation of portions of the corona, which is sometimes not desirable . Apart from this, even Professor Agassiz will agree, surely, that one may lament the loss of type-specimens of several of the insufficiently described species of older authors without being stigmatised as childish ; but I have never lamented the loss of specimens due to the necessary examination of the test; indeed I fail to see, why the removal of a few spines from the test should involve the loss of the specimen. Possibly Professor Agassiz has interpreted my occasional use of the word destroy to mean loss, though my intention was to allude only to the destruction of the beautiful appearance of the specimens. — For the rest, I may refer to the remarks of Professor Döderlein (Op. cit. p. 70) on this question, with which I fully agree, denn (auch) ich stehe auf dem Standpunkt, dass ich nur dann eine Art als genügend gekennzeichnet ansehe, wenn die alte Methode, die Beschreibung von Schale u. s. w. vereinigt ist mit der neuen Methode der Beschreibung der Pedicellarien u. s. w.

I now come to the gravest accusation brought against me by Professor Agassiz, that of gratuitous misrepresentation of facts . On p. 25 (Op. cit.) Professor Agassiz says: Dr. Mortensen names as *Dorocidaris micans* specimens of a Cidaris which he received from the U. S. National Museum, Washington, labelled as *Porocidaris Sharreri* (Albatross 1885. St. 2415) and also from the U. S. Fish Commission (‹Albatross 1885. St. 2345) under the same name. I beg to call Dr. Mortensen's attention to the fact that the publication of the «Blake› Echini dates back to 1883, and that I was in no way concerned in making the collection of the Albatross in 1885, or with the identification of the Echinoids then collected. Dr. Mortensen's statements (Ingolf Echinoidea. pp. 22, 23) in regard to *Porocidaris Sharreri* are gratuitous misrepresentations of facts . — My remarks on *Porocidaris Sharreri* run thus (loc. cit.): Agassiz unfortunately gives no details as to the pedicellariæ, and from the figure (op. cit. Pl. III) it cannot be decided whether it is a genuine *Porocidaris*. There seems to be no highly developed neck on the spines (in the text nothing is said of this feature); the pedicellariæ might well look like those of *P. purpurata*, but a close examination will be necessary for the decision. By the kindness of Prof. Rathbun I have from (the) U. S. National Museum received a specimen determined as *P. Sharreri* (Albatross 1875. St. 2415); it proved to be the new species *Stereocidaris ingolfiana* described hereafter; it has no relation to *P. Sharreri*. Further I have in (the) British Museum seen a specimen determined as *P. Sharreri*, from the U. S. Fish Commission (Albatross· 1885. St. 2345). Neither seems this specimen to be identical with the real, figured *P. Sharreri*, at all events it does not to any striking degree resemble the figure given by Agassiz. It is no *Porocidaris*. — Here follows a description of the pedicellariæ and spines of the specimen. — Perhaps the specimen of *Porocidaris Sharreri* mentioned by Agassiz (9. p. 13) which was of a light greenish pink color when alive, the spines white with a delicate brownish-pink base is identical with the specimen described here — in this case this specimen mentioned by Agassiz has certainly not been of the same species as the one he figures; but this latter must, of course, keep the name of *Sharreri*. There can be no doubt that the specimen described here is a new species: whether it is also to be regarded as a new genus, or belongs to *Dorocidaris*, can only be decided, when the systematic significance of the spines has been established. For the present it ought to be classed with *Dorocidaris* under the name of *D. micans* n. sp. Now I really must ask, what is the misrepresentation of which I am accused in this passage? I have not in the slightest way credited Professor Agassiz with the erroneous determination of the specimens sent to me from the U. S. National Museum or seen by me in the British Museum[1] — and I am unable to see what else can be the meaning of the accusation. Professor Agassiz also makes a similar accusation in another case (p. 85): Dr. Mortensen holds me responsible for the identification of specimens of *Ph(ormosoma) uranus* and *Ph. Petersii* sent by the Smithsonian (National Museum) to the Copenhagen Museum and to Professor Koehler. I must repeat again that I know nothing of the specimens collected by the Albatross in the Atlantic after the publication of the Challenger Echini. — I also must repeat again that I have not held or thought of holding Professor Agassiz responsible for the identification of those specimens, and to this statement everyone must agree who will take the trouble to read my remarks on this matter (Part I. p. 58—59). I beg, therefore, to suggest to Professor Agassiz that he must have laboured under a misapprehension when accusing me of gratuitous misrepresentation of facts; and I hope he will now do me the honour to recognize that, so far from there being a gratuitous misrepresentation, there was no misrepresentation at all.

Before entering on a discussion of the more detailed criticisms found in the work of Professor Agassiz I would on general grounds protest against the denunciation of my classification as based on a single character. On the contrary, every effort has been made to do justice to all available characters. Researches on the classificatory value of the characters found in the different structures led me to believe that the pedicellariæ were of special importance, but I did not beforehand plan that the classification should be based on those organs, as might be gathered from the following sentence of Professor Agassiz: Dr. Mortensen planned what he modestly calls a profound[2] and careful attempt at penetrating into the mysteries of the relationship of the Echinoids based upon a study of the pedicellariæ. (Op. cit. p. 106.) The continuation of the quotation from my work (p. 3) runs thus: — and the plan was the simple, but clear one: to let litterature alone for the present, while the animals were studied thoroughly. Everything had to be examined, that might in any way be supposed to show systematic characters: the test, the spines, the tube-feet, the pedicellariæ, the spicules, the sphæridiæ etc. Anyone who will take the trouble to look at my diagnoses of, for example, the genera of *Echi-*

[1] I may say that in the U. S. National Museum I found a specimen from the Blake 1878—79 (No. 151. Off Nevis. 356 fathoms) named *Porocidaris Sharreri*, which is really *Stereocidaris ingolfiana*. This specimen has evidently been identified by Prof. Agassiz and thus proves that he has also made that error, of which I did not accuse him, but which he so ardently rejects.

[2] Perhaps the word profound has not quite the same meaning as the Danish word grundig used in this place; at least, the Danish word does not sound immodest.

nothuridæ and *Echinometridæ*, or better still, to read the chapter on the classification of the Diadematids in my paper on the Siam-Echinoidea (pp. 40—56) will recognize that my classification is not based on the pedicellariæ alone. It is true that my classification of the *Cidaridæ* is almost exclusively based upon the structure of the pedicellariæ; but that is due to my inability to find other characters which could be used with success. Any reader of my introductory remarks on the Family *Cidaridæ* will recognize that I have not omitted to take other characters into consideration, while the conclusion of that chapter is as follows (p. 31): When in the diagnoses of genera given here other features than pedicellariæ and spicules have only been mentioned exceptionally the opinion of course is not that these structures should be sufficient for definitive diagnoses. It has already been emphasized above, and I shall here emphasize once more that all these structures must be thoroughly examined in order to get the mutual relations of the forms established. That I have here only treated the pedicellariæ more thoroughly is a consequence of the fact that neither my material nor my time has permitted me to treat the other features more particularly. The system of the Cidarids cannot get its definitive formulation, until all features have been examined in a greater number of species (or best in all species). What is given here is a provisional classification, which can scarcely be correct throughout... — Whilst I must thus decidedly protest against the accusation of having based my classification on a single character, I beg to suggest to Professor Agassiz whether that would not suit the classification of the *Echinometridæ* and *Echinidæ* given in the Revision of Echini . These Families are founded exclusively on the number of pores in the ambulacral plates, all the genera with only three pairs of pores being included in the family *Echinidæ*, those with more than three pairs of pores in the family *Echinometridæ*. And as for the impossible associations resulting from such artificial divisions according to one character I might suggest to Professor Agassiz whether the placing of *Hemipedina*, *Phymosoma*, *Echinus*, *Toxopneustes*, *Tripneustes* and *Evechinus (Heliocidaris)* in one subfamily, *Triplechinidæ*, as is done in the Revision , does not deserve to be thus characterized.

Professor Agassiz speaks in a very depreciatory manner of the results of my classification, which culminate in such impossible associations that we are loath to follow his lead . It would have been very interesting to hear some instances of these impossible associations, but unfortunately Professor Agassiz confines his examples to a few Cidarids. It scarcely seems fair to condemn the whole of my results on the evidence of a few debatable cases among the *Cidaridæ*, the classification of which family is expressly stated to be purely provisional. I should like to learn what are the impossible associations in my classification of the *Echinothuridæ*, *Echinometridæ* and the *Echinidæ*, the more so, since it was the greater naturalness of the associations resulting from my classification which were to my mind a proof of its correctness. I will, however, leave it to others to compare my arrangement of the forms included in, let us say, the genus *Strongylocentrotus* or in the Family *Echinometridæ* with the arrangement given in the Revision of Echini . And upon the whole I venture to believe that, since Professor Döderlein has now accepted my classification of these groups in the main points, it will be agreed, at least, that it cannot be so very unnatural; otherwise, so careful and judicious a naturalist, with so profound a knowledge of the whole class, would certainly not have accepted it.

Regarding the use of pedicellariæ in the definition of systematical characters of Echini Professor Agassiz agrees that it may be desirable to employ all the data possible from whatever source, which may throw any light on the subject . But the study of pedicellariæ has only added a new factor differing in no way in its potentiality from those formerly in use , and there are several difficulties to their use in classification. Like the other characters employed to distinguish the species they vary with age. They form no exception and do not appear fully fledged in the embryos and young specimens, in spite of Dr. Mortensen's statement to the contrary; though he acknowledges that there is in literature next to no more exact accounts of the development of the pedicellariæ of Echinoids. Certainly before making such a sweeping use of the minute and often infinitesimal characters supplied by pedicellariæ for classification it would have been instructive to trace the development of the several kinds of pedicellariæ, and obtain some data regarding the extent and nature of the variation of pedicellariæ during their growth. The only addition made by Dr. Mortensen to our knowledge of the development of pedicellariæ is shown on Figs. 15, 24, 30 Pl. XII of the Ingolf Echinoidea, giving three stages of a triphyllous pedicellaria of *Phormosoma placenta*. As long as we know so little regarding the nature of the relations of the large and the small pedicellariæ of the same kind to one another it seem useless to speculate on the improbability ... of the arrangements which must take place in the calcareous mass to make a small fully formed pedicellaria become a larger one . Every student of Echini is fully aware of the immense amount of resorption and rearrangement constantly taking place in the actinal and abactinal parts of the coronal plates in the interambulacral areas, and in the actinal and abactinal systems — changes that are far greater than those referred to above can be . — Further Professor Agassiz quotes my remark (p. 9): When no pronounced difference is found between large and small pedicellariæ, it may in fact be impossible to decide whether a certain specimen is to be regarded as a large or small form and adds that surely this acknowledgement that the pedicellariæ cannot be classified may throw some doubt on the statement that the pedicellariæ give absolutely excellent systematic characters (p. 106—7).

In reply to these objections I cannot do better than refer to the remarks of Professor Döderlein (Op. cit. p. 67—72). In a way that could scarcely be better or clearer the whole question is discussed there, and with full conviction I can subscribe to every word of it. Only a few remarks may be added. I want to state explicitly that I quite agree with the remark that the new factor (the pedicellariæ) differs in no way in its potentiality from those formerly in use ; it can never be said beforehand with certainty whether the pedicellariæ — or any other factor — are of primary importance in some group or not, only a careful comparative study can show the relative value of the different structural characters. I have never stated that the classification has always to be based on the pedicellariæ as the most important factor; on the contrary, I am of opinion that where structural characters of some significance occur in the test, these are upon the whole of higher classificatory value than the characters in the pedicellariæ. — The assertion that the pedicellariæ do not appear fully fledged in the embryos and young specimens in spite of Dr. M.'s statement to the contrary is quite unjustified. My statement is not founded on the accounts thereof in literature but on my own fairly extensive studies; and I would remark that I do not speak of the embryos in this connection but of the newly metamorphosed Echinoid (p. 7). All the different kinds of pedicellariæ may not perhaps be developed in the very young specimens; but those forms which are found do not differ essentially from those of the grown specimens, except in size. Until it is proved by facts that the pedicellariæ of the young specimens differ essentially[1] in structure from those of the grown ones my positive statement, founded on direct observations, that they are essentially alike must be accepted; by words alone it is not refuted, even if it be the words of an authority so famous as Professor Agassiz.

What most astonishes me in Professor Agassiz' objections against the systematic use of the pedicellariæ is his disbelief in my account of the development of the pedicellariæ. The whole matter seemed me so clear and its correctness beyond doubt that I did not find it necessary to figure the different developmental stages of all the different pedicellariæ in all the species. I might have filled several plates with figures of developmental stages of pedicellariæ. I have stated already in Part I. p. 6 that I have found such stages of development in most of the species I have examined , and this holds good also for those Echinoids, which I have studied since then. When Professor Agassiz states that the only addition made by me to the knowledge of the development of pedicellariæ is the development of a triphyllous pedicellaria of *Phormosoma placenta*, he has probably overlooked this remark as well as my figures of the developmental stages of a tridentate pedicellaria of *Phormosoma placenta*. Indeed, in spite of Professor Agassiz' doubt of the correctness of my view of the mode of development of the pedicellariæ, I do not find it necessary to give more figures thereof. I think nobody will follow the famous author in the belief that small pedicellariæ are gradually, through most intricate processes, transformed into large ones, a belief which is sustained by no facts, against my demonstration that the pedicellariæ develop at once to their final size. The reabsorption and rearrangement constantly taking place in the test can in no way be compared with the rearrangements that would be necessary for transforming a small, fully formed pedicellaria to a larger one. The changes in the test can all easily be understood as caused by the processes of absorption in some places and apposition in others, but by mere apposition a valve of a small tridentate pedicellaria with fully formed, even more or less decorated edges, could never get the form of a valve of a large tridentate pedicellaria. Even to suppose a process of intussusception would not help, the calcareous valves not being of a plastic matter like a plant-cell, but much more like some kind of crystalline structure.

Regarding the relation of pedicellariæ to the fossil forms Professor Agassiz remarks (p. 107): Dr. Mortensen does not fail to perceive that pedicellariæ are not likely to be of frequent use in the determination of fossil forms, and for that reason condemns the classification of all fossil forms, and, in passing, of the Irregular Echinoids . On this theme I have said (p. 8), after mentioning the description of the pedicellariæ of *Pelanechinus corallinus* by Groom and suggesting the possibility of also finding pedicellariæ in well preserved specimens of other fossil Echinoids: Of course, however, it will always be a rare thing — generally we have here to be content with the tests (and the spines). These structures also often give excellent characters, but they are far from being always reliable. The former great incertainty in the determination of the recent forms of regular Echinoids (and I think it is not much better with regard to the irregular ones) may be taken to imply that there cannot be any great certainty in the classification of the fossil forms either . — It seems to me that these few remarks are indeed very moderate and can not be said to condemn the classification of all fossil forms ; on the other hand, the fact that in all the families treated in Part I the pedicellariæ are of so great

[1] In *Echinus* the globiferous pedicellariæ appear to have the blade generally somewhat more open in young specimens than in the grown ones, as is pointed out by Döderlein. (Op. cit. p. 211.)

classificatory value, naturally led me to suppose that the same would generally be the case in all Echinoidea. Later studies on other families of the Echinoids (*Diadematidæ*, *Temnopleuridæ*, the Irregular Echini) have shown that these structures are not always of so high a value in classification, and in such groups the possibility of determination and classification of the fossil forms is, of course, more favourable than in those groups, where the pedicellariæ are of more importance, as in *Echinidæ*, *Toxopneustidæ*, *Echinometridæ* and, partly, *Cidaridæ*. In these groups it is certainly not too much to say that "there cannot be any great certainty in the classification of the fossil forms". — Regarding the classification of the Irregular Echinoidea I have not said a word on that subject in Part I, and accordingly I have not "condemned" it either in passing or in a more thorough way. I have only suggested that there would prove to be some uncertainty in the determinations of these forms, made without the use of the microscopic characters afforded by pedicellariæ etc. That I was quite right in that suggestion is, I think, sufficiently proved in this second Part of my work.

To turn now to the cases among the *Cidaridæ* pointed out by Professor Agassiz as especially unfortunate results of my classificatory attempts. Such a case is the uniting of *Cidaris metularia* and *verticillata* in one genus — "two species which are more readily distinguished by the characters of the spines and tests than any other species of the family". That *Cidaris baculosa* is added to the same genus is also held very unfortunate. It is true that *Cidaris verticillata* and *metularia* are very readily distinguished by their spines as well as by their tests; the differences found in the spines, however, could not convince me of the absurdity of uniting them in one genus, since I was unable to see very reliable generic characters in the structures of the spines — and certainly the differences between the spines of *C. verticillata* and *metularia* are not more important than are those between *C. verticillata* and *Phyllacanthus imperialis*, which are united in one genus in the "Revision of Echini". As for the differences in the structure of the test I might well have ascribed to them more systematic importance, if I had been fortunate enough to have had a specimen of this *C. verticillata* at my disposal and had been able to make a direct comparison. (It was upon the whole the lack of sufficient material for a comparative study of the tests of the Cidarids which made me unable to judge of the real value of these structures for the distinction of the genera.) Being then constrained to class the species after the structure of the pedicellariæ I could not get any other result than that these two species had "to be regarded as not too closely allied species of the same genus" (p. 15), and since Professor Döderlein (Op. cit. p. 101) after his very elaborate studies on the tests, the pedicellariæ and spines of the Cidarids has now come to the result that *C. vertillata*, *baculosa* and *metularia* have to be placed in the same genus, only in different subgenera, I cannot think my result so very unnatural.

That *Cidaris affinis* is separated from *Dorocidaris papillata*, with which latter species it was hitherto made synonymous, and even placed in another genus, Professor Agassiz finds erroneous. "There is nothing in the figures of the pedicellariæ given by Mortensen to warrant such a transposition" (p. 22). As evidence thereof the figures of pedicellariæ of these two species given on Pl. IX are cited. That the figures of the tridentate pedicellariæ as well as those of the small globiferous pedicellariæ do not show so very important differences I willingly agree, but I have not used these differences as distinguishing characters of the genera *Dorocidaris* and *Cidaris*. The main difference between the two genera I find in the large globiferous pedicellariæ; of the figures given thereof Professor

Agassiz compares 3, 5 and 5, 9, whereas the most characteristic of them, fig. 22, is not mentioned. If Profesor Agassiz had compared the figure 3 with fig. 9, and fig. 5 with fig. 22, as is the only natural way to compare them, he would probably have agreed with my placing these species in two different genera. Since Professor Döderlein now agrees with me in referring these two species to two different genera, I think there can scarcely be any more doubt of the correctness of that view. — On the other hand my genus *Petalocidaris*, established for *Goniocidaris florigera*, seems, indeed, untenable, as pointed out by Döderlein (p. 96). The remarks by Agassiz on this genus (p. 22) are singularly unfortunate. All the figures to which reference is made there are of *Tretocidaris*. The diagnosis of the genus (p. 28) and a comparison of the figure of a large globiferous pedicellaria (Pl. X. 27) with that of *Goniocid. tubaria* (Pl. X. 20) would have shown that the genus was not based on the small opening of the point of these pedicellariæ but on the elongated form of the blade.

The association of *Dorocidaris bracteata* A. Ag. with *Stephanocidaris bispinosa* may be wrong, but having no specimen of the former at my disposal I am unable to say anything definite; since Professor Döderlein has now completely altered the position of *Stephanocidaris bispinosa* by finding its large globiferous pedicellariæ, of the form without end-tooth typical of the genus *Cidarites* Lamarck (*Cidaris* Klein in Part I of this work), the form taken by me to be the large globiferous pedicellariæ being, in fact, the small form, it is probable that I have likewise only seen the small form of globiferous pedicellariæ in *Doroc. bracteata*. But as long as we do not know the large globiferous pedicellariæ of this species it is impossible to say with certainty to which genus it belongs. The characteristic, that the abactinal system of *Stephanocidaris bispinosa* is somewhat more flexible than in other Cidarids, does not seem to me so extremely important as Agassiz holds it, since he finds it "so entirely unique among the Cidaridæ that there is no excuse for associating with it a species with the abactinal system of the species of *Dorocidaris*" (p. 23). On comparing vertical sections of tests of *Stephanocidaris bispinosa* and *Dorocidaris papillata* I find that not only the apical system but the whole test is distinctly thinner in the former. Certainly, I cannot consider this difference a very important character. Professor Döderlein also evidently holds this character to be only of secondary importance, since he unites *Cidaris baculosa* and *verticillata* with *Stephanoc. bispinosa* in the same subgenus. (Op. cit. p. 101.)

Professor Agassiz evidently finds it too meaningless to deserve a refutation, when on account of a general resemblance I ventured to suppose that *Dorocidaris panamensis* had the same kind of globiferous pedicellariæ as *Cidaris affinis*. If he had found it worth while examining these structures he would have found that my suggestion was quite right[1], and he would have avoided the erroneous statement that this species is "the Pacific representative of *D. papillata*".

For my suggestion that "*Goniocidaris canaliculata* might be a *Stereocidaris*" Professor Agassiz can see no reason, especially since it is quite contrary to my principles to refer living species to genera established for fossil species. "To Mortensen affinities as usually recognized by most writers on Echini have no interest and have no value when not based on the pedicellariæ" (p. 32). The cases where I do refer living species to genera based on fossil species seem to me to show that I also

[1] I have had occasion to examine specimens of this species, identified by Professor Agassiz himself, in the U. S. National Museum. The only difference of some importance between the pedicellariæ of this species and those of *C. affinis* is that no limb of projecting rods is found on the stalk of the large globiferous pedicellariæ — at least not on the few I have examined. They occur very sparingly; I have only found them in two of the nine specimens examined by me in the U. S. National Museum.

recognize the value of affinities not based on the pedicellariæ, since, of course, only the accordance in the structural characters of the test could induce me to accept such genera. To be sure, the *Stereocidaris canaliculata* is not a very typical species of that genus, but the pedicellariæ are of the structure peculiar to that genus, and I did not find sufficient charaters in the structure of the test for founding a separate genus on it. Now, Professor Agassiz has established the genus *Centrocidaris* for this species and the species *Goniocidaris Döderleini* A. Ag., the only character of the genus being the broad bare space in the ambulacral and interambulacral areas. This character is certainly a very insufficient one for founding a genus on it, the more so as it is rather variable in *canaliculata*. Professor Döderlein quite agrees with me that the species *canaliculata* has to be referred to *Stereocidaris*[1]; he rejects the genus *Centrocidaris*, and I think, likewise, that this genus cannot be maintained as understood by Professor Agassiz. Perhaps it can be maintained for the species *C. Döderleini*, which had to be left incertæ sedis by Professor Döderlein, in spite of the careful description of the test given by Professor Agassiz in the Panamic Deep-Sea Echini.

Professor Agassiz further finds it impossible to conceive the ground for my separating *Porocidaris elegans* as another genus, *Histocidaris*, from *Porocidaris purpurata*, unless it be that the characters of a single valve of a small globiferous pedicellaria, which he (I) figure(s) as perhaps belonging to that species[2], is sufficiently characteristic for such a generic separation» (p. 24). It seems to me to be very easily seen from my remarks on *Porocidaris* (p. 21—22) and the diagnoses of the genera *Histocidaris* and *Porocidaris* (p. 30), that I regard the differences in the tridentate pedicellariæ as the main character: two-valved in *Porocidaris*, three-valved in *Histocidaris;* the depressions in the scrobicular areas and the long neck of the radioles are also pointed out as characteristic of *Porocidaris* (p. 21) — unfortunately, the two latter characters have not been mentioned in the diagnosis. I do not see that Professor Agassiz has in the least weakened these grounds for distinguishing *Histocidaris* from *Porocidaris;* Professor Döderlein also accepts the genus *Histocidaris*, though he finds that the two species einander nicht allzufern stehen (p. 98). I agree that it is too much to say that *H. elegans* has no relation with *P. purpurata* (p. 22), but I think the genus *Histocidaris* has to be maintained. — To this genus will have to be referred *Porocidaris Cobosi* A. Ag., of which I have examined an authentic specimen in the U. S. National Museum, whereas *Porocidaris Milleri* A. Ag., which I had likewise the opportunity of examining there, is a *Stereocidaris*, probably nearly related to *Stereocidaris japonica* Döderlein. As regards *Porocidaris Sharreri* it still remains uncertain, whether it is a *Porocidaris* or a *Histocidaris;* it is true that I have seen the type-specimen in the Museum of Comparative Zoology at Harvard College, but since Professor Agassiz thought it right to forbid me to make any studies at the Museum, I could only see it like any ordinary visitor, and unfortunately it was placed so high that I could not see the pedicellariæ. From the lack of a long neck on the spines and of the depressions in the scrobicular areas I would conclude that it belongs to the genus *Histocidaris*. What I have said of the species *Dorocidaris micans*, based on specimens wrongly referred to *Porocidaris Sharreri*, is right. I hope to be able soon to give a more detailed description of this species. On the other hand, I must agree that Professor Agassiz is right when reproaching me with inconsistency in

[1] I shall have to treat this species and the questions associated therewith more thoroughly in the Reports on the Echini of the German and the Swedish South-Polar Expeditions.

[2] On p. 173 I have stated that this form of globiferous pedicellariæ does not really belong to *Histoc. elegans*.

the use (or rejection) of generic names first used for fossil forms, since I retain the names *Arbacina, Porocidaris* and *Stereocidaris*. As regards *Stereocidaris*, I think it quite right to maintain that name, the structure of the test being so characteristic that it seems beyond doubt that the recent and fossil species belong to the same genus. (Comp. Döderlein. Op. cit. p. 95.) Regarding *Porocidaris*, I find it rather doubtful, indeed, whether it really belongs to the same genus as the fossil type, and perhaps it would be better to create a new genus for it; for the present, however, I will leave that undecided. It was probably wrong to accept the name *Arbacina* — even if the species *forbesianus* had not proved to be a *Prionechinus*. On the other hand, it was probably unnecessary to revive the name *Cœnopedina* — but upon the whole I must maintain that in those families, where the pedicellariæ are of great systematic importance, it is generally quite impossible to say with certainty to which genus, or in several cases even to which family, a species belongs of which only the test is known, as is generally the case with the fossil forms. To my remark on this subject (Part I. p. 85) that »identical structure of the test is no proof of near relationship«, Professor Agassiz objects (p. 107) that »we are perfectly justified in retorting that similarity of the pedicellariæ is no proof of relationship as shown by the structure of the test, and we are not warranted in classifying together forms which agree only in the structure of the pedicellariæ, and differ in the structure of the test«. I quite agree with this and have never thought of maintaining that the structural differences found in the tests of the different forms were of no systematic value, and I think that Agassiz will be unable to point out any case of my having associated forms differing essentially in the structure of the test on account of their pedicellariæ being alike in structure, except — perhaps — among the Cidarids, where my material did not allow me to study sufficiently the differences in the structure of the test. Professor Agassiz is not at all entitled to say that I »recognize(s) only such affinities as are indicated by the structure of the pedicellariæ. Affinities indicated by other structural features have little or no interest for him, or are entirely erroneous. It will be a great saving hereafter if illustrations of Echini are limited, as he would have us limit them, to figures of pedicellariæ«. — I need again only refer to the chapter on the classification of the Diadematids in my work on the Siam-Echinoidea for refutation of this assertion, and as regards the illustrations a mere glance at my work will show that I have figured the species treated there as carefully as possible. I wish Professor Agassiz had done so with all the species described by him — that would have saved his fellow-workers a great deal of trouble; I may remind the eminent author of such species as *Echinus Wallisi, Dorocidaris Bartletti, Hemiaster Mentzi*. On the other hand, I would maintain that for a preliminary description of some species, figures of the pedicellariæ may be much more valuable than a figure of the whole animal, on which none of the more important characters can be seen. And it may also be suggested that not everybody perhaps can afford the expense of so copious illustration as that given in Professor Agassiz' last magnificent work.

Against the results of my studies on the *Echinothuridæ* Professor Agassiz has made a great many objections, only very few of which, however, I can acknowledge as maintainable. I shall answer them one by one in the order in which they are set forth.

Firstly, Professor Agassiz objects to the arrangement of the figures of pedicellariæ in my plates; he finds it almost impossible to compare the figures of pedicellariæ of the different species »without a guide or key to their arrangement« (p. 81). It is, indeed, rather a difficult question how to arrange the figures on the plates in the best way. The simplest way is obviously to put together all the figures of the same species, but a comparison of the figures of the different species is not made easier in that way and the general appearance of the plates cannot then be taken into account. The latter fact, to be sure, has no real scientific value, but I willingly confess that I like to have the figures arranged with some regard to the appearance of the plates. It does not seem to me that the arrangement in my plates is so quite hopeless for comparing the figures of the different species. All the figures of pedicellariæ of the Echinothurids are put together on three successive plates, the first of them including all the figures of triphyllous pedicellariæ; and the numbering of the figures is constantly in transverse series from the left to the right, so that the figures are at least easily found out, in any case much more easily than in some of Professor Agassiz' plates, e. g. in Revision of Echini : Pl. VI, XXIV—XXVI, XXXVIII and Challenger Echinoidea: Pl. XXXVIII—XLV, where the numbering and arrangement of the figures seem without any plan whatever. Regarding the quality of my figures I am sorry to say that I am far from satisfied with several of them, and I likewise must agree that it might have been better to give the direct enlargement of the figures instead of the number of the oculars and objectives. But, on the other hand, the size of the pedicellariæ has upon the whole no such systematic importance that exact measurements are necessary, since generally they vary very much in size.

In dwelling upon the many points of relationship between Phormosoma and Asthenosoma, says Professor Agassiz (p. 82), I drew attention to the difficulties of describing the species of these genera owing to the changes due to growth. On the strength of this remark Dr. Mortensen assumes that I have stated that the two genera cannot be distinguished, and proceeds to ignore all that has been said of the different species of Echinothuriæ relating to the actinal and abactinal systems and the spines, because he thinks the Echinothurids are not adapted for examination in the dry state. But he claims to give a perfect classification based, first, upon the characters of the spines, as if his predecessors had not mentioned them in any way; next upon pedicellariæ, tube feet, pores and spicules, the last of which he has previously informed us were of no systematic value! Having stated that the genera Phormosoma and Asthenosoma cannot be distinguished, he then establishes a number of new genera based wholly upon the structure of the triphyllous and tridentate pedicellariæ. The latter show a great variety of forms, and are of great systematic importance ; while the former have little systematic importance in Echinidæ, they are considered by Dr. Mortensen of value for the determination of the Echinothuriæ.

That the genera *Phormosoma* and *Asthenosoma* as understood by Agassiz cannot really be distinguished, it seems to me superfluous to again demonstrate; Agassiz has not given any further distinctive characters of the two genera , and both de Meijere and Döderlein agree with me in the limitation given thereof in Part I of this work. As for the changes due to growth , I might remark that such changes are evidently upon the whole much smaller than Professor Agassiz thinks, since in several cases these changes are due to the specimens belonging to different species or even different genera. (See e. g. *Phormosoma uranus* and *Petersii* Part I. p. 58—59.) For the purpose of showing such changes, it seems to me highly important that the identification of the differently sized specimens be made as certain as possible by using all characters available for specific identification; a record of the changes undergone by a species during growth is worth less than nothing when the specimens upon which the changes are described do not belong to the same species or even the same genus.

That I ignore all that has been said of the different species of Echinothuriæ relating to the actinal and abactinal systems and the spines, because I (he) think(s) the Echinothuridæ are not adapted for examination in the dry state» needs no special refutation. I have found no reason to repeat all the facts made known by the different authors on *Echinothuridæ*, as in general I do not think it necessary to repeat all that has previously been made known each time some additional information is given. But I am sure that I have not ignored what was previously known of the *Echinothuridæ* when giving the new classification resulting from my predecessors' and my own researches. That the Echinothuridæ are not adapted for examination in the dry state I have not said. On the contrary I have said that the arrangement of the plates is generally only to be seen in dried specimens . But , I continue the Echinothurids are only very little adapted for preservation in dried state, and if the material in hand be slight one does not like to destroy it for the sake of determination (p. 43). This remark seems to me incontestable.

I do not at all claim to give a perfect classification of the *Echinothuridæ*. On the contrary I have said (p. 65): As has been done above in the Cidarids I shall also here expressly state that I do not regard the generic diagnoses given here as complete. As well the structure of the test as the inner anatomy stands in need of an exact examination in several of the genera. I must, however, regard all the genera established here as good ones, and also the limitation of the old genera *Phormosoma* and *Asthenosoma* is no doubt correct. Only the genera *Aræosoma* and *Hygrosoma* are perhaps still taken in too wide a sense ..... That the new genera established by me are based wholly upon the structure of the triphyllous and tridentate pedicellariæ is in so striking contest with the statement given by Professor Agassiz himself a few lines above that my classification is based first upon the characters of the spines, as if his predecessors had not mentioned them in any way .....; next upon pedicellariæ, tube feet, pores and spicules , that I need say no more about it. That my predecessors have both mentioned and described the spines more or less accurately, I have never denied or thought of concealing; but it is one thing to describe them, another to use them properly for systematic purposes, and I do not see that Professor Agassiz has made such use of the spines. Even now, after my pointing out the importance of the differences found in the structure of the primary actinal spines (ending in a thick fleshy sack in *Phormosoma*, in a curious white, naked hoof in the other genera — *Kamptosoma* still remaining unknown in this respect), he does not recognize this fact, though without giving any reason for not doing so, only referring to a statement in the Challenger -Echinoidea (p. 101): The presence of sheathed spines in two species of *Phormosoma* shows that this character, which at first seems to separate so strikingly from the rest of the group *Asthenosoma grubii*, is evidently one of little value, and which may be more or less developed in specimens of the same species in the same state of growth . To this statement I remarked (Part I. p. 48): the facts here put together by Agassiz are quite different: in *A. grubei* it is the spines on the abactinal side that are wrapped by a bag of skin, and the spine itself is of the common structure, a perforate tube ending in a fine point; in *Ph. placenta* and the species allied to it, it is the primary spines on the actinal side that are clavately widened in the point and wrapped by a thick bag of skin. These spines must, of course, be compared with the primary spines on the actinal side of the other species, but then we find a marked difference, these spines of the other species not being covered with skin — as far as is known — but ending in a larger or smaller hoof, distinctly marked off from the spine itself . Professor Agassiz remarks on this criticism: I have stated that I thought this character of no great systematic importance. Dr. Mortensen is of contrary opinion (p. 101); I confess my inability to understand how a statement, shown to be erroneous, can be made good again by simply reiterating it, even if this is done by so eminent an authority as Professor Agassiz.

The statement that I use the spicules in the classification of the Echinothurids, after having previously informed us that they are of no systematic value must be due to some error. So far as I know I have never stated that the spicules are of no systematic value. On p. 45 I have said that the spicules are almost always rather large, irregular, fenestrated plates situated more or less distinctly in 3—4 longitudinal series. In *A. varium, Grubei, heteractis* and *urens* they are very slightly developed, only small, branched calcareous pieces, rarely with a hole . In the following lines I say of the sphæridiæ that they show no differences so great that they can be of any systematic importance . Perhaps it is this remark which Professor Agassiz through some lapsus has referred to the spicules.

The difference between the genera *Aræosoma* and *Calveria* is, I agree, not so very important, and since the name *Calveria* cannot be used, as pointed out by Professor Agassiz and most carefully argued by Dr. F. A. Bather[1], it may, perhaps, be preferable to unite *C. hystrix* with the genus *Aræosoma:* to the genus *Asthenosoma* it cannot be referred. The species *A. varium* and *Grubei* I have never referred to the genus *Calveria*, as stated by Agassiz (p. 84).

Professor Agassiz claims to have figured an ophicephalous pedicellaria of *Phormosoma luculentum*, viz. on Pl. XLIV. fig. 27 of the Challenger -Echinoidea. I may remark on this account that he only mentions it in the explanation of the plates and under the name small short-headed, short-stemmed pedicellaria ; further I have by no means overlooked that figure, but mention it on p. 60 and p. 176, suggesting that it may represent an ophicephalous pedicellaria, but stating that I have myself been unable to find any similar form of pedicellaria in this species. I think Professor Döderlein is right in supposing (Op. cit. p. 121) that it does not really belong to this species. When Professor Agassiz takes the peculiar modified form of tridentate (or perhaps ophicephalous) pedicellariæ figured by me on Pl. XIII. Fig. 16 to be the same as that which he has figured in Pl. XLIV. 25—26 (Challenger - Echinoidea), he is quite right. I have stated that carefully on p. 60 and have given no figures of the valves, finding that his figures give a good representation of the single valve .

That figures of *Phormosoma placenta* are given in the Blake -Echini and of *Phormosoma bursarium* in the Challenger -Echini does not eliminate the fact, that Professor Agassiz in describing the latter species only points out the differences from the distantly related *Phormosoma luculentum* but not the characters distinguishing it from the very closely related *Ph. placenta*. Neither are such characters pointed out under *Phormosoma placenta* in the Blake -Echinoidea. That there was some reason for pointing out such differences appears also from the fact that Professor Döderlein is now inclined to regard *Ph. bursarium* as only a synonym of *Ph. placenta* (Op. cit. p. 127).

Further, Professor Agassiz says (p. 85): Dr. Mortensen thinks that I am wholly mistaken in suggesting any affinity between *A. pellucidum* and *A. coriaceum* and *A. tesselatum, because*[2] he has suggested a new genus, Hoplosoma, for *A. pellucidum*, based entirely upon the structure of the pedi-

[1] The Echinoderm name *Calveria hystrix*. Ann. Nat. Hist. 7. Ser. XVII. 1906. p. 249.
[2] The Italics are mine.

cellariæ; they are certainly very peculiar, but may be embryonic conditions of unknown pedicellariæ similar to those he figures for *Ph. placenta*. As for his remarks on *Phormosoma tenue*, I would suggest to Dr. Mortensen that the Report on the Challenger -Echini was issued in 1881, and that his memoir was published in 1903; he can scarcely expect genera proposed in 1903 to have received any recognition in 1881 .

It is possible that the genus *Hapalosoma* (not *Hoplosoma*) cannot be maintained, in which case the only species, *pellucidum*, would have to be referred to the genus *Aræosoma*, since its peculiar globiferous pedicellariæ are evidently only a special development of the tetradactylous pedicellariæ of the latter genus, as shown by Dr. de Meijere. That they are not embryonic conditions of unknown pedicellariæ is certain; otherwise, fully developed forms would also have been found among the not very few specimens seen by me, and Dr. de Meijere especially would have found them in the very rich material he has had for study. Whether now the genus *Hapalosoma* has to be maintained (as I think it has) or not, I certainly did not deny the close affinity of *A. pellucidum* with *A. coriaceum* and *tesselatum* because I suggested a separate genus for the former, but, on the contrary, I suggested a new genus for it, because I found it too distantly related to *A. coriaceum* and *tesselatum* to refer it to the same genus with these species. The use of the word because in this place is thus not quite fair, and the same holds good in other instances, thus for example when it is said on the same page as the above: I have nothing to say regarding Dr. Mortensen's sneers at descriptions of pedicellariæ, because they do not fit with his classification . My criticism of the description of the pedicellariæ of *Phormosoma tenue* (as well as of other species) given by Professor Agassiz is certainly sufficiently justified by the character of that description, as will be agreed, I imagine, by anybody who will take the trouble to read my remarks on that subject (Part I. p. 57).

That Professor Agassiz could not in 1881 recognize the genera proposed by me in 1903 is self-evident. But, nevertheless, I think the remark to which Agassiz refers here quite justified (Part I. p. 55). After quoting from the Challenger -Echini p. 87 as follows: In the only species of the group of which the Challenger collected a complete series *(Phormosoma tenue)* there was little difficulty in recognizing the young as belonging to the adult I continue: We could scarcely wish to find a more pregnant proof of the difficulty or impossibility of determining Echinids without taking the pedicellariæ into consideration ... With regard to the excellent long series of *Phormosoma tenue*, there are among the specimens referred to this species by Agassiz at all events two different genera, but no genuine *Phormosoma!* Professor Agassiz has now established a new species of the genus *Kamptosoma*, *K. indistinctum* A. Ag., on a specimen from the Challenger St. 272, referred to *Phormosoma tenue* (p. 110). I venture to imagine that a more careful examination might have made it possible to recognize this specimen as belonging to a separate genus already even in 1881; of course, it would at that time have been impossible to know the name to be proposed by me later on, but the genus really did exist already at that time. It is also worth noticing that this genus is sufficiently characterized by its peculiar ambulacral structure alone, without regarding the pedicellariæ and spines.

Professor Agassiz does not deny himself the pleasure of correcting me when mentioning *Phormosoma asterias* as the last of the Echinothurids described from the Challenger (p. 86); I am sorry to have to call his attention to the fact that, since I had already treated all the other species, including the last mentioned species *Phormosoma rigidum*, the *Ph. asterias* was necessarily the last of them — I did not say the last named. That the characters on which the genus *Kamptosoma* was founded appear to Professor Agassiz «most trivial», is, of course, a matter of slight importance, since he accepts the genus. In my opinion the structure of the ambulacra in this genus (which character is mentioned in the diagnosis besides the characters of spines and pedicellariæ) is a highly interesting feature, and even Professor Agassiz himself later on in the description of *Kamptosoma indistinctum* does not evidently think this feature so very trivial. — As regards the species *indistinctum*, it is to be regretted that Professor Agassiz does not say a word about the characters by which it is distinguished from the species *asterias*. On p. 177 (Part I) I stated that after a renewed examination of the specimens from St. 272 I thought it unjustifiable to separate them from *K. asterias* as a new species; it might not have been quite inappropriate therefore to point out the characters on which the new species was established. Until these specific characters are made known I must regard *K. indistinctum* as synonymous with *K. asterias*.

To enter on a renewed discussion of the genus *Hygrosoma* and its delimitation from *Phormosoma*, on account of Professor Agassiz' remarks on that subject (p. 85—86), I deem unnecessary, since Professor Döderlein has accepted my view thereon and given most careful and elaborate descriptions of both genera, to which I may simply refer. (Op. cit p. 125, 136.)

After describing the changes in the apical system due to age in *Phormosoma hispidum* Professor Agassiz says (p. 95): «It is this extraordinary change in the anal system which I had observed in the abactinal parts of the test, which has prompted Dr. Mortensen to credit me with the most extraordinary ignorance of the rudimentary embryological data, many of which I was the first to discover. That this remarkable intercalation exists there is not the least doubt, and it naturally suggests in old specimens a flow of the anal plates into the interambulacrum, similar to the flow of the ambulacral plates of the corona into the buccal plates of the actinal system». — I must answer to this statement that I have not at all credited Professor Agassiz with any ignorance of embryological facts, but only criticised his statements in the »Blake«-Echinoidea (p. 32) on the development of the young *Phormosoma placenta*, and I certainly think my criticism completely justified (Part I. p. 174—175). Professor Agassiz himself now agrees (p. 96) that his statement there of the formation of the buccal plates was erroneous, viz. that they are »separated from the coronal plates, and are developed, as I (Agassiz) have shown in the same manner as the imbricating plates of the Cidaridæ, independently of the coronal plates; new plates forming on the distal surface of the actinostome, which are intercalated between the old plates and the coronal plates«. That Professor Agassiz has himself found out, before my criticism had appeared, that this was a mistake, does not make this part of my criticism unjustified. I might have added that the conclusion necessarily derived from the statement quoted, that in the Cidaridæ also the buccal plates should originate in this way, is not less erroneous, as Professor Agassiz will certainly also agree.

Concerning the formation of the interambulacral plates, Professor Agassiz continues with the following statement (loc. cit.): »On the abactinal system, on the contrary, while the plates of the genital ring are well defined and seem to be distinctly separated from the coronal plates, yet new interambulacral plates are not added independently, as in the ambulacral system, and as in the interambulacral system of other young Echinoids where the genital ring remains permanently closed. The new interambulacral plates are found to be pushing out from the plates of the anal system on each side of the genital plates. As the ocular and genital plates of the genital ring become separated, with increasing size, the additional anal plates forming in the intervening spaces are pushed out, and become a part of the abactinal portion of the interambulacral area . To this I remarked (p. 175): «This statement is completely incorrect. The interambulacral plates are formed in *Ph. placenta* as in other Echinids, not by the anal plates. The genital ring , at all events, is closed, until the animal has reached a size of 17^{mm} in diameter, and so far accordingly the interambulacral plates must necessarily be formed in the common way, as may also easily be substantiated. In a specimen of a diameter of 30^{mm} a couple of ocular and genital plates are still joining, and here the case is quite the same. That a new mode of formation of the interambulacral plates, otherwise quite unknown among the Echinids, should then suddenly occur, is very improbable — and, above all, Agassiz has not at all proved it; all that may be seen in the larger specimens, is that the small anal plates directly adjoin the uppermost interambulacral plates». — I am quite unable to find in this criticism any accusation of ignorance of embryological facts, and I am unable to see, likewise, that I am mistaken in my criticism. So far as I can understand the meaning of the above passage quoted from the Blake -Echini, Professor Agassiz maintains here that the anal plates are directly developed into interambulacral plates. That mode of development would be in direct opposition to the generally accepted views on the homology of the Echinoid-skeleton, which hold that the interambulacral plates and the anal plates are of very different morphological value. A transformation of the anal plates into interambulacral plates is thus very improbable for morphological reasons, further also, on account of the younger specimens showing the normal condition, and finally, I must repeat that Professor Agassiz has not shown it to be the case. On examining Mr. Westergren's admirable figures of the abactinal system of *Phormosoma hispidum* on Pl. 39 or of *Asthenosoma coriaceum* on Pl. 52. fig. 1 of The Panamic Deep-Sea Echini , it is easily seen that the young interambulacral plates originate at the sides of the ocular plates and are not transformed anal plates. — That the anal plates push their way down into the median part of the interambulacrum, separating the two series of interambulacral plates at their upper end, I have never denied or thought absurd; but I must maintain that these anal plates never become interambulacral plates, which was, so far as I am able to see, the meaning of the statement given in the Blake -Echini. Whether that is also the meaning maintained in the Panamic Deep-Sea Echini . I am unable to gather; the expression »a flow of the anal plates into the interambulacrum similar to the flow of the ambulacral plates of the corona on to the buccal plates of the actinal system», as well as the expression the intrusion or flow of the anal plates into the interambulacral system (p. 117) do not seem to mean a transformation of these plates into interambulacral plates. If that be the case, Professor Agassiz seems to me to put a new meaning into his old statement, and thus, his remarks against my criticism have no bearing against me, since I have never thought of saying a word against the latter meaning.

I think I have now answered all the criticisms which Professor Agassiz directed against me. There are only a few of his more general remarks on the Echinothurids concerning which I must say a few words on this occasion.

Professor Agassiz begins the Chapter on the *Echinothuridæ* with this remark: We may be justified in assuming that the anal system is in the Echinothuridæ, as in the Cidaridæ, covered by five small anal plates (p. 75). I do not think we are justified in making this assumption. The youngest specimens of any Echinothurid hitherto examined (leaving aside the very doubtful *Asthenosoma hystrix* of 3·1^{mm} figured in Rev. of Ech., Pl. II c.) are those of 3^{mm} in diameter described by me (Part I. p. 174). I have stated there that the periproct is, even in the smallest specimens, covered by a number of small irregular plates, with no larger between. So a central plate seems never to be found here. Since in this very young stage the anal plates are thus already present in considerable number and do not show any trace of five original larger plates covering the whole anal area, I do not think we are justified in assuming that these 5 large plates are found in a yet earlier stage. I give here a figure of the anal area of the youngest specimen of *Phormosoma* (scarcely 3^{mm}) seen by me. (Fig. 1.)

A matter of much more importance, however, is the statement (p. 91) that in *Phormosoma hispidum* the bare interambulacral area adjoining the primordial plate is covered with a few minute, elongate, irregularly arranged plates, which correspond to the interradial buccal plates of Cidaris. The same thing is stated for *Kamptosoma indistinctum* (p. 112): In this species .... we find a few of the same irregular elongate interambulacral plates which in the Cidaridæ are as well and as regularly developed as the ambulacral buccal plates. It was hitherto assumed to be one of the most important features distinguishing the *Cidaridæ* from all the other regular Echinoids that both the ambulacral and interambulacral plates continue over the peristome; the *Echinothuridæ* were distinguished by the ambulacral plates alone continuing over the peristome. If these small plates of the peristome found in the two Echinothurids by Professor Agassiz were really homologous to the interradial buccal plates of the *Cidaridæ* this fundamental character would have to be given up. Fortunately, the figures given by Agassiz himself afford the proof that these plates are not homologous with the interradial buccal plates of the Cidarids; since the primordial interambulacral plate is persistent, these small plates lying in the buccal membrane inside (adorally) the primordial plate cannot possibly have any relation whatever to the interambulacral plates and cannot be said to correspond to the interradial buccal plates of Cidaris. They correspond to those small, irregular plates found in the peristome of the other regular Echini.

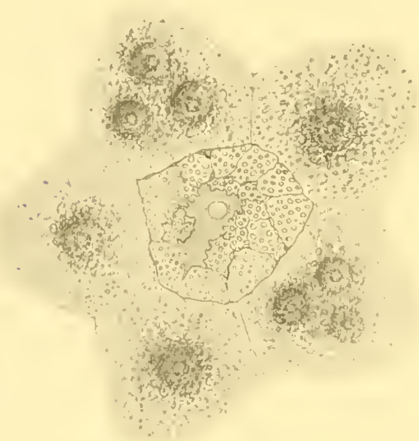


Fig. 1. Apical system of a young *Phormosoma placenta*, 3^{mm} in diameter. $^{28}/_{1}$.

In treating the Echinothurids in Part I, I had to leave *incertæ sedis* the species *Phormosoma panamense* and *hispidum*, and Professor Agassiz, not recognizing my limitation of the genus *Phormosoma*, does not take the trouble to state to which group these species belong. But from the very careful description and figures of the test combined with my examination of the pedicellariæ of the type specimens in the U. S. National Museum, it can be said with certainty that they belong to the genus *Echinosoma*. It is true that the character of the primary actinal spines of *panamense* is unknown, but all the other characters are decidedly those of *Echinosoma*, so that I think we may safely conclude that the spines also are tipped with a hoof and not provided with a fleshy sack. A more detailed description of the pedicellariæ I cannot give on this occasion; it will suffice to say that they agree rather closely with those of *Echinosoma uranus* and *tenue*; in *panamense* I have not, however, found the larger form of tridentate pedicellariæ. In *Ph. hispidum* I have found a kind of ophicephalous pedicellaria; this may suggest that ophicephalous pedicellariæ will prove to exist also in the other species of the genus *Echinosoma*. Agassiz is then evidently right in making *panamense* an ally of «*Ph.*» *tenue*, whereas it is certainly less fortunate to make *Ph. hispidum*, the Pacific representative of the Caribbean and Northern Atlantic *Ph. uranus*, as by the latter is probably meant not the true *Echinosoma uranus*, which is not known from the Caribbean Sea, but the *Hygrosoma Petersii*, which has hitherto been wrongly called *Phormosoma uranus*. — Regarding the new species *Phormosoma zealandiæ* A. Ag., established on a specimen from the Challenger St. 169, identified as *Asthenosoma gracile?*, it is impossible to state with certainty to which genus it really belongs, since not a word is said about the spines and pedicellariæ; to judge from the figure given of an ambulacrum (Pl. 51. Fig. 3) it may be supposed to be likewise an *Echinosoma*, which would be in accordance with the statement (p. 108) that it is allied to *Ph. hispidum*.

Professors Bell, de Loriol and Lambert besides Professor Agassiz have also opposed my classificatory results. Professor de Loriol only remarks regarding the genus *Pseudechinus* established by me for *Echinus albocinctus* Hutton, that he thinks que c'est aller un peu loin que de créer une coupe nouvelle basée sur ce seul et unique caractère (et encore faudrait-il s'assurer qu'il est parfaitement constant), qui ne peut s'observer que sur les exemplaires dont le revêtement est entièrement conservé [1]. As Professor Döderlein has already (op. cit. p. 231—3) carefully answered these objections, I need only refer to his remarks on the question with which I quite agree. I may however make the more general remark that in the Families *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*, the structure of the test is upon the whole very similar, so much so indeed, that it seems impossible in the test alone to find reliable characters even of the families, as is well seen by the manner in which forms of all three families were put together in the genera *Echinus* and *Strongylocentrotus*, before the characters of the pedicellariæ and spicules were taken into consideration. It almost looks as if, on reaching the high level of development of these forms, nature could not go any farther on those lines, (the *Echinometridæ*, of course, form a remarkable exception), and, instead, went on to develop the pedicellariæ, especially the globiferous, into very characteristic structures. Be that as it may; everybody who has studied a large number of the genera and species of these three families, with regard also to their pedicellariæ and spicules, must be struck with the remarkable constancy and characteristic appearance of these organs and find it very natural to make them the foundation of the classification, in spite of their being so small that they cannot be seen without careful microscopical examination. —

De Loriol's remarks (op. cit. p. 16) on my limitation of the genus *Sterechinus* as well as those of Professor Döderlein (loc. cit.), I cannot answer before I have undertaken a renewed study of this whole group, which I intend to do in my Reports of the Swedish and the German South-Polar Expeditions.

Professor Bell in his Report on the Echinoidea from South-Africa [2] most decidedly keeps aloof from my classification, without giving, however, very definite objections. To his remark that he does

[1] Notes pour servir à l'étude des Échinodermes. II. Ser. Fasc. II. 1904. p. 20.

[2] Marine Investigations in South Africa. Vol. III. 1904. The Echinoderma. Part I. Echinoidea.

not think that any single character should be made the basis of a classification or that a distance of even hundreds of miles of sea-bottom is sufficient evidence of specific distinctness (p. 167). I must refer in answer to what has been said above (p. 10) against Professor Agassiz' characterizing my classification as being based on a single character, and also to the above remarks on Professor de Loriol's objections. As for taking even hundreds of miles of sea-bottom as sufficient evidence of specific distinctness, I absolutely agree with Professor Bell, and I am sure he will be unable to point out any of the species described by me as being based upon geographical distance alone. But, on the other hand, I think Professor Bell will agree with me that great geographical and bathymetrical distance ought always to make one careful in referring specimens to a species otherwise known only from another region, and only to identify them with such species on finding after a careful study of all available characters that they cannot be distinguished. I, for my part, do recognize some species of Echini as almost cosmopolitan in their distribution, e. g. *Hemiaster expergitus* (see also my remarks on *Echinocardium cordatum* in this Part), though I do not recognize *Echinus norvegicus* as a cosmopolitan species, as it was made by Professor Agassiz.

Professor Bell's remark that the present condition of the family *Echinothuridæ* does not warrant any addition to it that need not be made (p. 169), does not seem to me quite warranted; at least it seems to me that it is easy enough to refer the species to the genera as diagnosed by me whereas it was extremely difficult indeed to distinguish between *Phormosoma* and *Asthenosoma* after the old fashion. And when Professor Bell expresses the hope that Professor Agassiz by means of his large collections will be able to give us a definite idea of the range and character of the variation of the *Echinothuridæ*, I must say that, if the minute differences are not taken into consideration, I fear the variations will not be very reliable. The generic value of characters found in pedicellariæ may, of course, be disputed; but we can be quite sure that specimens of the same species do not have pedicellariæ of very different structure, so that these minute characters, so easily seen with a very little technical skill, should at all events never be despised.

Lambert[1] remarks: «Sans nier la valeur des caractères fournis paz les organes caducs et microscopiques de l'Echinide, j'estime que leur nomenclature doit surtout être fondée sur un ensemble de caractères observables, aussi bien chez les fossiles que chez les vivants, car la phylogénie est aussi indispensable que l'embryogénie à l'exacte compréhension des formes actuelles. Il ne faut pas appliquer à des animaux inférieurs, dont les organes sont moins spécialisés, une méthode qui peut être excellente pour des êtres très évolués et perfectionnés, mais qui, pour les Echinides, fausse toutes les analogies en placant dans des familles différentes des formes aussi voisines que *Loxechinus* et *Strongylocentrotus*, que *Parasalenia* et *Goniopygus* . For the rest, he states that he agrees with Agassiz in his views on my classification. — The claim that the classification of Echini has to be founded on characters also observable in fossil forms is, so far as I can see, unscientific. It is quite impossible to say a priori which character will be of primary importance for classification. Only by a careful comparative examination of all the characters presented by the animals in question can it be decided on which of these characters the classification has to be founded. When it is proved that some organ which can-

[1] In M. Boule et A. Thevenin: Fossiles de la côte orientale de Madagascar. Annales de Paléontologie. I. 1906. p. 14 (56).

not be found in the fossil forms is of primary importance, we must admit that the fossil forms are in some respect insufficiently preserved for identification. I quite agree with Professor Döderlein in his remarks on this subject (op. cit. p. 69). It is, indeed, unfortunate that a good many forms of a group of such eminent palæontological and geological importance as the Echinidæ should not be in quite a fit condition for reliable identification; but that cannot be helped. It is a fact that the naked tests of several recent species of the three families *Echinidæ, Toxopneustidæ* and *Echinometridæ* cannot be referred with certainty to their proper genus, or even to the family — the old genera *Echinus* and *Strongylocentrotus* furnish the most evident proof thereof. But when that is the case with the recent forms, it can certainly not be much better with the fossil forms of such families. We must be glad that it is really possible in very many cases to get a definite result by the examination of the test alone. To point out the case of the genera *Loxechinus* and *Strongylocentrotus* being placed in two different families, as a proof that the use of pedicellariæ in classification fausse toutes les analogies , seems to me as unfortunate as the designation of the pedicellariæ as moins spécialisés . To unite *Loxechinus* and *Strongylocentrotus* on account of their both being polyporous (which, I think, is Lambert's reason for doing so) seems to me to be an overestimation of a character which has beyond doubt been developed separately in different groups (Part I. p. 132—33; Döderlein op. cit. p. 203). As for the other case pointed out by Lambert as an unfortunate result of my classification, the placing in different families of *Parasalenia* and *Goniopygus*[1], I admit that I am not personally acquainted with the fossil *Goniopygus*, and it may be quite possible that I have been mistaken in placing it in the family *Arbaciidæ*; but since it is stated to have its ambulacra composed after the diadematoid type, I fail to see how it could be so very closely related to *Parasalenia*, which has its ambulacra composed after the echinoid type. The pretended close relationship between *Goniopygus* and *Parasalenia* seems to me more founded on false analogies than their separation in two different families. And in any case this classificatory result was not reached by the study of pedicellariæ, *Goniopygus* being only known as fossil. — Finally, when Lambert marks the pedicellariæ as moins spécialicés , I really wonder how these organs, which exhibit so great a richness of forms, in many cases no less than four or five different kinds being found in the same specimen, and so exquisite an anatomical and histological structure, could be thus characterized. And I do not see the reason why it should be wrong to use the same classificatory principles for the lower animals which have proved good for the higher and more perfectionnés animals.

Upon the whole, I do not see that in all the critical remarks against my classification set forth by Professors Agassiz, Bell and Lambert there is any real, principal objection. I have no doubt that those who will take the trouble to make a careful study of the pedicellariæ in the different forms, especially the regular Echini of the families *Echinidæ, Toxopneustidæ* and *Echinometridæ*, and not be satisfied with literary criticisms alone without a study of the objects themselves, will agree with at least the main results reached by me. The fact that Dr de Meijere and, above all, Professor Döderlein after his extensive studies accept my results in the main points makes me confident that my method, which is, indeed, to take all the characters available for systematic purposes into consideration, and to find out by a comparative study of as many forms as possible the systematic value of the different characters, will ultimately prove the right one.

[1] Delage & Hérouard. Traité de Zoologie concrête. III. p. 238, 245.

Suborder **Clypeastroidea.**

Fam. **Fibulariidæ.**

18. **Echinocyamus pusillus** (O. F. Müller).

Pl. XII. Figs. 4, 6, 9, 18—20, 22, 23, 26, 27, 29—31.

Principal synonyms: *Echinocyamus angulosus* Leske.
Fibularia tarentina Lamarck.
Echinocyamus parthenopæus Costa.
— *speciosus* Costa.

Principal literature: O. F. Müller: Zoologiæ Danicæ Prodromus. 1776. p. 236. Zoologia Danica. III. 1789. p. 18. Tab. XCI. Figs. 5—6. — Leske: Additamenta. 1778. p. 215. — Lamarck: Animaux sans vertèbres. 1816. p. 17. — Forbes: British Starfishes. 1841. p. 175. Monograph Echinoderms Brit. Tertiaries. 1852. p. 10. Pl. I. — L. Agassiz: Monographies d'Échinodermes. II. Des Scutelles. 1841. p. 128, 130. Pl. XXVII. Figs. 1—8, 14—18. — Philippi: Beschr. einiger neuen Echinodermen etc. Arch. f. Naturgesch. 1845. p. 356. — Agassiz & Desor: Catalogue raisonné des Échinod. 1847. p. 82. — Düben & Koren: Skandinaviens Echinod. 1844. p. 279. — M. Sars: Norges Echinodermer. p. 95. Middelhavets Littoralfauna. p. 116. — Heller: Zoophyten u. Echinod. d. Adriat. Meeres. 1868. p. 66. — Costa: Monografia degli Echinocyami viventi e fossili delle Provincie Napolitane. Atti R. Acad. sci. fis. e matem. Napoli. III. 1867. (No. 14) p. 4. Pl. I. 1—2. — A. Agassiz: Revision of Echini. p. 111, 304. Pl. XI. e. 3. — Lovén: Études sur les Éch. Pl. XVI. 139. Pl. XLIV; Echinologica. Pl. IX. 102—9. XI. 141, 145. — Cuénot: Études morphologiques sur les Échinodermes. Arch. de Biologie. XI. 1891. Pl. XXIV. Figs. 9, 16. — Théel: Development of Echinocyamus pusillus. 1892. — Koehler: Échinides et Ophiures ... de l'Hirondelle. (229)[1]. 1898. p. 24. — Ludwig: Echinod. d. Mittelmeeres. p. 559 — Bell: Catalogue Brit. Echinoderms. p. 160. Pl. XVI. 8—9. — Hoyle: Revised List Brit. Echinoidea p. 419. — Airaghi:[2] Echinidi Terziari del Piemonte e della Liguria. Palæontogr. ital. VII. 1901. p. 178. Pl. XXII. — Grieg: Oversigt over det nordlige Norges Echinodermer. 1902. p. 32. — Döderlein: Archtische Seeigel. Fauna Arctica. 1905. p. 382. Die Echinoiden der deutschen Tiefsee-Expedition. 1906. p. 234.

Non: A. Agassiz: Revision of Echini. Pl. XIII. 1—8. Blake-Echinoidea. p. 40. Challenger-Echinoidea. p. 118. — Bernard: (78)[1].

For other less important literature reference may be made to Revision of Echini, Ludwig: Echinod. d. Mittelm., Bell: Catalogue Brit. Ech. and Hoyle: Rev. List Brit. Ech.

Though this species has been so often described I must make some additional remarks on it, which I think will not prove to be superfluous.

Agassiz has made the important observation that small pores occur along the horizontal sutures of the ambulacra as in other Clypeastrids[3]; as, however, his description and figures are not

[1] The number refers to the bibliographical list in Part I.
[2] Cited after Zoological Record. 1901. — Not seen by me.
[3] Joh. Müller: Bau der Echinodermen. Abhandl. d. Acad. Berlin. 1853.

based on the true *Ech. pusillus* — as is shown below — they do not give a correct representation of this feature in *pusillus*. These pores are not most numerous above the ambitus, as is stated in the diagnosis of the genus *Echinocyamus* given in »Revision of Echini» (p. 304); on the contrary, while they occur in a single series along each suture above the ambitus they become quite crowded on the actinal side, covering a considerable part of the plates and increasing in number towards the peristome (Pl. XII. Fig. 27). On the analysis of the test given by Lovén (Études. Pl. XLIV) the distribution of these small pores is very carefully shown. I must add only that these pores are also found within the petals, on the inner side of the double pores, though of course less numerous and diminishing in numbers towards the apical system, only one pore being found on the inner side of the upper pairs of pores of the petals. (Pl. XII. Fig. 31.) Outside the petals also a few small pores occur on both sides, but only at some few of the outer pairs of pores. — In young specimens these small pores are few in number and rather difficult to see; in quite small specimens no small pores are found within the petals. — The inner edge of the ambulacral plates adjoining the peristome is abruptly bent inwards and here two considerably larger pores are found (Pl. XII. Figs. 26, 27), corresponding to two tube-feet distinctly larger than the numerous small tube-feet which cover most of the actinal side. These larger tube-feet are evidently homologous to the large buccal feet of the Regular Echini; otherwise they differ from the small tube-feet only in size, and, like these, they are not provided with spicules or calcareous ring.

De Meijere (op. cit. p. 107) remarks that there must be some variation in the relative size of the genital and ocular pores in *pusillus*, referring to the figures given under that name by Agassiz in «Rev. of Echini». Having examined a large number of specimens of *Ech. pusillus* I find that the genital pores are always larger than the ocular pores, (Pl. XII. Fig. 31), and that the latter are generally much smaller, though sometimes the difference is not very great. The difference in this respect between the figure 3. Pl. XI. e. and figs. 1 and 6. Pl. XIII in »Rev. of Ech.» is due to the fact that these figures represent two different species, only the former being the true *Ech. pusillus*. The genital pores appear very early, in specimens of only c. 3^{mm} length; I have even seen specimens of only 2^{mm} in which the genital openings were already distinct. — As stated by Lovén (Études. Pl. XVI. 139) there is only one madreporic pore, situated near the anterior end of the apical system. This feature is of some importance, giving a good distinguishing character between *Echinocyamus* and young specimens of *Clypeaster*, the number of madreporic pores beginning to increase early in the latter. (In a young *Clypeaster* sp. from St. Cruz of only 5^{mm} length I find 6 pores in the madreporic plate).

The internal supports of the test as well as the depressions seen along the sutures between the actinal ambulacral plates are rather well shown on the figures Pl. I. 12—13 of Forbes (Monogr. Ech. Brit. Tert.), and Pl. XXVII. 6—7 of L. Agassiz. Costa also (op. cit. Fig. 2. C. D.) gives (rather coarse) figures of the interior of the test. The figure given in »Rev. of Ech.» (Pl. XIII. 7), differs very considerably from those above cited; it is evidently another species. A detailed description of these internal structures need not be given, I may refer to the figures given by Forbes and L. Agassiz and to the one given here (Pl. XII. Fig. 29) for comparison with the *Ech. grandiporus* described below. It will be remarked that the radiating supports continue as far as to the peristome; on the abactinal side they only continue to the outer end of the petals. These ridges are formed by the edges of the interambulacra. The ambulacra show, as seen from the inside, a fairly deep depression along each transverse suture, the pores being placed in these depressions. The innermost ones are directed almost straight towards the border of the peristome, farther out they become parallel to the ambitus; the same feature is seen in the arrangement of the pores as seen from the outside of the test. (Pl. XII. Fig. 27).

Among the tubercles are seen some mostly rounded, sometimes irregular, glassy protuberances about as large as the primary tubercles; they are only elevations from the test, not carrying spines or pedicellariæ. They are specially numerous on the actinal side (Pl. XII. Fig. 26), and when seen under the microscope are very conspicuous among the white tubercles on account of their smooth, shining surface. On the abactinal side they are less numerous; such a protuberance is generally situated between the two pores of each pair of the petals, elongated in shape and with a distinct longitudinal furrow in the middle. (Pl. XII. Fig. 22.)

The spines are short, making a dense clothing. The primary ones, about 0·5—0·7^{mm} long, are slightly tapering, densely serrate, except at the base (Pl. XII. Fig. 19); those around the peristome are curved. Generally they are a little thicker in the middle, as seen in the figure cited; sometimes they are distinctly widened in the outer part. The point is generally worn off. As pointed out by Agassiz those on the actinal side are somewhat longer than the abactinal ones. The miliary spines (Pl. XII. Fig. 9, 18) are only about half the size of the primary ones, a little widened in the point, which forms a sort of crown, the endcrown of de Meijere, to whom belongs the merit of having shown the great systematic importance of the structure of the spines, especially the miliaries, in the *Clypeastroidea*. (Siboga -Echinoidea. p. 113). The longitudinal ribs are slightly widened above with the edge finely serrate, sometimes almost smooth. The small radial plates in the crown are simple or with a few (2, sometimes 3 or 4) dentations. It is worth noticing that, when the living animals are put in alcohol, the spines turn intensely green; this holds good also for several other Clypeastrids, if not for all of them.

The pedicellariæ are represented by three kinds, viz. ophicephalous, tridentate and triphyllous. The ophicephalous pedicellariæ (Pl. XII. Figs. 4, 6) are small and rather simple in structure: the blade is narrow, elongated, widening a little in the outer part; the edge is somewhat densely serrate along the whole length. There is no distinct basal part; the articular surface is very strongly developed, the three valves articulating so closely together that it is almost impossible to separate them without breaking (in *Ech. grandiporus* the valves separate easily). In one of the valves the arc is very large; another has the arc prolonged into a long thornlike process, which goes through the hole in the large arc; its point is more or less bent. The third valve has the arc very slightly developed, with no process. (Comp. Pl. XII. Figs. 8, 11, 12 of *Ech. grandiporus*). This structure is well seen in the figure given by Cuénot (op. cit. — he wrongly names it a tridactyle pedicellaria); de Meijere also gives a description of it (op. cit. p. 108). The head articulates directly with the upper end of the stalk, the large arc resting on the cup-shaped upper end of the stalk, attached by some muscular fibres to the bottom of the cup, as shown in Cuénot's figure. The stalk is comparatively very robust, almost hourglass-shaped, in the middle part it consists of compact calcareous substance, at both ends it is of the common, looser structure. These pedicellariæ are especially numerous on the actinal side, behind the anal area. — The triphyllous pedicellariæ (Pl. XII. Fig. 20) are very small, the head not more than ca. 0·04^{mm}; the stalk is like that of the ophicephalous pedicellariæ, only much more slender and not cup-shaped at the upper end; the neck is well developed. The blade is coarsely dentate along the whole edge; the lower part of the blade is very narrow, forming a small tube. The basal part is not distinctly developed, the articular surface is broad and well developed. Some larger forms, very similar to these, might also be termed triphyllous pedicellariæ, but from analogy with the *Ech. grandiporus* described below, in which species there can be no doubt that these are tridentate pedicellariæ, the larger ones may also be termed tridentate in *pusillus.* (Pl. XII. Fig. 23). The blade is more elongated than in the triphyllous; the edge is serrate, the serrations on the point being the larger, often considerably larger than in the one figured; the basal part as in the triphyllous. Size ca. 0·08—0·09^{mm}.

The buccal membrane does not contain any plates or spicules; the same holds good for the internal organs. The genital organs are much branched and interlaced, but apparently not anastomosing, forming a broad ring. The axial organ shows some distinct swellings. The madreporic plate has on the inside a deep and large impression for the axial organ and the ampulla.

The largest specimen of this species seen by me is 15^{mm} in length. The size 9 lines (20^{mm}) given in Zoologia Danica (loc. cit.) seems hardly correct. It is very variable as regards the shape of the test. This has caused older authors (L. Agassiz, Forbes) to distinguish a number of »species» based almost exclusively on differences in the shape of the test, viz. among the recent forms: *E. pusillus, angulosus* and *tarentinus,* besides a number of fossil species from the Tertiaries. Philippi (op. cit.) has first pointed out that these differences are unreliable for specific characters, since all the different forms may be found among specimens from the same locality. Philippi and all the later authors after him (except Forbes) therefore regard all the recent forms from the European seas as one species including also several of the fossil »species». I quite agree with this, and might further add as synonymous the *E. hispidulus* Forb. and *E. oviformis* Forb., both from the Crag, examples of the same shape as these occurring likewise among the recent specimens. — Forbes further distinguishes no less than six different varieties of *Ech. pusillus,* all of which, he agrees, »may be taken in one locality at the present day». It is evident that all these forms cannot rank as »varieties», they represent merely individual variations in the shape of the test. — Perhaps the specimens from the Færoe Islands may rank as a distinct variety. On comparing them with specimens from the Kattegat and the Mediterranean I find that the number of pores is upon the whole a little smaller in the former (comp. the tables given below, p. 34); but it is no constant feature, specimens from the Færoe Islands occurring with as large a number of pores as is generally found in the specimens from the Kattegat. The shape of the test is upon the whole more elongated than in the specimens from the Kattegat; also, the primary spines are generally somewhat less serrate than those of the typical form, sometimes even quite smooth ones may be found. — The specimens from the Limfjord may also be distinguished as a local form, remarkable for the close tuberculation. — The Mediterranean form I am unable to distinguish as a separate variety: they closely agree with the specimens from the Kattegat. The same holds good for the specimens from the Azores.

This species was taken by the »Ingolf» at St. 86 (Brede Bugt, Iceland, 7 dead tests). At the Westmanöer, Dr. A. C. Johansen has taken 4 dead tests (30 fathoms); in the Zoological Museum is found further an old dead test from Reykiavik. These are, so far as I know, the only specimens of *Echinocyamus pusillus* known from Iceland; it thus seems that the species does not live there now, and Iceland must accordingly for the present not be named among the localities of this species. At the Færoe Islands I have taken (in 1899) enormous quantities of dead tests together with some living specimens; thus in ca. 150 fathoms, 13 miles W. by S. of Munken (at the South End of Suderö) I took in one dredging 672 dead tests and only 14 living specimens; in ca. 70 fathoms, 9 miles E. S. E. of Bispen (at the north end of the islands) one dredging gave 50 dead tests and 2 living specimens. At these localities also enormous quantities of dead mollusc-shells and very few living specimens were found; they may with full right be termed submarine shellbanks [1].

For the rest, *Echinocyamus pusillus* occurs from Northern Norway, along the European coasts, in the British Seas, the Mediterranean, at the Azores and along the African Coast down to Cape Bojador (Döderlein. Op. cit. p. 234). The bathymetrical distribution is from 0—ca. 400 fathoms, the greatest depth from which the species is hitherto known with certainty being 835 meters (61° 7' Lat. N. 9° 30' Long. W. — Thor 1904). The fairly numerous records of its occurrence at greater depths (down to (800—1000 fathoms) are, so far as I have been able to ascertain, all based on wrong identifications, as shown below. (A pair of small, old dead tests of *Ech. pusillus* from a depth of 1290 M. (Lat. N. 38° Long. W. 30°) do not prove that the species lives at so great a depth.)

According to Professor A. Agassiz, whom all the later authors follow in this, *Echinocyamus pusillus* is found also on the American side of the Atlantic, viz. at Florida and the West Indies (Gulf of Mexico, Caribbean Sea, Brazil) at a depth of 75—ca. 800 fathoms (most abundant between 150 and 400 fathoms. Blake -Echini. p. 40). It is also recorded from 5 fathoms at Salt Key (Pourtalès); but since Professor Agassiz himself owns to have at first mistaken young Clypeasters *(Stolonoclypus)* for *Echinocyamus* (Rev. of Echini p. 304), it may perhaps be allowed to suggest that the specimens from Salt Key are also really young Clypeasters, this *Echinocyamus* having nowhere else been recorded from less than 75 fathoms. The fact that *Ech. pusillus* is not known (living) from Iceland, Greenland and the American Coast north of the Florida Strait makes it beforehand doubtful, whether the American form can be really identical with the European species (though, of course, it is not impossible, other instances of species occurring both at the West Indies and in the Mediterranean being well known). A close examination of specimens from the Blake, the Albatross and the Challenger (St. 122), respectively in the U. S. National Museum, the Museum of Yale College and the British Museum has fully confirmed my doubt. These specimens differ from *Ech. pusillus* in so many important features that there can be no doubt of their forming a very distinct, new species. I am especially indebted to Professor Rathbun for sending material of this species for study to Copenhagen.

Echinocyamus pusillus is further recorded from a depth of 1300 M. from the Azores (Koehler. Op. cit. p. 24) and from 1694 M. at Cape Verde (Döderlein. Op. cit. p. 234). Having seen that the American specimens were not really *Ech. pusillus* I felt some doubt, whether the specimens from such great depths might not prove identical with the American species, and I therefore applied to Professors Döderlein and Koehler for permission to examine the specimens from these localities. With their usual great liberality they gave their permission; Professor Koehler even sent me all his rich material of *Echinocyamus*, and Professor Chun, besides allowing me to partly denude the only specimen

[1] Comp. A. C. Johansen: Om Aflejringen af Molluskernes Skaller i Indsoer og i Havet. Vidensk. Medd. fra Naturhist. Foren. Kjobenhavn. 1901. p. 30.

from the deep station off Cape Verde, lent me the coloured figure made on board the »Valdivia» from the living animal. Further, Professor Théel sent me all the material of *Echinocyamus* from the »Josephina«-Expedition. I wish here to express my deep gratitude to these gentlemen for their great liberality. I have also received two specimens of *Echinocyamus pusillus* from the Paris Museum from the »Travailleur« (or »Talisman«) 2100 M. The result of a careful study of all this material has been that most of these specimens proved identical with the American form, and that yet a third species is represented by some specimens from the greater depths, whereas the true *Echinocyamus pusillus* is only found among those from more shallow water. The two new species are described here under the names *Echinocyamus grandiporus* and *Ech. macrostomus*.

Echinocyamus grandiporus n. sp. The shape of the test (Pl. XII. Figs. 1, 5) is, as a general rule, more rounded than in *pusillus*, scarcely broader at the posterior than at the anterior end, which is almost invariably the case in the latter species. Also the height of the test is generally a little larger than in *pusillus*. On account of the great variability in *pusillus*, the shape of the test cannot, however, afford any very reliable character, the more so, as some variability occurs also in *grandiporus* in this respect, though not so much by far as in *pusillus*.

The madreporic plate is a little elevated and generally somewhat larger than in *pusillus*; the peristome and anal area are generally not larger than in that species. The anal area is small, a little nearer the edge of the test than is the case in *pusillus*. The peristome may be more or less pentagonal; the edge is only slightly bent inwards, and the whole actinal side is more flat than is generally the case in *pusillus*. The apical system presents a conspicuous difference from *pusillus*. The ocular pores are very large, as large as or even a little larger than the genital pores; the 4 genital pores and 5 ocular pores form together a conspicuous circle or pentagon round the madreporic plate with its one madreporic pore in the same position as in *pusillus*. (In one instance I have found a genital pore developed in the odd posterior interambulacrum). This feature makes a very easily observable character distinguishing this species from *pusillus*; in accordance herewith it may be said almost with certainty that the Fig. 3. Pl. XI. e in »Revision of Echini« is the true *pusillus*, whereas those figured on Pl. XIII. 1—8 are *grandiporus*, which is also seen by an examination of the number and arrangement of the ambulacral pores in these figures. — It will be noticed that in the Fig. 6. Pl. XIII of the »Revision« 5 very small pores are represented between the five large ocular pores in the place of the genital pores. I have myself seen a specimen, 5·5^{mm} in length, in which the genital openings are much smaller than the ocular pores. The figure mentioned may thus well represent such a specimen; the presence of 5 genital openings may, of course, be possible, since it can be found among specimens with the genital pores of the usual size; but, in any case, if the figure be correct, it represents an abnormal individual. The shape of the petals in this figure is, otherwise, not in accordance with what is generally found in *grandiporus*, so that it seems probable that the differences shown in this figure from other specimens of *grandiporus* are due to incorrect drawing. The small size of the genital pores in the case mentioned will probably be due to an abnormal late development of the pores. That the specimens with the small pores should represent the males is very unlikely; in that case their number would certainly be considerably larger.

Table showing the number of pairs of pores in the petals of Echinocyamus pusillus and grandiporus.

Echinocyamus pusillus.

Kattegat.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
6·5 mm	6—8	5—6	6
6 -	6—7	5—6	5—6
5 -	5	5	5—6
5 -	5—6	5	5—6
4·5 -	5—6	5	5—6
4·5 -	5—6	5—6	6—7
4·5 -	6	5	5—6
4·5 -	5—6	4—5	5—6
4 -	5	5—6	5—6
4 -	4	4	4
4 -	4	4	4—5
3·5 -	3—4	3—4	3—4
3 -	3—4	3	3—4
3 -	3—4	3	3—4
2·5 -	2—3	2	2—3
1·5 -	The petals not yet developed, only one pair of pores has appeared.		

Limfjord.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
8·5 mm	9—10	7—8	8—9
8 -	9	7—9	8—9
7·5 -	8	7	7—8
7·5 -	9	8	7—8
7 -	8	7	7
7 -	8—9	7—8	8
6 -	7	6—7	6—8
6 -	7	6	6—7
6 -	6	5—6	6—7
6 -	7—8	6—7	7—8
5·5 -	6—7	5—6	6—7
5 -	6—7	5—6	5—6
4·5 -	5—6	5—6	5—6

Færoe Islands.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
10 mm	6—7	6—7	8—9
9 -	7	6—7	7—8
9 -	7—8	6—7	6—7
8·5 -	8	7—8	7—8
8·5 -	7	6—7	7—8
8·5 -	6—7	5—6	6—7
8 -	6	6	6—7
8 -	8	6—7	6—7
7·5 -	7—8	6—7	6—7
7 -	7	5—6	6—7
7 -	6	4—5	5—6
7 -	6—7	5—7	6—7
6·5 -	6	5	5—6
6·5 -	6	5—6	6—7
6·5 -	6	5—6	6—7
6·5 -	4	3—5	4
6 -	5	4—5	4—6

Færoe Islands (continued).

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
6 mm	4—5	3—4	4—5
5·5 -	4—5	3—4	4—5
5·5 -	4—5	3—4	3—4
4·5 -	3—4	3—4	3—4
4 -	3—4	3	3—4
3·5 -	3	3	3
3 -	2	2—3	2—3

Mediterranean.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
10 mm	8—10	8—9	9—10
9·5 -	10—11	9—10	9—10
8·5 -	8	8	7—8
8·5 -	9	8	9—10
8·5 -	7—8	6—7	7—8
8 -	7	6—7	6—7
7·5 -	7	7—8	7—8
7 -	7	7	6—7
6·5 -	6	5—6	5—7
6·5 -	6	5—6	5—6
6·5 -	6—7	6—7	6—7
6·5 -	6—7	6	6—7
6 -	6	6	6—7
5·5 -	6	5—6	6
5·5 -	5—6	4—5	4—5
5 -	5	4—5	4—5
5 -	5	4—5	4—5
5 -	5—6	5—6	5—6
4·5 -	4—5	4	4
4 -	4	3—4	3—4

Azores.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
8 mm	8—9	7—8	8—9
7 -	10	8—9	9—10
7 -	7—8	6—7	7—8
6 -	8—9	8—9	9—10
6 -	7	6—7	7
5·5 -	6—7	5—6	5—6
5·5 -	5—6	4—5	5—6
4·5 -	4—5	3—4	4—5
4 -	4—5	3—4	4—5
4 -	3—4	3	3—4
3·5 -	4—5	4	4
3·5 -	3—4	2—3	3
3·5 -	3—4	2—3	3—4
3 -	3—4	2	3
2·8 -	3—4	3—4	3—4
2·8 -	3—4	3	3
2 -	1	1	1—2

The three smaller specimens with the genital pores well developed.

Echinocyamus grandiporus.

West-Indies.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
8 mm	3	3—4	4—5
8 -	3	3	3—4
8 -	2	2	2—3
7 -	3—4	3—4	4—5
6·5 -	3—4	3—4	4
6 -	2	2	2—3
5·6 -	1—2	2	2—3

Azores, Josephine Bank.

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
9 mm	4—5	4	4—5
8 -	5	4—5	5—6
7·5 -	3	3—4	4
7 -	3—4	4	4
6·5 -	2	2—3	3
6.5 -	2	2—3	2—3
5·5 -	1—2	2	2—3
5·5 -	2	2—3	3
5·4 -	2	2—3	2—3
5·2 -	1	2	2—3
5 -	2—3	3	4
4·3 -	0	0—1	0—1
4·3 -	0—1	0—1	0—1
4·2 -	1	1—2	1—2
4 -	0—1	0—1	1—2
4 -	0—1	0—1	1
3·5 -	0	0—1	0
3·4 -	0	0	0
3 -	0—1	0—1	0—1
2·8 -	0	0	0

The petals are considerably shorter and less developed than in *pusillus*, the number of pores being almost double in the latter species, when comparing specimens of a corresponding size of the two species, as is easily seen from the table given and from a comparison of figures 5 and 31. Pl. XII. The pores are somewhat smaller than in *pusillus* (those of the inner series smaller than those of the outer series), with no distinct glassy protuberance between the pores of each pair; the pairs are also more oblique and more distant than in *pusillus*. It is further a conspicuous feature that the petals are converging outwards, the two series of each petal being more distant at the inner end — likewise a very conspicuous difference from *pusillus*. (Comp. Figs. 5 and 31. Pl. XII). (In one specimen, $8{\cdot}5^{mm}$ in length, the petals are quite irregular, consisting of some few, scattered pairs of pores; only the right posterior petal is almost normal. Also the genital and ocular pores are quite abnormally placed in this specimen). There is further a considerable difference from *pusillus* in the number of the small ambulacral pores; on the actinal side they are arranged only in a single series along each horizontal suture, except in the two inner pairs of sets, in which they form, more or less distinctly, two series. This is the case also in the largest specimens seen, 9^{mm} in length. On the abactinal side they are arranged as in *pusillus*, only I have been unable to discern with certainty such pores within the petals. The genital pores I have found developed in a specimen only $2{\cdot}8^{mm}$ in length; on the other hand I have also seen a specimen of 4^{mm} length with as yet no traces of genital openings. Large genital papillæ may be developed.

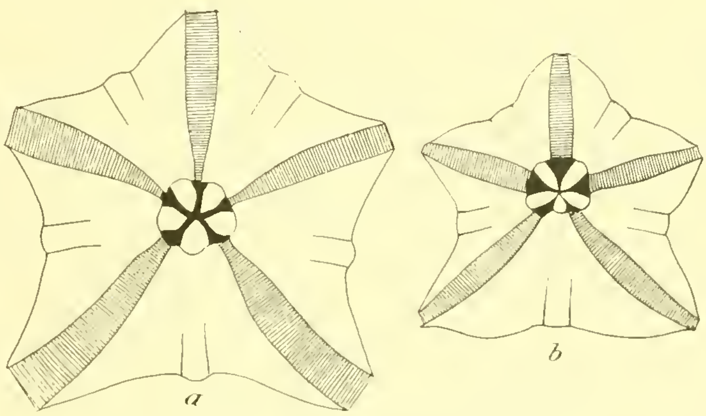


Fig. 2. Dental apparatus of *Echinocyamus*, 7^{mm}. *a Ech. grandiporus*. *b Ech. pusillus*. $^{17}/_{1}$.

The tuberculation is somewhat less close than in *pusillus*, and the glassy protuberances among the tubercles are likewise less numerous, but, on the other hand, they are more prominent being considerably higher than the primary tubercles; they are striated, ending in a knob, almost like the mamelon of a tubercle, which is, however, not perforated, since no spine is articulated to it. (Pl. XII. Fig. 14.) This seems, however, to be a rather inconstant feature, and in any case it is very indistinct in less well preserved specimens.

The supporting ridges of the interior of the test (Pl. XII. Fig. 3) are less strongly developed than in *pusillus*, not proceeding to the auricles as in the latter species, but ending some way outside the auricles, which are also more distant from the edge of the peristome than in *pusillus*. (Comp. Pl. XII. Fig. 3 and 29.) It will be seen that the figure given in Revision of Echini Pl. XIII. 7 is much more in accordance with the figure given here of *grandiporus* than with that of *pusillus*, though not quite agreeing with this figure either. The depressions along the ambulacral sutures are much less prominent than in *pusillus*. — In accordance with the place of the auricles the dental apparatus is considerably larger than in *pusillus*, as shown in Fig. 2, which represents the dental apparatus of specimens of 7^{mm} length of *pusillus* and *grandiporus*. Both agree in having it unequally developed the pyramid (5) of the odd posterior interambulacrum being considerably larger than the others. (Comp. Lovén. Echinologica. p. 69).

The spines are a little longer than in *pusillus*, the largest being ca. 1^{mm}, and more slender. They are provided with only a few serrations and end in rather a slender point. (Pl. XII. Fig. 15.) The miliary spines are only about one third as long as the primary ones. They are a little slenderer than those of *pusillus*, often slightly serrate near the upper end. The endcrown is a little larger than in *pusillus;* the longitudinal ribs are more widened at their upper end, almost joining with their edges, and the radial plates are larger and broader, generally with 4—5 serrations, sometimes in a double series. (Pl. XII. Figs. 10, 16). — The pedicellariæ also differ rather considerably from those of *pusillus*. The ophicephalous pedicellariæ differ from those of *pusillus* in having fewer serrations along the edge of the blade, otherwise the shape and structure is the same as in that species. (Pl. XII. Figs. 8, 11—13). The tridentate pedicellariæ (Pl. XII. Figs. 25, 28) are gradually narrowed towards the articular surface, whereas in *pusillus* they narrow abruptly at the lower end of the blade. The triphyllous pedicellariæ (Pl. XII, Fig. 21) have a much broader blade than in *pusillus*, and the edge is much more closely serrate; they are very small, the head only ca. $0{\cdot}04^{mm}$. — The buccal tube-feet are not distinctly larger than the other actinal tube-feet. Spicules are wanting as in *pusillus*.

To this species so well distinguished by its large ocular pores, little developed petals, few actinal pores, as well as by its spines and pedicellariæ, belong all the specimens of »*Echinocyamus pusillus*» from the »Blake» and »Albatross» which I have seen (viz. from »Blake» St. 5 and 239, »Albatross» St. 2352, 2666 and 2668), as well as the specimens from the »Challenger» St. 122 (examined in the British Museum); a pair of specimens dredged by myself in 500 fathoms off Frederiksted, St. Cruz, also belong to this species. Probably all the specimens of *Echinocyamus* recorded from the West Indies and Florida (and Brazil) under the name of »*pusillus*» will turn out to belong to this species (and perhaps partly to the following species). In any case the existence of *Ech. pusillus* in these regions must remain doubtful, until by renewed careful examination it is proved beyond doubt to exist there besides *Echinocyamus grandiporus*. I have further seen rather numerous specimens of this species from the Azores from depths of ca. 100—700 fathoms (1365 m.) and from the Josephine Bank (110—430 fathoms).

The occurrence of this species on both sides of the Atlantic is in good harmony with the distribution of other Echinoids, e. g. *Genocidaris maculata*, *Cidaris affinis* a. o. — and likewise it would not be contrary to these facts of geographical distribution, if *Ech. pusillus* should turn out to occur in the West Indian Seas; it must only be emphasized that it cannot be considered as an established fact, before the specimens of *grandiporus* (and possibly also of *macrostomus*) are distinguished from the true *pusillus* by renewed examination.

Echinocyamus macrostomus n. sp. The shape of the test (Pl. XII. Figs. 17, 24) is very like that of *grandiporus*, a little more elongated, but not so much that it can be relied upon as a specific character. The peristome is generally very large; there is, however, some variation in this respect, but I have always found it considerably larger than in specimens of *grandiporus* of a corresponding size. The edge of the peristome is not incurved; the buccal membrane is devoid of spicules as in the other species. The anal opening is generally larger and nearer the edge of the test than in *grandi-*

porus. The apical system differs from that of *grandiporus* in the ocular pores being much smaller than the genital pores as is the case in *pusillus.* The madreporic plate is generally larger than in *grandiporus,* otherwise it is elevated as in that species and the genital pores are likewise covered with long genital papillæ. Also in this species I have seen one specimen with 5 distinct genital pores. The petals are very slightly developed, even scarcely so much as in *grandiporus,* as seen by the following table. The genital pores I find developed in the specimen of 4^{mm}, while in that of $4{\cdot}2^{mm}$ they have not yet appeared and in the specimen of $4{\cdot}8^{mm}$ (the one figured) only the anterior pair is developed.

As regards the arrangement of the actinal pores, the tuberculation, the structure of pedicellariæ and spines as well as the internal structure of the test I do not find any reliable differences from *grandiporus.* (Pl. XII. Figs. 2 and 7 represent an ophicephalous and a triphyllous pedicellaria of this species.)

The colour of the living animal is, according to the sketch made on board the "Valdivia", green; there are ten darker radiating bands, answering to the bands of tube-feet, the intermediate spaces having a slight yellowish tint; around the peristome there is a darker pentagon, radiating a little into the ambulacra.

To this species belongs the specimen referred to *Echinocyamus pusillus* from the German Deep-Sea Expedition, St. 37, 1694 m. (off Cape Verde. Döderlein op. cit. p. 234), and the two specimens from the "Travailleur" 2100 m., which I received from the Paris-Museum. Further, among the specimens sent me by Professor Koehler two specimens from 37° 54′ Lat. N. 27° 3′ Long. W. 2178 m. (off the Azores), three specimens (the Azores, 1360 m.), one living specimen and some dead tests from 32° Lat. N. 16° Long. W. 2286 m., and one specimen from 39° Lat. N. 32° Long. W. 1600 m. belong to this species. — The species is then evidently a more abyssal species than *grandiporus.*

Number of pairs of pores in *Echinocyamus macrostomus.*

Size	Anterior Petal	Antero-lateral Petals	Postero-lateral Petals
7·5 mm	2	1—2	3—4
7·4 -	2	2—3	3
7·2 -	1 2	1—2	1—2
7 -	1—2	1—2	2—3
6·8 -	2	2	2—3
6 -	1	1—2	2—3
5 -	1	1—2	2
5 -	1	1—2	2—3
4·8 -	0	0—1	0—1
4·2 -	0	1	1
4 -	0—1	0—1	1 2

I have been in considerable doubt as to whether this form ought to be established as a separate species or not. It is beyond doubt that it is very closely related to *Ech. grandiporus*, from which species it is distinguished only by the small size of the ocular pores and the large size of the peristome, other small differences being too inconstant to be relied upon as specific characters. The two features pointed out are, however, so conspicuous and so far as my experience goes constant, that it seems quite necessary to keep this form separate, as the bathymetrical distribution seems also to indicate its specific difference from *grandiporus.* Otherwise it is evidently of no great importance whether it is regarded as a variety only of the latter species or as a separate species; the main thing is that it should not be merely confounded with the typical *grandiporus* — not to mention *pusillus* with which it was hitherto confounded, but to which it is not so nearly related.

Perhaps yet another species of *Echinocyamus* will prove to occur in the Atlantic. Among the specimens from the "Josephina" and among those from the Azores sent me by Professor Koehler there are a few small specimens, which look rather different from the other species. They agree with *pusillus* in the shape of the test, the small size of the ocular pores and in the petals. But the primary tubercles are larger than is generally the case in *pusillus,* and the scrobicular area is more deepened. Further, it may be noticed that the tubercle is placed excentrically at the anterior side of the scrobicular area. Miliary tubercles are scarce, the primary ones leaving but little room for them. — Perhaps these curious small specimens represent merely an individual abnormality; from the few small naked tests to hand it is impossible to decide the question.

In his »Note sur le genre Échinocyamus«[1] Lambert calls attention to the fact that the species figured under the name of *Echinocyamus* by van Phelsum[2] are not of the flat form to which the name is now applied, but of the high form which is designated by the name *Fibularia* Lamarck. Accordingly these two names should be exchanged and used in a way contrary to what has for so very long been the general use. »Pour rejeter mes conclusions il faudrait à la fois attribuer seulement à Leske, et malgré lui, la paternité du genre Echinocyamus, prendre pour type de ce genre une forme que le savant commentateur de Klein n'y rattachait que d'une facon accessoire et exclure du genre Fibularia la seule espèce authentique que Lamarck y ait placée. Triple résultat qui me parait inadmissible.« (Op. cit.). Cotteau[3] objects thereto that, since the specimens of v. Phelsum had been collected in America and the Adriatic Gulf, flat forms must have been among his »species«, as »les Fibularia, propres à la mer des Indes, n'ont jamais été rencontrés sur les côtes de l'Amérique et encore moins dans le golfe Adriatique, où abondent les Echinocyamus«. Further, the figures given by v. Phelsum »laissent assurément à désirer; dans le grossissement elles sont pour la plupart renflées d'une manière exagérée«. — »Autant il nous paraît nécessaire, lorsque les faits sont positifs et indiscutables, de revenir au principe de l'antériorité, qui doit toujours être respecté, autant il serait dangereux, quand la question est douteuse et sujette à controverse, d'adopter des modifications qui n'auraient d'autre résultat que d'apporter une grande perturbation dans la nomenclature et de compliquer la synonymie«. Also de Loriol[4] agrees with Cotteau in this question, and I for my part cannot see, but that Cotteau and de Loriol are right. The figures of v. Phelsum are, indeed, so bad and quite unlike either the flat or the high form, that they seem to me quite insufficient to support such an extremely unhappy change of names. The fact that some of his specimens came from the Adriatic is a proof that the flat form was among his »species«, and some of the figures also seem to represent this flat form. The figures in the two first columns are indeed, in my opinion, much more like the flat forms (except the two first figures, which are, however, still less like the elongated *Fibularia*-forms); those in the third column (side views) are somewhat more like the high form, though always very badly representing the true shape of the test of the high forms; the figures of the end-views of all his 14 »species« are so very much alike that it would be impossible to point out which belong to the flat and which to the high form. Lambert, indeed, thinks that all his figures represent only fourteen scarcely different specimens of a single species. After all it seems to me that the only thing which is certain in this question is, that the flat form is represented among van Phelsums species, and being from the Adriatic Sea (as van Phelsum himself states p. 36) it must even be *Echinocyamus pusillus*, the only species found there. Whether the high form is really represented by any of his »species« must remain doubtful, though by a mere glance at his figures one might at first be induced

[1] Bull. Soc. géol. de France. 3 Sér. XIX. 1891. p. 749.
[2] Brief aan Cornelius Nozeman over de gewelw-slekken of Zee-Egeln. 1774.
[3] Paléontologie Francaise. Terrain Tertiaire. II. Échinides. 1894. p. 349.
[4] Notes pour servir à l'étude des Échinodermes. V. 1897. p. 8.

to refer them all to the high form. Only in case all the species of v. Phelsum were beyond doubt of the high form, would it be necessary to change the names *Echinocyamus* and *Fibularia;* but this is so far from being the case that perhaps they all really belong to the flat form. Accordingly it would not only be a very unfortunate thing to change the names *Echinocyamus* and *Fibularia,* but it would even be wrong and contrary to the rules of priority to do so. It may be considered as certain that *Echinocyamus pusillus* is among the species of van Phelsum, since some of his specimens came from the Adriatic, and if Lambert is right — as I think he is — in regarding all the 14 species of *Echinocyamus* figured by van Phelsum as one species only, they are all *Echinocyamus pusillus.* I agree that from the three last columns of the plates in van Phelsum's old book and — perhaps — from some of the descriptions it might seem to be the high form which is represented; but the two first columns in any case resemble much better the flat form, and above all the localities given by van Phelsum prove definitely that they cannot represent the high form, because only flat forms occur in the Adriatic and at America. It is then only the bad drawing which makes the figures in the three last columns (sideview, endview and from below) look like the high form. But to ascribe such importance to some evidently quite impossible figures as to found thereupon a most unhappy change of names universally used, against the (in this case) quite certain deduction from the localities, seems to me unjustifiable, and I must protest against such a proceeding with all my force.

Suborder **Meridosternata.**

Fam. **Urechinidæ.**

19. **Urechinus naresianus** A. Ag.

Pl. VI. Figs. 10—11. Pl. VII. Figs. 6, 8, 13, 15. Pl. IX. Figs. 4, 8—9, 15—16, 18, 21, 26, 29—39.

A. Agassiz: Challenger -Echinoidea. p. 146. Pl. XXIX. Figs. 1—4. Pl. XXX. XXX a. Figs. 1—4. Pl. XXXIX. Figs. 29—30. Pl. XL. Figs. 56—58. — Blake -Echinoidea. p. 52. Pl. XXVI. 1—3. — Panamic Deep-Sea Echini. p. 156. Pl. 58. 5. 60. 4—5. 74. 6—8. — Lovén: On Pourtalesia. p. 90. Pl. VIII. 56. Pl. XXI. — Duncan: Revision of the genera of Echinoidea (132) p. 211—12. — Bell: Echinoderma found off the Coast of South Africa. I. Echinoidea. (Marine Investigations in South Africa. III. 1904.) p. 173.

The structure of the test of this highly interesting Echinoid has been so well worked out by Agassiz and Lovén that very little can be added in this respect. I only wish to call attention to the fact that the inner edge of the plates round the peristome is somewhat thickened (Fig. 3) as pointed out for *Cystechinus* by Agassiz. (Comp. e. g. Pl. 78. 5. Panamic Deep-Sea Ech.) The irregularity in the specimen figured Pl. VI. Fig. 10, the plate II. b. 3 having two pores, 4 none, is worth noticing, though, of course, only an individual abnormality.

The rich material from the Ingolf includes some young specimens, so that I am able to give some information of the changes due to growth in this species.

The youngest specimen taken by the Ingolf is 3^{mm} in length. Unfortunately it is impossible to find out the relations of the apical system in this small specimen; on account of its extreme fragility I have been unable to remove the spines completely without destroying the test, and I have not succeeded in making clear the limits of the plates, either by treating it with alcohol-glycerine, mounting it in Canada balsam or drying it. The most prominent feature of the specimen is the position of the anal area, almost in the middle of the abactinal side. The subanal fasciole is faintly indicated; the spines are rather long, equalling in length the diameter of the test. The pedicellariæ are like those of the adult specimens, viz. the globiferous and small ophicephalous (see below), other kinds not being found. The peristomial tubefeet are already penicillate.

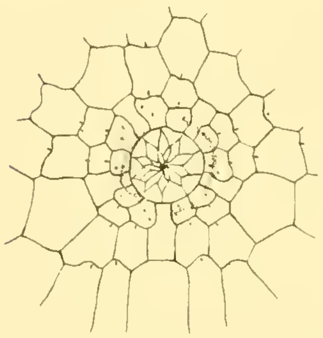


Fig. 3. *Urechinus naresianus.* Peristome and adjoining part from the inside. $^2/_1$.

The next size represented is $7{\cdot}5^{mm}$ in length. Here the anal area has reached near to the posterior end of the test, three pairs of plates being developed above it in the unpaired interambulacrum; the ventral side, however, projects still a little beyond the anal area, the posterior end of the test thus sloping a little downwards and outwards, whereas in later stages it is vertically cut, and in grown specimens the posterior end slopes downwards and inwards, the abactinal side projecting over the anal area, till at last the anal area is almost on the flat actinal side. The figure 4 shows the position of the anal area in the different stages. — The plastron and bivium in this specimen of $7{\cdot}5^{mm}$ has upon the whole the same form and relations as in the grown specimens. The subanal fasciole is distinctly developed. The apical system is essentially as in the grown specimens. — In the next stages I find no important changes to notice. They become gradually higher, however, there is a rather great variation in the height in grown specimens, as remarked by Agassiz. The displacement of the periproct gives the most prominent change. The genital openings appear rather late; I have not seen them in specimens smaller than 22^{mm}, but sometimes they do not develop till later, thus there is no trace of them in a specimen of 27^{mm}. The genital pores (three in all the specimens) are covered by very conspicuous genital papillæ. — It may be noticed that the plates show the same marks of growth and radiating ridges as described and figured from *Cystechinus Wyvillii* by Agassiz (Chall.-Ech. Pl. XXIX. b. 9), though not so distinct as in that species; the same feature has been made known for the fossil *Echinocorys ciplyensis* by Lambert[1].

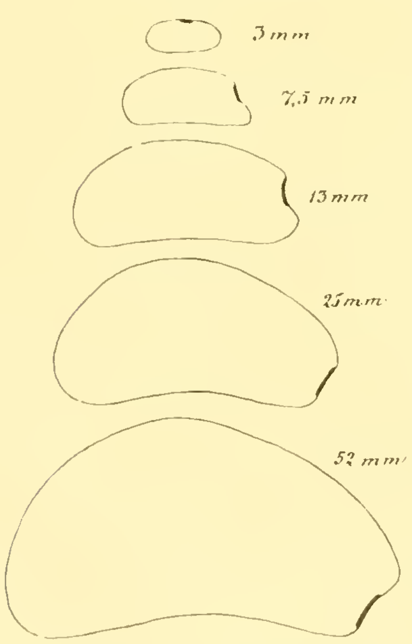


Fig. 4. Outlines in profil of different stages of *Urechinus naresianus*, showing the change in the position of the anal system.

The primary spines (Pl. IX. Fig. 30) are very slender, the longest ones found are ca. 5^{mm}; they are almost all broken on all the specimens except the smallest, in which they are as long as the diameter of the test. They are smooth in the lower part, somewhat spinous in the outer part, terminating in a short, oblique thorn. Those of the actinal plastron are, judging from the very few unbroken ones found, a little flattened at the point, but not widened. The clavulæ of the fasciole are like the miliary spines (Pl. IX. Fig. 31) covering the ab-

[1] Étude monographique sur le genre Échinocorys. (Mém. Mus. R. d'hist. nat. de Belgique. II. 1903. p. 28.)

actinal side, only a little shorter and clad with a thicker skin. The spines upon and around the peristome are somewhat clubshaped (Pl. IX. Fig. 39); the base of the primary spines is rather large; it seems somewhat exaggerated in the Chall.-Ech. Pl. XXX. Fig. 20 — the Fig. 21 of the same plate, representing a miliary spine, according to the explanation of the plate, it is better not to speak of.

In the specimen of 7.5^{mm} the primary tubercles form, on the abactinal side, an almost regular vertical series in each row of plates, the tubercles being placed in the middle of the plates. In later stages other tubercles grow larger than the primary ones, thus obscuring the vertical arrangement, and it even sometimes looks as if the true primary tubercles have become resorbed[1].

In grown specimens the arrangement of the large tubercles is quite irregular, as described by Agassiz. In the Challenger-Ech. p. 147 Agassiz remarks that in some specimens there may be rudimentary bourrelets. I have seen the same thing. The Figures 10 and 11, Pl. VI represent the actinal side of two specimens, one with a very distinct bourrelet, the other with scarcely a trace of it. Also in *U. giganteus* this feature is found (Panamic Deep-Sea Ech. p. 155) though not so distinctly developed, judging from the figure (Pl. 73. 1) to which reference is made.

The tube-feet may be quite devoid of spicules, or with a single series of simple, somewhat spinous rods with rounded ends (Pl. IX. Fig. 8) in the actinal, penicillate tube-feet as well as in the simple abactinal feet; in the lower part of the tube-foot they are generally more irregular, more or less branched. The peculiar fenestrate rods of the filaments have been figured by Lovén (On Pourtalesia. Pl. VIII. 56); they are, however, less fenestrate than shown there. No supporting skeletal plates are found below the rods of the filaments in the actinal tube-feet. The frontal tube-feet are simple, without a sucking disc (rosette), not differing from those of the other ambulacra. No large, specially developed subanal tube-feet.

Two sorts of pedicellariæ are figured by Agassiz (Challenger-Ech. Pl. XXX. 22—24), viz. tridentate (large trifid longstemmed pedicellariæ) and ophicephalous (shorter roundheaded pedicellariæ, in the explanation of the plates called clubshaped pedicellariæ with heavy-stemmed articulation). I find five different kinds of pedicellariæ in this species, viz. globiferous, tridentate (two sorts), triphyllous and ophicephalous pedicellariæ.

The globiferous pedicellariæ (Pl. IX. Fig. 35) have a rather conspicuous cap of evidently glandular skin, thickening especially over the point of the valves. The latter (Pl. IX. Fig. 9) are very characteristic; the blade is a closed tube ending in a large opening surrounded usually by nine long, slender gracefully curved teeth, one of which is median in the outer edge. The basal part is large, rounded; no neck. The stalk consists of long, thin calcareous fibres, connected only above and below;

[1] Agassiz (Panamic Deep-Sea Ech. p. 153, 159—60, 166) has found such resorption to occur in *Urechinus giganteus* and *Cystechinus*, as also in *Palæopneustes* and *Linopneustes*; he sees therein a proof of "the constant struggle that must exist for the deposition of needed carbonate of lime ... The least disorder in the growing tissue of any part of the test evidently affecting at once the active deposition of the carbonate of lime of that region". I may, however, remark that the tubercles of these forms are very easily broken off. It is quite easy, as I have tried myself, in this way to produce all the different stages of "resorption" figured by Professor Agassiz (especially Pl. 86. 2). The suggestion therefore does not seem unreasonable that at least part of what Professor Agassiz thinks to be the result of a resorption is, indeed, only the result of the animals having been "badly rubbed" in the dredge or otherwise. That the empty place of such a primary tubercle may be covered by a pigmented skin (as I have seen it very distinctly in a specimen of *Pourtalesia Jeffreysi*) is no proof of a resorption having occurred; it may as well be the result of some injury, by which the spine and tubercle was lost some time before.

it may be very long, up to 3^{mm} (in a specimen from the Cape, German South Polar Expedition, it reaches a length of 5^{mm}). These pedicellariæ are found almost exclusively on the abactinal side.

The tridentate pedicellariæ, which occur mainly on the actinal side, are of two kinds; one of them is rather slender, the head reaching scarcely a size of $0{\cdot}5^{mm}$. (Pl. IX. Figs. 33—34, 36, 38). The valves join in their outer half; the lower part is narrowed, sometimes even for some distance forming a closed tube. There is, however, in this respect great variation; sometimes the valves join over almost their whole length. The edge is distinctly serrate, and there may be a rather long tooth at the point (in the Cape specimens, only slightly developed in the specimens from the "Ingolf"). The neck is well developed, the stalk compact. The other somewhat larger and coarser form (Pl. IX. Figs. 15—16, 32) which mainly occurs on the actinal side and at the periproct has the basal part very strongly developed, much larger than the blade; generally there is only a very slight narrowing between the basal part and the blade, sometimes, however, there is a rather deep sinuation. The edge of the blade is very thick, finely serrate. There is a slightly developed neck, and the stalk is a little widened at the upper end. This form, especially those with a deeper sinuation between the blade and the basal part, reminds one very much of the short tridentate pedicellariæ of *Spatangus* etc. That they are really tridentate pedicellariæ is evident from *Cystechinus clypeatus*, in which species all transitional forms between such short coarse forms and the more slender forms are found. The triphyllous pedicellariæ have the blade a little elongate, finely serrate along the whole edge. (Pl. IX. Fig. 26). They are not distinctly different from small tridentate pedicellariæ, in which the valves are hardly narrowed in the lower part of the blade.

The ophicephalous pedicellariæ are generally exceedingly numerous, sometimes literally covering the test on the abactinal side. They are of the typical spatangoid form (Pl. IX. Fig. 18, 37); there is no neck, the lowermost and largest arc resting directly on the cup-shaped upper end of the stalk. The blade has a rounded deepening, the edges are thick, widened somewhat wingshaped, finely serrate down to the apophysis, where they join. The basal part is narrower than the blade. The lowermost arc has a small prolongation at the point. The edge of the cup on the upper end of the stalk is simple, not deeply sinuate as in the figure in the "Challenger"-Echinoidea. — The sphæridiæ are rather elongate, more or less spinous; they may proceed to the 4th ambulacral plate in the bivium.

Of the internal anatomy the figures 6, 8, 13 and 15, Pl. VII give some information. There is a well developed diverticulum and two siphones intestinales, the second, shorter one not separated from the intestine. (In the "Challenger"-Echinoidea Pl. XXIX. b. 8 is figured the intestine of *Cystechinus Wyvillii*, but neither diverticulum nor siphones are seen there. This would, indeed, be so very surprising a difference between so nearly related forms that it may be allowed to suppose that a closer examination will show these structures to occur also in *Cystech. Wyvillii*. and probably in all the *Urechinidæ*). — The stone canal is directed backwards on its way to the abactinal side, then passing a rather long way forwards along the abactinal side to the madreporic plate. The axial organ is very inconspicuous. The genital organs are rather small; those in Fig. 6. Pl. VII are full of nearly ripe eggs which are ca. $0{\cdot}4^{mm}$ in diameter.

This species was taken by the "Ingolf" at the following stations:

St. 18	(61° 44'	Lat. N.	30° 29'	Long. W.	1136	fathoms	3°0	C. Bottom temp.)	23	spec.
— 36	(61° 50'	—	56° 21'	—	1435	—	1°5	—	)	27	—
— 37	(60° 17'	—	54° 05'	—	1715	—	1°4	—	)	39	—
— 39	(62° 00'	—	22° 38'	—	865	—	2°9	—	)	1 [1]	—
— 40	(62° 00'	—	21° 36'	—	845	—	3°3	—	)	1 [1]	—
— 76	(60° 50'	—	26° 50'	—	806	—	4°1	—	)	1	—
— 83	(62° 25'	—	28° 30'	—	912	—	3°5	—	)	3	—

The species was hitherto recorded only from the dredgings of the »Challenger», »Blake» and the Cape investigations (Bell. Op. cit.). Regarding the specimens from the »Challenger» Duncan (loc. cit.) has thrown doubt on their being all really *U. naresianus.* »It must be admitted that the shape and details of *U. Naresi* .... given in the »Challenger» Report, Pl. XXIX, XXX, XXX a. are not those of one species. Some forms have and others have not a subanal fasciole; and these last are, moreover, (as Lovén has pointed out), without the peculiar arrangement of the pores of the postero-lateral ambulacra in the subanal region, which is seen invariably with a true subanal fasciole. It may be that there are two groups of forms, one without and the other with a subanal fasciole, and yet closely allied, as in the instance of *Micraster* and *Epiaster;* or the fasciole may be so small in the area which it surrounds, that it does not interfere with the ambulacra. The final solution of these questions must be left to the distinguished author of the Report on the »Challenger»-Echini». — Also Lambert (Echinocorys. p. 29. Note) is of opinion that the specimens with a distinct fasciole are specifically distinct from those without a fasciole. — Lovén (On Pourtalesia. p. 91) points out that the ambulacral plates I. a. 4 and V. b. 4 are »slightly expanded interiorly, so as to fill up the feeble re-entering angle offered by the corresponding plates of the posterior interradium, a structure commonly met with also in Holaster and other Meridosterni, and in the Prymnadetes, that is, in forms devoid of a subanal fasciola, and in no wise to be compared with the well known wedge-shaped, extended plates 6 + x, present in all Prymnodesmic Spatangidæ. Its deficiency in Urechinus is a sure sign of the absence of a subanal fasciola, of which not one of the several specimens carefully examined showed the least trace. There is, close under the periproct, a dense accumulation of ordinary miliary tubercles, not unlike that seen in the same position in some Brissi; it has no relation to the fasciola». — Contemporaneously Agassiz in the »Blake»-Echini p. 52 states that the structure of the subanal fasciole in *Urechinus* »assumes all the stages of development intermediate between a well defined subanal plastron .... and a stage in which the fasciole is indicated merely by irregular accumulations of miliary tubercles. So that the genus *Urechinus* is the representative of the oldest Spatangoids .... in which the subanal fasciole (the only one existing) is still in process of formation».

Though Duncan thus reserves the final solution of these questions for Professor Agassiz, I may be allowed to set forth a few remarks thereon. I must fully join Professor Agassiz in his statement about the fasciole; I likewise find all transitional stages between a distinct fasciole and no traces at all of a fasciole, even in specimens from the same locality. Moreover, I find that in young

[1] The two specimens from St. 39 and 40 differ somewhat in shape from the other specimens, the test being lower and more regularly rounded. The peristome is somewhat smaller than usual, and the secondary tubercles perhaps a little more prominent and numerous. Otherwise I do not find any difference. Unfortunately they are both almost denuded so that I have been unable to find any globiferous pedicellariæ on them. There can, however, scarcely be any doubt that they are really *U. naresianus.*

specimens the fasciole is generally distinct, whereas in larger specimens it gradually becomes less distinct on account of numerous small miliary spines, like those of the fasciole, developing between the primary spines on the adjacent part of the plastron. Lovén is scarcely right in maintaining that the extension of plates I. a. 4 and V. b. 4 can in no wise be compared with the extension of plates I. a 6 + x and V. b. 6. + x. in Prymnodesmic Spatangidæ. It is a fact of importance for this question that in *Brissopsis (Toxobrissus) pacifica* and the species *elongata* described below the first extended plate is not the 6th but the 7th — a case unknown to Lovén[1]; had he known this, he would probably not have laid so much stress on the numero 6. I think it not unreasonable to conclude that, when the subanal fasciole of the Prymnodesmic Spatangidæ includes sometimes the plates I. a. 7 + x and V. b. 7 + x instead of 6 + x (and nobody will doubt the homology of the fasciole and extension of plates in this case), it may also be possible to regard a fasciole including only the extension of plates I. a. 4 and V. b. 4 as homologous with that of the Prymnodesmic Spatangidæ[2] — and that likewise will hold good for the extension of this plate, in case the fasciole is wanting, whether it has disappeared with age or was never formed. That only one plate extends so as to reach within the fasciole cannot be against the homology. In the young *Echinocardium cordatum* likewise only one plate extends within the fasciole, viz. the 6th, as is described below. The fact that only one plate extends within the fasciole in *U. naresianus* thus evidently marks the fasciole of this species as being very primitive and of an embryonal character. — Otherwise, if it be right what Lambert (Études sur le plastron des Spatangides) and de Meijere (Siboga-Ech. p. 153) maintain that the Amphisterni have not developed from the Meridosterni, (and I, for my part, am fully convinced that they are right herein), the fasciole evidently will have developed independently in each group, and it is thus not surprising to find some differences in its relations in the two groups. Be that as it will, it is certain that the forms without a subanal fasciole agree exactly with those provided with a fasciole in the structure of the ambulacra of the bivium; there cannot be distinguished two groups, one without, the other with a subanal fasciole, as was suggested by Duncan.

Nevertheless Duncan was certainly right in suggesting that Agassiz has confounded two species under his *Urechinus naresianus* in the Challenger-Report. On an examination of the specimens of *Urech. naresianus* in the British Museum I find that those from St. 158 are not really that species; their globiferous pedicellariæ differ so considerably from those of *naresianus*, that they can certainly not belong to this species; they agree exactly with those of *Cystech. Wywillii* (comp. below p. 49). Probably these specimens will prove to belong to this latter species; since, however, *Cyst. Loveni* and *Urech. giganteus* also have similar globiferous pedicellariæ, I shall not try to decide to which species these specimens really belong, but be satisfied with having shown that they are not *naresianus*.

As pointed out by Lovén it is the 4th ambulacral plate in the series I. a and V. b which expands internally to meet the episternal angle, and this is a very constant feature. Among the numerous specimens I have examined, I have found only two exceptions: in one case the plate I. a. 1 is abnormally divided into two plates with one tentacle each, the plate with the episternal prolongation

[1] Also in *Micraster coranguinum* there is some irregularity in this respect, it being the V. b. 5 which reaches the fasciole according to the analysis of the test given in Lovén's: Études. Pl. XXXIII.

[2] In *Urechinus giganteus* it is the 6th plate which is extended (Panamic Deep-Sea Echini. p. 154. Fig. 221); no fasciole, however, has been observed in this species.

thus being number 5; in another case it is the plate V. b. 5 which is expanded, but the 4th plate just touches the episternal plate 5. a. 3. — Now on the Figure 2, Pl. XXX. a of the Challenger -Echinoidea it is seen to be the 5th or 6th plate which thus expands; neither is the fig. 9 on this plate in accordance with the rule. This would seem to prove that the specimens represented in these figures cannot be *narcsianus* (Agassiz also doubts himself, whether the specimen represented in Figs. 1—6 is correctly referred to *U. narcsianus* (Chall. -Ech. p. 147) and since in *U. giganteus* it is the 6th ambulacral plate which expands, the suggestion lies at hand that they belong perhaps to this species. On a careful examination of the specimen represented in Figs. 1—6, however, I find the plastron of the same structure as in *narcsianus*, the 4th ambulacral plate being expanded. The difference in the structure of the plastron from the normal condition shown in Pl. XXX. a Fig. 2 is due to incorrect drawing. (It is beyond doubt that it is really the specimen, figured in the quoted figures, which I have examined; it quite agrees otherwise with the figures, and also the size agrees — it is ca. 28^{mm} in diameter, and the figures represent it twice magnified; it is from St. 146.) That this specimen is only an abnormal *U. narcsianus*, as stated by Agassiz (op. cit. p. 148), I think quite certain. — As for the figure 9. Pl. XXX. a. it is so indistinct in the delimitation of the plates that it is certainly allowable to suggest that it is also incorrectly drawn.

The specimens from St. 302, which I have likewise examined in the British Museum, differ somewhat from the Atlantic specimens of *narcsianus* in regard to the pedicellariæ. The ophicephalous pedicellariæ (Pl. IX. Fig. 4) have shorter and broader valves, and likewise the coarse form of tridentate pedicellariæ (Pl. IX. Fig. 21) is somewhat different, being more slender than in the Atlantic specimens. On the other hand, the globiferous pedicellariæ are like those of *narcsianus*, and likewise the structure of the plastron is the same. Perhaps on a careful comparison with the Atlantic specimens this form will prove to be a distinct species; the differences in the pedicellariæ pointed out here are, however, certainly too small for founding a new species upon them alone.

The geographical and bathymetrical distribution of *U. narcsianus* has thus to be somewhat restricted; it is stated in the Challenger -Report (p. 218) to occur, from Marion Island to Kerguelen to Australia; Juan Fernandez to Straits of Magellan; Caribbean Islands , at a depth of 1200—1800 fathoms (on p. 255 it is stated to occur at 422 fathoms at the Caribbean Islands). In reality the species is as yet known with full certainty only from the Atlantic and off South Africa (Marion Island), from depths of 422—1715 fathoms.

A few remarks may be given here on *Urechinus giganteus* Ag., which I had occasion to examine in the U. S. National Museum, only some fragments, to be sure, but determined by Professor Agassiz himself. (Albatross St. 3431.) The structure of the test has been most carefully worked out by Agassiz (Panamic Deep-Sea Echini. p. 152), but no mention is made there of the pedicellariæ. They prove to be very characteristic. The globiferous pedicellariæ (Pl. IX. Figs. 2, 6) differ considerably from those of *narcsianus;* the blade is an elongate, rather thick tube, which has a large, oval opening on the inside at the point, with 1—3 slender teeth on each side at the outer end; the basal part is comparatively small. The valves are invested with a thick skin, not especially thickened over the point, as is the case in *narcsianus*. (Probably there will be some kind of glands within the large tube). The stalk as in *narcsianus*. The ophicephalous pedicellariæ are somewhat more elongate, the basal part less developed and the blade more rounded than in *narcsianus;* also the arrangement of the teeth along the edge is somewhat different. (Pl. IX. Fig. 11.) The tridentate pedicellariæ (Pl. IX. Figs. 25, 27), both larger and smaller forms, are more open than in *narcsianus:* (I have seen nothing corresponding to the coarse form of tridentate pedicellariæ); also the triphyllous pedicellariæ (Pl. IX. Fig. 12) differ a little from those of the former species, being a little broader. — The miliary spines are like those of *narcsianus:* the primary spines are smooth in the lower part as in that species; if the outer part is also as in *narcsianus,* I cannot say, having seen only broken spines.

The genus *Cystechinus* is evidently very nearly related to *Urechinus;* in fact, I am unable to see how to distinguish these two genera, as hitherto understood. The diagnoses of the two genera in the »Challenger«-Report (p. 146, 148) do not precisely indicate the differences: the only distinguishing character which may be gathered from these descriptions of the genera is »the rudimentary auricles, the raised edge of the actinal opening« mentioned for *Cystechinus.* This feature, highly interesting indeed and important from a morphological point of view, as pointed out by Agassiz, is, however, found fully as distinctly developed in *Urechinus narcsianus* (Fig. 3). This character cannot thus be used for distinguishing the two genera. I am likewise unable to find in the elaborate diagnoses of the genera given by Duncan (Revision p. 212—13) and by Gregory[1] any distinguishing feature of reasonable importance. In all the more important features they agree: structure of ambulacra and interambulacra, sternum, actinal and apical system, tube-feet, spines and general shape of the test. The only characters I can find, which might be taken into consideration for distinguishing them as different genera are the following: a subanal fasciole is generally found in young specimens of *U. narcsianus,* whereas it is not found in *Cystechinus;* but in larger specimens of *U. narcsianus* the fasciole has generally disappeared, even so fully that Lovén could find in the structure of the test a sure sign of the total absence of the fasciole, and in *U. giganteus* it is not found either. On the other hand it seems to be found in *Cystech. clypeatus,* since according to Agassiz (»Challenger«-Ech. p. 149) »the edge of the test adjoining the anal system is thickly covered by miliaries forming a broad band, with an indistinct outer edge (almost a fasciole) surrounding it«. — The position of the periproct is below the ambitus in *Cystechinus* (unknown in *C. clypeatus*); in *U. narcsianus* it is generally not quite below the ambitus, but the difference is, indeed, very slight, and in *U. giganteus* it seems to be quite as in *Cystechinus.* Finally I may notice the difference in the structure of the pedicellariæ, especially the globiferous — but if the genera were to be founded upon the structure of the globiferous pedicellariæ, we would have to make *U. naresianus* the type of one genus, to unite *U. giganteus, Cystech. Wyvillii* and *Loveni* in another genus, further to make a separate genus of *Urech. Drygalskyi*[2] and a fourth genus of *C. clypeatus.* I think Professor Agassiz would be the first to object against founding these genera on the differences in the globiferous pedicellariæ alone, and I for my part do not hold that necessary either. But then the conclusion is inevitable that the genera *Urechinus* and *Cystechinus* cannot be distinguished as hitherto understood. *Cystechinus* then becomes a synonym of *Urechinus,* or in any case the species *C. Wyvillii* and *Loveni* must be transferred to *Urechinus.* Probably the *C. clypeatus* (or one of the species confounded under that name) will prove to make a separate genus, which will then keep the name *Cystechinus.* The *Cystech. vesica* has recently been removed by Agassiz himself

[1] Cystechinus crassus, a new Species from the Radiolarian Marls at Barbados. Quarterly Journ. Geol. Soc. 1889. p. 640.

[2] Th. Mortensen: Some new species of Echinoidea. Vidensk. Medd. Naturh. Foren. Kobenhavn. 1905. p. 241.

(Panamic Deep-Sea Ech. p. 163) to the genus *Pilematechinus* established there for *Cystech. Rathbuni.* — A few remarks on the forms mentioned above may be given here.

Cystechinus clypeatus. In the description of this species (Chall.-Ech. p. 149) Professor Agassiz remarks that in the specimens from the greater depths (ca. 1900 fathoms) the test is much thinner than in the fragments which are found near the 1000 fathom line. This may perhaps be true for other species (Agassiz refers to *Pourtalesia, Cystechinus* and *Urechinus*), though I do not see any such difference among the specimens of *U. naresianus* from the Ingolf; but as for *C. clypeatus* the difference in the thickness of the test is in any case not alone due to the different depth at which the specimens lived, but also to their being different species, as I can state after having examined the fragments preserved in the British Museum; the pedicellariæ differ so considerably that it seems quite impossible that they can belong to the same species. Also the structure of their apical systems will probably be found to differ considerably. In the description it is said: The abactinal system closely resembles that of *Cystechinus Wyvillii;* the genital plates are, however, proportionally larger, the left anterior and the right posterior far exceeding the others in size, and extending entirely across the abactinal area, the whole central part of which is formed by the junction of the genital plates. But the figure, Pl. XXXV. b. 10, is, as will be seen, not in accordance with that description; the left anterior and right posterior genital plates do not exceed the others in size or extend entirely across the abactinal area, and the whole central part is not formed by the junction of the genital plates, the large ocular plates of the anterior paired ambulacra separating widely the anterior and posterior genital plates. — Among the fragments of *Cystechinus clypeatus* preserved in the British Museum the apical system is found in those from St. 334, which belong to the thin-plated form. This apical system does not agree, however, either with the description or the figure (Pl. XXXV. b. 10) as will be seen from the sketch given here (Fig. 5). (It may be remarked that this figure was made free hand, without a camera, so that the form of the plates may not be quite correct, but in the main features the figure is correct.) In the fragments from St. 133, which evidently belong to the same species as those from St. 334 (both these stations are near Tristan d'Acunha), only the two posterior apical plates, together with some of the plates behind them, are preserved; this part agrees with the figure in the Challenger-Echini, which thus seems to have been made after this specimen. Whether the whole figure is correctly drawn can no longer be seen. — Among the fragments from St. 205 (off Luzon, in the China Sea)[1], the thick-plated form, no trace of the apical system is found.

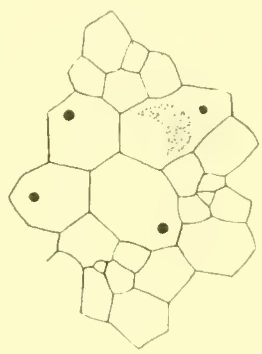


Fig. 5. Apical system of *Cystechinus clypeatus* (St. 334).

On the fragments of the thick-plated form (St. 205) I have found three kinds of pedicellariæ, viz. tridentate and two kinds of ophicephalous pedicellariæ. Unfortunately, no globiferous pedicellariæ were found; they will probably also be very characteristic, as is the case with the ophicephalous. The tridentate pedicellariæ (Pl. IX. Figs. 14, 28) have a simple, leaf-shaped blade, somewhat narrowed in the lower part. The edge is thick, only faintly serrate, often with a larger tooth at the point; in the larger ones there is, generally, a wingshaped lateral widening below the edge in the lower part of the blade.

[1] Alone this very wide distance between the stations might beforehand raise some doubt of these forms being the same species.

The basal part is rather large. In the larger ones the valves join along about the outer half, in smaller ones they join a longer way down; in the largest specimens seen the head is 0·6^{mm} long. The ophicephalous pedicellariæ are very peculiar. One form has an almost globular head; the valves (Pl IX. Fig. 22) are short and broad, reminding one, indeed, very much of the ophicephalous pedicellariæ of the *Echinina;* the arcs are, however, not distinctly developed, and the stalk is not cup-shaped. In these features they resemble the short broad form of tridentate pedicellariæ in *Urechinus naresianus*, and perhaps they ought really to be regarded as tridentate pedicellariæ. The other form (Pl. XI. Figs. 7, 10) has very elongate, narrow valves, with a terminal widening (the blade); the long narrow part represents the apophysis, whereas the basal part is not distinctly developed. The outer edge of the blade forms a series of large teeth, continuing a little way down the sides, rapidly diminishing in size. There is a simple oval deepening in the widened outer part. One of the valves is considerably longer than the two others, and this one alone has an arc developed below the articular surface. The stalk is cup-shaped above, otherwise compact. The length of the head of these pedicellariæ is ca. 1^{mm}, and they are, indeed, very conspicuous objects, and by no means rare, but they seem to occur only on the abactinal side, whereas the short, globular form seems to occur only on the actinal side. — Regarding the structure of the test of this form, I can only say that the plates are very large and the pores simple.

The fossil *Cystechinus crassus* described by Gregory (Op. cit) must probably be nearest related to this thick-plated species. Since neither the apical or the actinal system of this fossil form is known, it was perhaps somewhat hazardous to associate it with this genus, as maintained by Agassiz; but when Professor Agassiz says that »the great thickness of the plates .... would seem to preclude the association of this species with *Cystechinus*« this objection seems a little curious, since Professor Agassiz himself associates the equally thick-plated form from St. 205 with *Cystechinus* — and even includes it in the same species with the exceedingly thin-plated form from off Tristan d'Acunha.

In the fragments of *Cystechinus clypeatus* from St. 133 and 334, the thin-plated form, I have found four kinds of pedicellariæ, viz. globiferous, tridentate, ophicephalous and triphyllous. The globiferous pedicellariæ (Pl. IX. Fig. 1) are very peculiar; the blade is an almost closed tube, with a narrow slit along the inner side, and ends in a single hook. I have found only one specimen of this kind of pedicellaria in the dried fragments from St. 133; there is no trace of a thick investing skin, as might be expected in a globiferous pedicellaria; I think, however, that it is really a globiferous pedicellaria (the only other kind to which it might possibly be referred is the rostrate)[1]. The tridentate pedicellariæ are of two kinds; one has simple, leaf-shaped valves (Pl. IX. Fig. 20), narrowed only for a short space below, in the smaller ones joining along their whole length; the edge is very finely serrate. The largest ones seen are ca. 0·8^{mm} (head). The other form (Pl. IX. Fig. 23) is short, coarse; it was found especially developed in some fragments from St. 133. This form recalls the short thick form of tridentate pedicellariæ of *Urech. naresianus*, and as all intermediate stages occur between the short, robust form and the long and slender form of tridentate pedicellariæ, it seems to give the proof that this form in *Urech. naresianus* must also be regarded as a tridentate pedicellaria. — The small large-headed pedicellaria of *Cystech. clypeatus*, figured in the »Challenger«-Echinoidea, Pl. XLII. Figs. 15—16

[1] By the name »rostrate« I designate the kind of pedicellariæ named »die schnabelförmigen« by Döderlein, as well as those named »die kochlöffelförmigen«, which are only a modification of the former type, as pointed out by Döderlein; these two forms Professor Döderlein also designates by the name »laternenförmige tridentate« pedicellariæ. (Echinoidea d. deutschen Tiefsee-Exp. p. 73).

and Pl. XLV. Figs. 30—31 is evidently this form of tridentate pedicellariæ. (The figure 31. Pl. XLV is, otherwise, not the tip of the blade as stated in the explanation of plates — though the expression »blade» is, of course, not used —, but a fragment of the articular surface seen from above). The ophicephalous pedicellariæ (Pl. IX. Fig. 13) have rather elongate valves; the fine teeth along the outer edge of the blade do not continue along the edges down the apophysis, as is the case in *Urech. naresianus* and the other species related thereto; only a few coarse serrations are found along the sides of the apophysis. The basal part is distinctly developed, though not reaching the outer widened part of the valve. The arc is distinctly developed on all the valves; the upper end of the stalk is cupshaped. The triphyllous pedicellariæ (Pl. IX. Fig. 29) are somewhat different from those of the other species of »*Cystechinus*»; the valves are more elongate and spoon-shaped and more narrowed below than is the case in the other species.

The description of *Cystech. clypeatus* given in the »Challenger»-Echini is evidently made after this species. I can only add that the plates are large and very thin, with concentric lines (marks of growth), and that the abactinal pores are simple. The very thick miliary spines, represented in Pl. XLV. Fig. 29 of the »Challenger»-Echini are found on the anal area of this species. The primary spines are brownish at the base, white in the outer part; they are (some of them at least) coarsely serrate in the outer part.

That the thickplated and the thinplated form represent two very distinct species is beyond doubt; another question is, which of them must keep the name *clypeatus*, and that is not so easily solved. It is certain that the figures given in the »Challenger»-Echini represent the thinplated form, and the description likewise is evidently made from this. But on the labels of the thinplated specimens (St. 133 and 334) there is a mark of interrogation (though this doubt is, as usual, not mentioned in the text), which seems to indicate that Professor Agassiz himself regarded the thickplated form as the type of the species, as seems also to be indicated by the name *clypeatus*. However, considering the fact that the species described and figured under that name is really the thinplated form, I think it correct to let this species keep the name *Cystechinus clypeatus*. The thickplated form (St. 205) must then have another name; but since its structure is almost quite unknown, so that, in fact, we cannot say to which genus it belongs (probably a new genus), I think it better to let it remain unnamed for the present.

Cystechinus (Urechinus) Wyvillii. Four kinds of pedicellariæ have been found, viz. globiferous, tridentate, ophicephalous and triphyllous. The globiferous pedicellariæ (Pl. IX. Figs. 3, 5, 24) are essentially like those of *Urech. giganteus*, only the blade is shorter and more curved; there is generally only one tooth on either side of the terminal opening, sometimes, however, there are two on either side. The tridentate pedicellariæ occur in two forms: a more slender form, very similar to that of *U. naresianus*, and a larger more coarse form (Pl. IX. Fig. 17), generally more or less irregular in the lower part of the blade; size up to ca. $0{\cdot}8^{mm}$. These two kinds are, however, not sharply distinguished, all transitional forms being found. The figures given in the »Challenger»-Echinoidea Pl. XLII. 13 and XLV. 28 as »large-headed» (Spatangoid-like) pedicellariæ evidently represent the larger form, though a less coarse specimen than that figured here. The ophicephalous pedicellariæ are very like those of *U. giganteus*; the head of an ophicephalous pedicellaria is represented, though not very clearly, in the figure 27. Pl. XLV of the »Challenger»-Echini, under the name of a »Clypeastroid-like» pedicellaria.

The triphyllous pedicellariæ are likewise very similar to those of *naresianus*. The same holds good for the spines and for the spicules of the tube-feet. — Agassiz states (Panamic Deep-Sea Echini p. 124) that in young *C. Wyvillii* the labrum is followed by two plates, the sternum being absent; this is, evidently, due to a lapsus memoriæ. I need only refer to the figure 236 on p. 164 of the same work, representing the plastron of a specimen 18^{mm} in length; it shows the plastron to be of the same structure as in *Urechinus*, as might be expected to be the case.

Perhaps two species have also been confounded under the name of *Cystechinus Wyvillii* in the »Challenger«-Report. A comparison of the figures 1—4 with figs. 5—8 of Pl. XXIX, further of Pl. XXIX. a with Pl. XXIX. b at any rate gives a strong impression that two distinct species are represented here; moreover, the high form is so very like *Cystechinus Loveni* that it must beforehand seem much more reasonable to associate it with this species than with the low form of *C. Wyvillii*. To be sure, Agassiz points out (Panamic Deep-Sea Ech. p. 159) several features which distinguish *C. Loveni* from the high form of *C. Wyvillii*; but none of them seem to be of such value that it would preclude regarding them as the same species. I have examined the pedicellariæ of a specimen of the high form (St. 147) and find them to agree with those of the low form of *Wyvillii*. On the other hand, the pedicellariæ of *C. Loveni* differ only little from those of *Wyvillii*; I cannot therefore find herein a definite proof that the high form is really the same species as the low form. Neither is it any proof of their identity that they occur together on the same locality. The question can only be decided after a very careful examination.

Cystechinus (Urechinus) Loveni (a specimen from the »Albatross«, St. 3415, examined in the U. S. National Museum) differs only little from *U. giganteus* and *Wyvillii* with regard to the pedicellariæ. The globiferous pedicellariæ are more like those of *giganteus*, though not so large; in the two specimens I have found, there are two teeth on each side of the terminal opening of the blade. The tridentate pedicellariæ (Pl. IX. Fig. 19) are upon the whole longer and more slender than in *giganteus*; the edges of the basal part are generally more or less produced. Ophicephalous and triphyllous pedicellariæ as in *giganteus*, the latter, however, mostly a little more narrowed below the blade. Spines and spicules do not present any characteristic specific features.

The two species *vesica* and *Rathbuni* originally referred to *Cystechinus* have with full right been transferred by Agassiz to a new genus, *Pilematechinus* which is distinguished from the former (*Urechinus*) by the small size of the plates adjoining the peristome and especially through the structure of the plastron, the labrum being in contact with the two plates 5. a. 2 and b. 2, a very conspicuous difference from *Urechinus* (*Cystechinus*) in which the plate 5. b. 2[1] alone occupies the whole space at the outer end of the labrum. The genus *Pilematechinus* would thus represent a more primitive form than *Urechinus*. Another very peculiar feature of this genus is the very thin and flexible test.

Pilematechinus Rathbuni has been very carefully figured and described by Agassiz (Panamic Deep-Sea Ech. p. 165) as regards the structure of the test; the pedicellariæ etc. are not mentioned. Having examined specimens of this species (»Albatross« St. 3360) in the U. S. National Museum I am able to give some information thereof. The four usual kinds of pedicellariæ were found. The globi-

[1] I quite agree with Lambert in his interpretation of this plate. (Comp. Lambert: Études morphologiques sur le Plastron des Spatangides. Bull. Soc. Yonne. 1892.)

ferous pedicellariæ (Pl. X. Figs. 9, 11) are very characteristic, the valves ending in a single long tooth, at a right angle with the narrow blade, which forms a flattened, closed tube. As in *Urechinus* the valves are clad with a thick, dark, evidently glandular skin. No neck; the stalk is more compact than in *Urechinus*. In the two globiferous pedicellariæ I have seen, the valves are unsymmetrically developed in the basal part, the one figured from the inside being the most regular of them. Whether this is a constant feature it is, of course, impossible to decide from such scanty material. The ophicephalous pedicellariæ (Pl. X. Fig. 26) have low and broad valves, somewhat sinuate and very finely and closely serrate along the edge of the blade down to the apophysis. The upper end of the stalk as usual cupshaped. The tridentate pedicellariæ occur in two distinct forms; the one (Pl. X. Fig. 22) has very long and narrow valves, somewhat widened in about the outer third, where the valves join. The edge of this widened part is closely serrate; in the lower, narrowed part the edge has only some very few small thorns. The blade is open along the whole length; there may be a faint indication of a meshwork in the blade. This form reaches a length of ca. 1·2^{mm} (head). The other form (Pl. X. Fig. 8) has the blade almost, sometimes completely, closed as a tube in the lower half; the outer half is spoonshaped widened, with the edges finely serrate. In smaller specimens the narrowed part of the blade is shorter, in quite small ones it is not narrowed at all, the blade being simply leaf-shaped. This form is much smaller than the former, the largest ones seen being ca. 0·5^{mm}. The triphyllous pedicellariæ (Pl. X. Fig. 14) are like those of *Urech. giganteus*, only somewhat more narrowed below the blade. — The spicules and the rods supporting the filaments of the actinal tube-feet as in *Urechinus*. — The miliary spines as in *Urechinus*, very similar to those of *U. naresianus;* I have not secured any of the primary spines, so that I cannot give any information of their structure.

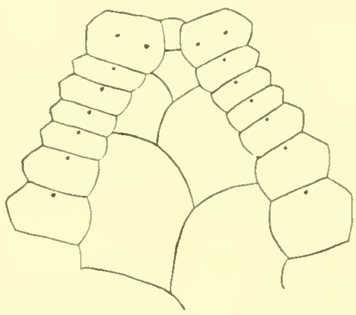


Fig. 6. Actinal plastron of *Pilematechinus vesica;* from the inside of the test. Not drawn with Camera.

Pilematechinus vesica. The figures given of the structure of the actinal part of the test of this species in the Challenger -Report (Pl. XXXV. 11—12) are not very accurately drawn. The inner ambulacral plates are represented as being in contradiction to the general rule of I. a, II. a, III. b, IV. a, V. b having two pores; this is not really the case, they are fairly in accordance with the rule, as I have been able to determine in the British Museum by the examination what seems to be the original preparation after which the two cited figures are drawn. I give here a sketch of the actinal plastron and adjoining ambulacral plates (Fig. 6).

The feature pointed out by Agassiz as making a radical difference between *Pilematechinus* and *Cystechinus*, viz. that the labrum is followed by two plates in *Pilematechinus*, would indeed be an extremely interesting fact, distinguishing this genus not only from *Cystechinus (Urechinus)*, but upon the whole from all the Meridosternata. Only in the *Dysasteridæ* (and the Cassidulids) is a similar structure of the odd interambulacrum found. *Pilematechinus* would then represent the most primitive of all recent Spatangoids. I was therefore very anxious to see, if *P. vesica* has the same primitive structure of the plastron. I had occasion to examine this question at a short visit to the British Museum this year, and the result was that *P. vesica* does not show the very primitive structure of the plastron described by Agassiz for *P. Rathbuni*. The labrum is very small, as shown in Fig. 6, reaching scarcely beyond the middle of the first plate of the adjoining ambulacra. The sternum is likewise very small, these two plates together representing what has been interpreted by Agassiz in *P. Rathbuni* as the labrum alone. It also appears from the remark (Panamic Deep-Sea Ech. p. 163) It is possible that the labium is made up of two plates and then followed by the regular succession of plates , that Professor Agassiz has not been quite certain of the structure in *P. Rathbuni*[1], and I think we may then safely conclude that *P. Rathbuni* agrees with *P. vesica* regarding the structure of the odd interambulacrum, since they otherwise agree in all more important features. — The plastron of *Pilematechinus* is thus in general accordance with that of *Urechinus*, and the genus has a typical meridosternon, differing from that of *Urechinus* only in the small size of the plates, as upon the whole all the plates near the actinostome are much smaller than in *Urechinus*. It is worth noticing that in the paired interambulacra the inner plates are quite similar to those of the odd interambulacrum, as is especially well seen in Pl. 85. Fig. 2 of the Panamic Deep-Sea Ech., when the transverse line which is wanting between the labrum and sternum is added. — It may be stated expressly that the pores are simple.

Another feature of no small interest I noticed on examining *P. vesica*, viz. that it has quite distinct auricles; they do not form a ringshaped thickening of the plates all round the peristome, but are present in the shape of five distinct elevations across the interambulacra close to the peristome, ending with a somewhat more elevated portion in the middle of the adjoining ambulacral plates. They are so distinct that one might indeed be tempted to suggest the existence of a rudimentary dental apparatus in this species; there is, however, no trace of it, at least in the grown specimens, but it seems not unreasonable to suggest that the embryos will show some traces thereof.

It may further be remarked that in *P. vesica* the alleged resorption of the tubercles is very conspicuous — but it is beyond doubt that they have not been resorbed, but only rubbed off; it is very easy to rub the tubercles off, and exactly the same appearance as the resorbed tubercles is produced. (Comp. above p. 41.)

Concerning the inner anatomy of *P. vesica* it may be noticed that there is at least one very well developed sipho.

The pedicellariæ of this species have received some attention in the Challenger Report, three different kinds being mentioned. I have found four kinds, viz. globiferous, tridentate, ophicephalous and triphyllous. The globiferous pedicellariæ (Pl. X. Fig. 7) are like those of *P. Rathbuni*, the valves ending in a single hook. The tridentate pedicellariæ are rather richly developed; Agassiz gives no less than four figures of them (Pl. XXXV. 16, XLIII. 9—11), besides a figure of a single valve (Pl. XLV. 36). I have found two distinct forms of tridentate pedicellariæ; the one has the valves rather abruptly narrowed and the edges inrolled in the lower part (Pl. X. Fig. 13); there may be some meshwork in the blade. In the smaller forms the narrowed part is shorter, and quite small ones are, as usually, simply leafshaped. The largest ones seen were 1^{mm} long (head). The figures Pl. XXXV. 16 and XLIII. 9 of the Challenger-Echinoidea represent this form, and since the Pl. XLV. Fig. 36 is said in the explanation of plates to be a valve of the form represented in Pl. XLIII. 9, this figure also belongs

[1] Also in one specimen of *P. vesica* the transverse line between the labrum and sternum was not quite distinct; in other specimens it was beyond doubt.

here; it is, however, evidently not very correctly drawn. I have seen nothing resembling the figures Pl. XLIII. 10—11; they probably represent only small specimens of this kind of tridentate pedicellariæ. The second form (Pl. X. Figs. 1, 4, 24, 28, 29) is coarser and the form of the blade often somewhat irregular; it has generally some very irregular meshwork. This kind of pedicellariæ is found on the actinal side, and especially on the peristome, even in the mouth they are quite crowded, reaching some way up the oesophagus; those found here are generally more irregular than those on the outside of the test (Pl. X. Figs. 28—29). It is probably this second form of tridentate pedicellariæ which is figured in Pl. XLIII. Fig. 12 of the Challenger-Ech. under the name of Clypeastroid-like pedicellaria; the valve represented in Pl. XLV. Fig. 35 as belonging to this form is certainly that of an ophicephalous pedicellaria, but it seems very unlikely that it can belong to this form; the figure Pl. XLIII. 12 does not seem so very bad, as it would be in case the valve did really belong to it — and on the other hand, this coarse form of tridentate pedicellariæ is generally invested with a rather thick, brown skin, so that by a superficial examination not much more is seen than the figure cited shows. — The ophicephalous pedicellariæ are like those of *P. Rathbuni*, the valves being low and rather broad. The Pl. XLV. Fig. 35 of the Challenger-Ech. gives a rather good representation thereof. The figures Pl. XXXV. 17—18 may perhaps also represent the ophicephalous pedicellariæ; they are however, so crudely made that it is quite useless to speculate on what they are meant to represent. — The triphyllous pedicellariæ are like those of *P. Rathbuni*. The supporting rods of the filaments of the actinal tube-feet are like those of *Urechinus;* spicules I have not seen. The spines evidently deserve to be carefully studied; my preparations however do not allow me to give more than a few remarks thereon. The only (broken) primary spine I have seen does not agree with the figure and description given by Agassiz, it is curved and finely undulated along the longitudinal ridges. Clubshaped spines are found at the actinostome as in *Urech. naresianus*.

To the *Urechinidæ* is further referred the genus *Calymne*. The figures given in the Challenger Report do not allow one to see the real structure of the anterior paired interambulacra; finding that this was an important character for the classification of the Meridosternata (viz. whether the second plate of these interambulacra is single or double — Comp. below p. 85), I carefully examined the fragments of the type specimens in the British Museum in this regard and found that the first plate is in contact with two of the following plates. The unusual size of the actinal ambulacral plates makes it a little difficult to see the real structure in the poor fragments preserved; but the pores of the ambulacral plates are distinct and leave no doubt of the morphological value of the plates (Fig. 7). (The figure is made after a sketch taken without camera and thus cannot claim to be quite correct as regards the outline of the plates; but in the main features it is correct.)

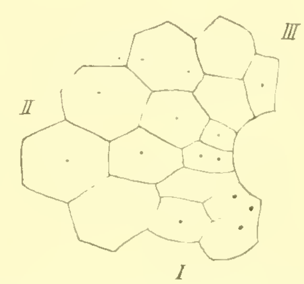


Fig. 7. Part of the actinal side of the test of *Calymne relicta*.

The apical system is certainly not very correctly given in the Fig. 2. Pl. XXXIV of the Challenger-Ech. The two anterior genital plates with the madreporite seem to be confluent, not forming two (or three) separate plates as in that figure. Of the two posterior genital pores seen in this figure only one, the left, is distinct in the fragment preserved. By a very careful preparation it will certainly be possible to make out fully the structure of the apical system in this very interesting form.

As regards the pedicellariæ *Calymne* agrees with the Pourtalesiæ in having rostrate pedicellariæ of the form common in that family. They are of two kinds (Pl. X. Figs. 5, 6), one with the outer end of the blade rather widened and finely serrate, the other with the outer edge only little widened and provided with few, rather large teeth. (This is, evidently, the form figured in the Challenger -Echinoidea Pl. XLIII. 24 and XLIV. 47 as a Clypeastroid-like pedicellaria.) The stalk may be rather thorny, as is well shown in the Chall. -Ech. Pl. XLIV. 48; probably it is the coarse-toothed form which has the thorny stalk, the other form having it smooth; but I cannot say this with certainty. The triphyllous pedicellariæ are like those of *Urech. naresianus*. The miliary spines (Pl. X. Fig. 30) have the point widened so as to form a broad, fenestrated plate, finely serrate along the outer edge; the shaft is very slender, consisting of fine rods, which are not connected with transverse beams, except a few at the base. This form of spine also recalls those found in some Pourtalesiæ. — Evidently *Calymne* is not very closely related to the *Urechinidæ;* I think it must form a separate group (family), as it cannot be transferred to the *Pourtalesiidæ*, the anterior ambulacrum not being invaginated. (Comp. below p. 86.)

The genus *Phrissocystis* is also referred to this family (by Meissner in Bronn. Classen u. Ordnungen, by Agassiz in the Preliminary Report on the Albatross -Echini, and by Döderlein in Echinoidea d. deutschen Tief-See Exped.). This seems to be a rather unnatural place for this genus. Unfortunately the structure of the plastron is not known, but so many other features point towards *Palæopneustes* that I think Agassiz is quite right in referring it to the new family *Palæopneustidæ* established by him (Panamic Deep-Sea Ech.), and I also think the establishment of that family quite justified.

20. **Plexechinus hirsutus** Mrtsn.

Pl. VI. Figs. 8—9, 12—16. Pl. VII. Figs. 9, 19 20. Pl. X. Figs. 2, 15—17, 19, 21, 23, 25, 27, 31—32, 34, 36—38.

Th. Mortensen: Some new species of Echinoidea. Vid. Medd. Naturh. Forening. Köbenhavn. 1905. p. 242.

The outline of the test is almost regularly oval, especially in the smaller specimens; in larger specimens it is straight across the anterior ambulacrum or even slightly reenteringly curved. On the actinal side the anterior ambulacrum is a little sunken; the posterior interambulacrum forms a very prominent keel, prolonged into a broad, little projecting anal snout, surrounded by a fasciole. The abactinal side is beautifully rounded, except the posterior end, the odd interambulacrum not sloping at all but forming a rather prominent hood over the periproct. This feature together with the keel on the actinal side makes the posterior end much higher than the anterior. The anal snout is distinctly less prominent than in *P. cinctus*, being scarcely discernible in dorsal view, a very conspicuous difference from the latter species, as will be seen on comparing the figures 13, 14. Pl. VI with Pl. 58. Figs. 2—3 of the Panamic Deep-Sea Echini, and the figures 12, 15 of the same plate with Pl. 55. 4—5 of the work quoted. — The whole of the test (except the ambulacra of the bivium on the actinal side) is covered by a rather dense, uniform coat of slender primary spines, rising from a ground thickly covered by short miliary spines. — The test is not very fragile. The largest specimen is 20^{mm} in length.

The actinostome is somewhat before the middle, a little sunken. It is round, covered by an outer circle of larger, irregular plates and several smaller ones inside these. The mouth opening is excentric, near the posterior edge. (Fig. 8.) (Comp. also Pl. VII. Fig. 19.)

The structure of the test agrees upon the whole with that of *P. cinctus*. In one specimen (the denuded one figured Pl. VI. Fig. 9) the labrum is separated from the following plate by the junction in the median line of the ambulacral plates I. a. 2 and V. b. 2 (Pl. VII. Fig. 19), as is the case in *P. cinctus*: in all the other specimens these two plates do not join in the middle line and the labrum is not separated from the sternum (Fig. 8), but it is very narrow at the aboral end. The 4th plate of the ambulacral series I. a and V. b has an episternal widening, which reaches within the subanal fasciole; no other ambulacral plates reach the fasciole. As in *P. cinctus* the fasciole encloses the inner part of the interambulacral plates 5. a. 2—5 and b. 3—6 (the plates a. 3 and b. 4 are completely within the fasciole). The following plates, a. 6 and b. 7 are rather elongate and reach the periproct, encircling it together with the three following pairs of plates (a. 7—9 and b. 8—10); in *P. cinctus* the periproct is surrounded by only three pairs of interambulacral plates in all, viz. a. 6—8 and b. 7—9, according to the figures given of that species. The periproct is much sunken in its lower part, the point where the plates 5. a. 6 and b. 7 reach the lower edge of the periproct being the deepest; the upper part of it is at a level with the prominent hood formed by the abactinal part of the odd interambulacrum. — The anterior ambulacrum is short, as in *P. cinctus*; the plates above the ambitus are distinctly lower than those below the ambitus, and likewise they are distinctly lower than those of the paired ambulacra. (Pl. VI. Fig. 13, Pl. VII. Fig. 20.) The pores of these plates are somewhat elongate vertically, showing a distinct tendency towards becoming double (Pl. VII. Fig. 20). This form thus differs from the other genera of the *Urechinidæ* in having the ambulacra somewhat unequally developed. The same feature is seen in the figures of *P. cinctus*, though not mentioned in the description.

Fig. 8. Peristome, labrum and adjoining plates of *Plexechinus hirsutus*. $^{6}/_{1}$.

The apical system (Pl. VII. Fig. 9) is like that of *P. cinctus*, disjoint in the same manner. Two genital pores, covered with long genital papillæ, are found in a plate joining the ocular plate of the anterior ambulacrum (Pl. VII. Fig. 20); this plate also bears a single madreporic pore. Evidently the same is the case in *P. cinctus*, as Agassiz supposes[1]. The plate with the genital pores must probably be regarded as the confluent left and right anterior genital plates; otherwise, I think, the genital pores in these forms may perhaps not be exclusively bound to the basal plates, the whole apical system

[1] On p. 151 (Pan. Deep-Sea Ech.) Agassiz says that no trace of genital openings could be seen, unless one of the openings seen on the large interambulacral plate in continuation of the odd (inter)ambulacrum be a genital pore . In the light of the fact that both the corresponding pores in *P. hirsutus* bear genital papillæ and thus prove themselves to be genital pores it is certainly not too hardy to conclude that both the pores of this plate in *P. cinctus* are likewise genital openings. In the figure 1. Pl. 60 this plate bears a third small pore, quite as in *hirsutus* — evidently the madreporic pore. The supposition that the specimens of *P cinctus* (the smaller 21^{mm}) are only young stages thus becomes erroneous (though it is of course possible that the species may reach a more considerable size).

showing some tendency to dissolution in this group. To determine with certainty which of the other plates in the apical area of this species ought to be regarded as basal or as «intercalated» plates is scarcely possible, and I cannot feel convinced either that the interpretation of these plates in *P. cinctus* given by Agassiz is quite correct. — The genital openings are present in a specimen of 13^{mm}, but have not yet appeared in a specimen of 11^{mm}.

The primary tubercles are scattered quite without order over the whole test, except the ambulacral plates joining the sternum and episternum. A great number of small tubercles are found among the primary ones. On the primary interambulacral plates, which are all in contact with the peristome, the tubercles may be rather numerous, forming like a rudimentary bourrelet. The larger ones of the plates of the peristome may carry a single tubercle (spine). — The primary spines (Pl. X. Figs. 21, 31) are ca. 3^{mm} long, slender, gracefully curved, more or less spinous, a little widened towards the point. The spines of the sternum are rather widened in the point and hollowed (Pl. X. Fig. 38). The spines round the actinostome are not distinctly clubshaped. The miliary spines (Pl. X. Fig. 32) are short, ca. 0·5^{mm}; the point is widened and serrate, more or less flattened. The clavulæ of the fasciole do not differ from the other miliary spines.

The tubefeet of the two or three inner ambulacral plates are penicillate, forming a rather conspicuous phyllode. The rods supporting the filaments of these tubefeet are irregularly fenestrate, rather coarse (Pl. X. Fig. 37); the spicules (Pl. X. Fig. 27) are arranged in two series; they are of the same general shape as in *Urechinus*. The tubefeet of the anterior ambulacrum are rather large, but simple; a more or less distinct calcareous ring, formed by some few irregular, fenestrate plates is found, at the point of the simple tubefeet. — The sphæridiæ are found only on the inner one or two pairs of ambulacral plates, generally only one on each plate. They are rather elongate, smooth (Pl. X. Fig. 25).

The pedicellariæ are represented by the four usual forms. The globiferous pedicellariæ (Pl. X Figs. 23, 34) are very peculiar; the blade forms a short but rather wide tube, which ends with a large round opening, sometimes prolonged a little downwards on the inside; the edge of the opening is rather finely serrate, except on the lower side. No neck; the stalk is rather thick. — It may, indeed, be regarded as a little doubtful whether this form really represents the globiferous pedicellariæ, since there is no thick skin covering the valves, as is the case in the related genera *Urechinus* etc. But on the other hand it is rather similar in structure to the undoubted globiferous pedicellariæ of *Urechinus giganteus, Wyvillii* etc., and it would be more unnatural to refer it to any of the other kinds of pedicellariæ. (The glandular tissue may perhaps be found within the tubeshaped blade). The tridentate pedicellariæ (Pl. X. Figs. 2, 16, 36) are small, the largest ones only ca. 0·3^{mm}. The blade is simply leafshaped, sometimes shorter and almost round; the edge is serrate, generally with some longer teeth at the point. The figure 15. Pl. X represents a somewhat different form, with the blade more narrow and the apophysis ending down in the blade. I have not seen transitional forms between the two kinds of tridentate pedicellariæ. The ophicephalous pedicellariæ (Pl. X. Fig. 19) are very simple, of the usual structure; the upper end of the stalk cupshaped. The triphyllous pedicellariæ (Pl. X. Fig. 17) differ only little in shape from those of *Urechinus*. — The pedicellariæ of this species are upon the whole few in number and little conspicuous.

The species was taken at the following stations by the »Ingolf«:

St. 11	(64° 34' Lat. N.	31° 12' Long. W.	1300	fathoms	1°6 C.	Bottom	temp.)	2	specimens.	
— 76	(60° 50'	—	26° 50'	—	806	—	4°1	—	—)	2	—	
— 81	(61° 44'	—	27° 00'	—	485	—	6°1	—	—)	2	—	(young)
— 83	(62° 25'	—	28° 30'	—	912	—	3°5	—	—)	3	—	

One young specimen was further taken by the Thor 1904 at 61° 15' Lat. N., 9° 35' Long. W. 900 Meter.

This species is evidently nearly related to the Californian species *Plexechinus cinctus* A. Ag. It is, however, easily distinguished from the latter species by the very different outline of the posterior end of the test, the actinal keel being much higher and the anal snout much less prominent in the Atlantic than in the Californian species; the periproct is also more sunken in *hirsutus*. If it proves to be a constant feature in *P. cinctus* that only three pairs of plates are in contact with the periproct whereas in *hirsutus* four pairs are so, this will be a very good distinguishing character. (In the *Pl. Nordenskjöldi*, to be described in the Report on the Echinoidea of the Swedish South Polar Expedition, only three pairs of plates are in contact with the periproct). — The pedicellariæ can scarcely be supposed to show more important differences.

The genus *Plexechinus* is placed among the Pourtalesiæ by Agassiz, mainly on account of its anal snout and the position of the periproct; probably also other features: the elongated shape, the apical system, the disjointed sternum and the rudimentary phyllodes are taken as arguments in favour of such a position of the genus though it is not stated clearly. The genus certainly shows some Pourtalesian affinities, but it is evidently more nearly related to the *Urechinidæ*. It differs essentially from the Pourtalesiæ and agrees with the Urechinids in having a flat peristome, one of the most prominent characters of the Pourtalesiæ being the vertical peristome at the inner end of a deep groove. Another feature of eminent importance is the structure of the anterior paired interambulacra; the second plate is single in the Urechinids, whereas in all Pourtalesiæ it is paired — in *Plexechinus* it is single. Further *Plexechinus* agrees with the *Urechinidæ* in regard to the pedicellariæ: globiferous pedicellariæ occur, but no rostrate; the ophicephalous pedicellariæ are of the type found in *Urechinus* (the elongate form of ophicephalous pedicellariæ characteristic of Pourtalesiæ is found in *Cystechinus clypeatus* (the thick-plated form), but it is not certain that this is an Urechinid, the structure of its test being quite insufficiently known). Also the structure of the spines points towards the Urechinid affinity. On the other hand several of the characters pointed out by Professor Agassiz seem to me less important. The phyllodes are not so very rudimentary, at any rate not in *P. hirsutus*. in which the two or even three inner tubefeet in each series are distinctly penicillate; the fact that *Sternopatagus* has penicillate tubefeet, however, shows that much stress cannot be laid on this feature. If it were of greater importance it could, of course, only be a further argument for placing *Plexechinus* among the *Urechinidæ*, all the Pourtalesiæ, except *Sternopatagus*, which Agassiz will even refer to the Urechinids (without sufficient reason, as far I can see (comp. below)), having only simple tubefeet. The apical system shows so great differences in the whole Ananchytid group that it seems unreasonable to lay much stress on its being a little more or less disjointed. Regarding the sternum both

P. hirsutus and *Nordenskjöldi* have the labrum in contact with the sternum, this feature thus evidently pointing towards the Urechinids. It thus seems evident that *Plexechinus* must be referred to the *Urechinidæ*; but it must be conceded that the position of the anal system and especially (what Agassiz seems to have overlooked) the shortened anterior ambulacrum show it to be a somewhat modified type; it is also worth noticing that there is a faint trace of a deepening of the anterior ambulacrum (more distinct even in *P. Nordenskjöldi*). These characters point towards the Pourtalesiæ and may perhaps indicate that the latter have developed from forms like *Plexechinus*, though the different structure of the paired anterior interambulacra evidently forbid thinking of a direct derivation of the Pourtalesiæ from the *Urechinidæ*; the structure of the test of the Pourtalesiæ is more in accordance with the *Echinocorythinæ*, and it would, indeed, seem more natural to suggest that the *Urechinidæ* and the *Pourtalesiidæ* are two separate branches from the *Echinocorythidæ (Ananchytidæ)*. — The resemblances between *Plexechinus* and the amphisternous *Palæotropus* pointed out by Agassiz can scarcely be more than superficial analogies. Upon the whole I do not see the reasons why the typical amphisternous *Palæopneustidæ* should be reckoned among the »Ananchytid Spatangoids«, as is done by Agassiz (Panamic Deep-Sea Ech. p. 150).

Fam. **Pourtalesiidæ.**

21. **Pourtalesia Jeffreysi** Wyv. Thomson.

Pl. V. Figs. 13—14, 16—19, 21, 23. Pl. VII. Figs. 2—4, 11—12, 14, 21. Pl. VIII. Figs. 4—6, 8—11. Pl. XI. Figs. 4, 7—10, 30.

Wyv. Thomson: Depths of the Sea. p. 108—9. Fig. 12. p. 457. (394) Ann. Nat. Hist. 4. Ser. X p. 305. »Porcupine«-Echinoidea. p. 747. Pl. LXX. 1—10. Pl. LXXI. — Lovén: On Pourtalesia. Pl. I—V Pl. XII. 149. — Danielssen: Echinida. Norske Nordhavs-Expedition. p. 5. — Pfeffer: (319) p. 101. — Agassiz: Echinoidea. (»Knight Errant«) (10). — Ostergren: (450) p. 253. — Hoyle: Rev. List British Echinoids. p. 430. — Koehler: (233. b). — Döderlein: Arktische Seeigel. Fauna Arctica. p. 385. Echinoiden d. deutschen Tiefsee-Expedition. p. 268. — Grieg: Echinodermen v. d. norwegischen Fischereidampfer »Michael Sars« in den Jahren 1900—1903 gesammelt. I. Ophiuroidea. p. 14. Bergens Mus. Arbog. (1903). — Michailovskij: Zoolog. Ergebnisse d. Russischen Exped. nach Spitzbergen. Echinodermen. Ann. Mus. St. Petersbourg. VII. 1902. p. 524. Nachtrag. Ibid. VIII. 1903. p. 393. Die Echinodermen der zoologischen Ausbeute des Eisbrechers »Jermak« vom Sommer 1901. Ibid. IX. 1904. p. 163, 184. — Knipowitsch: Explorations zoologiques sur le bateau casse-glace »Ermak« en été de 1901. Ibid. VI. 1901. p. IX, XV. — Kolthoff: Til Spetsbergen och Nordöstra Grönland Ar 1900. p. 176, 210.

Non.: Rathbun: Catalogue of the Echini of the U. S. Nat. Museum. (337) p. 287. — Verrill: Results of the Explorations of the »Albatross« 1883 (426). p. 539. — Norman: Notes on the French exploring Voyage of »Le Travailleur« in the Bay of Biscay (302). p. 435.

The rich and partly well preserved material of this species collected by the »Ingolf« enables me to give a little additional information thereof, though, of course, not much remains to be done after the elaborate descriptions given by Wyv. Thomson and especially by Lovén in his classical work »On Pourtalesia«. The most needed information, viz. that of the development of the test from quite young stages, I cannot give, since, unfortunately, no quite small specimens are found among the present material. On the other hand, I do not doubt, as does Lovén (Op. cit. p. 22), that the young ones will be found some day. Since we have found quite young specimens of *Hemiaster expergitus* (see below), a species much more rarely met with than *Pourtalesia Jeffreysi*, it seems not improbable that we shall some day also have the good fortune to meet with the young *Pourtalesia*.

The general form of the test is well described by Lovén (Pourtalesia. p. 6); there is, however, some variation, as pointed out by Michailovskij (Echinod. d. Jermak p. 163). Some specimens are rather short and broad and with short anal rostrum, others are rather flattened; also deformities occur not very seldom, with irregular depressions or with the posterior end awry (Pl. V. Fig. 14), the supra-anal prolongation turning to one side, the anal rostrum to the other. Also the anterior end may be unequally developed, the one side projecting in front of the other. — The Figures 19, 21, 23. Pl. V represent a specimen in which the spines are uncommonly well preserved; the two side-views, Pl. V. Figs. 13, 18 show how different the outline in profil may be. (See also Michailovskij. Loc. cit.) — The species reaches a considerable size; the largest specimens at hand are up to 58^{mm} in length.

Wyv. Thomson states (Op. cit. p. 749) that the test is so remarkably thin that it will scarcely bear its own weight. I do not find the test of this species so very fragile; on the contrary, I find it almost stout for a deep-sea species. It deserves to be noticed that among the Ingolf material there are several old tests (St. 113 and 117), which have evidently been partly or completely embodied in the bottom deposits (they were full of mud); most of them are quite uninjured. On one of these tests was found a sea-anemone, on another a sponge. — The sutures of the abactinal lateral plates are, in the larger specimens at least, generally somewhat raised, the plates themselves being somewhat concave; this may perhaps be a structure tending to strengthen the test.

The morphological structure of the test has been most admirably worked out by Lovén. There is, however, one point of interest on which my rich material enables me to make an addition to our knowledge, which is of some importance, viz. the labrum and the adjoining ambulacral plates. Lovén finds that in *P. Jeffreysi* the labrum is quite rudimentary, only represented by a small plate on the incurved edge, below the actinostome and not seen from without. The ambulacral plates I. a. 1 and V. b. 1 are large and join in the median line in their whole length, whereas the plates I. b. 1 and V. a. 1 are wanting (or, as Lovén thinks, coalesced with the large plates I. a. 1 and V. b. 1, which are thus really compound; p. 83) — a considerable difference between this species and the other species examined by Lovén: *P. laguncula*, *carinata* and *ceratopyga*, in which the labrum is distinctly seen from without, separating the inner plates of ambulacra I and V; the plates I. b. 1 and V. a. 1 are also developed in these species.

This feature of *P. Jeffreysi* is, however, no constant one. To be sure, the labrum is often, perhaps in most cases, not to be seen from without; but there is considerable variation with regard to this plate. In some specimens it is seen as a very narrow plate, quite enclosed between the two large inner ambulacral plates, in others it is well developed, reaching to the border of the invagination; it may even be divided into a larger outer part and a smaller inner part at the edge of the invagination (Pl. VIII. Fig. 10). Regarding the inner plates of ambulacra I and V there is likewise great variation. I have seen one specimen in which only the plate a. 1 was developed in ambulacrum I, otherwise I have constantly found both the inner plates of I and V developed; but the plates I. b. 1 and V. a. 1 are generally very small and easily overlooked. The plates I. a. 1 and V. b. 1 may be very unequally developed, one of them simulating the labrum, but the presence of the pore at its inner end shows its real nature. Generally only the four larger of these plates bear distinct pores and tube-feet, in the other plates only quite rudimentary pores are present, sometimes the pore has even quite disappeared. Besides the supposed coalescence between the two inner plates of ambulacra I and V, Lovén, points out (Op. cit. p. 36) as another peculiar feature in this species, that the inner plates of ambulacra II and IV are not in accordance with the general rule that the plates I. a, II. a, III. b, IV. a, V. b are the largest. I have constantly found the inner plates of the paired ambulacra to be in accordance with the rule, only as to ambulacrum IV I have sometimes been unable to see it distinctly. As it seems very unlikely that all the specimens examined by Lovén should happen to be abnormal in this respect, I must venture to suggest that Lovén has overlooked some of these small plates, which may, indeed, be rather difficult to see. (I have found them easiest to discern when examining the denuded test in alcohol; on dried tests, treated with alcohol-glycerine it is almost impossible to trace the limits between the small plates). A very small plate may sometimes be found between the inner plates of the ambulacra I and II on one side and IV and V on the other side (Pl. VIII. Figs. 5, 8, 9, 11). It must doubtless be regarded as the rudimentary inner plate of the interambulacra 1 and 4. Whether this plate was really absent in Lovén's specimens or perhaps was overlooked, it follows from its occasional (not very seldom) occurrence that the plates interpreted by Lovén as No. 1 of the interambulacra 1 and 4 (On Pourtalesia. Pl. II. 9) are really No. 2. In the figure 9 copied from the quoted figure of Lovén, I have shown my interpretation of these plates. (Comp. Figs. 10, 11 of *Pourt. phiale*). Upon the whole there is so great variation in the development of the plates of this region that it is scarcely possible to find two specimens quite alike in this respect. Such extensive variation in structures of considerable morphological importance is of no small interest, and it is shown hereby that the mutual relation of the plates in this region cannot be relied upon for specific differences, in any case for this species, and for the other species it will also be necessary to be very cautious in the use of such characters. The figures 4—6, 8—11. Pl. VIII show some of the variations in the structure of this region found in *P. Jeffreysi*. (These specimens otherwise are all quite typical *P. Jeffreysi*: all variations may be found in specimens from the same station).

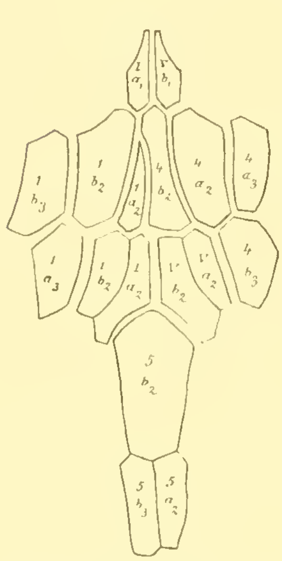


Fig. 9. Actinal plastron of *Pourtalesia Jeffreysi*. After Lovén.

The primary tubercles form distinct longitudinal (from a morphological point of view: transverse) series on the sides at the anterior end of the test. These series generally are very prominent on the plates of the anterior series of the two antero-lateral ambulacra (II and IV), each plate bearing one series in the middle, the tubercles increasing somewhat in size from the anterior towards the posterior edge of the plate. On the plates of the posterior series of these two ambulacra the tubercles are more irregularly arranged, and on the posterior part of the test they are upon the whole quite irregularly arranged, though sometimes there is a tendency towards a serial arrangement. The plates forming the anterior edge (posterior series of the antero-lateral interambulacra) are rather closely covered by primary tubercles, not arranged in distinct series. (Comp. Lovén. Pourtalesia. Pl. I. 3). The miliary tubercles are generally very numerous, especially on the anterior end of the test. — One specimen is interesting in showing in considerable number the empty places of primary tubercles; the places are distinctly seen, but covered with pigmented skin, and it looks as if miliary spines have appeared in some of them. As mentioned above (sub *Urechinus naresianus*, p. 41) Agassiz thinks such cases a proof of the spines having been resorbed — I think it more probable that it is the result of some damage undergone by the specimen.

The primary spines are of a rather uniform length, the longest of them (the posterior ones of those on the anterior series of plates of the antero-lateral ambulacra, in accordance with the size of the tubercles) scarcely reaching one third of the length of the test. They are slightly curved, generally smooth, ending in a simple point. Those of the sternum are somewhat flattened, widened at the point. The spines on the invaginated portion are short and very robust (Lovén. Pourtalesia. Pl. V. 36); those near the edge are longer and more slender, gracefully curved. The miliary spines are widened at the point and curved, as figured by Wyv. Thomson (Pl. LXX. 8); the clavulæ of the fasciole essentially as the miliary spines, the widened point only a little shorter and thicker.

Spicules are almost totally wanting; sometimes, however, a very few irregular, branched rods occur at the outer end of the tube-feet. The tip of the tube-feet, on the contrary, is enclosed by a rather thick cap (or broad ring) of calcareous network (Pl. VII. Fig. 21); this holds good, however, only for those of the antero-lateral ambulacra, which are, upon the whole, rather well developed. In those of the odd anterior ambulacrum such a calcareous cap is generally not found; sometimes a few irregular spicules occur there, but mostly they are quite destitute of spicules.

Of pedicellariæ two kinds, viz. ophicephalous and tridentate, were described and figured by Wyv. Thomson, and two kinds, viz. ophicephalous and rostrate (laternenförmige tridentate) by Döderlein (Echinoiden d. deutschen Tiefsee-Exped. p. 269). I have found these three forms; globiferous pedicellariæ do not seem to occur. The rostrate pedicellariæ (Pl. XI. Figs. 9—10, 30) are rather conspicuous and numerous; the head up to ca. 0.5^{mm}, more or less dark pigmented. They are generally threevalved, but two- and fourvalved specimens occur. (For the description of the valves, comp. Döderlein, loc. cit.) The elegantly shaped ophicephalous pedicellariæ are likewise well described by Döderlein, whilst Wyv. Thomson has given a pair of rather good figures of them; I give here only figures of isolated valves in front and side view (Pl. XI. Figs. 4, 7). — It may be noticed that the narrow part of the valves of these pedicellariæ contains a small irregular cavity, which opens into the deepening in the widened outer part. This is, otherwise, especially distinct on the ophicephalous pedicellaria of *Pourt. paradoxa* figured Pl. XI. Figs. 3, 6. I have not found the ophicephalous pedicellariæ on all the specimens. — The tridentate pedicellariæ, the form figured by Wyv. Thomson Pl. LXX. Fig. 10, are very small, with a short but distinct neck. The valves (Pl. XI. Fig. 8) are simply leafshaped, the edge of the outer part rather coarsely serrate. (That this form must be regarded as a tridentate, not a triphyllous pedicellaria becomes evident from what is found in *Pourt. hispida* (comp. below p. 78); also in *Plexechinus hirsutus* a quite similar tridentate pedicellaria occurs together with typical triphyllous pedicellariæ; comp. above p. 56.)

Regarding the internal anatomy it may be pointed out that there is a double sipho, the outer one rather widened at its aboral end (Pl. VII. Fig. 14); the blind diverticulum is well developed, lobate (Pl. VII. Fig. 2, 4). The course of the stone canal (Pl. VII. Fig. 2) as in *Urechinus naresianus*. The axial organ is seen as a small swelling near the upper end of the stone canal (Pl. VII. Figs. 3, 12). (The figures of the internal anatomy of Pourtalesiæ given in the "Challenger"-Echinoidea only show the course of the intestine and the shape of the genital organs; the diverticulum, the siphones, stone-canal and axial organ are not represented). The genital organs show the curious feature of being very different in shape in the two sexes. The female genital organs are long thick tubes, quite unbranched, but irregularly folded (Pl. VII. Fig. 11); the male organs are of the usual bush-shape, with an unusually long efferent duct (Pl. VII. Fig. 12). No spicules are found in the walls of the genital organs or intestine. Genital papillæ are well developed, sometimes even very long (ca. 8mm). The genital openings are not developed in specimens of 18—20mm length; in a specimen of 22mm they are developed.

The smallest specimens in hand (18—20mm) do not differ essentially in the shape of the test from the grown specimens, they are only somewhat more slender. The abactinal keel is distinct, but is less produced over the periproct than in the grown specimens.

Considerable numbers of this species were taken by the "Ingolf" at the following stations:

St. 103	(66° 23' Lat. N.	8° 52' Long. W.	579 fathoms	÷ 0°6 C. Bottom temp.)	2 specimens.						
— 113	(69° 31'	—	7° 06'	—	1309	—	÷ 1°0	—	—)	74	— (+ ca. 10 dead tests)
— 116	(70° 05'	—	8° 26'	—	371	—	÷ 0°4	—	—)	22	—
— 117	(69° 13'	—	8° 23'	—	1003	—	÷ 1°0	—	—)	10	— (+ 1 dead test)
— 119	(67° 53'	—	10° 19'	—	1010	—	÷ 1°0	—	—)	25	—
— 124	(67° 40'	—	15° 40'	—	495	—	÷ 0°6	—	—)	15	—
— 126	(67° 19'	—	15° 52'	—	293	—	÷ 0°5	—	—)	1	—
— 138	(63° 26'	—	7° 56'	—	471	—	÷ 0°6	—	—)	24	—

The species is distributed all over the "cold area" of the Norwegian Sea, from the Færoe Channel to Spitzbergen, Novaja Zemlja (Knipovitsch. Op. cit.) and East Greenland (Kolthoff. Op. cit.). The bathymetrical distribution is from ca. 125 (Döderlein. Fauna Arctica) to ca. 1300 fathoms. It is further recorded from the Bay of Biscay (Norman. op. cit.) and from the American side of the Atlantic (Rathbun, Verrill. op. cit.). The specimens upon which these indications are founded, will probably turn out to belong to the *Pourtalesia Wandeli*, described below, or to *P. miranda* A. Ag. Among the specimens of *Pourtalesia* from the warm area of the Atlantic dredged by the "Ingolf" there is no *P. Jeffreysi* (with regard to a few small specimens from St. 40, 67 and 68, comp. below, p. 68), and some specimens which I examined in the U. S. National Museum are likewise certainly not *P. Jeffreysi* — as far as they are not so badly broken that it is impossible to identify them with any probability (which was exactly the case with the specimens from St. 2084, mentioned in Rathbun's Catalogue, loc. cit.). The specimens more tolerably preserved seemed to me to be all *P. Wandeli*; but in view of the uncertainty prevailing with regard to *P. miranda* (comp. below p. 65—66) I do not venture after the short examination which I could undertake there, to say with certainty to which species they belong. I only want to state that I have seen no true *P. Jeffreysi* among them. The same holds good for several specimens, which Professor Verrill kindly let me examine. — Upon the whole it must be emphasized that at the present time *P. Jeffreysi* is not known with certainty from the warm area of the Atlantic (— its occurrence in the Bay of Biscay (Norman. op. cit.) must likewise be regarded as doubtful, the statement evidently being made without a close examination of the specimens —), and I doubt that it will be found there. *Pourtalesia Jeffreysi* is the only deep sea Echinoid known from the cold area; it is only known from there, and it will probably turn out to inhabit the cold area alone, as has been proved for most of the animal forms of that region. From this consideration Grieg (op. cit.) has already doubted the correctness of the identification of the specimens from the American coast recorded by Professor Verrill under the name of *Pourtalesia Jeffreysi*, and the doubt was quite justified.

22. **Pourtalesia Wandeli** Mrtsn.

Pl. V. Figs. 1—7, 11—12. Pl. VIII. Figs. 1—3, 7. Pl. XI. Figs. 1, 13—14, 18—20, 23, 34—37, 40—41.

Th. Mortensen: Some new species of Echinoidea. Vid. Medd. Naturh. Foren. Kobenhavn 1905. p. 242.

The shape of the test is rather elongated, more slender than in *P. Jeffreysi*. The front end is almost vertical; on the abactinal side the test rises gently towards the middle, where the greatest height is found, and then slopes gradually towards the posterior end. An abactinal keel is hardly indicated in larger specimens, whereas it may be more distinct in smaller ones. The test is not produced over the periproct; in side view the outline of the abactinal side is thus seen to continue to the posterior end of the short anal rostrum scarcely without any sinuation over the periproct, a very conspicuous difference between the species and *P. Jeffreysi*, as is seen on comparing the figures 11 and 13, 18, 23 of Pl. V, representing side views of the tests of these two species. — In younger specimens the outline in profil of the posterior end is somewhat different (Pl. V. Figs. 5, 12) in accordance with the more developed abactinal keel, the periproctal sinuation being considerably more distinct. The sides of the test are almost parallel, the width augmenting only very little towards the posterior half, the greatest width being found a little past the middle; from there it rapidly narrows towards the posterior end. The actinal side is almost flat — a conspicuous difference from *P. Jeffreysi*, as is seen on comparing the figures 11, 12 and 13, 18. Pl. V. Among smaller specimens of the two species this difference is, however, not so great, *P. Jeffreysi* being flatter on the actinal side when younger. The sternum and episternum form a rather distinct actinal keel, which continues along the under side of the anal snout. The actinal invagination is somewhat longer than in *P. Jeffreysi*; the number of plates in the odd ambulacrum is, however, the same as in *Jeffreysi*, 12—13. The form of the peristome as in *Jeffreysi*. — The test seems to me a little more fragile than in *Jeffreysi*.

Regarding the structure of the test this species agrees in the main features with *P. Jeffreysi*. The labrum is generally not seen from without, may, however, be found as a small plate between the ambulacrals I. a. 1 and V. b. 1, which are distinctly developed; eight simple pores are found at the posterior edge of the invagination (Pl. VIII. Figs. 1, 3); none of the inner ambulacral plates have two pores. If the tube-feet are developed on all the plates I dare not assert, as it is rather difficult to discern them among the small spines in this place, both spines, tube-feet and skin being covered by dark violet pigment; also the pores may be very difficult to discern, as in *P. Jeffreysi*. A small plate may be found between the ambulacrals I and II on one side and between IV and V on the other side, evidently the inner plate of interambulacra 1 and 4 (Pl. VIII. Fig. 1), as it is also found sometimes in *P. Jeffreysi.* Upon the whole the structure of the actinal side, labrum, sternum, episternum, the two ambulacra of the bivium and the postero-lateral interambulacra agree very nearly with that of *P. Jeffreysi.* The periproct differs a little in outline from that of *Jeffreysi*, being more elliptical, not abruptly widened in the upper part as in that species. The plates surrounding the periproct are 5. a. 6—8 and b. 7—9; this holds good also for younger specimens, whereas in smaller specimens of *P. Jeffreysi* (till at least a size of 30^{mm}) there are 4 epiproctal plates on each side (5. a. 5—8 and b. 6—9) (in larger specimens there are only three epiproctal plates as in *P. Wandeli*, the lower pair being shut off from the periproct). The apical system (Pl. VIII. Figs. 2, 7) as in *Jeffreysi*, perhaps a little closer to the anterior border than in that species. I have found a case of the genital plates being distinct (Pl. VIII. Fig. 2) as found exceptionally by Lovén in *Jeffreysi* (in that species I have not met with such a case).

The tuberculation shows some difference from *P. Jeffreysi.* The linear arrangement of the primary tubercles is in larger specimens more prominent than in that species. The interambulacral plates at the front sides (posterior series of interambulacra 2 and 3) each bear two prominent parallel or posteriorly a little diverging, series of primary tubercles; on the uppermost and lowermost 2—3 plates of this series the linear arrangement of the tubercles is indistinct. The part of these plates, which is bent over on the front edge, bears only few, irregularly arranged primary tubercles, as is also the case with the other plates on the front. The following two series of plates (ambulacra II and IV, a. b.) bear a series of primary tubercles each. Also the following interambulacral plates show a tendency towards a serial arrangement of the tubercles. In these series the tubercles always increase in size from before towards the posterior end, the hinder one being the largest. It is only the plates on the sides of the test which have the tubercles thus serially arranged. The rest of the test has like *P. Jeffreysi* only irregularly scattered primary tubercles, somewhat less numerous, however, than in that species. The miliary tubercles are upon the whole less numerous than in *Jeffreysi*, the test looking more smooth than is generally the case in that species. The sutures are not elevated as in *Jeffreysi.* — Though the serial arrangement of the primary tubercles is much more prominent in *P. Wandeli* than in *Jeffreysi*, when larger specimens are compared, it must be conceded that in smaller specimens the serial arrangement is almost equally developed in both species.

The primary spines of the abactinal side are very long, especially those of the anterior series of the antero-lateral ambulacra and those of the interambulacral plates on the front edge, and — in accordance with the size of the tubercles — the posterior spine of each series is the longest. The longer of these spines reach from the anterior end of the test to the periproct, thus reaching more than two thirds of the length of the test. They are curved and bent backwards, lying rather close to the test; generally they are strongly thorny, especially along the convex side, which gives them a characteristic lustre. Sometimes they are irregularly curved at the point. (Pl. V. Figs. 1, 3, 5. Pl. XI. Fig. 36). These long spines give this species a very characteristic appearance, differing highly from *P. Jeffreysi* in which species the spines are much shorter, smooth, and generally not bent backwards over the test. (Comp. Pl. V. Figs. 1, 3, 5 with Pl. V. Figs. 19, 21, 23). — The spines of the actinal plastron (Pl. XI. Fig. 35) are flattened at the point, like those of *Jeffreysi*, and likewise those within the invagination (Pl. XI. Figs. 20, 34) as well as the miliary spines (Pl. XI. Figs. 37, 41) and the clavulæ agree with those of *Jeffreysi.*

The tube-feet are small and simple, without spicules, but generally with a calcareous cap as in *Jeffreysi.* The sphæridiæ placed singly, not presenting peculiar features. The pedicellariæ are represented by the same three kinds as in *Jeffreysi.* The rostrate pedicellariæ (Pl. XI. Figs. 1, 19, 23) are characteristic, broadly rounded and rather densely serrate at the point, differing distinctly from those of *Jeffreysi.* The ophicephalous pedicellariæ are much more alike in the two species, only the terminal portion is perhaps upon the whole a little smaller in *P. Wandeli* (Pl. XI. Figs. 13, 14). The tridentate pedicellariæ (Pl. XI. Fig. 40) are alike in both species.

The internal anatomy agrees with *Jeffreysi*, only the female genital organs are slightly ramose. The genital openings are not yet developed in a specimen of 20^{mm} length, but in a specimen of 21^{mm} they are found; on the other hand they are not yet fully developed in a specimen of 26^{mm}. It is thus evident that this species is not mature before it has reached a size of a little over 20^{mm} length. The largest specimens are 53^{mm}. Distinct genital papillæ are found in the grown specimens.

The colour is dark violet; also the spines may be so coloured (always so in life?). According to a coloured sketch from a living animal (St. 36) the living animal is more claret coloured, or to speak very exactly, intermediate between «vinosus» and «atro-violaceus», with a tint of «atropurpureus» along the abactinal keel. (Saccardo. Chromotoxia. Ed. II. 1894).

This species was taken by the «Ingolf» at the following stations:

St. 18	(61° 44' Lat. N.	30° 29' Long. W.	1135 fathoms	3°0 C. Bottom temp.)	1	specimen.
— 24	(63° 06' —	56° 00' —	1199 —	2°4 — —)	1	—
— 36	(61° 50' —	56° 21' —	1435 —	1°5 — —)	19	—
— 37	(60° 17' —	54° 05' —	1715 —	1°4 — —)	8	—
— 39	(62° 00' —	22° 38' —	865 —	2°9 — —)	1	—
— 40	(62° 00' —	21° 36' —	845 —	3°3 — —)	5	—
— 67	(61° 30' —	22° 30' —	975 —	3°0 — —)	1	—

Most of the specimens were broken. — Further a pair of broken specimens were taken by the «Thor» St. 164 (62° 10' Lat. N. 19° 36' Long. W. 1144 fathoms); they are mentioned as *Pourtalesia miranda?* in Johs. Schmidt: Fiskeriundersogelser ved Island og Færoerne i Sommeren 1903. p. 24[1]. — The species is thus known to occur in the warm area of the Northern Atlantic from South of Iceland to Davis Strait, from 845—1715 fathoms; probably it will prove to be distributed over a large part of the warm area of the Atlantic. It seems to be a more exclusively deep-sea species than *P. Jeffreysi.*

I have named this species in honour of the chief commander of the «Ingolf»-Expedition, Admiral Wandel.

P. Wandeli is, evidently, rather nearly related to *P. Jeffreysi*, but is easily distinguished from the latter species, mainly by the shape of the test, the long, curved and thorny abactinal spines and the rostrate pedicellariæ. Its relation to *P. miranda* A. Ag. is, for the present, not quite clear, because our knowledge of the latter species is rather unsatisfactory. In the «Panamic Deep-Sea Echini» p. 139 it is stated that the type specimen was only $3·5^{mm}$ in length; nevertheless it was mature, the genital openings being already fully developed, as shown in Fig. 9. Pl. XVII of «Rev. of Echini» and

[1] Skrifter udgivne af Kommissionen for Havundersogelser. No. 1. 1904. København.

also mentioned in the description (p. 345). As *P. Wandeli* is not mature at a smaller size than ca. 20^{mm} length, this difference between these two species seems so essential that they could for that reason alone not be regarded as so very closely related. I must, however, be allowed to suggest, that this statement of the size of the type specimen of *P. miranda* is a mistake. In the description in »Rev. of Echini» as well as in the preliminary description (Bull. Mus. Comp. Zool. I. 1869. p. 272) nothing is said about the size of the specimen, but in the explanation of the Pl. XVIII the figure 1 is said to represent the specimen »magnified 3·5 in diameter». The figure being 70^{mm} in length, this would give a size of 20^{mm} for the type specimen. (In »Three Cruises of the »Blake» II. p. 101 the figures from the »Revision» are copied in half size, and the figures are then said to represent the specimen twice magnified; this would give a size of 18^{mm} for the type specimen). I think there can be little doubt of the correctness of my suggestion as to the size of the type of *P. miranda* (which has, unfortunately, been lost), and thus this difference between *P. miranda* and *Wandeli* is reduced to nothing. (It would also be quite surprising that a specimen of so small a size as $3{\cdot}5^{mm}$ should be mature). The structure of the test of *P. miranda* is not worked out in the »Revision of Echini», but in »Panamic Deep-Sea Echini» p. 140 careful figures are given thereof, from a specimen of 18^{mm} length, collected by the »Blake». This specimen, it must be conceded, agrees very closely with *P. Wandeli*, the only differences worth mentioning being that the anal snout bends a little upwards and that the labrum is large, which I have never found to be the case in *P. Wandeli*. Remembering, however, the inconstancy of this feature in *P. Jeffreysi*, it is not safe to lay much stress on this single feature. I thus think it very likely, indeed, that the specimen figured in the »Panamic Deep-Sea Echini» under the name of *P. miranda* is identical with *P. Wandeli;* but on the other hand I cannot think that it is really *P. miranda*. A comparison with the original figures in »Revision of Echini» Pl. XVIII shows several important differences. The outline in side view is very different; in the figure in »Rev. of Ech.» the front slopes forwards from the apical system, in the specimen figured in »Pan. Deep-Sea Ech.» it slopes inwards; but the anal region especially is very different, the projection over the periproct being much larger and the anal snout turning much more upwards than in the specimen from the »Blake»; the snout is also much broader in the type specimen. The differences pointed out here hold good also when comparing with *P. Wandeli;* further I may notice a very conspicuous difference in the spines. According to the description the primary spines are long, curved, slightly fan-shaped at the extremity, as also appears in the figures; no serial arrangement of the spines is indicated on the figures or mentioned in the text. It seems hardly possible that the serial arrangement, so evident in *P. Wandeli* and the specimen from the »Blake», could have escaped completely the notice of the author of »Revision of Echini», the figures looking, indeed, much too good and carefully drawn for suggesting such an omission. Also the length of the spines is very different from what is the case in *P. Wandeli*. — Further the large tentacles in the odd ambulacrum and the coloration are conspicuous differences from *P. Wandeli*. In my opinion it can scarcely be doubted that the specimen described and figured in »Panamic Deep-Sea Echini» as *P. miranda* is not that species but *P. Wandeli*, (or a nearly related, undescribed species — comp. below), whereas *P. miranda*, which has still to be rediscovered, belongs to a quite different type of Pourtalesiæ, characterized (as far as hitherto known) by the broad anal snout, the large front tentacles and the comparatively short, not serially arranged spines. In these characters *P. miranda* agrees with *P. laguncula*, and Agassiz (Challenger-Echini p. 137) is certainly right in stating that this species is closely allied to *P. miranda*. Also the *P. Tanneri* is regarded by Agassiz as closely related to *P. laguncula;* it is, however, not clear from his otherwise (regarding the structure of the test) very elaborate description and figures of this species, whether it agrees with *laguncula* (and *miranda*) in the shape of the spines and the development of the front tentacles. Of the spines it is only said: the primary radioles on the flanks of the test are also longer, while in *P. laguncula* and *P. miranda* they are somewhat spathiform (Pan. Deep-Sea Ech. p. 132). The front tube-feet are not mentioned at all. Having received a specimen of *P. Tanneri* from the U. S. National Museum I can state that the spines are not widened towards the point, whereas the frontal tube-feet are really rather large and conspicuous The pedicellariæ do not afford any proof of a close relationship between *P. Tanneri* and *laguncula*. In the former species I have found only rostrate pedicellariæ with rather slender valves (Pl. XI. Fig. 11) and small tridentate pedicellariæ of the same form as in *P. Jeffreysi*.

In *P. laguncula* (examined in the British Museum) I have found (in a specimen from St. 232) globiferous pedicellariæ with the valves ending in two or three long teeth, resembling closely those of *P. carinata* (comp. Pl. XI. Figs. 16, 22), ophicephalous pedicellariæ with rather elongated, slender valves (Pl. XI. Fig. 12) — (differing considerably from those figured in the Chall.-Ech. Pl. XLIII. 18—19 under the name of Clypeastroid-like pedicellariæ, so much, indeed, that they can scarcely belong to the same species) — and two forms of tridentate pedicellariæ, viz. the usual small form, which, however, here occurs also with the apophysis continuing into the outer edges of the blade, and a larger form with long and slender valves with the blade almost flat (Pl. XI. Fig. 33), the outer edge very finely serrate. (This form differs so much from the pedicellariæ of the other species that it may perhaps be suggested not to belong really to this species). Of rostrate pedicellariæ I have found only one small specimen, which does not differ essentially from those of *P. Tanneri*. Small spicules, in the shape of fenestrated plates are found in the large frontal tube-feet.

The form figured in the Challenger-Echinoidea Pl. XXXI. 7—11 and mentioned (p. 138) as younger specimens of *P. laguncula* showing considerable variation in the outline can hardly be the same species as that figured in the same Plate, Figs. 1—6, which must be taken as the type of the species. The latter specimen was 22^{mm}, that represented in the figure 7—11 was 12^{mm} in length. It seems hardly conceivable how so great a difference in the shape of the test could be due merely to changes during growth, and a growth only from 12 to 22^{mm} in length. This is made even more unlikely when we learn (Chall.-Ech. p. 138) that some of the specimens with narrow anal snout characteristic of the smaller specimens measuring from 12—16^{mm} were nearly 19^{mm} in length. The conclusion seems quite inevitable that this form with the narrow anal snout is a distinct species, which will perhaps prove identical with *P. Tanneri*. The material preserved in the British Museum does not give the solution of the question, since no specimen is found which can with certainty be recognized as belonging to the narrow type (Chall.-Ech. Pl. XXXI. 7—11). Specimens of the broad type, the real *P. laguncula* are preserved from St. 232 and St. 191 (the latter are badly crushed, but can, however, be recognized as belonging to this form); from St. 169 small fragments only are preserved, which cannot be recognized as belonging to either of the forms, and the same is the case with the anterior ends of two specimens from St. 168. A specimen from St. 244 is certainly not *P. laguncula*; whether it is the narrow form cannot be decided with certainty, since it is very crushed, but it does not seem to be that form — in that case the figures Pl. XXXI. 7—9 would indeed be very bad. Probably it is a third species, related to *P. phiale*. The spines are widened at the point as in the latter species. Also the true *P. laguncula* is represented as having the spines distinctly widened at the point (Pl. XXXI. Figs. 1—5); in the description they are said (p. 137) to be "tapering very slightly or clubshaped". They are, in fact, not at all widened or clubshaped, but several of the spines are invested towards the point with a dark brown matter, the nature of which I could not decide. But in any case it is a foreign matter, not part of the spine itself. The figures cited therefore give a wrong impression of this species as regards the form of the spines.

Perhaps one more species, allied to *P. Jeffreysi* and *Wandeli*, will be found to occur in the northern Atlantic (warm area). Among the specimens of *Pourtalesia Wandeli* from the "Ingolf" St. 40 and further from St. 67 and 68 there are some small specimens (18—25^{mm}) of a *Pourtalesia*, which differ from *P. Wandeli* in having shorter and smooth (or very little serrate) spines and the abactinal keel more developed and produced over the periproct; the anal snout bends a little upwards. In fact these specimens are rather like *P. Jeffreysi*; from this species they differ, however, in having only three epiproctal plates (5. a. 6—8 and b. 7—9), whereas in *Jeffreysi* of a corresponding size there are four epiproctal plates on each side (a. 5—8, b. 6—9); also the anal snout is flatter in *Jeffreysi*. The general shape of the test is as in *P. Wandeli*, though a little narrower at the anterior end and comparatively a little wider in the middle. The serial arrangement of the tubercles not distinct in the posterior series of plates of the antero-lateral ambulacra. Upon the whole this form is quite intermediate between *P. Wandeli* and *Jeffreysi*, uniting several of the prominent characters of these two species. It further agrees rather closely with the form figured as *P. miranda* in "Panamic Deep-Sea Ech.", excepting the labrum, which is not seen from without in these specimens. — Whether this be a distinct species or only a variety of *P. Wandeli* (or perhaps a warm area variety of *P. Jeffreysi*) I do not venture to decide from the present scanty and not too well preserved material; I must be content with calling attention to this form and leave it to those who will be so fortunate to get sufficient material to decide the question.

23. **Echinosigra**[1] **(Pourtalesia) phiale**[2] Wyv. Thomson.

Pl. VI. Figs. 1—2, 7. Pl. VII, Figs. 1, 7.

Wyville Thomson: Depths of the Sea. p. 90. (394). Ann. Nat. Hist. 4 Ser. X. p. 305. Porcupine-Echinoidea. p. 749. Pl. LXX. Fig. 11. — A. Agassiz: Challenger-Echinoidea. p. 138. Pl. XXII. 1—5. XXII. a. 1—2. — D'Arcy Thompson: (392). Proc. R. Soc. Edinburgh. XXII. 1899. p. 431. — St. W. Kemp: The Marine Fauna of the West Coast of Ireland. III. Echinoderms. Ann. Rep. Fish. Ireland. 1902—03. Pl. II. App. VI. (1905). p. 206.

[1] With regard to this name, see below p. 82.

[2] In the Report on the Echinoidea of the "Porcupine" Wyv. Thomson writes "phyale". Both on account of priority and etymology "phiale" is the correct name.

It seems very doubtful, as pointed out by d'Arcy Thompson (Op. cit.) whether the specimen described and figured by Agassiz in the Challenger -Echinoidea is really the same species as the *P. phiale* of Wyv. Thomson. The expression test very much prolonged, almost tubular does not seem so very appropriate for the form figured in the Challenger -Report, and the figure given by Wyv. Thomson does not resemble the figures of the Challenger -specimen very much either. It seems, indeed, more like the *Pourtalesia paradoxa* described below; but Wyv. Thomson's figure and description of the *P. phiale* are not sufficiently detailed for deciding the question, and since the type specimen does not seem to exist any longer, as I am informed by Professor Bell, we must remain at the decision made by Professor Agassiz and let the species described and figured as *P. phiale* in the Challenger -Echinoidea keep that name.

Some additions and corrections may be given to Professor Agassiz' description and figures of the test of this species. Judging from the Pl. XXII. a. Fig. 2 the odd interambulacrum is constructed on a rather different plan from what is the case in the other species of Pourtalesiæ thus far known, representing indeed, the most primitive structure of the plastron known among the Pourtalesiæ; the labrum and sternum are represented as being in contact with each other, and likewise the ambulacra I and V are continuous, the interambulacra 1 and 4 not separating the first and the second plates of these two ambulacra. This more primitive structure is the more surprising as this species is otherwise a very modified form. On a careful examination of the specimens in hand, I find, however, that the structure of the test is not as represented by Agassiz; it agrees in the main features with that of the other species. (Pl. VI. Figs. 1—2, 7). The labrum is large and carries several primary tubercles; the single plate seen on Pl. XXII. a. Fig. 2 of the Challenger -Echinoidea in contact with the aboral end of the labrum and which de Meijere (Siboga-Echinoidea. p. 168. Pl. XXI. Fig. 417) interprets as the sternum, as it would undoubtedly have to be interpreted in case the figure were correct, does not really exist. In continuation of the labrum follows a pair of large plates the ambulacrals I. a. 2 and V. b. 2, which at their aboral end separate a little to give room for a large, single plate, the sternum, which is again followed by a pair of elongated plates, the episternal plates. The two large plates following the labrum show the curious feature of being divided at their oral end by a longitudinal line, which does not reach to the middle of the plate. It does not join any other line and thus does not cut off any separate plate. This feature I have found quite distinct in the three larger specimens examined by me (among which is one from the Antarctic Sea[1], from the German South Polar Expedition); in the two smallest specimens I have been unable to trace the limits of the plates with certainty.

Both the inner plates of the ambulacra I and V are distinct and rather large and in conformity with the rule: I. a, II. a, III. b etc.; those of the ambulacra II and IV are much smaller and seem not to be always in accordance with the rule; thus in the specimen figured Pl. VI. Fig. 7 the plate II. b was the larger — but the limits of the anterior (especially II. b and IV. a) of these small plates are generally very difficult to see. The pores and tubefeet are distinct in all the 8 inner plates, but there is only one in I. a. 1 and V. b. 1. The plates I. a. 1. b. 1 and V. a. 1. b. 1 are in contact with

[1] In this specimen there is also at the outer end of these plates an indication of such a line; but it does not reach the line from the oral end, so that the plate is not divided.

the corresponding plates 2, the bivial ambulacra thus not being interrupted by the interambulacra 1 and 4. The inner plate of these interambulacra is small, but distinct, at the edge of the invagination it is separated from the corresponding second plate by the ambulacral plates II. a. 2 and IV. b. 2, sometimes also IV. b. 3, which are prolonged backwards so as to join the ambulacral plates I. b. 1 and V. a. 1. The interambulacra 1 and 4 are much prolonged backwards, and the plates 1. a. 4 and 4. b. 4 have especially become very large; in the abactinal part these interambulacra have a forward direction, thus being in some way bent upon themselves (Fig. 10) — a feature which is carried to the extreme in *P. paradoxa* (see Fig. 13. p. 74). In the interambulacrum 1 in the specimen from which the Fig. 10 was made the plate 1. a. 3 is abnormally divided into two; also the plate designated 1. b. 4 is evidently abnormal.

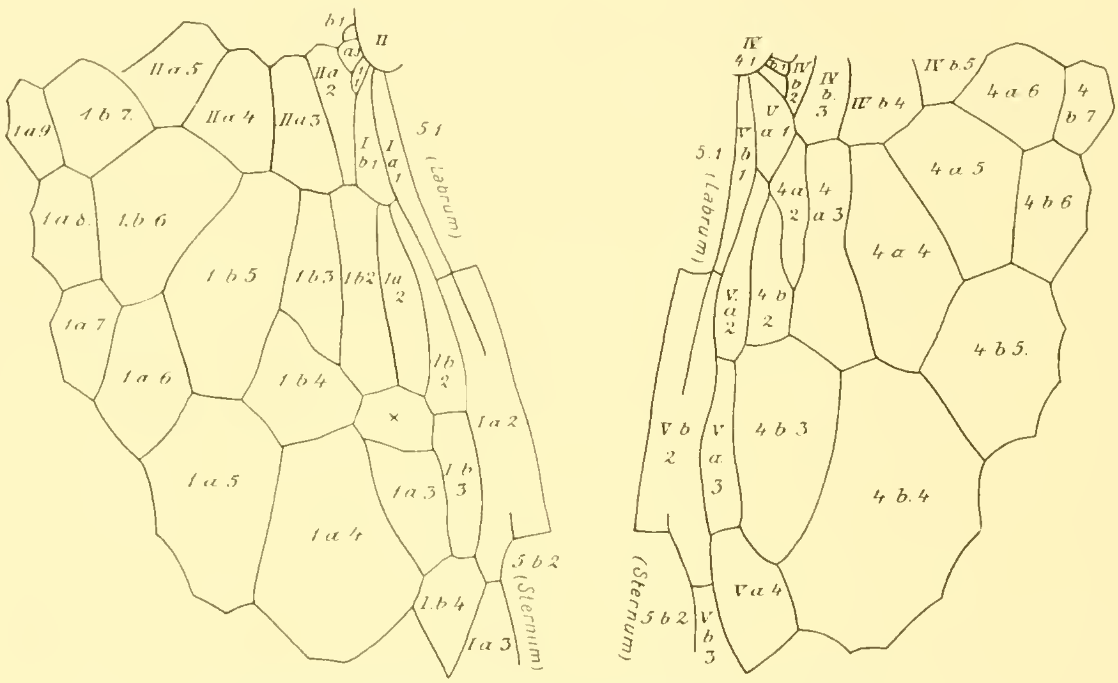


Fig. 10. Analysis of Part of the test of *Pourtalesia phiale*.
The plate marked x is probably part of 1. a. 3, abnormally separated off from the latter.

Whether any of these plates should be interpreted as being compound (in the sense of Lovén's Heteronomy) I do not venture to decide.

The periproct is not sunken; it is surrounded by three epiproctal plates on each side, viz. 5. a. 6—8 and b. 7—9. The apical system (Pl. VII. Fig. 7) is disconnected as in *P. Jeffreysi*; the genital openings are not developed in the specimens in hand. The primary tubercles are not serially arranged. — The description and figures of spines and pedicellariæ will be given in the Report on the Echinoidea of the German South Polar Expedition, founded on the single, very beautifully preserved specimen taken by that Expedition. The specimens from the Ingolf are smaller (8—13^{mm}) and less well preserved, sufficiently well, however, to show that they agree in every respect so closely with that from the Antarctic Sea that it is quite out of the question to separate them as a distinct species. The question whether the antarctic species described in the Challenger -Report as *P. phiale* is really the same as the *P. phiale* of Wyv. Thomson from the Rockall Channel, thus loses its interest from a zoogeographical point of view, since in any case this species really occurs both in the Northern Atlantic and in the Antarctic Sea. (Comp. *Urechinus naresianus.*)

This species was taken by the "Ingolf" at the following stations:

St. 11.	(64° 34' Lat. N.	31° 12' Long. W.	1300 fathoms	1°6 C. Bottom temp.).	2 specimens.
— 40.	(62° 00' —	21° 36' —	845 —	3°3 —	—)	1 —
— 83.	(62° 25' —	28° 30' —	912 —	3°5 —	—)	1 —

The geographical distribution of the species is: Northern Atlantic (S. of Iceland, Denmark Strait) and Antarctic Sea. It will doubtless be found to occur all over the Atlantic Ocean. The bathymetrical range, as hitherto known, is 845—1975 fathoms.

The very interesting morphological relations of the bivium show that *P. phiale* is really one of the more primitive Pourtalesiæ, in spite of its modified form. The continuity of the ambulacra I and V it has in common with *Sternopatagus* and *Pourtalesia carinata*, which latter species through its two pores in the plates I. a. 1 and V. b. 1 as well as by its large labrum, maintains the place as the least modified of the *Pourtalesia*-species, (viz. among those species whose structure of the test is thus far known)[1]. Otherwise important light is thrown on the structure of *P. carinata* by what has here been made known of the structure of the actinal part of the test in *P. phiale*. A comparison of the figure of the actinal side of *P. phiale* (Pl. VI. Fig. 7) with the Pl. VI. Fig. 42 of Lovén's "On Pourtalesia" shows almost beyond doubt that the plates named by Lovén 5. a. 2 b. 2 and V. a. 2 b. 2 are wrongly interpreted. The plate named V. b. 2 is seen to agree very closely with the plate V. a. 2 in *P. phiale;* but in case that plate is really V. a. 2, which can scarcely be doubted, the plate named by Lovén 5. a. 2 really becomes the ambulacral plate V. b. 2. To be sure, it is separated from the plate V. b. 1, by the corner of the labrum; but the connection between these two plates in *P. phiale* is already so very narrow, that it is very easily conceivable how the total separation has been produced in *P. carinata* by the great development of the labrum. The plate "V. a. 2" in Lovén's Figure thus becomes a plate of interambulacrum 4. I may give here a copy of the figure from Lovén with my interpretation of the plates for the direct comparison with *P. phiale* Figs. 11 and 12). I think it will be agreed that my interpretation thereof has all evidence of being the right one. But this leads to the very important conclusion that *Pourtalesia carinata* is not amphisternous as thought by Lovén as the result of his, evidently wrong, interpretation[2] of the plates in this figure, but

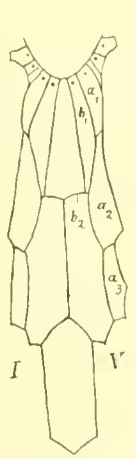


Fig. 11. Part of actinal plastron of *Pourtalesia phiale.*

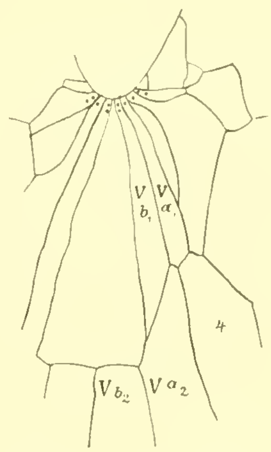


Fig. 12. Part of actinal plastron of *Pourtalesia carinata* after Lovén.

[1] De Meijere (Siboga Echin. Pl. XXI. 418 p. 168) represents *Echinocrepis cuneata* as having the same structure of the bivial ambulacra, founding his opinion on Pl. XXXV. a. 10 of the "Challenger"-Ech. *Echinocrepis setigera* has its bivial ambulacra separated by the interambulacra 1 and 4 (Panamic Deep-Sea Echini. Pl. 67. 1, Fig. 167). Also the apical system is very different in these two species, compact in *Ech. cuneata*, disconnected in *Ech. setigera*. It can then scarcely be doubted that the latter species was unrightly referred to the genus *Echinocrepis* and will have to be made the type of a new genus. (Comp. below p. 83—84.)

[2] It is of course, the fragmentary condition of his material of this species which has caused that interpretation. Not knowing the real structure of *P. phiale*, Lovén could scarcely interpret these plates in *P. carinata* otherwise.

meridosternous — and this is the only reason which Lovén can adduce for maintaining the whole of the Pourtalesiæ as amphisternous. As far as I can see there cannot be the slightest doubt that Lambert (Études morphol. sur le plastron des Spatangides p. 93) is right in maintaining that the Pourtalesiæ are meridosternous (de Meijere also agrees with this); the sternum of the Pourtalesiæ is not a compound plate, representing 5. a. 2 + b. 2, but a single plate, viz. 5. b. 2. The affinity of the Pourtalesiæ to the *Urechinidæ* and *Ananchytidæ* cannot then be doubted either, and the systematic position of the Pourtalesiæ as an extreme development of the *Ananchytidæ* seems beyond doubt.

24. **Echinosigra (Pourtalesia) paradoxa** Mrtsn.

Pl. VI. Figs. 3—6, 17—21. Pl. VII. Figs. 5, 10, 16, 18. Pl. XI. Figs. 2—3, 5—6, 17, 21, 24—25, 27—29, 32, 42—44.

Th. Mortensen. Some new species of Echinoidea. Vid. Medd. Naturh. Foren. Kobenhavn 1905. p. 243.

The shape of the test of this species is very peculiar, highly deviating from the usual form, so as to be unique in this respect even in a group containing so many curious forms as the Pourtalesiæ. Were it not for the comparatively hard test it would by no means be easy to recognise the Echinoid in this disguise. It is, indeed, an almost quite natural thing to speak of a head, neck, body and tail in this species, especially in the largest specimen. Nevertheless, it is easy to see that the structure of the test is in accordance with the other Pourtalesiæ, especially with its nearest relation, *P. phiale*, the remarkable transformation being attained simply by the prolongation of some of the plates, mainly a few of the inner ones in the bivium, of those of the posterior paired interambulacra and an augmentation in the number of dorsal plates of the posterior interambulacrum.

The test (Pl. VI. Figs. 3—6, 17—21) is very elongated and slender, compressed, distinctly keeled above and below; the abactinal keel is distinct in the whole length, from the «head» to the anal area; the actinal keel goes from where the test begins to widen and proceeds to the end of the «tail». In the anterior, headlike widened end is the invagination characteristic of Pourtalesiæ; it is rather short only about a seventh of the whole length. The front end makes only a rather narrow upper edge of the invagination. — The «head» continues posteriorly into a long and slender neck, highly compressed and so very fragile that it is quite remarkable that it is not broken in two of the specimens. One cannot help thinking that it must be rather unpractical and dangerous to have such a fragile neck and that it would be more safe to have a flexible test, like *Pilematechinus vesica* e. g. — The posterior part of the test is much higher and broader than the «neck», forming the «body», in which is contained the intestine, the neck having room only for the œsophagus. Posteriorly the body narrows into a rather long and narrow anal snout simulating a tail; it bends a little upwards, and is as usual surrounded by a rather broad fasciole. The abactinal keel is not produced over the anal area, which is oval, not much sunken. — The test is rather transparent, the largest specimen brownish, the smaller ones lighter, almost colourless.

As is seen on comparing figures 3—5 and 6, 18, 20 of Pl. VI the shape of the test becomes somewhat transformed with age, mainly by the «body» growing comparatively higher and, especially, broader (thicker); in the larger specimens the «ventral» side is rather flat (though always with a median keel), the test thus keeping the natural position very easily — a fact probably of no small importance for the animal, since it is hardly conceivable, how the animal could get the right position again, if it were turned over, the short spines being hardly able to set up the thick body with its heavy contents. In the younger specimens the ventral side is not so flat, but the spines are here comparatively larger and in so far better adapted for keeping the body in the right position.

Some measurements are given here of the three best preserved specimens; the two larger ones have only a few small holes in the test; in the third one the neck is broken, but the specimen is otherwise well preserved. The other specimens are represented by separated anterior and posterior ends. — All the measurements are in mm.

Total length	Width of »head	Width of neck»	Height of »neck	Height of »body»	Width of »body»	Length of »tail
37	6	3	5	12·5	12	4
26	4·7	2·5	3·8	8	5·8	3·5
22	4·8	3	3·5	7·5	6	3·5

The structure of the test (Pl. VI. Figs. 17, 19, 21. Pl. VII. Fig. 5) is essentially the same as in *P. phiale*, the main difference lies in the extreme elongation of the inner plates of the bivium. The labrum is rather broad and very long, 6·5^{mm} in the specimen of 26^{mm} length. The inner plates of the ambulacra I and V are both well developed, narrow and very elongate, joining at their outer end the second plate of the corresponding series, the bivial ambulacra thus being uninterrupted. Each of the inner plates carries a single tube-foot[1], the same is the case in the ambulacra II and IV, the edge of the invagination thus being provided with 8 rather well developed and distinct tube-feet. The plates I. a, II. a, IV. a V. b thus do not carry two pores, but their relative size is in conformity with the general rule. The inner plate of the interambulacra 1 and 4 is distinct, but, as in *phiale*, separated from the corresponding second plates by the widened ambulacral plates II. a. 2—3 and IV. b. 2—4. The labrum joins at its outer end the two ambulacral plates I. a. 2 and V. b. 2. They are also very much prolonged, no less than 7·5^{mm} in the specimen of 26^{mm} length, somewhat widened in the outer half. As in *phiale* they show the curious feature of being split up at the oral and aboral end by a longitudinal line proceeding from both ends a long way into the plates; these two lines, however, do not join in the middle (Pl. VI. Fig. 21), the plates thus being undivided. In this figure the outer part of the oral end of this plate is seen to be prolonged a considerable distance along the labrum to meet the first ambulacral plate; in the largest specimen it is — as far as I am able to discern it — not prolonged orally down the side of the labrum, in the smaller one it is somewhat prolonged, but not so much as in the specimen figured here. The sternum is situated very far back; it is not so much prolonged, 5^{mm} long in the specimen figured; the episternal plates which are comparatively rather short (3^{mm}), reach the point of the anal snout. The epiproctal plates are three on each side, viz. 5. a. 6—8 and b. 7—9. The abactinal plates of the odd interambulacrum are not distinctly prolonged, their number therefore being larger than usual, 15 or 16 in the specimen figured of 26^{mm} length. The bivial ambulacra begin on the abactinal side at the anterior end of the test, being thus very little separated from those of the trivium, which occupy the usual position at the anterior end of the test. The posterior paired interambulacra (1 and 4) are very curiously modified (Fig. 13). The plates a. 2 and b. 2 are

[1] In V. a there is exceptionally no pore in the specimen figured (Pl. V. Fig. 21).

pushed far backwards, separated from the small inner plate at the peristome not only by the ambulacral plates IV. b. 2—4 and II. a. 2—3, the posterior one of them being much prolonged backwards along the ambulacral plates V.a.1 and I. b. 1, but also by the interambulacral plates 4. a. 4 and 1. b. 4—5, which join the ambulacral plates V. a. 1—2 and I. b. 1—2 for a long way. The plates 1. a. 4 and 4. b. 4 are very much enlarged, and upon the whole all the plates of these interambulacra are unusually large. As in *phiale* these interambulacra are very much bent upon themselves, the median part being near the posterior end, whereas the upper and lower end is at the anterior end of the animal. That the interpretation of the plates given here is correct seems beyond doubt, from a comparison with *P. phiale* (Fig. 10), in which the interpretation lies quite evident. — The plates of the antero-lateral ambulacra and interambulacra are rather small, in accordance with the small size of the head. The odd anterior ambulacrum contains ca. 14 pairs of plates; I have been unable to count the number with full certainty. The invagination is comparatively small, but otherwise of the usual form. The peristome is almost round, covered with rather large plates. The mouth is a little below the middle.

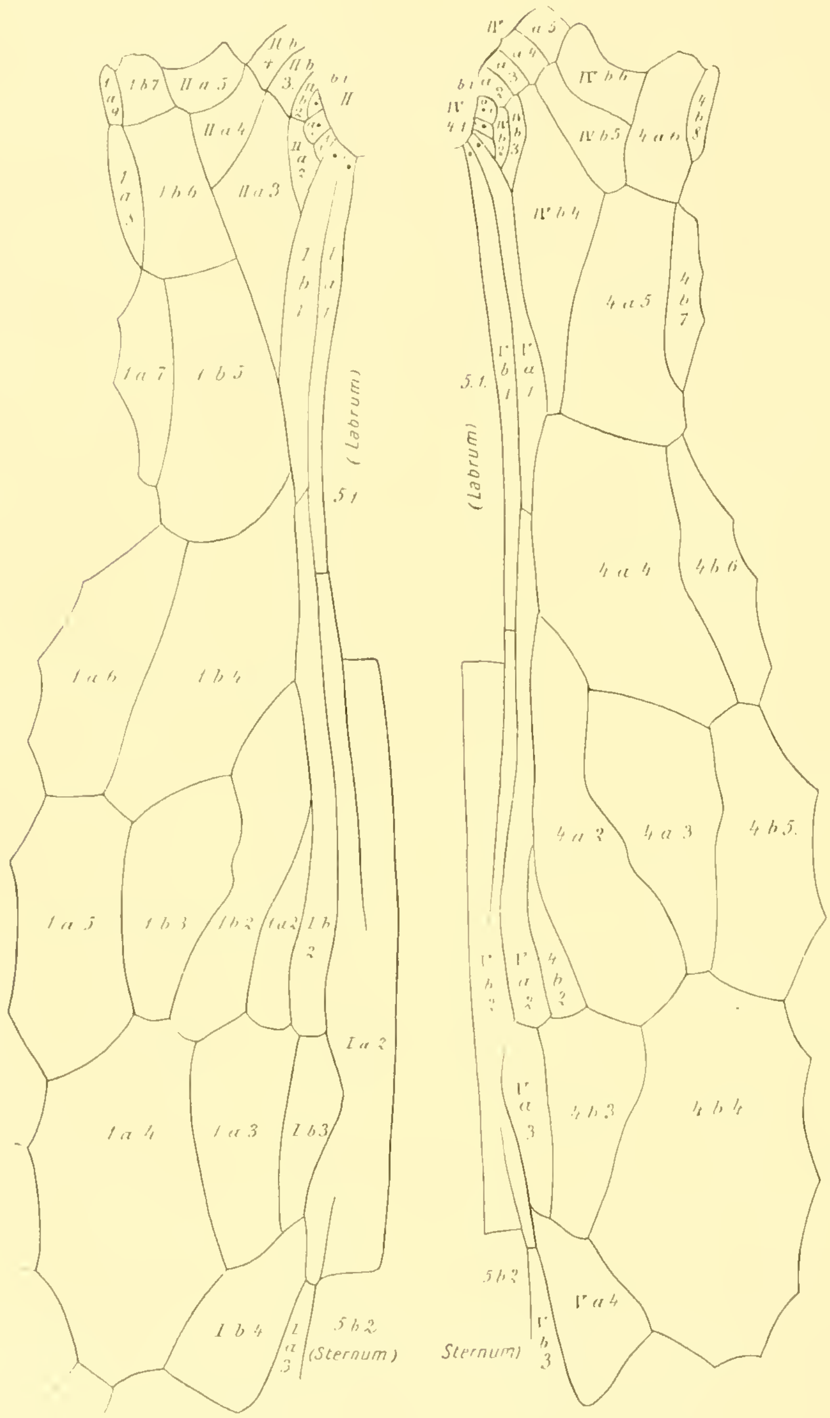


Fig. 13. Analysis of part of the test of *Pourtalesia paradoxa*.

The apical system is situated near the anterior end; from the outside I was unable to see the limits of the plates in this region with any certainty, but from the inside most of them could be distinctly seen (Fig. 14). Probably the plate just behind the large inner prolongation from the madreporic plate will really be divided in two, but I could not distinguish any line there. Also the small innermost plate of the antero-lateral interambulacra (posterior series) is a little uncertain, as I was unable to see distinctly the limit betwen it and the ankylosed genital plate.

There are only two genital openings, covered by long genital papillæ; it is probably the anterior pair which is found, the posterior pair having disappeared, evidently because there is no room for more than one pair of genital organs. The madreporic pores are rather few in number (Pl. VI. Fig. 17), placed behind the genital pores; in the specimen of 26^{mm} there are only two madreporic pores. The genital openings are present only in the two larger specimens and in a separated head-end. The smaller specimen shows no trace of genital openings. This species thus is not mature till a rather considerable size, since a specimen of 22^{mm} is immature.

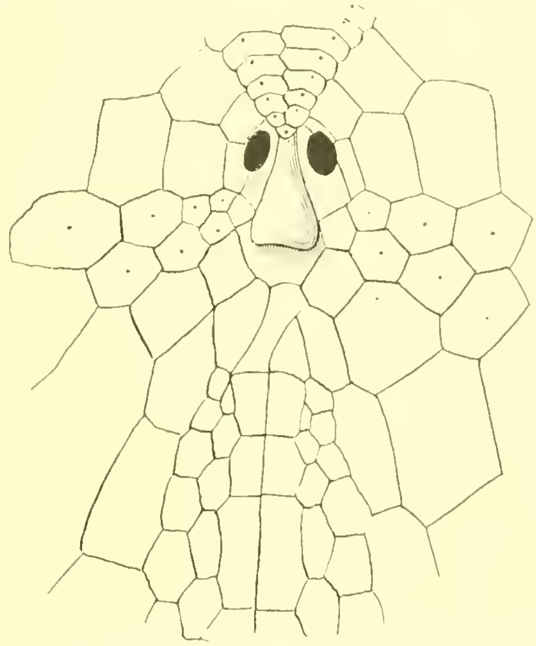


Fig. 14. Apical region of *Pourtalesia paradoxa*. From the inside.

The primary spines are rather scarce, only along the actinal and abactinal keel they are close-set; also along the anterior border they are more numerous; there is no serial arrangement of the spines. They are all short, the longest scarcely reaching 3^{mm} length; they are curved, widened towards the point, which is generally bifid (Pl. XI. Fig. 44); they are more or less serrate, generally more on one side than on the other. Those along the plastron are somewhat more widened than the abactinal ones; those on the posterior end of the abactinal keel bend down over the anal area. The spines within the oral invagination (Pl. XI. Fig. 21) are, as usual, coarser and stronger than those on the outside; they are curved and more or less sharply serrate along the concave side. The miliary spines (Pl. XI. Fig. 43) are likewise rather scarce in number; they are only ca. $0{\cdot}5^{mm}$ in length, curved towards the point which forms a somewhat widened, slightly fenestrated plate. The clavulæ of the fasciole are somewhat stronger, with a rather complicated widening at the point (Pl. XI. Fig. 42).

The tube-feet along the border of the invagination and those of the odd anterior ambulacrum are rather well developed, though, of course, simple. They contain rather numerous irregular spicules, (Pl. VII. Fig. 18) arranged in a longitudinal series. In the tip of the foot is generally found a small calcareous ring, evidently corresponding to the more developed cap (or, as it really is, ring) found in *Pourtalesia Jeffreysi* and *Wandeli* (comp. Pl. VII. Fig. 21). — The sphæridiæ are placed singly behind the tube-feet along the border of the invagination. They are of the usual shape, quite smooth, except at the lower end (Pl. XI. Fig. 25).

The pedicellariæ are represented by three kinds, viz. tridentate, rostrate and ophicephalous; no globiferous pedicellariæ have been found. The tridentate pedicellariæ occur in different forms, which are, however, connected by transitions. The smaller ones (Pl. XI. Fig. 2) have a short, oval blade, finely serrate along the edge, except in the lower part; they differ rather much from those of *Pourt. Jeffreysi* etc. by the apophysis continuing into the edge of the blade, whereas in the other species it ends down on the sides, not reaching the edge. There is a somewhat larger, though very inconspicuous tooth at the point. In larger specimens (Pl. XI. Fig. 24) the valves become more slender and elongated and the tooth at the point more prominent, and in the largest ones (ca. 0·2mm head) the tooth at the point is very long, the blade narrow, the edges serrate only in the outer part, where the valves join. (Pl. XI. Fig. 5.) — The rostrate pedicellariæ (Pl. XI. Figs. 17, 27, 28) differ considerably from those of *P. Jeffreysi* and *Wandeli*. The blade has not the outer edge sharply set off from the sides; the point is simply rounded, set with some slender teeth, which continue some way down the side-edges; the edges are rather thick, having only a small deepening along the middle of the blade with few holes there, and sometimes near the point a transverse beam, which may be provided with a tooth. These pedicellariæ may be invested in a rather thick, pigmented skin. — The ophicephalous pedicellariæ (Pl. XI. Figs. 3, 6, 32) are not so beautifully developed as in *Jeffreysi* and *Wandeli*, though agreeing in the main points with these. The outer end of the valves is hardly widened and with rather few teeth along the edge. I have found only two specimens of them, at the anal area. Also the rostrate pedicellariæ occur mainly near the anal area; the larger tridentate pedicellariæ I have found within the oral invagination.

Regarding the inner anatomy I cannot give full information, as I do not want to destroy one of the better preserved specimens. In a crushed specimen the intestine is preserved; the walls are, however, so incrusted with the Globigerina-mud, which fills the intestine, that it is impossible to discern the convolutions with certainty; likewise I am unable to ascertain the presence of a diverticulum or of the siphones, though it can scarcely be doubtful that they will be present as in other Pourtalesiæ. — As in *P. Jeffreysi* and *Wandeli* the genital organs differ considerably in shape in the two sexes: large, bush-shaped in the males, simple tubes in the female. The male genital organs are situated one behind the other, far back, the posterior one at the beginning of the »body«, and connect with the genital openings through very long efferent ducts, passing up the whole length of the neck. (Pl. VII. Fig. 16.) In the female the genital organs are situated in the »head«, having rather short oviducts. (Pl. VII. Fig. 10). The stone-canal evidently runs as in *P. Jeffreysi*, making a great curve backwards, following the intestine into the body; to be sure I have been unable to trace it in its whole length, only the two ends of it (Pl. VII. Fig. 16), but the fact that it passes backwards through the whole length of the neck along the dorsal side does not leave any doubt that its course must upon the whole be as in *P. Jeffreysi*. There is a slight thickening, representing the axial organ, near the upper end of the canal. Below the ankylosed genital-madreporic plate there is a rather large calcareous process, to which the end of the stone-canal is fastened. The radial water-canals of the bivium are very thin and inconspicuous, those of the trivium are more distinct; ampullæ I have been unable to find.

This species was taken by the »Ingolf« at the following stations:

St. 40	(62° 00′ Lat. N.	21° 36′ Long. W.	895 fathoms	3°3 C. Bottom temp.)	1	specimen.	
— 68	(62° 06′ —	22° 30′ —	843 —	3°4 — —	1 (2?)	—	(fragments)
— 83	(62° 25′ —	28° 30′ —	912 —	3°5 — —	4	—	(two in fragments).

The species is thus known only from off Southwest Iceland, from a depth of 843—912 fathoms. That it will prove to be distributed over a large part of the warm area of the northern Atlantic can scarcely be doubted.

The nearest relation of *P. (Echinosigra) paradoxa* is *P. (Echinosigra) phiale;* it agrees with that species in the main features of the test, as also in the pedicellariæ and spines. That it is a distinct species and not only representing the grown form of *P. phiale* is beyond doubt, as is easily seen by a direct comparison of the largest specimen of *phiale* (17^{mm}) with the smallest specimen of *paradoxa* (22^{mm}); both these specimens show all the characteristics of their species quite distinctly developed — it would be quite unreasonable to think that a form like that figured in Pl.VI. Figs. 1—2, 7 *(phiale)* could be transformed into a form like that figured in Pl. VI. Figs. 17, 19, 21 *(paradoxa)* during the growth from a length of 17^{mm} to a length of 22^{mm}. The fact alone that in the specimen of *phiale* of 17^{mm} the lowest part of the anterior end is 5^{mm} high, whereas in the specimen of *paradoxa* of 22^{mm} the neck is only $3{\cdot}5^{mm}$ high, is sufficient to prove them to be two distinct species.

A form like this species is, evidently, only fit to inhabit the soft bottom of the deep sea; in less quiet regions it would run the risk of breaking the neck. Lovén (On Pourtalesia. p. 85) thinks that several of the more important characters of the Pourtalesiæ point though remotely, towards animal forms of another and higher type, animals of annulose differentiation . Had he known the species here described, he would probably have seen a confirmation of this view herein, except as regards the annulose differentiation , of which there is no trace. One might easily fancy how such a form, if it proved favourable in the struggle for life and the species therefore became numerous and wide spread, might give rise to quite new types, in which the Echinoid organization would scarcely be recognizable. — It is, however, more probable that this form represents an extreme development, the ultimate end of that branch of the great Echinoid genealogical tree.

I may here give some additional information, mainly on the pedicellariæ of the other species of Pourtalesiæ which I have had occasion to examine in the British Museum.

Pourtalesia carinata A. Ag. Regarding the structure of the test of this species I may refer to the remarks above (p. 71), in which I think it is shown beyond doubt that the two plates following the labrum are not a double sternum, as it is interpreted by Lovén, but the ambulacral plates I. a. 2 and V. b. 2, the species thus agreeing with *P. phiale* and *paradoxa* in this respect. The material preserved in the British Museum, unfortunately, does not allow one to state this by direct observation, no specimen having more of the plastron left than what has been figured by Lovén. In the Challenger Report are given several figures of the pedicellariæ, which in the explanation of plates are named: large-headed, hooked pedicellaria, large-based, slender-pronged and Clypeastroid-like pedicellaria. In the description they are not mentioned. I have found three kinds of pedicellariæ in this species, viz. globiferous, rostrate and tridentate. The globiferous pedicellariæ (Pl. XI. Figs. 16, 22) have the valves ending in two (sometimes three) rather large teeth; it is this form which is figured in the Challenger Report Pl. XLV. Fig. 49, as a large-based, slender-pronged valve . The head is invested in a thick, evidently glandular skin; there is no neck; the stalk is rather compact. The rostrate pedicellariæ (Pl. XI. Fig. 39) are of a peculiar form; the basal part of the valves is very broad, with finely serrate edges; the narrow blade is short and thick, with the outer edge rounded, not forming an angle with the side-edges; it is rather coarsely serrate, the teeth continuing a little way down the side-edges. The tridentate pedicellariæ are richly developed; in the larger forms there is a very long tooth at the point, in smaller ones this tooth is less prominent, or not at all differing in size from the teeth along the side-edges. In Pl. XLII. 24—25, Pl. XLIII. Fig. 20 and XLV. Figs. 46—48, 50 of the »Challenger» Echini different forms of tridentate pedicellariæ are rather well represented, to which figures the reader may be referred. I only want to call attention to the fact that the apophysis continues into the edges of the blade as in *paradoxa*, a noteworthy difference from *Jeffreysi* etc. On the other hand it seems rather problematic what may be meant by the figures 21—23 of Pl. XLIII in that work. In the explanation of the plate they are said to represent different views of »Clypeastroid-like» pedicellariæ; this generally means ophicephalous pedicellariæ, but these figures can scarcely represent the ophicephalous pedicellariæ, always so easily recognizable e. g. by the cupshaped upper end of the stalk. It may be suggested that the figure 23 represents a globiferous or perhaps a rostrate pedicellaria; what the two other figures represent I feel unable to give a reasonable suggestion of, the fig. 22 especially seems quite enigmatic. — The miliary spines are of a rather characteristic form (Pl. XI. Fig. 38), the outer end is curved and rather thick, almost or quite smooth. — The spicules mainly as in *P. paradoxa*, only a little larger; the ring at the point of the foot is more developed, more like that figured of *P. Jeffreysi*.

It is well worth noticing that this species agrees rather closely with *P. paradoxa* (and *phiale*) as regards the tridentate and rostrate pedicellariæ, besides in the structure of the test; it can scarcely be doubted that they are rather nearly related, but the shape of the test and the fact that there are two pores in the ambulacral plates I. a. 1 and V. b. 1 show *P. carinata* to be the more primitive form.

Pourtalesia hispida A. Ag. is stated in the »Challenger» Echini (p. 136) to be nearly related to *P. Jeffreysi*, whereas later on (»Panamic Deep-Sea Echini» p. 141) Professor Agassiz is inclined to think it so distant from all the other species that it ought to form the type of a new genus. Unfortunately the structure of the plastron was not worked out in the »Challenger» Echini, and there is now no specimen in the British Museum with the plastron completely preserved. From what is preserved it seems, however, almost certain that this species agrees with *P. Jeffreysi* in the structure of the plastron. The labrum is very small and the two adjoining ambulacral plates very large, especially V. b. 1. It may further be noticed that the abactinal plates of the odd posterior interambulacrum are not so distinctly alternating as shown in Pl. XXII. Fig. 19 of the »Challenger» Ech., they are paired as in *P. Jeffreysi*, at least the posterior six pairs. In the shape of the test *P. hispida* reminds one rather much of *P. Wandeli*, as also the very conspicuous serial arrangement of the primary spines somewhat recalls that species. The primary spines are thorny as in *P. Wandeli*, but much shorter. Only one kind of pedicellariæ was found, viz. tridentate. (Pl. XI. Fig. 31). They agree with those of *Jeffreysi* and *Wandeli*, the apophysis ending far down on the sides of the blade, another feature speaking in favour of that relationship. They grow a little larger than in these species. In my preparation of pedicellariæ of this species I find a pair of globiferous and ophicephalous pedicellariæ resembling exactly those of *Urechinus Wyvillii*. Since the specimen examined was from St. 147, from which station likewise *Urech. Wyvillii* is recorded, I suppose that these pedicellariæ really belong to the latter species and have accidentally got between the spines of *Pourt. hispida*.

Pourtalesia ceratopyga A. Ag. The structure of the bivium of this species is unknown, but judging from the edge of the actinal invagination, as made known by Lovén, it may well be suggested that it will prove to have the bivial ambulacra uninterrupted as in *carinata*. The plastron is not preserved in any of the specimens in the British Museum. In a fragment from St. 299 I find two pores in the ambulacral plate V. b. 1, but not in I. a. 1. I may call attention to the fact that the abactinal plates of the odd interambulacrum are alternating, not paired as in *P. Jeffreysi*, as correctly figured by Agassiz and Lovén. The pedicellariæ are upon the whole well figured in the "Challenger"-Report, though no mention is made of them in the text. The forms figured there are globiferous, ophicephalous and tridentate. The globiferous pedicellariæ (figured in Pl. XLV. Fig. 56 as "a broad based, slender-pronged, and hooked pedicellaria") agree rather closely with those of *P. carinata*. The ophicephalous pedicellariæ (figured in Pl. XLII. Fig. 18, XLIII. Fig. 16 and XLV. Figs. 53—54 as "Clypeastroid-like pedicellariæ) differ from those of *P. Jeffreysi* in having more numerous teeth along the edge of the terminal widening, and these teeth continue along the "dorsal" side of the widening, whereas in *Jeffreysi* they are only found along the inner side. This feature is well shown on Pl. XLV. 53. — The pedicellaria figured in Pl. XLIII. 17 is said to be a "small Clypeastroid-like (ophicephalous) pedicellaria. This must, evidently, be a mistake; the long neck shows that it is no ophicephalous pedicellaria, this form of pedicellariæ being always devoid of a neck in the Irregular Echini. Probably it is a small tridentate pedicellaria like that figured in Pl. XLII. 20, only with the valves opened. The tridentate pedicellariæ occur in two forms; probably there will be found intermediate forms as in *carinata*, but I have not found such. The smaller form has simply leafshaped, more or less elongate valves, with the apophysis continuing into the edges, (figured in Pl. XLII. 19—20, XLIII. 15 and XLV. 59 as "large-headed" pedicellariæ); the end-tooth is only little prominent in the larger ones. The larger form (Pl. XLII. 17, XLV. 57—58) has very slender, narrow valves, ending in a rather short hook and with the edges serrate only near the point; this is a rather large form, the head reaching a length of ca. $0{\cdot}7^{mm}$.

Regarding *Pourtalesia rosea* A. Ag. it is stated in the "Challenger"-Echinoidea (p. 140) that "the tuberculation of this species, and the shape of the test, must have been very similar to that of *Pourtalesia ceratopyga*". In the British Museum are preserved only the anal snout represented in Pl. XXII. a. Figs. 3—5 and some very poor fragments connected with a genital organ; from these fragments alone it is certainly impossible to judge of the shape of the test — it seems even not very likely that they belong to one species. The figures given in the "Challenger" Ech. do not give a better proof of the shape of the test; the apical area figured in Pl. XXII. a. Fig. 6 with the large thin plates, showing distinct concentric striation, recalls much more the thin plated *Cystechinus clypeatus* than a species of *Pourtalesia*, and it still more resembles the apical system of *Sternopatagus* as pointed out by de Meijere (Op. cit. p. 163). (I have been unable to detect the apical system among the fragments preserved in the British Museum). I want to maintain that there is no proof in the description and figures given in the "Challenger"-Echinoidea, and neither is such proof afforded by the fragments preserved in the British Museum, that the apical system figured Pl. XXII. a Fig. 6 really belongs to the same species as that to which the anal snout figured in the same plate Figs. 3—5 belongs, and I for my part think it probable that this apical system does not belong to any *Pourtalesia* at all, no other species of this genus having a compact apical system. To be sure, Duncan states in his "Revision" (p. 282) that the apical system of *P. miranda* is compact like that of *P. rosea*, "as can most distinctly be seen on the Pl. XVIII. Fig. 9 of the "Revision of Echini". This figure, however, only shows four genital openings close together — it does not show anything of plates, especially of the posterior ocular plates. Until *P. miranda* has been rediscovered and carefully examined we may think it probable that its apical system is like that of *P. laguncula*, evidently its nearest relation. (Lovén. On Pourtalesia. Pl. VII. Fig. 52).

I have found two kinds of pedicellariæ in *P. rosea*, viz. ophicephalous and tridentate. The ophicephalous pedicellariæ (Pl. XI. Fig. 26) are rather large, with elongated, slender valves. The terminal widening is smaller and has fewer teeth than in *P. ceratopyga*. The tridentate pedicellariæ (only one form found) have simply leafshaped valves; the endtooth is a little prominent, the apophysis continues into the edges of the blade (Pl. XI. Fig. 15). I have noticed especially that the ophicephalous pedicellariæ were found on the fragment of the posterior end (— about the tridentate pedicellariæ I have forgot to notice that especially, so they may perhaps belong to the other fragments —); they are sufficiently characteristic for distinguishing this species from any other of the species hitherto known of this genus — and, evidently, it is the species represented by the anal snout-fragment which must keep the name *Pourtalesia rosea*, not that represented by the fragment with the apical system, which is probably no *Pourtalesia* at all. The affinities of *Pourtalesia rosea* must, of course, be left undecided, so long as we know almost nothing of its shape and structure of test[1].

Pourtalesia laguncula A. Ag. and *Tanneri* A. Ag. have been treated above (p. 67).

The question whether all the species referred to the genus *Pourtalesia* can rightly remain together in this single genus has repeatedly been treated. In the »Challenger»-Report (p. 132) Professor Agassiz comes to the result that all the species must remain in one genus, though the character of the test seems to indicate two natural groups (*P. ceratopyga* and *rosea* forming one group, the rest of the species another); in his last great work »The Panamic Deep-Sea Echini» he is inclined to think that »the striking differences found in the various groups of species of Pourtalesiæ would seem to warrant the splitting up of the genus Pourtalesia into subsections. We might retain the name of the genus, Pourtalesia, for the bottle-shaped types allied to *P. miranda*, such as *P. Tanneri*, *P. laguncula*, *P. Jeffreysi*, and form a section of the genus for the elongate *P. phiale* and another for the stout-tested *P. ceratopyga* and *P. rosea*. *P. hispida* may yet be found to belong to a special genus». (Op. cit. p. 141). Duncan (Revision. p. 285) excludes from the genus *P. miranda* and *rosea* on account of their compact apical system and their postero-lateral interradia being separated dorsally. — Neither Agassiz nor Duncan propose new generic names for the subdivisions. Pomel (Classification méthodique (324) p. 40) goes more radically to work. He divides the group into four genera. *Pourtalesia* is restricted to the species *miranda*, *hispida* and (?) *phiale*; a new genus, *Phyalopsis*, is established for *P. laguncula*, another genus, *Ceratophysa*, for *P. rosea* and *ceratopyga*, and a third genus, *Phyale*, for *P. Jeffreysi* and probably, *P. carinata*.

I cannot agree with any of these proposed divisions of the genus; especially those proposed by Pomel seem to me very unfortunate and quite in disaccordance with the natural relations of the species. Also Duncan's exclusion of *P. miranda* from the genus *Pourtalesia* is very unfortunate, first because it is the type species of the genus, and further because its apical system is, in all probability,

[1] De Meijere (Siboga-Ech. p. 169) finds the statement that the bivial ambulacra are in mutual contact only on the abactinal side (»so dass das Sternum höchstens von den benachbarten Ambulacren unterbrochen sein kann») in Duncan's remarks Op. cit. p. 281. As far as I can see this is not the meaning of Duncan, on the contrary, he probably means to say that in *P. rosea* and *miranda* there is no contact on the abactinal side between the two postero-lateral interradia. In any case no new information on the structure of these two species is given there by Duncan.

disconnected like that of *P. laguncula*. It is beyond doubt that in a restriction of the genus the name *Pourtalesia* has to be retained for the group of species to which *P. miranda* belongs. Thus far I agree with Agassiz, whose above cited proposition of a subdivision of the genus is evidently much more in accordance with the natural relations of the species than Duncan's and Pomel's subdivisions. Nevertheless I cannot fully accept Agassiz' subdivisions either.

On reviewing the characters of the species it seems to me that one feature may reasonably be taken to be of primary importance for a grouping of the species, viz. whether the bivial ambulacra are interrupted by the postero-lateral interambulacra or not. Also the shape of the test seems rather important, whereas pedicellariæ and spines seem to be of secondary importance. The character of the apical system, whether it is disconnected or compact, cannot be used, all the species thus far known having in fact a disconnected apical system [1].

The bivial ambulacra are continuous in *carinata* (almost certain!), *phiale*, *paradoxa* and probably *ceratopyga*, disconnected in the other species (*P. rosea*, *hispida* and *miranda* are unknown in this respect, but the two latter may well be supposed to have them disconnected). Further it is to be remarked that *P. carinata* differs from all the other species in having two pores and tube-feet in the ambulacral plates I. a. 1 and V. b. 1. (*P. rosea* and *miranda* again are unknown in this respect, though the latter may doubtless be supposed to have the pores single as in *laguncula* etc.). Finally it may perhaps be a character of some importance whether the dorsal plates of the odd posterior interambulacrum are paired or alternating, the latter being, of course the more primitive structure; they are alternating in *P. carinata* and *ceratopyga*, paired in *Jeffreysi*, *Wandeli*, *hispida*, *laguncula*, *Tanneri*, *phiale* and *paradoxa*. Upon the whole this character evidently cannot, however, be taken too rigorously, the paired plates generally showing more or less distinct traces of their originally alternating condition. In typical examples the difference between these structures is very conspicuous, as seen e. g. by a comparison of Figs. 51 and 52. Pl. VII in Lovén's: On Pourtalesia. In accordance with the characters pointed out here as the more important, I think the following grouping of the species will prove to be the natural one:

1. Bivial ambulacra continuous; two pores in the ambulacral plates I. a. 1 and V. b. 1. Test not especially widened or elongate. Dorsal plates of odd interambulacrum alternating. . . . . *P. carinata.*
2. Bivial ambulacra continuous; one pore in the plates I. a. 1 and V. b. 1. Test very elongate; dorsal plates of odd interambulacrum paired. . . . . . *P. phiale* and *paradoxa.*
3. Bivial ambulacra (probably) continuous; one pore (sometimes two) in the plates I. a. 1 and V. b. 1. Dorsal plates of odd interambulacrum alternating. Test much widened anteriorly. . . . . *P. ceratopyga.*
4. Bivial ambulacra disconnected; one pore in the plates I. a. 1 and V. b. 1. Dorsal plates of odd interambulacrum paired. Test not especially widened or elongated. . . . . *P. laguncula*, *miranda* (?), *Tanneri*, *Jeffreysi*, *Wandeli* and *hispida.*

Unknown: *P. rosea.*

[1] Whether the genital plates be separate or not, seems to be a character of small importance, since both cases may occur in the same species. Likewise the presence or absence of the labrum is of small importance, as shown by its great variation in *P. Jeffreysi* and *Wandeli.*

If we take these four groups to represent genera, or at least subgenera, which seems not at all unreasonable, the latter group must keep the name *Pourtalesia*. Of the names proposed by Pomel two become synonyms only of *Pourtalesia*, viz. *Phyalopsis* (for *lagunculu*) and *Phyale* (for *Jeffreysi*). Only the name *Ceratophysa* may be retained; *P. rosea* is named as the first species of this genus, but the diagnosis is made from *ceratopyga*. The latter species must then be taken as the genotype. For the two other groups I may propose the names: *Helgocystis* and *Echinosigra*.

The old genus *Pourtalesia* is thus divided into four genera (or subgenera), viz.:

Helgocystis n. g. with the species *carinata* (A. Ag.).

Echinosigra n. g. with the species *phiale* (W. Th.) (genotype) and *paradoxa* (Mrtsn.).

Ceratophysa Pomel with the species *ceratopyga* (A. Ag.).

Pourtalesia A. Ag. with the species *miranda* A. Ag. (genotype), *laguncula* A. Ag., *Tanneri* A. Ag., *Jeffreysi* W. Th., *Wandeli* Mrtsn. and *hispida* A. Ag.

Perhaps the species *Jeffreysi*, *Wandeli* and *hispida* may yet prove to form a separate genus, which would then get the name *Phyale* Pomel.; for the present, however, it seems not necessary to separate these species from the genus *Pourtalesia*, though it must be conceded that they form a distinct group in that genus, differing from the other species in the shape of the test. *P. Tanneri*, however, is in some way intermediate between the two groups (by its narrow anal snout). That it should be necessary to make *P. hispida* the type of a separate genus there is no reason to suppose.

Spatagocystis Challengeri A. Ag. has been very carefully worked out, especially in the »Panamic Deep-Sea Echini» (p. 141), as regards the structure of the test. Three kinds of pedicellariæ have been figured in the »Challenger«-Report (Pl. XLII. 10—12 and XLV. 39—43), though — as is mostly the case in that work — not mentioned in the text. I have found (on specimens examined in the British Museum) two kinds of pedicellariæ, viz. tridentate and rostrate. Further I find in my preparation a single globiferous and an ophicephalous pedicellaria resembling exactly those of *Urechinus Wyvillii*. As the specimens examined proceed from St. 147 from which station also *Urech. Wyvillii* is recorded, I think these pedicellariæ do really belong to that species, having only accidentally got between those of *Spatagocystis*. The tridentate pedicellariæ are richly developed, occurring in at least two different forms, viz. one with simply leafshaped, more or less slender valves with the apophysis continuing into the edge of the blade (Pl. X. Fig. 20 represents a small specimen of the slender form; larger specimens are rather similar to those of *Echinocrepis cuneata*), and another with rather short, broad valves, narrowed in the lower part of the blade and terminating in a more or less prominent hook (Pl. X. Fig. 10); this is evidently the form figured in the »Challenger«-Report Pl. XLII. 10 and Pl. XLV. 39—40 as a »large-headed» pedicellaria. I have not found so much meshwork in this as figured in the Pl. XLV. 40 of the »Challenger»; there is often nothing at all. The form figured in Pl. XLII. 12, evidently another form of tridentate pedicellariæ, I have not seen. The rostrate pedicellariæ, figured as »short-headed, toothed, cup-pronged» pedicellariæ (Pl. XLII. 11 and XLV. 41 and 43), are of a quite typical form, with the outer edge of the rather short and broad blade provided with ca. 10—16 thick teeth (Pl. X. Fig. 18); the edge of the basal part is generally closely serrate, though not always so regularly as in the specimen here figured. The stalk is more or less thorny (Pl. X. Fig. 35). — There is a very distinct calcareous cap in the point of the tube-feet (Pl. VII. Fig. 17), though not formed by one plate. The spicules are of the usual form, lying in two close longitudinal series.

Echinocrepis cuneata A. Ag. In this species the bivial ambulacra are evidently uninterrupted (Chall.-Ech. Pl. XXXV. a. 10), as is also pointed out by de Meijere (Siboga-Ech. p. 168). In Pan. Deep-Sea Ech. p. 147 Agassiz states that the arrangement of the actinal plates of *Echinocrepis cuneata* is, according to Lovén (Pourtalesia. Pl. VII. Fig. 53), much like that of *Spatagocystis Challengeri* .... which seems to mean that the bivial ambulacra are interrupted by the interambulacra 1 and 4. This can, however, not be deduced from the small fragment figured by Lovén, and the figure from the Chall.-Ech. quoted above does not seem to be so very incorrect, as it would be, in case the species really agreed with *Spatagocystis* in this respect. Also Lovén states expressly (p. 17) that he considers *Echinocr. cuneata* to differ in a marked manner from *P. Jeffreysi, laguncula* etc. in having the bivial ambulacra uninterrupted. Unfortunately the specimen in the British Museum does not afford any solution of the question, the plastron not being preserved. The apical system[1] is compact, the postero-lateral (bivial) ambulacra not being separated from the rest of the apical system through intercalated plates, as has been shown by Lovén (On Pourtalesia. Pl. VII. Fig. 54); I may further point out the fact that the dorsal plates of the odd interambulacrum are not paired, but alternating (as seen in this same figure) evidently a more primitive condition. Of pedicellariæ I have seen only one kind, viz. tridentate. The small ones are of the common simple leafshaped form, with the apophysis continuing into the edges of the blade; the larger form is figured in the Challenger-Report Pl. XLV. Fig. 44, I have only to add that generally there is a wingshaped keel along the dorsal side of the blade (Pl. X. Fig. 39). The spicules are rather numerous, simple or triradiate.

Echinocrepis setigera A. Ag. differs from *E. cuneata* in several important features. The bivial ambulacra are interrupted on the actinal side by the postero-lateral interambulacra, and the apical system is disconnected. I have found three kinds of pedicellariæ (on some small fragments examined in the U. S. National Museum), viz. tridentate, rostrate and ophicephalous. The tridentate pedicellariæ are of the common form, with simple leafshaped valves (only a small specimen seen). The rostrate pedicellariæ (Pl. X. Fig. 12) are more or less elongate, the outer edge finely serrate. (Perhaps this form is not really the rostrate, but another kind of tridentate pedicellariæ.) The ophicephalous pedicellariæ (Pl. X. Figs. 3, 33) are somewhat smaller and more longstalked than usual; otherwise they do not differ

[1] Agassiz (Panamic Deep-Sea Ech. p. 131) says that »the plates of the apical system of *Echinocrepis* are not as they have been described by de Meijere; those of the bivium are well separated by the posterior lateral interambulacra from those of the trivium. There are the two posterior ocular plates, and the anterior ones are ankylosed, the oculars of the trivium being lost and occupied by the madreporite. (Pls. 67. fig. 2; 69, figs. 3, 4)». Quite apart from the fact that Agassiz here is in evident contradiction to his own statement (p. 146) that in *Echinocrepis setigera* »the ocular plate can only be traced in the odd anterior ambulacrum. In the crowding due to the intrusion of the intercalated and interambulacral plates between the bivium and the trivium they (— evidently the other ocular plates —) have been pushed out of place or resorbed», it may be stated that de Meijere's description (Siboga-Ech. p. 162) is quite correct, his description being based on Lovén's Figure 54. Pl. VII (On Pourtalesia), as expressly named, and it is *Echinocrepis cuneata* whose apical system is described, as is also expressly said, not *E. setigera*, to which Agassiz refers. Further de Meijere remarks (p. 164) »Nach Agassiz' Figur (viz. Pl. XIII. 1 of the Prelim. Report on the »Albatross«-Echini) scheint die von der »Albatross«-Expedition erbeutete *Echinocrepis setigera* auch ein ebensolches, aus einander gerücktes Apicalsystem zu besitzen, wie *Spatagocystis* u. s. w. und würde sich somit von *E. cuneata* scharf unterscheiden«. De Meijere's description of the plates of *Echinocrepis* is thus quite correct.

essentially from those of other Pourtalesiæ[1]. — These differences in the pedicellariæ are certainly not very important, and probably *Ech. cuneata* will also prove to have both ophicephalous and rostrate pedicellariæ. The more important are the differences in the apical system and the bivial ambulacra, so important, indeed, that it seems quite unnatural to unite the two species in one genus. I think it necessary to create a new genus for *setigera*, for which I may propose the name **Cystocrepis** n. g. Also the difference in the shape of the test is very conspicuous, though perhaps not reliable for a generic character.

Regarding the systematic position of the family *Pourtalesiidæ* I quite agree with de Meijere, who has in a most skilful manner discussed the whole question («Siboga»-Ech. p. 160—71); it seems to me that he has shown beyond doubt that the *Pourtalesiidæ* represent a very special development from the *Ananchytidæ*, the highly interesting genus *Sternopatagus* being in many respects a transitional form between the *Pourtalesiidæ* and the *Ananchytidæ*, though already decidedly belonging to the former family. (I can not agree with Agassiz, who thinks *Sternopatagus* more related to the *Ananchytidæ* whereas, on the other hand, he refers the genus *Plexechinus* — in my opinion undoubtedly an Urechinid — to the *Pourtalesiidæ*).

It is Lambert's merit to have first emphasized (in his excellent «Études morphologiques sur le plastron des Spatangides»)[2] that the difference between the meridosternous and the amphisternous structure of the plastron in the Spatangoids is of primary systematic importance, so that the whole of the recent Spatangoids may be divided into *Meridosterni* and *Amphisterni*, names given by Lovén, who did not, however, clearly point out the importance of these different structures, which he had detected. The two types cannot be derived one from the other, but must have derived from forms with a simple, unmodified structure of the odd interambulacrum, something like what is found in *Dysaster* and the *Cassidulidæ*. To be sure, Agassiz (Pan. Deep-Sea Ech. p. 164) thinks that Lambert «has himself given us the best possible proof of the accuracy of Lovén's view of the development of the amphisternal from the meridosternal plastron. The development of the adult amphisternal Abatus from a meridosternal young (Pl. 99. 1—5, 8) seems to settle this question in favour of Lovén's view». But, as is easily seen, the young *Abatus* represented in Pl. 99. 3 does not show the slightest trace of a meridosternous structure, both the plates 5. a. 2 and b. 2 being in wide contact with the labrum, whereas the meridosternous structure, as is well known, means that only one plate (b. 2) is in contact with the outer end of the labrum. The specimen figured by Agassiz might perhaps be said to have as yet no sternum developed, the plates 5. a. 2 and b. 2 being rather small, though distinctly larger than the following ones. At most this stage can show that the amphisternum is derived from a primitive structure, where no sternum is developed as yet; in this way Lambert[3] refers to the figure of a young *Palæopneustes cristatus* in the «Blake»-Echini (Pl. XXI. 11) as showing «comment on doit comprendre le développement amphisterne du plastron, qui procède d'un état originaire où les plaques sont semblables dans toutes les aires interradiales, comme chez les Cassidulides».

[1] Whether it is the ophicephalous pedicellariæ, which «are brilliant glassy heads standing out like miniature spheres on the dark test» (Pan. Deep-Sea Ech. p. 147) I dare not say.

[2] Bull. Soc. de l'Yonne. 1892.

[3] Note sur quelques Échinides crétacés du Madagascar. Bull. Soc. Géol. de France, 3. Ser. 24. 1896. p. 323.

In the last named paper by Lambert he evidently does not lay so much stress on these two different types of plastron since he places the typical meridosternous *Menuthiaster* in his family *Acropidæ* which otherwise comprises forms with the plastron »plus ou moins developpé, et dans le premier cas toujours amphisterne«; he considers the genus *Menuthiaster* as »une forme profondément modifiée, avec tendance au retour vers un groupement homogène des assules interambulacraires et dont la disposition exceptionellement méridosterne n'a qu'une importance relative, incapable de prévaloir contre l'ensemble des autres caractères, notamment le groupement des plaques apicales« (p. 323). This leads us to consider more closely the systematic value of the characters afforded by the apical system in the *Meridosterni*. I may then recall the differences occurring among the *Pourtalesiidæ* with regard to the apical system: disconnected in the *Pourtalesia*-species; compact in *Echinocrepis cuneata*, disconnected in *Ech. setigera*; compact in *Sternopatagus*, disconnected in *Spatagocystis*. Even if it is scarcely correct to admit species with compact and with disconnected apical systems into the same genus (for which reason I have made *Echinocr. setigera* the type of a new genus, see above p. 84), nobody will doubt that all these genera are very nearly related, and are rightly referred to the same family[1]. — Even among specimens of the same species there may occur rather great differences in the structure of the apical system — see e. g. the two figures of apical systems of *Urechinus naresianus* given by Agassiz (Pan. Deep-Sea Ech. p. 156. Figs. 226—27). There can thus be no doubt that the apical system is of comparatively little systematic importance among the *Meridosterni*, and it seems to me very irrational to place the meridosternous *Menuthiaster* among the amphisternous »*Aëropidæ*« on account mainly of its apical system, the more so as it differs, indeed, only very little from the normal structure thereof in the *Ananchytidæ*. Likewise the fascioles are of comparatively small systematic importance among the *Meridosterni* — I may recall e. g. the subanal fasciole of *Stereopneustes*, the marginal fasciole of *Calymne*, and the fact that in *Urech. naresianus* some specimens have a subanal fasciole, while other specimens show no trace thereof.

It seems then beyond doubt that the meridosternous and the amphisternous structure of the plastron is the primary systematic character among the higher Spatangoids. On grouping the genera accordingly, we get in the group of the *Meridosterni*: the *Ananchythidæ* (or *Echinocorythidæ*), *Urechinidæ* and *Pourtalesiidæ*, in the group of the *Amphisterni*: the rest of the *Spatangidæ*. (I cannot here enter on a discussion of the families of the *Amphisterni*). It is at once seen that these two main groups are very natural, another sign of the correctness of using the structure of the sternum as the principal character.

Without giving detailed diagnoses of the families of *Meridosterni* I may point out what to me appear their main characters. In the *Urechinidæ* the second plate of all the interambulacra is a single plate — probably not the result of the fusion of the plates a. 2 and b. 2, as thought by Lovén, but of a »meridosternous« arrangement of these plates in all the interambulacra, as thought by Lambert[2]. The *Urechinidæ* thus represent a separate branch from the *Ananchytidæ*, characterized by the

[1] Agassiz, it is true, doubts that *Sternopatagus* is really a Pourtalesiid, but — in my opinion — without sufficient reason. Gregory (in Ray Lankester's Treatise on Zoology. III. p. 321) places *Echinocrepis* and *Spatagocystis* in the family *Spatangidæ*, even in two different sections, whereas *Pourtalesia* is kept as a distinct family. This classification is, indeed, so absurd, that it needs no refutation.

[2] In the great Monograph of *Echinocorys* (Mém. Mus. d'hist. nat. de Belgique. II. 1903) p. 26 Lambert says: »en réalité, je ne crois pas que le système périsomatique interradial des Echinides comporte une seule plaque double, pas même

single plate 2 of the anterior interambulacra and by the simple pores. The figure of *Offaster corculum* given by Lovén (On Pourtalesia. p. 92) is highly interesting as showing the beginning of such an arrangement in the antero-lateral interambulacra; this form does undoubtedly show us the way from the *Ananchytidæ* to the *Urechinidæ* — also the pores are very small and the ambulacral plates high in this form, characters pointing towards the *Urechinidæ*, but the pores are, however, double as in the true *Ananchytidæ*.

The *Pourtalesiidæ* evidently form another separate branch from the *Ananchytidæ*, with which they agree in having the second plate in the antero-lateral interambulacra paired. The main character of this family otherwise is the oral invagination of the anterior ambulacrum with the structural features of the actinal part of the test resulting therefrom, and the vertical position of the peristome. The homoiopodous condition of the tube-feet can no longer be regarded as a family character, since *Sternopatagus* is shown to have penicillate actinal tube-feet like the *Urechinidæ* and *Ananchytidæ;* but the simple or even quite rudimentary pores afford another good distinguishing character between this family and the *Ananchytidæ*, in which the pores are double. Whether we have to seek the transitional forms between the *Ananchytidæ* and the *Pourtalesiidæ* in such forms as *Infulaster*, *Hagenowia* or *Stegaster* I dare not have any definite opinion, being too little acquainted with these genera; but as far as I can see it is rather probable. In any case the Urechinids cannot be regarded as ancestral forms of the Pourtalesiæ; the single plate 2 in the antero-lateral interambulacra is alone a sufficient proof that there cannot be a direct genetic connection between these two families.

The genus *Calymne* cannot be referred to either of the two families named, differing from the *Urechinidæ* in having the plate 2 of the anterior interambulacra paired, from the *Pourtalesiidæ* in having no oral invagination and from the *Ananchytidæ* in having simple pores. It must then, evidently, form a separate family, **Calymnidæ.** Whether the marginal fasciole is a family-character it is impossible to decide, as long as this form is the only one known of the family; but judging from the other families it will scarcely be more than a generic character.

The genus *Pilematechinus* would be exceedingly interesting, in case the structure of its plastron were really as figured and described by Agassiz in the Panamic Deep-Sea Echini ; it would then be a living representative of the forms in which the plastron is still in the primitive condition, known in the *Collyritidæ* and *Cassidulidæ*, and from which the meridosternous and amphisternous plastron are later developments. *Pilematechinus* would then be the most primitive of the recent *Spatangoidea*. It can, however, scarcely be doubted that *Pilematechinus* is a true meridosternous form, belonging to the *Urechinidæ*, the plate interpreted by Agassiz as the labrum being in fact two plates, a short labrum followed by a larger sternum. — A feature of great interest in *Pilematechinus* is that it has comparatively well developed auricles; this evidently points towards the *Gnathostomata*, viz. the *Holec-*

le labrum». This would involve the incorrectness of all the cases of Heteronomy in the Interambulacrum 1 in the *Spatangidæ*, pointed out by Lovén. Though I cannot follow Lovén in all these instances, I think that in many of them Lovén's interpretation of the larger plates as being fused from two or three is quite correct. That the labrum is really a single plate I most decidedly agree with Lambert, and I suppose that I am likewise in accordance with Lambert in rejecting his previous view (Études morph. sur le plastron des Spatangides. p. 63, 72), that in the *Spatangidæ* the labrum should be considered «comme une pièce complexe formée par la soudure intime de divers éléments empruntés aux deux séries des assules constitutives de l'interradium impair», viz. composed of the two (theoretical) plates a. 1 and b. 1 and further of the plates a. 2 and b. 2, the great sternal plates being thus really a. 3 and b. 3.

typoidea, among which the ancestors of both Spatangoids, Cassidulids and Clypeastrids undoubtedly must be sought for. The Holectypoidea again must be derived from the *Diademina* (or perhaps from the Echinothurids (*Streptosomata*)), as must be concluded alone from their perforate and crenulate tubercles.

Gregory (Op. cit.) divides the *Atelostomata* into the two suborders *Asternata (Echinoneidæ, Nucleolitidæ* and *Cassidulidæ)* and *Sternata (Collyritidæ, Echinocorythidæ, Spatangidæ, Palæostomatidæ* and *Pourtalesiidæ).* To this must be objected — apart from the position of the *Pourtalesiidæ* — that the *Collyritidæ* are really asternous. Since the *Collyritidæ* evidently cannot be referred to his suborder *Asternata*, their relation being decidedly with the Spatangoids, I think we must let them rank as a distinct suborder besides the *Amphisternata* and *Meridosternata*: I propose to name this suborder **Protosternata.**

In my view the ancestral history of the Irregular Echinoids may then shortly be comprised as follows. The *Holectypoidea*, which are derived from the *Diademina*, develop into three separate main groups: the *Clypeastroidea, Cassiduloidea* and *Spatangoidea*. In the former the masticatory apparatus undergoes a further development, in the two latter groups it becomes lost. Leaving out of consideration the *Clypeastroidea* and *Cassiduloidea* we may follow the third branch, the *Spatangoidea*. From the more primitive forms of this group, represented by the *Collyritidæ*, two separate main branches have developed[1], each characterized by their peculiar structure of the plastron, in one meridosternous, in the other amphisternous. The *Meridosternata* develop through the *Ananchytidæ*, of which the genus *Stereopneustes* is the only known living representative, into three separate branches, the *Urechinidæ*, the *Calymnidæ* and the *Pourtalesiidæ*. The *Amphisternata* I cannot here follow in a more detailed manner, having not yet had occasion to study them all very closely; but I think it beyond doubt that the more primitive forms are those included by Lambert and Agassiz in the families *Aëropidæ* and *Palæopneustidæ*, together with the *Palæostomatidæ*, the more specialised forms being such as *Spatangus, Brissus* etc.

To seek for transitional forms between the Pourtalesiæ and the more primitive amphisternous forms is, so far as I can see, rather absurd. The Pourtalesiæ are so far from being "embryonic Spatangoids"[2] that they must be regarded as the most specialized branch of the whole group, in which the development has been carried out to such extremes that it may be hard enough to see the accordance with the general rules of the echinoid structure. In the "Challenger"-Echinoidea (p. 130) Agassiz finds "the affinities developed in so many directions in the group of Pourtalesiæ (is) one of its most interesting features", tracing its relationship "to the Brissina, and to such genera as *Hemiaster, Echinocardium, Lovenia* and the like through *Aërope, Aceste* and *Cionobrissus*", further "to the Spatangina proper through such genera as *Palæotropus, Genicopatagus* and *Homolampas*, and again to the Galeritidæ and Echinolampadæ through such genera as *Urechinus* and *Cystechinus*", besides "the many-sided affinities ..... to the Ananchytidæ, Dysasteridæ, and such genera as *Cardiaster, Holaster, Toxaster* and the like". Also to the Clypeastroids the Pourtalesiæ are said to show affinities, viz. "in the simple actinostome and in the structure of some of the pedicellariæ" (Op. cit. p. 129. Note),

[1] I do not mean to say that they have developed directly from the *Collyritidæ*; the real ancestor of the *Meridosternata* and *Amphisternata* must have had a simple, not disconnected apical system.

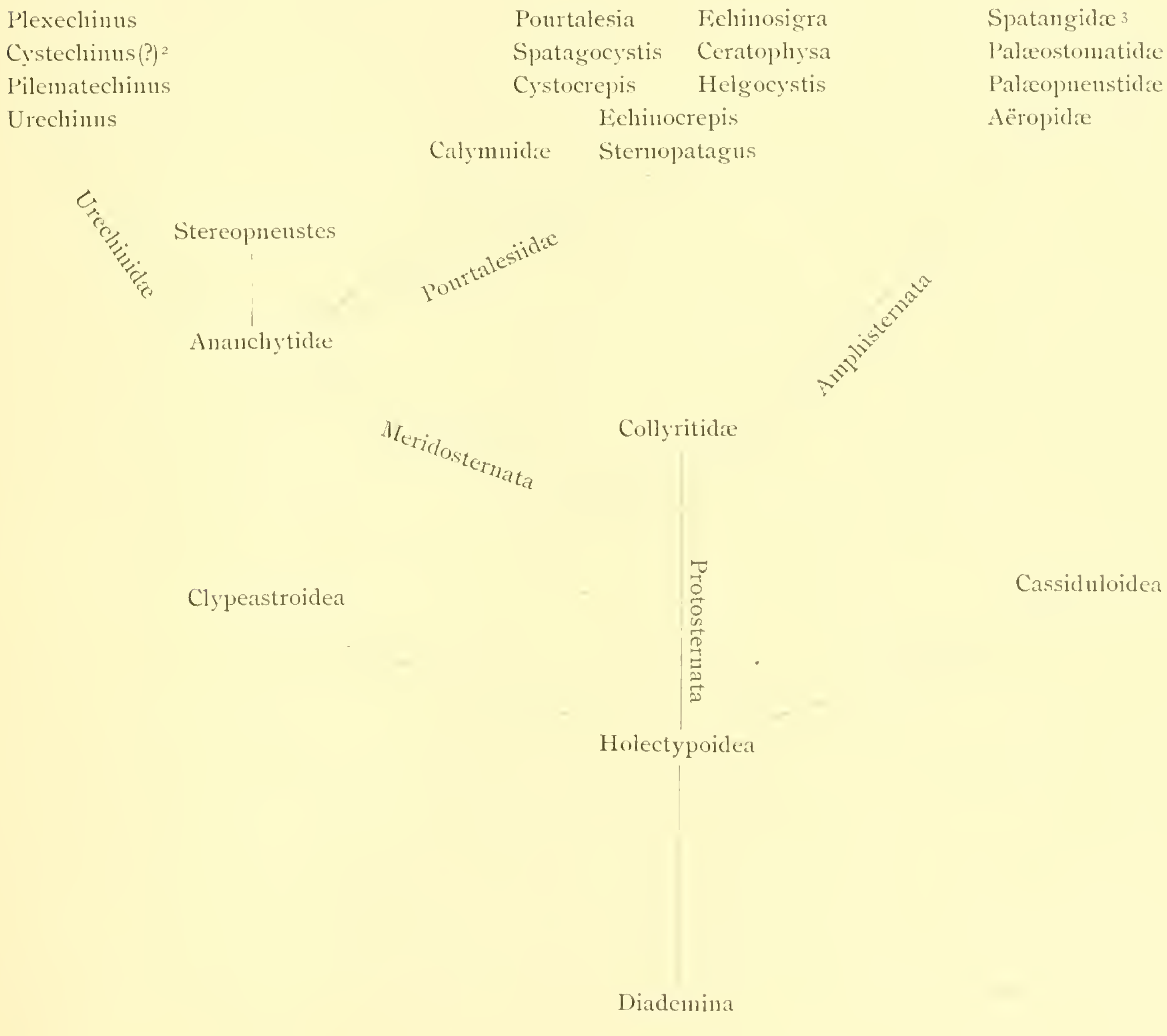
[2] Rev. of Ech. p. 347. The expression is, strictly speaking, used only of *Infulaster* and the *Ananchytidæ*.

and even to the *Echinidæ* and *Echinometridæ* they seem to show affinities, viz. through their »large headed (tridentate) pedicellariæ (Op. cit. p. 132). — In the »Panamic Deep-Sea Ech.» p. 150 Professor Agassiz finds it »interesting to trace the changes between Pourtalesia proper with its bottle-shaped outline, deeply sunken actinal and anal grooves, its well developed anal proboscis, and such a type as Plexechinus, in which the Pourtalesian features have almost disappeared, to pass into a more Ananchytid type, represented by Urechinus and Cystechinus. In the further development the rudimentary phyllodes and labium become specialized in Genicopatagus, Argopatagus and Homolampas. Next Ananchytid petals like those of Paleopneustes, Linopneustes lead us gradually to the petaloid type of the recent Spatangoids». — On p. 173 it is stated for *Argopatagus* that »the fact that the second plates of the posterior zone of the posterior lateral ambulacra almost separate the labium from the sternum as in Plexechinus ..... is an indication of the affinities of the genus to the Pourtalesiæ».

Agassiz thus evidently seems to consider the Pourtalesiæ as the centre from which all the other Irregular Echinoids have developed; that the group itself has developed from one of those named does not seem to be the meaning of the famous Echinologist — the Pourtalesiæ are evidently regarded as »embryonic» forms, which have given rise to all the different groups, to which the affinities are pointed out, since the »affinities» probably must mean real genetic relationship. I think I need not here point out in a more detailed manner that the more prominent characters of the Pourtalesiæ are highly specialized, not at all embryonic. But Professor Agassiz does not seem to take into consideration that the different characters are not of the same value; structural characters of the highest systematic importance and irrelevant, vague resemblances are regarded as equivalent criteria of relationship. (Comp. my remarks on this theme in the Echinoidea of the Danish Siam-Exped. p. 50.)

Also *Urechinus naresianus* is held by Agassiz (»Blake»-Ech. p. 52) to be a representative of the oldest Spatangids, »leading us little by little to Spatangoid genera in which the ambulacra become more or less petaloid, as in Homolampas, Paleopneustes and the like, till we get the modern type of Spatangus proper, with well defined petaloid ambulacra and a highly developed subanal fasciole» etc. It is evident that the quite rudimentary abactinal tube-feet and pores in *Urechinus* is a highly specialized feature, which may possibly give rise to further stages in which these tube-feet and pores completely disappear; but it is rather inconceivable how these rudimentary pores and tube-feet, which doubtless represent a reduction from the more primitive condition, where the pores were double and the tube-feet well developed, should again give rise to petaloid structures with large, double pores and well developed tube-feet. Also the fascioles have doubtless developed separately in several groups — in the same manner as the polyporous condition of the ambulacra among the *Echinina*. — The same objections may be made against regarding *Calymne* as holding »an intermediate position between the Pourtalesiæ proper and such genera as Paleopneustes and Palæotropus», and against finding in *Cystechinus (Urechinus), Pourtalesia* — and »the allied genera *Palæotropus, Neolampas* and the like» a proof of »the affinities of the Spatangoids with the Echinolampadæ». (»Chall.»-Ech. p. 148). — Upon the whole I cannot join Professor Agassiz when expressing his joy of »how the structure of so many of the Spatangoid forms is satisfactorily explained by the different genera of Pourtalesiæ collected by the »Challenger» and how greatly the knowledge of the members of this family has helped us to understand the true relationship not only of many aberrant groups of Spatangoids, but also their relationship to the Clypeastroids and Echinolampadæ». (Chall.-Ech. p. 148).

I give here a graphic representation of the mutual relationship of the Spatangoids, as I understand it. It will be seen that my view of the *Meridosternata* is in rather close accordance with that represented in the tabular view of the *Meridosterni* given by Lambert.[1] I may notice expressly that it is not meant as a genealogical tree of the genera. As for the families, I do not doubt that they have really been derived from one another in the direction here indicated.



[1] Études morph. sur le plastron des Spatangides. As for Lambert's remark (Op. cit. p. 93) that the Pourtalesiæ must form a small separate family »reliée par *Urechinus* aux vrais *Ananchytidæ* et rattachée aux *Spatangidæ* par *Palæotropus* et *Physaster*», I must refer to the above remarks against seeking transitions between the Pourtalesiæ and the Amphisternata. Lambert is here, evidently, in disaccord with the views otherwise expressed throughout that excellent paper.

[2] This genus is quite insufficiently known and possibly does not really belong to this family. (Comp. above p. 46, 49).

[3] Sensu latiori, comprising *Spatangina*, *Brissina* etc.

Suborder **Amphisternata.**

Fam. **Spatangidæ.**

It may be expressly stated that by including here in the family *Spatangidæ* all the genera mentioned in the following, viz. *Aëropsis, Hemiaster, Schizaster, Spatangus, Echinocardium* and *Brissopsis*, besides some few others, as *Aceste, Periaster* which I have taken the opportunity to discuss, I do not mean to maintain that all these genera do really belong to one and the same family. It is only a provisional arrangement; so long as I have not studied more carefully all the recent genera of Amphisternous Spatangoids, or at least so many of them as are available for me, I do not want to give my view of their classification. I hope to be able to do so in Part II of the Siam-Echinoidea.

Aëropsis nom. nov.

The name *Aërope* by which Wyv. Thomson designated the curious Spatangoid described by him in »The Atlantic« I. p. 381 was preoccupied and thus cannot be kept for the Spatangoid. It was first used by Leach, though only as a Manuscript name, *Aërope bidens*, for a crab of the genus *Macrophthalmus* Latr. (*Macr. parvimanus* Latr.).[1] Later on, in 1860, it was employed by Albers for a pulmonate Gastropod of the Fam. *Helicoidea* (*Aërope caffra*; South Africa)[2]. It is thus beyond doubt that the Spatangoid named *Aërope* in 1877 must have another name. I therefore propose the name *Aëropsis*, which recalls the old familiar name so much that this change of name can scarcely give much trouble.

25. **Aëropsis rostrata** (Wyv. Thomson).

Pl. V. Figs. 8—10, 15, 20, 22. Pl. XV. Figs. 1—2, 5, 8, 13, 19—21, 29, 37, 40, 43, 52.

Synonym: *Aërope rostrata* Wyv. Thomson.

Literature: A. M. Norman: Crustacea, Tunicata, Polyzoa, Echinodermata etc. Biology of the »Valorous« Cruise 1875. Proc. Royal Soc. 25. 1876. p. 211. — Wyv. Thomson: The Atlantic. I. p. 381. Fig. 99. — A. Agassiz: »Challenger«-Echinoidea. p. 192. Pl. XXXIII. Figs. 6—13, XXXIII. a. 8—12, XXXIX. 23, XLI. 7—8. (Non.: Pl. XXXIII. 1—5.) — Verrill: Results of the Explorations made by the Steamer »Albatross« off the Northern Coast of U. S. in 1883. (426). p. 539.

In his description of this species Professor Agassiz points out that his specimens differ considerably in outline, as is also very well seen in the figures given on Pl. XXXIII of the »Challenger«-Echinoidea. Nevertheless he does not regard them as different species, and in his recent work »The Panamic Deep-Sea Echini« (p. 194) it is maintained that the differences in outline of the specimen(s) figured on the Pl. XXXIII of the »Challenger«-Echinoidea are all »compatible with differences due to

[1] List of specimens of Crustacea in the British Museum. 1847. p. 37.
[2] Tryon: Structural and systematic Conchology. 1884. III. p. 18.

age». This, indeed, seems highly improbable.[1] The smaller specimen (20^{mm}) has its genital pores well developed, and thus cannot be regarded as a quite immature specimen. But a change so enormous as would be necessary to make the short form like the elongated during its growth from a size of 20^{mm} to 43^{mm} would be quite unparalleled among Echinoids — and that change should even take place after the animal had become sexually ripe. Adding hereto that the smaller, short form is from the Atlantic, whereas the large, elongated form proceeds from the Arafura Sea (Kee Islands, »Chall.« St. 191); that the latter closely resembles the pacific species *A. fulva*, and further that a specimen of 34^{mm} length from the »Ingolf« agrees with the short form in the shape of the test, we may safely conclude that the elongated form figured in the »Challenger«-Echinoidea is not *A. rostrata*; if it is identical with *A. fulva* is not so certain, perhaps it will prove to be a new species. (Comp. below p. 94).

The specimens from the »Ingolf« agree very closely in the shape of the test with the figures given by Wyv. Thomson and with the figures of the short specimen given in the »Challenger«-Echinoidea; there can thus be no doubt of their identity with *A. rostrata*, except in case there should turn out to be more than one species among the short forms. Also the locality agrees: the specimens of the »Ingolf« were taken in the Davis Strait, the type-specimen of Wyv. Thomson between Cape Cod and Cape Hatteras (»Chall.« St. 45).[2] The locality where it was taken by the »Valorous«-Expedition (59° 10′ Lat. N. 50° 25′ Long. W. 1750 fathoms), is also in the Davis Strait, and rather near the »Ingolf«-stations.

The largest of the specimens taken by the »Ingolf« is 34^{mm} long, 17^{mm} broad and 18^{mm} high. Another specimen is 25^{mm} long, 12^{mm} broad and 13^{mm} high. (Pl. V. Figs. 8—10, 15, 20, 22.) — Concerning the shape of the test it is to be remarked that it is a little compressed in the posterior part, the actinal plastron forming a slight keel. The front end is, as pointed out by Wyv. Thomson and Agassiz, rather abruptly cut; but the anterior edge forms a narrow, almost vertical ridge whose lower corners are rather prominent. Along the lower edge of this ridge the fasciole passes. The anterior ambulacrum is somewhat deepened almost down to the vertical ridge; only the plates in this deepened part carry large tube-feet. According to Agassiz (»Chall.« p. 194) »the posterior extremity turns upwards« (in the short form). In his figures that is not seen very distinctly, to say the least, and in my specimens I do not see it either. Perhaps this ought to have been said of the large specimen; in *A. fulva* it is a distinct feature, as shown by Agassiz in his »Panamic Deep-Sea Echini«, Pl. 61. 3; — on this occasion (p. 194) it is otherwise stated that »the posterior extremity of *A. rostrata* slopes quite gradually to meet the rounded anal extremity«.

Fig. 15. Apical system of *Aëropsis rostrata*.

The apical system is described as »compact, the madreporic body occupying the greater part of the inner edges of the anterior genital plates and of the eight posterior plates«. This would give a composition of the apical system of no less than eleven plates, which is evidently wrong, 9 plates, as is well known, being the usual number of plates in the apical system

[1] Duncan evidently also doubted the identity of the two forms, as appears from his remark: »It is very important that separate descriptions of the specimens from Davis Straits and the remote Arafura Sea should be presented to science«. (Revision. p. 272).

[2] »The Atlantic«, loc. cit. Agassiz does not mention this locality in his Report on the Echinoidea, only »Bay of Biscay and Coast of Spain« besides the wrongly cited St. 191.

of Spatangoids. In *Aeropsis rostrata* the number is even not larger than 7, the two genital plates of each side being, generally, united into one (Fig. 15); in the smallest of the specimens in hand, $7{\cdot}5^{mm}$ in length, the two left genital plates are, however, separate. Duncan (Op. cit. p. 272) suggests that «in the beautiful drawing given in the »Challenger«-Report, pl. XXXIII. a, fig. 10, there is a possibility of the existence of a fifth imperforate basal plate»; this figure, however, is too little detailed or exact for founding a so remarkable conclusion upon, and no such plate exists in this species. — The madreporic plate occupies only the middle of the right (composed) genital plate; it is somewhat elevated. Wyv. Thomson and Agassiz have found 4 genital openings; two of the specimens before me have only two genital pores, a third specimen has three pores, none of them has four pores. The genital papillæ are well developed as in the type specimen. The genital pores have not yet been formed in a specimen of 15^{mm} length, in a specimen of 17^{mm} length they have appeared; it may thus be concluded that they appear at a size of ca. 16^{mm} length. — The labrum reaches to the middle of the 2. ambulacral plate, as is also seen in the figures in the »Chall.«-Ech.; in the smallest specimen ($7{\cdot}5^{mm}$) it reaches only to the end of the 1st adjoining ambulacral plate on each side. In one of the specimens (that figured as denuded) the anal area is almost quite naked, in the other specimens it is covered by plates as described and figured by Agassiz. — It is to be emphasized, that in the general form of the test the small specimens agree with the large ones — one proof more that the differences between the large form figured in »Chall.«-Ech. Pl. XXXIII. 1—5 and the short, typical form are not «compatible with differences due to age».

The number of tube-feet in the odd anterior ambulacrum increases with age. The specimen of $7{\cdot}5^{mm}$ has only two large tube-feet (one pair), the largest specimen has 12 (6 on each side). The size of the sucking disk is comparatively the same in both small and large specimens — not distinctly »an embryonic feature«. No large tube-feet are developed near the periproct. According to Agassiz (»Chall.«-Ech. p. 193) there are only ten large tube-feet round the actinostome. I find all the 15 tube-feet of the inner plates well developed and of the usual form; in the largest specimen those of the second ambulacral plates likewise begin to develop into the usual form. No spicules are found in the actinal tube-feet; in the large frontal tube-feet the spicules are very numerous, almost smooth, elongate rods, not arranged in longitudinal series, but forming a close mail round the foot (Pl. XV. Fig. 5). The extremely elongate rosette plates consist of a small flat, pointed inner part and a very long outer part, the edges of which are bent inwards on the lower side so as to form an almost closed, narrow tube at the inner end; towards the outer end the edges become less and less incurved, the point of the plate being quite flat. The inner and outer parts of the plate are separated by a distinct widening, somewhat thickened and with a bow on the lower side, evidently serving as a support of muscles (Pl. XV. Figs. 19, 20). To be sure I have been unable to see these muscles with certainty, but as the terminal disk in the preserved specimens is often folded in different ways, it seems almost beyond doubt that such muscles really occur.

The spines along the odd anterior ambulacrum are long and straight, not widened in the point; those on the anterior part of the test, inside and outside the fasciole, as well as round the peristome, are short, spear-shaped, a little curved in the point; those on the posterior end are simple, of medium length. De Meijere (»Siboga«-Ech. p. 195) mentions as a character of *A. rostrata*, distinguishing this species from *A. fulva*, that no »spatelförmige« spines occur inside the fasciole (evidently judging from Agassiz' statement in his description of the large form that »within the peripetalous fasciole the spines are longer, not clubshaped«); this does not hold good, at least in the specimens before me. De Meijere further finds a difference in the structure of the spines of the two species, viz. that in *A. fulva* the widened point of the spines is serrate along the edge, whereas it is smooth in *A. rostrata* — founding on the figure (Pl. XLI. 7 evidently) given by Agassiz. This character will not hold good either; the widened part of the spine is (more or less) serrate at the edge also in *A. rostrata*. — The small spines and clavulæ have an »ampulla«[1] at the point, as found by de Meijere in *A. fulva* (Pl. XV. Fig. 43). — The sphæridiæ are slender, generally rather elongate; in the anterior ambulacra they continue up to the fasciole, in the posterior to the anal area.

Pedicellariæ. Only rostrate and tridentate pedicellariæ have been found. The rostrate pedicellariæ (Pl. XV. Figs. 1, 13) have almost straight, flat valves, with the point rounded, not widened, faintly serrate; neck very short; the stalk may have a faint »milled« ring below. The head is ca. 0.5^{mm} in length; the strong brownish adductor muscles between the valves make these pedicellariæ rather conspicuous. They may occur very numerously over the whole test, or very sparingly. The tridentate pedicellariæ (head up to 1^{mm} in length) have simple, leafshaped valves, which join in almost their whole length. In large specimens the edges are bent somewhat inwardly in the lower part of the blade and very irregularly serrate. The blade may be open down to the apophysis, or the edges may unite to form a coverplate over the lower part; generally there is no meshwork in the blade, but in a specimen examined in the Museum of Yale College I found the larger tridentate pedicellariæ with a rather richly developed meshwork (Pl. XV. Fig. 2). The basal part is rather narrow; the edges may be somewhat serrate. The neck is short, the stalk without a »milled« ring below. They occur in all sizes from quite small to ca. 1^{mm} length of head. (Pl. XV. Figs. 8, 21, 29, 52.) Quite small forms (Pl. XV. Fig. 37) may perhaps better be termed triphyllous. According to a sketch of a living specimen made on board the »Ingolf« the colour is light yellow, the fasciole alone being of a prominent brown colour. In some specimens seen in the Museum of Yale College the frontal tube-feet were violet. —

This species was taken by the »Ingolf« at the following stations:

St. 36 (61° 50′ Lat. N. 56° 21′ Long. W. 1435 fathoms. 1°5 C. Bottom temp.) 3 specimens.
— 37 (60° 17′ — 54° 05′ — 1715 — 1°4 — —) 5 —

The geographical distribution, as far as hitherto known, is the Northern Atlantic, at the American side, and the Davis Strait; the bathymetrical distribution is 1240—1750 fathoms. In the »Challenger«-Report the species is stated to occur also in the Bay of Biscay and at the Coast of Portugal, as also in the Arafura Sea (Chall. St. 191. 800 fathoms). That the specimen from the latter locality is wrongly referred to *A. rostrata* I have shown above. Regarding the locality »Bay of Biscay and Coast of Portugal«[2] it may be remarked that in »Summary of Results of the Challenger«-Expedition I. p. 114 *A. rostrata* is named from St. 2, off the Mouth of the Tagus, 470 fathoms; but since the specimens were without »distinctive« Station number, it seems not to be relied upon that the

[1] I name it thus, as it is evidently a structure of the same kind as the »ampulla« in the secondary spines of some Cidarids, described by Hamann and Prouho.

[2] Duncan (Revision. p. 270) from this expression concludes that one specimen was taken in the Bay of Biscay, later on another off the coast of Portugal, which there is nothing else to support.

specimen really came from that locality. Further, since the type specimen of Wyv. Thomson was taken at St. 45 (38° 34' N. 72° 10' W. 1240 fathoms)[1], and only two specimens are mentioned in the «Challenger»-Report, one of which (St. 191) is no true *A. rostrata*, it seems not hazardous to suggest that »Bay of Biscay and Coast of Portugal» was wrongly named among the localities of *A. rostrata*. Both the localities named in the «Challenger»-Report, p. 194, are thus wrong; on p. 220 the locality Davis Strait is rightly named.

A few remarks must be made on the pacific species, *Aëropsis fulva* (A. Ag.) The structure of the test has been very elaborately worked out by Professor Agassiz (Pan. Deep-Sea Ech. p. 194—97, Pl. 61, 62), and the spines and pedicellariæ have been described and figured by de Meijere (»Siboga»-Ech. p. 195. Taf. XXIII. Fig. 481—87). Having examined some specimens from «Albatross» St. 3361 and 3399 in the U. S. National Museum I am able to give a little additional information. In the shape of the tridentate pedicellariæ I do not find any distinct difference from *A. rostrata*: I have seen none with meshwork in the blade. The rostrate pedicellariæ (only one specimen found) differ distinctly from those of *A. rostrata* (Pl. XV. Fig. 34); the blade is shorter and broader than in that species and somewhat serrate at the lower end. — In the elongate specimen from the «Challenger» St. 191 I find the tridentate pedicellariæ somewhat different (Pl. XV. Figs. 6, 12, 27). In the larger ones the edges in the lower part of the blade are very irregular, somewhat thickened or thorny, and there may be a rather well developed meshwork. The smaller ones have upon the whole shorter and broader valves than is the case in *A. fulva* and *rostrata*, and there is often some meshwork developed already (Pl. XV. Fig. 27, comp. with Fig. 29). These small differences, in addition to those pointed out by Professor Agassiz (Pan. Deep-Sea Ech. p. 194), may perhaps tend to show that this specimen from the Arafura Sea represents a third species, different from *A. fulva*, though certainly nearer related to that species than to *A. rostrata*. Unfortunately the figures of pedicellariæ given by Dr. de Meijere are so little detailed that it cannot with any certainty be concluded from them whether his specimens agree in regard to the pedicellariæ with *A. fulva* or with the »Challenger»-specimen from the Arafura Sea. This question about a third species of *Aëropsis* must be left undecided for the present; but the main thing here was to show that the elongated form from the Arafura Sea is not *A. rostrata*, and this, I think, has been put beyond doubt.

Also on *Aceste bellidifera* a few remarks must be made here. (I have examined a specimen from the »Challenger» St. 8 in the British Museum, and another from the »Albatross» St. 2117, which Professor Rathbun most liberally lent me for examination). First as regards the name *Aceste*, though apparently so original, it is perhaps a little doubtful if it can be maintained, the name *Acesta* having been used already in 1855 by Adams for a bivalve mollusc *(Lima excavata)*. Still the ending of these two names is really different so that I do not think it necessary to alter the name *Aceste*. (It might, otherwise, easily be done sufficiently e. g. by adding only an »s», so that the name would be easily recognizable). — Regarding the structure of the test I have nothing to add to the careful analysis given thereof by Lovén; especially the apical system is seen by Lovén's Figure (Pourtalesia. Pl. XX. 237) to differ considerably from what is seen in the Fig. 7. Pl. XXXIII. a. of the »Challenger» Report.

The pedicellariæ have partly been figured by Professor Agassiz, but not all sufficiently de-

[1] »The Atlantic». I. p. 381.

tailed. I have found globiferous, rostrate, tridentate and triphyllous pedicellariæ, whereas ophicephalous ones were not met with. The globiferous pedicellariæ have a large space in the blade continuing almost down to the articular surface; evidently it includes a gland, as is the case in the globiferous pedicellariæ of the Cidarids. The terminal opening is small, transversely elongate, with one tooth on each side; the basal part is rather wide, with rounded, smooth edges. (Pl. XV. Fig. 14). The Fig. 45, Pl. XLIV of the «Chall.»-Ech. evidently represents a valve of this kind; that the figure is not sufficiently correct will be seen by a comparison with the figure given here. I have never seen them with the edge of the basal part serrate. The rostrate pedicellariæ (Pl. XV. Fig. 32) have rather short and robust valves, a little widened in the point, which is serrate in the usual way; the apophysis generally a little serrate. They may, however, also have more elongate and slender valves, with the terminal part somewhat larger. (Pl. XV. Fig. 15). The stalk has a distinct milled ring below. Very small pedicellariæ (Pl. XV. Fig. 36) which may perhaps also be termed rostrate are found in rather great numbers inside the fasciole (on the lateral ambulacra) and in the fasciole itself, among the clavulæ. The tridentate pedicellariæ are very richly developed, being represented by no less than three distinct forms. The simplest form has elongate, narrow, simply leafshaped valves, which join in their whole length. The edge is finely serrate. In the specimen from the «Albatross» this form is more elongate and narrow; the edges in the lower part are bent a little inwards and smooth (Pl. XV. Fig. 51). The second form of tridentate pedicellariæ (Pl. XV. Fig. 22) has the edge of the blade very coarsely dentate; the blade otherwise is leafshaped. The third form (Pl. XV. Fig. 25) is rather like the more slender rostrate pedicellariæ, the blade being narrow with a widened point; but this widened part is not sharply set off from the narrow part, bending gently inwards. The two latter forms have only been found in the specimen from the «Albatross». The stalk of all three forms has the upper end thickened, the lower end provided with a distinct «milled» ring. The neck may be well developed or quite short. — The triphyllous pedicellariæ are like very small and simple tridentate pedicellariæ.

The spicules (Pl. XV. Fig. 41) are simple rods, a little spinous (generally only at the ends), not so numerous as those of *Aëropsis*. The plates of the rosette are elongate and narrow, flat, the edges not curved as in those of *Aëropsis* (Pl. XV. Figs. 10, 39). — The peculiar clubshaped spines found in the anterior ambulacrum are «interesting as showing a possible transition from normal to more specialised spines, which may in part perform the functions of pedicellariæ» («Chall.»-Ech. p. 196). They are certainly interesting, but that they have anything to do with the functions of pedicellariæ there is nothing at all to prove — it seems, indeed, very improbable that they can perform functions like those performed by the pedicellariæ with their movable valves. It might seem more appropriate to compare them with the sphæridiæ which are undoubtedly only specialised and transformed spines.

Professor Rathbun (332. p. 89) suggests the possibility of another species of this genus occurring in the Atlantic, on account of a small specimen which «differs considerably from the larger specimens», without giving, however, anything more detailed about these differences. Perhaps the existence in the Atlantic of a species distinct from *A. bellidifera* would account for the differences between the figures of the pedicellariæ given by Agassiz and by me. In fact I am unable to find in the specimens examined by me pedicellariæ corresponding passably to the Figures 27 and 28, Pl. XLII, Fig. 25, Pl. XLIII and Fig. 46, Pl. XLIV of the «Chall.»-Ech. The fig. 28, Pl. XLII evidently represents the slender form of tridentate pedicellariæ; but I have not seen them without neck, and also the shape is rather different from that seen in the specimens examined by me. The Fig. 46. Pl. XLIV is said in the explanation of plates to be a valve of both the forms figured in Fig. 27. Pl. 42 and Fig. 25. Pl. 43, which seems impossible. It undoubtedly belongs to the first of these. — It might perhaps be doubted whether the specimen(s?) from »Chall.«-St. 272, in the Pacific (between Hawaii and Paumotu), 2600 fathoms, are really identical with the Atlantic specimens. The above mentioned figures of pedicellariæ may perhaps have reference thereto; only some fragments are preserved in the British Museum, so that the question cannot be solved from that material alone. In case the Pacific specimens prove to be another species, the specimen from the »Siboga«-Expedition (de Meijere. Op. cit. p. 196) will certainly not be *A. bellidifera* either. (No specimens from St. 323 of the »Challenger» are found in the British Museum.)[1]

That *Aëropsis* and *Aceste* are closely related can scarcely be doubted. The globiferous pedicellariæ of *Aceste* (such will probably also turn out to exist in *Aëropsis*) undoubtedly point towards *Hemiaster*, with which genus *Aëropsis* and *Aceste* agree in several important characters: the existence of a peripetalous fasciole alone, the ethmophract apical system (in *Aceste* it is, however, ethmolytic, though the madreporic pores do not pass beyond the posterior ocular plates (Lovén. Loc. cit.)), the structure of the spines, and the prominent suckers of the odd ambulacrum. On the other hand the primitive condition of the mouth and of the paired ambulacra show them to be of a more primitive type than *Hemiaster*.

The enormous development of the frontal tube-feet, is, according to Professor Agassiz, »an eminently embryonic feature, it exists in the youngest stages of all the Spatangoids of which we know the development«. (»Chall.«-Ech. p. 195). We know the postembryonal development of *Echinocardium flavescens* (O. F. Müll.), *Echinocardium cordatum* (Penn.)*, *Abatus cordatus* (Verr.) (Lovén. On Pourtalesia), *Spatangus purpureus* O. F. Müll.*, *Brissopsis lyrifera* (Forb.) (Agassiz. Revision of Ech. Pl. XIX), *Hemiaster expergitus* Lovén* and *Schizaster fragilis* (Düb. Kor.)*. (On those marked with an * information will be found in this work.) But in *Echinocardium flavescens, cordatum, Spatangus purpureus* and *Abatus cordatus* at least these suckers can by no means be said to be very large and prominent in the young specimens. On the contrary, it seems to be the rule that those forms which have, when fullgrown, large suckers get them early developed, whereas those which have only small or little prominent suckers when grown up have them small also in the young stages — as might, indeed, be expected. It seems then more safe to conclude that the small suckers represent the more primitive condition, the less specialized stage being, of course, prior to the more specialized. Thus, I think, the large suckers of *Aëropsis* and *Aceste* show these genera to be a rather specialized branch from an otherwise primitive type; this especially holds good for *Aceste*, whose test has got its very peculiar form evidently on account of the extreme development of the odd ambulacrum and its tube-feet.

The affinities of *Aëropsis and Aceste* to the Schizasterids repeatedly pointed out by Professor Agassiz seem very probable; also the globiferous pedicellariæ are in accordance with this. On the other hand I am unable to see the real affinity of these genera to the »*Brissina*«, likewise repeatedly

[1] In the Preliminary Report on the Echini collected, in 1902, among the Hawaiian Islands by U. S. Fish. Comm. Steamer »Albatross« (Bull. Mus. Comp. Zool. L. Nr. 8. 1907) published after the above was written, Agassiz and Clark describe two new species of *Aceste* (p. 258–59). This fact highly strengthens the doubt of the identity of the »Challenger«- and »Siboga«-specimens of *Aceste* from the Pacific with the *A. bellidifera* from the Atlantic.

emphasized by Agassiz. It is mainly the large frontal tube-feet which are taken as a proof of this affinity — »the striking resemblance of the young *Brissopsis* with its gigantic suckers in the odd anterior ambulacrum (Rev. of Ech. Pl. XIX. 1—2) to the full-grown *Aërope*, plainly shows the Brissoid affinities of the genus» (Chall. -Ech. p. 190); but also the shape of the test is, if I understand it rightly, taken as a proof of this affinity (Chall. -Ech. p. 196). Quite apart from the fact that it seems rather exaggerated to term the frontal tube-feet of the young *Brissopsis* »gigantic», this isolated feature, the large frontal tube-feet, does not appear to me a sufficient proof of near relation between these otherwise very different types; the subanal fasciole so characteristic of *Brissopsis* seems especially a proof against the suggested affinity with *Aëropsis* and *Aceste*. Also the structure of the globiferous pedicellariæ is a proof against more close affinity of these forms, far more important than a possible resemblance in the shape of the test of *Aceste* when seen in end view.

If the view expressed above (p. 84—85) of the primary classificatory importance of the structure of the sternum be correct — of which I for my part am fully convinced — it naturally follows that the affinities of *Aëropsis* and *Aceste* to *Pourtalesia* and other Ananchytid genera, likewise repeatedly emphasized by Professor Agassiz, are not real; they are merely superficial analogies. *Aëropsis* and *Aceste* are rather primitive amphisternous forms, which cannot be more closely related to the higher meridosternous genera, and neither can they be taken as »showing the passage of the *Pourtalesia*-group to the Brissina among the Spatangoids» (Chall. -Ech. p. 190).

26. **Hemiaster expergitus** Lovén.

Pl. II. Figs. 1, 4, 18, 20. Pl. IV. Figs. 6—8, 10—12. Pl. XV. Figs. 9, 16—18, 24, 26, 30—31, 35, 38, 44—45, 47—48, 50.

Synonyms: *Hemiaster zonatus* A. Ag.
— *gibbosus* A. Ag. (? — see below, p. 102—5).
— *Mentzi* A. Ag.

Literature: Lovén: Études sur les Échinoidées. p. 13. Pl. V. 46—47. XI. 93—94. XIII. 114—20. XXVI. — On Pourtalesia. p. 53. Pl. X. 92. XVIII. 222. — Bernard (78). — Th. Mortensen: Some new species of Echinoidea. p. 243.

The specimens of *Hemiaster* dredged by the »Ingolf», »Michael Sars» and »Thor» must undoubtedly be referred to the species described by Lovén, *H. expergitus*. Professor Théel most kindly sent me the type specimens of Lovén so that I have been able to make a direct comparison, and the identity is thus established beyond doubt. The species was hitherto recorded, since Lovén, only from the »Talisman» by Bernard, and it is thus a fact of no small interest that it now proves to occur also in the northern Atlantic, and evidently not very rarely. The specimens before me are of different sizes, from 5^{mm} to 37^{mm} in length; I have further taken a quite young specimen of only 3^{mm} length off Frederiksted, St. Cruz, ca. 500 fathoms, which evidently belongs to the same species. (Lovén had only a pair of young specimens of $10—14^{mm}$ length). We are thus able to follow the changes which appear with age.

The shape of the test is seen from the figures representing the naked test and the test with the spines (Pl. II. Figs. 1, 4, 18, 20. Pl. IV. Figs. 6—8, 10—12). The outline is oval, a little broader in the anterior half. The abactinal side is almost flat, sloping rather strongly from behind towards the front, the vertex being at the end of the posterior petals. The sides of the test are almost vertical, the actinal side almost flat. The periproct is situated near the abactinal side, in a slight furrow. The ambulacra are very little deepened. — The young specimens are somewhat more egg-shaped, but the posterior end is high as in the larger specimens, the outline in profil being mainly the same; only in the specimen of 3^{mm} length the posterior end is yet rather sloping, the anal opening being very near the apical system.

To give a detailed description of the structure of the test would be superfluous after the elaborate analysis and figures given by Lovén, only a few additional remarks can be given on account of the larger material at disposal. — In the younger specimens the peristome and mouth is as yet quite embryonal, the labrum not prominent at all; in the specimen of 3^{mm} the peristome is

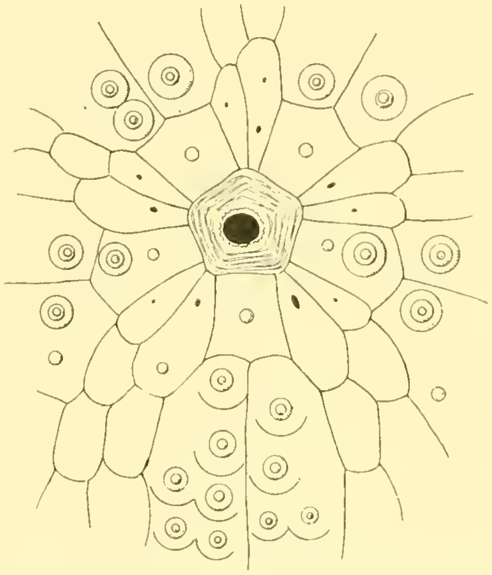


Fig. 16. Peristome and adjoining part of the test of a young *Hemiaster expergitus*, 3^{mm} in length. $^{25}/_{1}$.

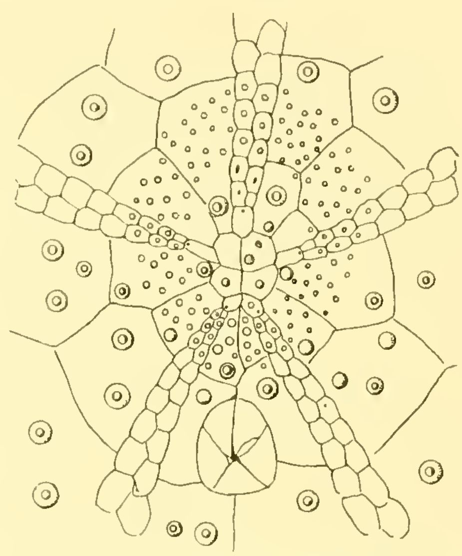


Fig. 17. Apical system of a young *Hemiaster expergitus*, 3^{mm} in length. $^{25}/_{1}$. The outline of the smaller ambulacral plates and of some of the inner interambulacral plates not quite sure.

quite pentagonal; the peristomial membrane is full of small somewhat concentrically arranged plates (Fig. 16). In the larger specimens the labrum becomes by and by rather prominent, a little pointed, with the edge a little thickened and reverted. Its posterior edge reaches, in the smaller specimens, only to the middle of the adjoining ambulacral plates I. a. 1 and V. b. 1 (Comp. Lovén. Pl. V. 46); in somewhat larger specimens it reaches to the end of the first ambulacral plates, or a little farther on the right side, as in Lovén's Figure 114 (and his Pl. V. 47), and in the grown specimens it reaches to the middle or even to the end of the second adjoining ambulacral plate on each side (Pl. II. Fig. 4); generally the ambulacral plates of V. b. are a little shorter than those of I. a, so that the right side of the labrum appears to reach a little farther than the left, but it is really symmetric. In the larger specimens the inner ambulacral plates are comparatively much smaller than in the young specimens, and their outline likewise is different. But though it thus looks rather different in the young and grown specimens, no character for eventually distinguishing two species is to be found herein; it is a difference due only to age, all transitional stages being found in the corresponding intermediate sizes.

It is a remarkable fact that in some of the small specimens only one tubefoot is developed in the plates I. a. 1 and V. b. 1; the posterior tubefoot in these plates must then develop later on. From the specimen of 3^{mm} (Fig. 16) it appears that the first tubefoot to develop is the inner one of the plates I. a. 1, II. a. 1, III. b. 1 ..... then follows that of the plates I. b. 1, II. b. 1, III. a. 1 ..... and lastly the outer tube-foot of the plates I. a. 1, II. a. 1, III. b. 1 ..... It is also seen there that the latter appears first in the plate III. b. 1. In one specimen I have found both tubefeet developed in the plate I. a. 1, only one in V. b. 1. — Some of the plates in the outer series of the bivial ambulacra may want pores totally; this may hold good also for one or two of the plates of the inner series between the proximal ones and those bearing the large subanal tubefeet (the 6th—9th plate).

The apical system of the youngest specimen (Fig. 17) is quite in accordance with that described and figured in the best possible way by Lovén for the more advanced stages studied by him. It is extremely important to learn, how it is in the fullgrown specimens, as Lovén holds its »ethmophract« structure to be of very great systematic importance, a view not universally accepted, the numerous transitional stages from an ethmophract to an ethmolytic condition figured by Gauthier[1] tending especially to show this feature to be of no primary systematic importance. As shown in Fig. 18 the apical system of the largest specimen is as ethmophract as that of the smallest specimens, the madreporic plate does not separate the posterior genital plates. There are four genital pores, with well developed, up to more than 3^{mm} long, genital papillæ. A few madreporic pores are found also in the left posterior genital plate. The madreporic plate is often somewhat elevated.

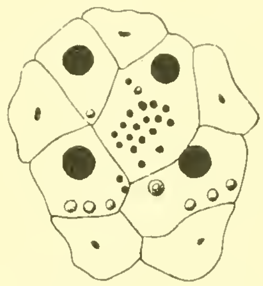


Fig. 18. Apical system of *Hemiaster expergitus*. 37^{mm} in length.

The spines of the anterior end of the test are somewhat spearshaped, with coarsely serrate edge, in side-view curved and quite sharp. (Pl. XV. Fig. 44). Those on the posterior end of the test are more spoonshaped, with smooth edge; the spines of the sides of the test are intermediate in shape between these two forms. The spines of the actinal plastron (Pl. XV. Fig. 50) are much widened in the point[2], the widened part being sometimes almost quite hyaline, almost without any reticulate tissue in the middle; in others the reticulate tissue has a greater extent, both kinds occurring together in the same specimen. It is worth noticing that in the specimen of 3^{mm} length these spines are already of the typical form. The spines within the fasciole are more or less spoon-shaped; those along the anterior ambulacrum increase in length towards the apical system, the uppermost being the longest, reaching even beyond the fasciole behind (not widened in the point). The size of the tubercles is, of course, in accordance with this fact, as is seen in Lovén's Fig. 115. The small miliary spines are mainly of the same structure as the clavulæ. (Comp. Agassiz

[1] Recherches sur l'appareil apical dans quelques espèces d'Échinides appartenant au genre »Hemiaster«. Assoc. Franc. pour l'avancement des Sciences. 1886. It is especially to be remarked that in a single species, *Hemiaster batnensis*, Gauthier finds all stages represented from a typical ethmophract apical system in the young specimens to an ethmolytic in the large specimens. (Comp. also: Lambert. Note sur le développement de l'Echinospatangus neocomiensis d'Orbigny. Bull. Soc. Yonne. 1889. p. 11. Note; De Loriol. Notes pour servir à l'étude des Echinodermes. VI. Rev. Suisse de Zool. V. 1897. p. 175; A. Valette. Description de quelques Échinides nouveaux. Bull. Soc. Yonne. 1905. p. 44).

[2] In the »Blake«-Echini p. 67 Professor Agassiz says of these spines in the young *H. Mentzi*: »The outer sheath of calcareous rods becomes solidified as thin lamellæ, forming in one case in the primary interambulacral spines of the anterior part of the test on the abactinal side, above the ambitus, a spearlike head to the shaft of the radioles; ..... in the shorter radioles of the actinal plastron the lamellæ all develop into this spoon-shaped extremity«. — Only two of the lamellæ develop in this manner, the rest of them disappear on the lower part of the head.

Chall.-Ech. p. 185, on *Hemiaster gibbosus*), only somewhat longer and less widened in the point. The widening is, especially in the clavulæ, unequally developed, being largest on the posterior side of the spine.

The tube-feet of the anterior ambulacrum within the fasciole are large and prominent, with a large disk, not lobed in the edge. The rosette-plates have been figured by Lovén (On Pourtalesia. Pl. X. 92); they sometimes bifurcate in the outer part. The spicules are simple, more or less spinulose rods (Pl. XV. Fig. 38), mostly very numerous in the abactinal tube-feet, less numerous in the actinal ones; they are arranged in two longitudinal series. The 6—9th (10th) plates of the median series of the bivial ambulacra bear large tube-feet like those at the mouth, corresponding to the large tube-feet within the subanal fasciole of *Brissopsis* etc.

The pedicellariæ were hitherto unknown; only Agassiz mentions from *H. Mentzi* «a few large, stout-stemmed, globular pedicellariæ, irregularly scattered over the abactinal surface of the test» (Blake-Echini. p. 68). I find all the usual forms: globiferous, rostrate, tridentate, ophicephalous and triphyllous. The globiferous pedicellariæ (Pl. XV. Figs. 47—48), which occur both on the abactinal and the actinal side, are rather conspicuous; the head is about 0·5^{mm}, the stalk ca. 1^{mm}; no neck. The valves are much curved. The blade is quite closed, tubeshaped, ending in a transverse-oval opening, whose outer edge is generally provided with 6 teeth, the inner edge being generally smooth. The basal part is rather wide, with smooth edges. In a specimen from the «Talisman», examined in the Paris Museum, I find also the inner edge of the terminal opening provided with teeth and the edge of the basal part more or less serrate (Pl. XV. Fig. 24). The stalk is simple without thickenings or free projecting rods. The rostrate pedicellariæ (Pl. XV. Figs. 9, 16, 18) have rather straight valves, curved only at the outer end. The blade is narrow, open, with a terminal widening, differing to some degree in extent; it is generally short, but may take as much as the outer half of the blade. The edge of the widened part is finely serrate, the edge of the lower part smooth; in larger specimens there may be some cross-beams between the edges in the lower part of the blade. The edge of the basal part is generally more or less serrate. No neck; the head of the largest specimens seen of this kind was 0·5^{mm}. — The tridentate pedicellariæ are of two kinds; the one (Pl. XV. Figs. 17, 30, 45) is very small (head ca. 0·2^{mm}), with a well developed neck. The blade is simply leafshaped, a little narrowing below. The edge is smooth in the lower part, serrate in the outer part, the serrations increasing in size towards the end of the blade and generally directed outwards, which gives the valves a rather characteristic appearance. The stalk is delicate, tubeshaped. The second form (Pl. XV. Fig. 26) is larger (head ca. 0·4^{mm}), the valves join in their outer half, the edge of this part being somewhat irregularly serrate. Only one specimen of this kind was seen; perhaps transitional forms may be found. — The rostrate pedicellariæ with a large terminal widening may be rather like this second form of tridentate pedicellariæ, and it may not always be possible to determine whether such a pedicellaria is to be termed rostrate or tridentate — as, upon the whole, the distinction of these two kinds of pedicellariæ is not very sharp. — The ophicephalous pedicellariæ (Pl. XV. Fig. 31) I have found only in the smaller specimens; they are small, shortstalked, without a neck and with the upper end of the stalk cupshaped, as usually among the Spatangoids. The blade is round, only faintly serrate in the edge; there is no prolongation from the lowermost of the three arcs. — The triphyllous pedicellariæ have a somewhat elongate blade, rather strongly serrate at the edge (Pl. XV. Fig. 35). The sphæridiæ do not present prominent features; they occur (in the larger specimens) also at the large tubefeet at the posterior end of the test.

It is an important fact that even in the smallest specimens there is no trace of a latero-anal fasciole, so that it may be regarded as proved that this fasciole is never found in *Hemiaster* — a very characteristic difference from the young of the genus *Abatus*. In the young *Abatus* there is a large fasciole enclosing both the apical system and the anal area; a transverse band then develops between the apical and anal area, and the part of the original fasciole behind the transverse band thus becomes the latero-anal fasciole, whereas the anterior part of the original fasciole in connection with the transverse band forms the peripetalous fasciole. In *Hemiaster* the anal area is never intrafasciolar.[1] In the specimen of 3^{mm} the peripetalous fasciole is already distinct (Fig. 17), and at a comparatively large distance from the anal area. It is very small and in the anterior petal only one tube-foot is distinct — and by no means very large — and two more are about to appear. In specimens a little larger the peripetalous fasciole is very prominent, broad, but still enclosing only a very small space (Pl. IV. Fig. 10); upon the whole the fasciole is comparatively much broader in the smaller specimens. The odd anterior ambulacrum develops early, thus at a size of $5-6^{mm}$ already 4—5 rather large tube-feet are formed. The paired petals are not developed till later on. In a specimen of 10^{mm} length I find in the antero-lateral petals 5 pairs of pores in each series, but of the postero-lateral petals no trace is seen as yet. In a specimen 12^{mm} in length I find 2 pairs of pores in each series in the postero-lateral petals. The smallest specimen in which I have found the genital pores developed was 14^{mm} long.

This species was taken by the »Ingolf« at the following stations:

St. 24	(63° 06' Lat. N.	56° 00' Long. W.	1199	fathoms	2°4 C.	Bottom temp.)	1	specimen.
— 39	(62° 00'	— 22° 38'	—	865	—	2°9	—	—) 2	—
— 40	(62° 00'	— 21° 36'	—	845	—	3°3	—	—) 8	—
— 63	(62° 40'	— 19° 05'	—	800	—	4°0	—	—) 2	—
— 67	(61° 30'	— 22° 30'	—	975	—	3°0	—	—) 2	—
— 68	(62° 06'	— 22° 30'	—	843	—	3°4	—	—) 1	—
— 69	(62° 40'	— 22° 17'	—	589	—	3°9	—	—) 3	—

Unfortunately several of the specimens were in a more or less broken condition. — The species was further taken by the »Thor« at 62° 57' Lat. N. 19° 58' Long. W. 975 M. (1903) and by »Michael Sars«, 61° 40' Lat. N. 3° 11' Long. E. 220 fathoms, 6°3 bottom temperature (Ad. Jensen. 1902). The latter locality (the Shetland-Norway ridge) is rather surprising and may indicate the possibility of the species occurring along Norway. (Comp. *Echinus Alexandri*).

The geographical distribution of this species is thus the Northern Atlantic, from the Davis Strait to the Caribbean Sea and from South of Iceland to the Azores. It belongs to the warm

[1] This feature, combined with the ethmophract apical system, the 4 genital pores, the difference in the pedicellariæ (evidently the least important character) and the very great difference in the whole shape and appearance, proves beyond doubt that Lovén was quite right in maintaining that the antarctic forms: *Abatus cavernosus* etc. cannot be referred to the genus *Hemiaster*, as done by Professor Agassiz. »An extraneous form like this, if suffered to remain in the otherwise homogeneous group of true Hemiasters, is sure to vitiate its integrity, and the mixed assemblage thus set up for a natural genus, if taken on trust, cannot fail to mislead when the question is to trace out comparatively its former geological and actual geographical distribution«. (Lovén. On Pourtalesia. p. 73). In his last work, »The Panamic Deep-Sea Echini«, Agassiz recognizes the correctness of Lovén's views, while Döderlein (Echinoidea d. deutsch. Tiefsee-Exp.) still refers the antarctic forms to *Hemiaster*, without entering upon the question, however. This question will be treated at more length in my Reports on the Echinoidea of the German and Swedish South-Polar Expeditions).

area. The bathymetrical distribution is from 220 (or 170, comp. below, *H. Mentzi*) to 1700 fathoms («Talisman»).

Besides the species *H. expergitus* four more recent species of the genus *Hemiaster* (excl. *Abatus*) have been described, viz. *Hemiaster gibbosus* A. Ag., *zonatus* A. Ag. both from the «Challenger», *H. Mentzi* A. Ag., from the «Blake», and *H. florigerus* Studer, from the «Gazelle». (The *Hemiaster apicatus* Woods is referred by Woods himself to the subgenus *Rhinobrissus* and therefore, being no true *Hemiaster*, does not concern us here). As for the first and third of these species it seems rather probable that they will prove to be synonyms only of *H. expergitus*.

In his description of *Hemiaster gibbosus* (Chall.-Ech. p. 184, Pl. XX. 5—16, 22) Agassiz does not point out by which features this species is distinguished from *H. expergitus*, and a careful analysis of his description and figures does not reveal any good distinguishing characters either. De Meijere (Siboga-Ech. p. 182) has had some specimens of *H. gibbosus*, but he only remarks that he finds them answering well to the description given by Agassiz. Through the kindness of Professor M. Weber I have received one of these specimens, 20mm in length; I have thus been able to compare the species with equal-sized specimens of *H. expergitus*, and finally I have examined the «Challenger»-specimens in the British Museum. The comparison of *H. gibbosus* and *expergitus* gives the following results.

The shape of the test is the same; to be sure I have seen no specimen of *expergitus* of the form shown in Fig. 6. Pl. XX of the «Challenger»-Echini, all the specimens being wider in front than behind, or (the small ones) almost elliptic. But Agassiz himself states that the outline is variable, and the outline of the specimen figured in Pl. XX. 5[1] is almost quite as in *expergitus*. (Comp. Pl. II. Fig. 1). Evidently the form of the test thus does not give any distinguishing character. Agassiz points out that the plates of the lateral posterior interambulacra are comparatively bare — but in *expergitus* they may be quite as bare, and I am unable to find any difference herein between the specimen of *gibbosus* before me and equal-sized *expergitus*. — «The bivium is separated from the trivium by two large intercalated interambulacral plates». I suppose, that by these are meant the two large plates within the fasciole between the anterior and posterior petal seen in the Fig. 9. Pl. XX. The figure, however, must certainly be wrong. It would be a quite exceptional thing to find in this place two large, paired plates; I find these interambulacra in the specimen before me of the usual structure (Fig. 19), the fasciole passes over the third and fourth plate, quite as in *expergitus* of the same size. It could not be made out with certainty, how this is in the «Challenger»-specimens, but I do not doubt in the slightest that they will show the usual structure. (In the largest specimen of *expergitus* the fasciole traverses the 5th—7th plate in these interambulacra). The «intermiliary granulation», which Professor Agassiz figures (Pl. XX. Fig. 13), I am unable to find either in the specimen of *gibbosus* or in *expergitus* of corresponding size. In the largest specimen of *expergitus* it is well developed, though not so close as in the figure quoted.

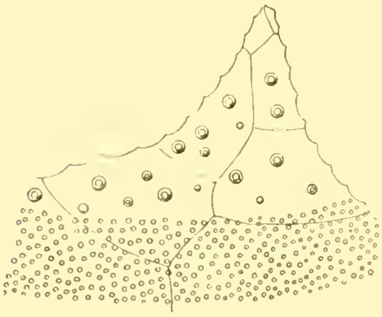


Fig. 19. Abactinal part of the left posterior Interambulacrum (4), of *Hemiaster gibbosus*; comp. with Pl. XX. Fig. 9 of the «Challenger»-Echinoidea.

[1] In the explanation of Plates (p. 292) it is stated that Fig. 5 and 6 represent the same specimen which is evidently impossible and in contradiction to the text (p. 184).

From the description given by Agassiz it is thus impossible to find how to distinguish *H. gibbosus* from *expergitus*. A comparison of the figures seems to give a somewhat better result, the petals and the odd ambulacrum showing some difference: In the specimen of *gibbosus* figured by Agassiz in Pl. XX. 5 and 9 (ca. 30^{mm} in length) the posterior petals are only a little shorter than the anterior ones, and the number of pores in both petals is almost the same. In the largest specimen of *expergitus* (37^{mm}) the posterior petals are only half as long as the anterior ones and the number of pores in the posterior petals is likewise only about half that in the anterior; further in *expergitus* the inner ca. 7 pairs of pores in the median (anterior) row of the anterior petals are small, in *gibbosus*, according to Fig. 9, they are all large and conjugated. The number of plates in the odd ambulacrum within the fasciole is in *gibbosus* (according to Fig. 9) ca. 18, in *expergitus* 29. — These differences look very good. If, however, we compare the specimen of *gibbosus* of 20^{mm} before me with equal-sized *expergitus*, these differences become very slight. In both I find the anterior petals twice as long as the posterior and with the double number of pairs of pores. In *gibbosus* I find the 4 inner pairs in the median row of the anterior petals small (in *expergitus* about 7). In the odd anterior ambulacrum I find in *gibbosus* 14—15 plates within the fasciole, in *expergitus* 17—18. And in the specimens from the »Challenger» in the British Museum the posterior petals are only about half as long as the anterior ones, and the inner 5—7 pores of the inner series of the anterior petals are small, not conjugate. No specimen in the British Museum corresponds to the Fig. 9. Pl. XX of the »Challenger»-Echini. These differences thus become so slight that they seem rather inappropriate for distinguishing two species thereby. But other distinguishing characters do not seem to be found in the structure of the test. The fasciole is alike in shape, likewise the spines. To be sure the labrum, according to Agassiz' Fig. 6 would seem to give some difference: Its posterior end reaches on the right side the middle of plate 3 in the adjoining ambulacrum, on the left side to the middle of plate 2. As, however, this figure gives in any case a quite wrong representation of the plates in the left posterior ambulacrum (I), it probably cannot be relied upon for the right side either, the more so as in the specimens in the British Museum the labrum reaches only to the middle of the second ambulacral plates of the adjoining series. The specimen from the »Siboga» likewise agrees exactly with equal-sized *expergitus* in this respect. — The number of buccal plates and the form of the peristome is the same in both of them. The tube-feet and spicules are alike. — The globiferous pedicellariæ (not seen in the »Siboga»-specimen) present a small difference (Pl. XV. Fig. 46): the blade is more elongate, with four teeth around the terminal opening, and the basal part is narrower than in *expergitus*. The rostrate pedicellariæ do not present any reliable differences, whereas the large tridentate pedicellariæ (Pl. XV. Fig. 42) differ from those of *expergitus* in having the edge in the outer part, where the valves join, regularly serrate — but in view of only one specimen of this kind having been found in *expergitus*, it does not seem reasonable to lay any stress upon this feature. Ophicephalous pedicellariæ were not met with in any of the specimens of *gibbosus* examined. There seems then not to be a single reliable difference of any reasonable importance by which to distinguish *gibbosus* from *expergitus* (— also in the structure of the globiferous pedicellariæ there is some variation in *expergitus*, as pointed out above, p. 100, so that they present no reliable difference either —). If specimens of both »species» were put together, I think it would be impossible to separate them rightly again. Accordingly I must regard *H. gibbosus* as a synonym only of *H. expergitus*; but since one is known only from the Northern Atlantic, the other only from the Malay Archipelago and Japan, it may be well to keep the Pacific form as a Var. *gibbosus*, for the present, though it seems to be distinguished almost alone by the character of its geographical distribution.

The other species from the »Challenger», *Hemiaster zonatus*, is so very imperfectly described that it is impossible to found upon that description any definite opinion of its claim to form a separate species. The figures, to be sure, show it clad in a close and uniform coat of spines; but also in *H. expergitus* the coat of spines may be rather close — and in the description of *H. Mentzi* (Blake - Echini. p. 66) the tuberculation of *H. zonatus* is stated to be more distant, as it is in *H. expergitus*. It is thus, evidently, no very reliable character. The large fasciole and the deep anal groove do not seem very reliable characters either, as it may be almost exactly similar in *expergitus*, so that it does not seem very improbable, when Agassiz thinks the differences from *expergitus* may be due only to age. On examining the type-specimens in the British Museum, I get the following result. The specimen from St. 8, off Gomera, Canaries, is undoubtedly *H. expergitus*, with which species it also agrees exactly in the pedicellariæ; but the specimen from St. 126 (off Rio Janeiro, 750 fms.) is undoubtedly something quite different. Unfortunately the specimen is completely crushed, only the apical and the actinal regions being tolerably preserved. As regards the structure of the test, it may be pointed out that the labrum does not reach the second adjoining ambulacral plates. There are only two genital openings and the apical system is not ethmophract as in *Hemiaster;* the madreporic plate extends backwards and separates the posterior ocular plates, but is not prolonged into the posterior interambulacrum. The peripetalous fasciole is more *Schizaster*-like, not round as in the figured specimen, and it is not so broad as in that figure; any trace of a latero-anal fasciole cannot be seen — but that is no definite proof of its non-existence, on account of the poor condition of the specimen. For the rest the specimen is abnormal, the right anterior petal lacking; the left side is normal, showing the posterior petal only one third the length of the anterior petal. The spines are simply widened towards the point, not of the elegant shape of those of *Hemiaster*. The globiferous pedicellariæ are very different from those of *H. expergitus;* the valves (Pl. XV. Figs. 3, 7) enclose a large (probably glandular) space, which opens with a small pore at the base of the single, compressed tooth, which terminates the long and slender, curved blade — a structure exactly similar to that found in *Schizaster fragilis* a. o. (comp. below, p. 110). The tridentate pedicellariæ are like those of *expergitus*, but only the small form was found; the rostrate pedicellariæ (Pl. XV. Fig. 11) differ somewhat from those of *expergitus*, as seen by a comparison of the figures. That the spicules of the tube-feet are few in numbers can scarcely mean anything as a distinguishing character, since there is considerable variation in this respect in *expergitus*.

Quite recently Professor Döderlein (Echinoidea d. deutsch. Tiefsee-Exp. p. 247) has referred with some doubt a specimen from the Rockall-Bank to *Hemiaster zonatus*, and probably he is quite right herein, judging from his figures and description of the pedicellariæ. The globiferous pedicellariæ are seen to agree with those figured here from the type specimen; the single difference, a swelling on the stalk, which I have not found in the type specimen, can scarcely be of any importance. More different are the rostrate pedicellariæ — but as in *expergitus* these pedicellariæ differ rather much in form, the difference herein can scarcely necessitate a separation. Unfortunately also Professor Döderlein's specimen was quite crushed, so that we must still remain ignorant of the structure and form of the test of this species. But it seems beyond doubt that in the »Challenger« Report two separate forms were included under »*Hemiaster zonatus*«: one (St. 8), evidently the figured one, a true *Hemiaster* and even the same as *H. expergitus*, the other (St. 126) probably a *Schizaster*, which will certainly prove to be a new species. The name *Hemiaster zonatus* ought then certainly to be dropped as a synonym of *H. expergitus*.

Hemiaster Mentzi A. Ag. has unfortunately not been figured by Professor Agassiz, and from the description (»Blake«-Echini. p. 66) it is quite impossible to see by which characters it is distinguished from *H. expergitus*, the only feature not agreeing very well with the latter species being the »narrow, comparatively elongate space included within the peripetalous fasciole«. — From the U. S. National Museum I have received for examination a large specimen of *H. Mentzi*; it is certainly identical with *H. expergitus*. Of course, I cannot state with certainty that it is the true *H. Mentzi*, I have seen; but I have no reason to doubt the identification. Until the contrary is proved I must then regard *H. Mentzi* as a synonym only of *H. expergitus*. — From *H. gibbosus* it is stated to differ in having a larger number of buccal plates, a feature which I do not find to hold good by comparing the specimen of *gibbosus* from the »Siboga» with the specimen of *H. Mentzi* or with *expergitus*.

Hemiaster florigerus Studer differs from *expergitus* in several respects, judging from the description and figures given by Studer (Echinoidea d. Gazelle. (386) p. 882. Taf. II. 3). The test is broadest in the middle, not in the anterior end as in *expergitus*, and the height of the posterior end is evidently smaller than in the latter species.[1] According to the description the anterior petals are the shorter, but this is in contradiction to the figures 3 a and 3 c. The apical system, according to the Fig. 3 d, is ethmolytic, a very important character, so important, indeed, that it must certainly exclude the species from the genus *Hemiaster*. (Dr. Meissner kindly informs me that Studer's description of the apical system is correct). The two anterior genital pores are distinctly smaller than the posterior: in *expergitus* they are of equal size. The relation of the labrum to the adjoining ambulacra cannot be seen from the figures; but Dr. Meissner informs me that the labrum ends off the first ambulacral plate. (Fig. 20). By a short examination of the type-specimen during a visit to the Berlin-Museum I found two sorts of pedicellariæ, viz. tridentate and rostrate. The former (Pl. XV. Fig. 23) are essentially like the large form of tridentate pedicellariæ in *expergitus*, but only $0{\cdot}2^{mm}$. The rostrate pedicellariæ differ only very little from the form with the small end-part of *expergitus*. The spicules of the frontal tube-feet (Pl. XV. Fig. 28) are more numerous, larger and more thorny than those of *expergitus*. They are arranged in two close series; on one side those of both series have their ends intermingled, on the other side they leave a bare space between them — just as has been described and figured for *Dorocidaris papillata* (Part I. p. 33. Pl. VIII. Fig. 1). — That *H. florigerus* is a distinct species is beyond doubt, but it is very doubtful if it can remain in the genus *Hemiaster*, on account of its ethmolytic apical system. However, as long as the species is so unsufficiently known it will scarcely be possible to determine with certainty to which genus it ought to be referred.

Fig. 20. Labrum and adjacent ambulacral plate of *Hemiaster florigerus*. (From a sketch by Dr. M. Meissner).

[1] Studer gives the following measurements: Length 24^{mm}, Breadth 21^{mm}, Height 13^{mm}. In *H. expergitus* of a corresponding size the measurements are: Length 20^{mm}, Breadth 20^{mm}, Height $16{\cdot}5^{mm}$.

Though no more recent species of *Hemiaster* have been described (— except the *Abatus*-species wrongly referred to this genus —) there is reason to discuss one more species in this connection, viz. the *Periaster tenuis* A. Ag. described and figured in the »Panamic Deep-Sea Echini» p. 209, Pl. 103, figs. 5—7, 104, 105, figs. 1—3. At the first glance on the figures, especially on Pl. 104, one is struck by the close resemblance of this species to a *Hemiaster*, and a study of the details of the structure of the test can only strengthen the first impression. Above all the ethmophract apical system, so closely like that of *Hemiaster bufo*, as pointed out by Agassiz, but also the total want of a latero-anal fasciole, tend to show that it is really a *Hemiaster*. Further the elongate labrum, reaching to the middle of the second ambulacral plates of the adjoining series, the condition of the petals and the shape of the test, recall very much *H. expergitus*. Also the pedicellariæ point decidedly towards *Hemiaster*, as I can state having examined a specimen (»Albatross» St. 3398) in the U. S. National Museum. The globiferous pedicellariæ resemble those of *H. expergitus*, though more coarse (Pl. XV. Fig. 33), the terminal opening is rather wide and surrounded by teeth as in *expergitus;* they are, unfortunately, all somewhat broken in the only specimen found. The blade is a rather wide tube, with a comparatively narrow (glandular) space continuing down into the basal part. The stalk is thick and compact, but without distinct thickening or projections. The tridentate pedicellariæ are of two kinds of different size; the small form (Pl. XV. Fig. 49) is very like that of *expergitus*, only the skin is much thicker, especially the neck is very conspicuous; the large form (head ca. $0{\cdot}7^{mm}$) differs from that of *expergitus* in the outer part of the blade being more rounded (Pl. XV. Fig. 4). Specimens of this kind of tridentate pedicellariæ not larger than the small form may be found, which shows that they are, indeed, two separate forms of pedicellariæ. Rostrate and ophicephalous pedicellariæ were not found; the triphyllous pedicellariæ do not differ from those of *expergitus*. Spicules as in *expergitus*.

From what has here been pointed out I think it evident that this species really belongs to the genus *Hemiaster*, the absence of a latero-anal fasciole especially being a character non-conformable with referring it to the genus *Periaster*. Through the prominent labrum and narrow plastron, as well as through the pedicellariæ and the general shape of the test (especially the outline in profil — comp. Pl. II. Fig. 20 with Pl. 104. Fig. 3 of the »Pan. Deep-Sea Ech.») *Hemiaster tenuis* (A. Ag.), as its name must be, is easily distinguished from its nearest relation, *H. expergitus* (incl. *gibbosus*).

It may be appropriate to give in this connection some remarks on *Periaster limicola*, the only other recent species hitherto referred to the genus *Periaster*.[1] — The tubercles along the anterior ambulacrum increase in size towards the apical system, the largest tubercle and longest spine being that nearest the apical system, as is also the case in *Hemiaster expergitus*. The apical system (which is not represented in a sufficiently detailed manner in the otherwise beautiful Figure 6. Pl. XXVI of the »Blake»-Echini) is said in the »Panamic Deep-Sea Echini» p. 211 to be *Hemiaster*-like, though it has only two genital pores. In the specimens in hand the apical system is not very *Hemiaster*-like; it is ethmolytic, the madreporite separating also the posterior ocular plates (Fig. 21). This is evidently also the case in the figure quoted of the »Blake»-Echini, though the sutures are not distinct. This species is thus not in accordance with the diagnosis of the genus *Periaster* given by Pomel (Classif. mé-

[1] In A. Agassiz and H. Lym. Clark: Preliminary Report on the Echini collected, in 1902, among the Hawaiian Islands (Bull. Mus. Comp. Zool. L. 1907), a new species of *Periaster*, *P. maximus*, is described (p. 259).

thodique. p. 41), who limits the genus to include only the species in which the posterior ocular plates are not separated by the madreporite. Considering, however, what has been made known by Gauthier about the apical system in some species of *Hemiaster* (Op. cit.), I would not feel inclined to separate the *P. limicola* from the genus *Periaster* on this account. (Comp. also De Loriol. Notes pour servir à l'étude des Echinodermes. VI. p. 175 and Lambert. Note sur le développement de l'Echinospatagus neocomiensis. p. 11. Note). The labrum reaches the beginning of the second adjoining ambulacral plates. The actinal plates of the posterior ambulacra are rather elongate; the first of the 5 large subanal tube-feet is found on the 5th ambulacral plate. The frontal tube-feet have a well developed disk, with numerous elongated, narrow rosette-plates; the edge of the disk is not lobed. The spicules are irregular, slightly branched rods. Long genital papillæ occur. Globiferous tridentate, rostrate and triphyllous pedicellariæ have been found. The globiferous pedicellariæ (Pl. XIV. Figs. 6, 9) have a rather large (glandular) space within the blade, continuing almost to the articular surface; the terminal opening has two teeth on either side. The stalk has a thickening above and below, but no free, projecting rods. — Only one small rostrate pedicellaria was found, which does not show any peculiar feature. The tridentate pedicellariæ occur in two, not very distinct forms: one (Pl. XIV. Fig. 35) with the blade somewhat widened in about the outer third part, where the valves join, the edge of this widened part being finely serrate, that of the lower part smooth; the other (Pl. XIV. Figs. 28, 44, 47) with the blade very elongated, slender, narrowing evenly towards the basal part, the edge being serrate in its whole length. In larger specimens (up to 2^{mm} length of head) the serrations are coarse and irregular; there is a little meshwork in the bottom of the blade in these larger ones. In the largest specimen seen the valves are very unequal in length (Pl. XIV. Fig. 47). This is probably an abnormal case. The neck is well developed, the stalk has only a slight indication of a ring below. The triphyllous pedicellariæ are of the usual form.

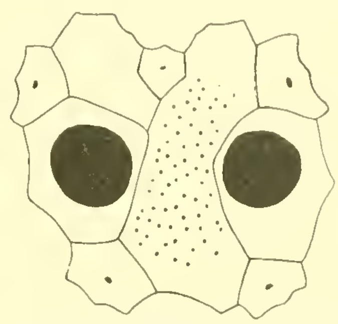


Fig. 21. Apical system of *Periaster limicola*. $^{14}/_1$.

The information given here is based on a specimen from the U. S. Nat. Museum, which Professor Rathbun has kindly sent me (»Albatross« St. 2401. — Gulf of Mexico. 142 fathoms). It agrees closely with the description and figures of *P. limicola* given by Agassiz in the Report of the »Blake«-Echinoidea (Bull. Mus. Comp. Zool. V. 1878. p. 193. Pl. III), except in having no distinct anal fasciole. On the other hand I have seen in the British Museum (3) specimens of »*Periaster limicola*« from the station (»Blake« St. 49) from which the species was first described; but these specimens differ so considerably in regard to the structure of the pedicellariæ from what is made known above, that it seemed to me certain that it must be another species, viz. the *Brissopsis alta* Mrtsn. described below; the pedicellariæ of this latter species exactly agree with the present form. A renewed examination of these specimens in the British Museum has proved this conclusion from the structure of the pedicellariæ to be quite true: they are very typical *Brissopsis*, with the subanal fasciole very well developed, quite agreeing in form and structure with the *Br. alta* described below.

In the »Panamic Deep-Sea Echini« p. 210 Professor Agassiz says: »There must have been some mistake in the identification of the Schizasterid collected by the »Challenger« (Pl. XXXV. b.

Figs. 1—4) as *Periaster limicola*. I quite agree with the eminent author herein, and having examined the specimens in the British Museum I am able to add some more differences to those now found by Professor Agassiz between the «Challenger» specimens and the true *P. limicola*. The labrum ends off the first adjoining ambulacral plates. There are four large subanal tube-feet. One specimen has two genital pores, the other has four, the two anterior being quite small. The latero-anal fasciole has quite disappeared in one specimen, in the other there are distinct traces of it. The frontal tube-feet have a well developed disk, strongly lobate in the edge, the rosette-plates reaching only the beginning of the lobes. The spicules are very numerous, rather much branched, otherwise like those of *limicola*. The globiferous pedicellariæ are of the Schizasterid type, with a very large space within the blade (Pl. XIV. Figs. 1, 4); there is one tooth on either side of the terminal opening. The stalk has a limb above, where the muscles from the head are fastened, and a small ring below. The tridentate pedicellariæ (Pl. XIV. Fig. 21) are rather similar to those of *P. limicola*, viz. the slender form. The long and slender valves join only at the point; the edge is in the lower part very coarsely and irregularly serrate; there is a little meshwork, sometimes rather coarse, in the blade. Rostrate pedicellariæ have not been found; the ophicephalous pedicellariæ (Pl. XIV. Figs. 5, 36) are of the usual Spatangoid type, and there is a prolongation from the lowermost of the arcs. The stalk is not distinctly cupshaped above. The triphyllous pedicellariæ do not present peculiar features.

The differences pointed out by Professor Agassiz and here, together with the geographical distribution: one a deep-sea form from the Gulf of Mexico, the other a littoral form from the Arafura Sea, leave no doubt that this is another species; if it be a new species is not so certain. It is very like the *Schizaster Jukesii* Gray both in the characters of the test and of the pedicellariæ, and even the locality is the same; indeed, I think it almost beyond doubt that it is really identical with that species. — (In «Revision of Echini» *Schizaster Jukesii* is made a synonym of *Sch. ventricosus* (*lacunosus* L.); this is, however, certainly not correct; the verification thereof will be given in Part II of the Siam-Echinoidea). Whether *Schizaster Jukesii* ought really be reckoned to the genus *Periaster*, as is done, in fact, by Agassiz in the «Challenger»-Echinoidea, is not easy to determine, these genera being upon the whole very closely related. Perhaps the globiferous pedicellariæ may indicate the correctness of referring *Sch. Jukesii* to *Periaster*; in any case they differ considerably from those of *Schizaster lacunosus* a. o. (comp. below). But upon the whole I do not venture to enter in a more detailed manner on a discussion of the rather difficult question of the genus *Periaster*, my knowledge of the fossil forms being too insufficient.

27. **Brisaster (Schizaster) fragilis** (Düb. Kor.).

Pl. I. Figs. 6—7. Pl. XIII. Pl. XIV. Figs. 3, 7, 11, 13—16, 18, 20, 24—25, 31, 37, 39, 43, 46, 50—51.

Synonyms: *Brissus fragilis* Düb. Kor.

Tripylus fragilis Sars.

Principal literature: Düben & Koren: Skandinaviens Echinodermer. 1844. p. 280. Tab. X. 47—49. — Gray: Catalogue Rec. Echinida. 1855. p. 61. — Lütken: Bidrag til Kundskab om Echiniderne. p. 175 (107). — Sars: Norges Echinodermer. p. 96. — Agassiz: Rev. of Echini. p. 157, 363. Pl. XXI. 3, XXVI. 42. — «Challenger»-Echinoidea. p. 201, «Blake»-Ech. p. 74. Pl. XXVIII. 8—14. — Lovén: Études sur les Éch. Pl. XII. 102, XXXI. — On Pourtalesia. Pl. X. 100. — Bell: Catalogue Brit. Ech. p. 164. — Hoyle: Revised List Brit. Ech. p. 422. — Koehler: Note prélim. sur les Échinides, Ophiures et Crinoidées rec. en 1898—99, «Princesse Alice». Bull. Soc. Zool. de Fr. 1901. p. 99. — Grieg: Nordlige Norges Echinodermer. p. 32. — Döderlein: Echinoiden d. deutschen Tiefsee-Expedition. p. 253. Taf. L. Fig. 2. — Fauna Arctica. Seeigel. p. 385.

For other less important literary references see «Rev. of Ech.» and Bell's Catalogue.

This species is very well described by Düben and Koren and later on by Agassiz, so that very little remains to be added as regards the structure of the test. —

The shape of the test is rather variable; sometimes it is more rounded, sometimes more elongated; not seldom it is unequally developed, the right side projecting beyond the left in front, though somewhat less than is generally the case in *Spatangus purpureus*. — In «Revision of Ech.» Pl. XXI. 3 is figured a specimen in which the left side projects beyond the right. There can, however, scarcely be any doubt that this figure (photograph) has been reproduced in inverted position; this is especially shown by the genital pores: in this figure there are two genital pores on the right side, whereas they are really found on the left side, as stated by Agassiz himself, (Rev. of Ech. p. 263 —: «three genital openings, right anterior obliterated»). — (A similar inverted reproduction is found in the «Hassler»-Echinoidea. Pl. II. 4, *Nacospatangus gracilis*, and, probably, Pl. IV. 6, 8, («*Hemiaster*» *Philippii*). — The height of the test likewise is rather variable, especially the abactinal keel formed by the posterior interambulacrum may differ very much, being sometimes quite indistinct, sometimes very prominent.

The length of the posterior petals is generally scarcely one third of that of the anterior ones; in a specimen from Bergen, however, they are more than half as long as the anterior ones, and the apical system in this specimen is subcentral, whereas the apical system is otherwise near the posterior end. (This specimen is figured in Pl. I. Fig. 7, the Fig. 6 showing a normal specimen of the same size for comparison). In the same specimen the posterior part of the labrum is longer than usual, reaching to the 2. ambulacral plate on one side, to the posterior edge of the 1. ambulacral plate on the other side, whereas it normally ends off the middle of the 1. ambulacral plate. Also the plastron is broader than usual. Upon the whole this specimen differs very considerably from the typical form and would undoubtedly have been made the type of a distinct species, had it come from a more distant, less well known locality; but, as the Norwegian specimens otherwise do not show these characters, such a single specimen can certainly only be regarded as an abnormal, probably atavistic case. But it might well be worth looking out for similar specimens — as, of course, the existence of another species of *Schizaster* in these regions, cannot be declared impossible. — Evidently the specimen of which Grieg (Op. cit.) gives some measurements has some resemblance to the above mentioned, though the posterior petals are not so long as here.

According to the statements of Agassiz («Blake»-Ech. p. 74) there is «considerable variation in the distinctness of the lateral fasciole as it passes under the anal system. In some cases it stops suddenly near the level of the anal system; in others it can be faintly traced as an indistinct, irregular anal fasciole; in others the anal fasciole is most clearly marked. These differences do not depend on size, but specimens from one locality are usually similarly affected». Under the description of *Schizaster orbignyanus* («Blake»-Ech. p. 76) Agassiz further says: «It is interesting to note that in the specimens of *S. fragilis* dredged off our eastern coast, the anal fasciole disappears first, leaving only a part of the lateral fasciole extending from the peripetalous fasciole towards the anal system». On all the numerous specimens of *S. fragilis*, I have examined, I have found the anal fasciole distinct, whereas the lateral fasciole is more or less rudimentary in a few (3) specimens from St. 32. In two of these specimens the lateral fasciole is quite wanting on the one side, only partly distinct, not reaching the peripetalous fasciole, on the other side; on the third specimen it is wanting on both sides, only the anal part remaining distinct. But specimens without the anal part of the fasciole I have never seen; my experiences thus are not in accordance with those of Agassiz. Evidently the specimens without the anal part of the fasciole deserve to be reexamined; it is not impossible that they will prove to belong to another species. (Comp. *Hemiaster zonatus*, p. 105).

The pedicellariæ of *Sch. fragilis* were until recently almost quite unknown. Agassiz (Revision of Ech. Pl. XXVI. Fig. 42) figures a valve of a pedicellaria, which he finds (p. 666) »resembling the gemmiform type of the Echinidæ» (in the explanation of plates called »stout-headed pedicellaria»); it is the rostrate form. The tridentate pedicellariæ were seen by Koehler (Op. cit.), who only states that they are of the usual form. Lastly, however, Professor Döderlein (Op. cit.) has given very important information on all the pedicellariæ (except the ophicephalous) of this species and of most of the other recent species of *Schizaster*. My own observations, which were made about two years before Professor Döderlein's work was published, agree almost completely with his. Having, however, several additional remarks to make, I may give my original description almost unaltered; likewise I give most of the figures of pedicellariæ made at that time. The figures given by Döderlein are, of course, quite correct, being photographs; but several important details are not seen, so that my figures will probably not be found superfluous.

The globiferous pedicellariæ (Pl. XIV. Figs. 14, 16, 24, 51) are rather conspicuous. The valves are enclosed by a thick, evidently glandular coat of skin, which continues down over the upper part of the stalk, covering the great muscles which go from the valves to a thickening of the stalk, a little above the middle. Also at the lower end of the stalk there is a generally less distinct thickening for the fastening of the basal muscle. The stalk is rather thick and compact; the head rests directly upon the rounded upper end of the stalk. The valves are very characteristic (Pl. XIV. Figs. 14, 16). As in the globiferous pedicellariæ of the Cidarids there is a large space in the interior of the valves, probably enclosing a poison gland, passing far down into the basal part, almost to the articular surface. The opening of this space is at the point of the valve at the base of the single rather large and compressed endtooth; the opening may be at its right or left side indifferently, that side with the opening being somewhat hollowed. Very seldom abnormal globiferous pedicellariæ occur, whose valves end in two diverging teeth between which the opening lies (Pl. XIV. Fig. 24); sometimes pedicellariæ are found in which one of the valves ends in two teeth, the others in the usual way. Generally these pedicellariæ are strongly pigmented, often almost black, and, where they occur in greater numbers, very conspicuous. They may be very numerous especially on the anal area, on the abactinal side in the posterior interambulacrum and along the petals; on the actinal side they are very seldom found. I have found them in specimens of only ca. 4^{mm} length. They differ rather much in size, the thick part (head and upper part of the stalk) reaching about 1^{mm} length.

The rostrate pedicellariæ (Pl. XIV. Figs. 11, 15, 43) have the valves very little widened in the point; they generally end in 6 small teeth; sometimes they are even narrowed in the point ending with only 4 small teeth. Not seldom they are 4-valved (Pl. XIV. Fig. 43). This kind of pedicellariæ is especially developed round the mouth and in the anterior ambulacrum; also on the anal area they often occur, but generally only small ones. Upon the whole these pedicellariæ are smaller and much less conspicuous than the globiferous ones; the length of the head up to ca. $0{\cdot}5^{mm}$. The neck is short, especially in the larger ones; the stalk is thick and compact.

The tridentate pedicellariæ (Pl. XIV. Figs. 3, 7, 18, 20, 25, 37, 46, 50) are uncommonly richly developed, the valves varying from simply leafshaped to almost tubular, but all intermediate forms occur, so that separate forms of them cannot be distinguished. As the more typical form I must regard those with large leafshaped valves, narrowed in the lower part, widened towards the point, where usually some coarse serrations are found; the edge of the lower, narrowed part may be almost smooth, with only a few large teeth or more closely serrate. There may be a more or less developed meshwork in the bottom of the blade. (This form is represented in Figs. 18, 46, 50. Pl. XIV and in Döderlein's Fig. 2. b, f. Pl. L). Another form has the narrow lower part of the blade more distinctly set off from the outer, widened part, and the point of the blade more or less distinctly bent inwards (Pl. XIV. Fig. 25). Quite small specimens may be simply leafshaped (Pl. XIV. Fig. 20, and Döderlein's Fig. 2. c), or more or less recalling the rostrate pedicellariæ (Pl. XIV. Figs. 3, 7) and perhaps they ought really to be reckoned to that type; this, however, cannot be decided and is of no importance. — Large tridentate pedicellariæ with almost tubular blade (Pl. XIV. Fig. 37) I have found only in a large specimen from the Faroe Islands — perhaps it is an abnormal form. The large tridentate pedicellariæ are found almost exclusively on the actinal side, round the peristome and along the ambulacra. They have a well developed neck; the stalk is rather compact, with a more or less distinct "milled" ring below.

Ophicephalous pedicellariæ (Pl. XIV. Fig. 39) I have found only on quite young specimens of 3—6^{mm} length. They are of the usual Spatangoid type, without neck. The blade is broadly triangular, continuing almost down to the articular surface, the apophysis being short and broad. The triphyllous pedicellariæ (Pl. XIV. Fig. 31) are of the usual form, with finely serrate edge.

The sphæridiæ continue, as is usually the case, along the posterior ambulacra to the anal area; they do not present features of specific value, and are almost spherical, smooth or grooved. — The spicules (Pl. XIV. Fig. 13. a. b) are irregular, spinous rods; in the large tube-feet of the anterior ambulacrum they are more complicated, their protuberances being larger and partly uniting so as to form fenestrate plates. Lovén (Pourtalesia. Pl. X. Fig. 100) figures the rosette-plates as reaching only halfway out in the lobes; I find them generally reaching almost to the point of the lobes.

In the "Blake"-Echini (p. 74) Professor Agassiz describes young specimens of *Sch. fragilis* of 6 and 10^{mm} length. The "Ingolf"-Expedition has taken (especially at Station 28) several small specimens, the youngest of which are only 2^{mm} in length. I am thus able to give a rather full account of the development of this species from a size of 2^{mm} upwards, a development which proves of no small interest. (Pl. XIII).

In specimens of 2^{mm} length (Pl. XIII. Figs. 2, 4) the anal system is almost in the middle of the abactinal side; it is, in fact endocyclic, closely joining the two large anterior genital plates, while the posterior ambulacra end off the posterior edge of the anal area. The posterior genital plates are not developed; the ocular plates as well as the abactinal plates of the paired ambulacra are rather indistinct, but the course of the ambulacra is sufficiently distinct. The same, from a phylogenetic point of view, highly interesting construction of the apical area has been described and figured for *Abatus cavernosus* by Lovén (On Pourtalesia. p. 20—22, Pl. XIV) and by Agassiz (Panamic Deep-Sea Echini. p. 211—13. Pl. 99). The plates of the anterior ambulacrum are comparatively large and elongate, with single pores, and only two tube-feet in each series of plates have as yet appeared within the fasciole. They are rather large as shown in Fig. 3. Pl. XIII, but can by no means be said to be of very prominent size. Especially interesting is the fasciole, which consists only of a broad band encircling both apical and anal system, as is also the case in *Abatus cavernosus* of a corresponding size. The actinal system is quite embryonal, round (Pl. XIII. Fig. 4), the labrum not at all prominent. The sternum is typically amphisternous,[1] though the plate 5. a. 2 is longer than b. 2. The test is almost oval in circumference, with a very slight sinuation at the front, but the frontal ambulacrum is not deepened. The shape of the test is rather flat, not at all globular, as is maintained by Professor Agassiz (»Blake»-Echini. p. 78) to be the case in young Schizasters.

In the course of the further development the following changes take place. The postero-lateral ambulacra and the two series of plates of the odd posterior interambulacrum grow forwards along each side of the anal system, which is by and by pushed backwards, and a pair of interambulacral plates develop between the two large genital plates and the anal system (Pl. XIII. Fig. 1). The fasciole now presents a very important change: from the primary fasciole has developed a transverse branch, passing over the postero-lateral interambulacra and between the apical and anal system. This transverse band, together with the anterior part of the primary fasciole develops into the peripetalous fasciole, whereas the part of the primary fasciole posterior to the transverse band becomes the latero-anal fasciole. — This stage is found at a size of 3^{mm} length (Pl. XIII. Fig. 1). — Plates are now continually developing in the odd posterior interambulacrum, the new ones appearing at the posterior end of the two large genital plates. Thereby the anal area is pushed more and more backwards, till it comes on the posterior edge of the test and is at last not at all seen from above. These interambulacral plates between the anal area and the apical system form the prominent abactinal keel; the shape of the test is thereby very much altered, as seen by a comparison of the Figs. 9 and 7, Pl. XIII, representing side views of the test in specimens of 3 and $4{\cdot}5^{mm}$ length. The latero-anal fasciole, of course, is gradually pushed more backwards, as it must retain its original relation to the anal area, viz. passing just behind it. In specimens of ca. 6^{mm} length its anal part cannot be seen from above any longer.

We may now follow the development of the abactinal ambulacra. The odd anterior ambulacrum, which is at first not much broader than the paired lateral ambulacra, soon enlarges considerably, the plates becoming much broader and comparatively lower. The sinuation in the front edge becomes gradually deeper, and at the same time the ambulacrum deepens, forming a groove, bordered by the adjoining antero-lateral interambulacra. At about 4^{mm} length the pores become double, the outer pore

[1] Agassiz (loc. cit.) says of the quite similar sternum in the young *Abatus cavernosus* that it is »almost a true meridosternum». As I have pointed out above (p. 84), it is not at all meridosternous but typically amphisternous.

constantly being larger than the inner one in each pair. The number of plates increases considerably; whereas at 2^{mm} length only 2—3 pairs of plates are developed between the fasciole and the ocular plate, there are 17 pairs in a specimen of 11^{mm} length. The fasciole here keeps its original position, close to the anterior edge. — As said above it was very difficult to trace the exact number of plates of the abactinal paired ambulacra in the smaller specimens. From a size of ca. 4^{mm} length there was no difficulty in tracing the exact number and shape of these plates; while therefore the figures 1, 2 and 5. Pl. XIII do not claim to be quite exact in this respect, the figures of the later stages give them correctly. In the younger stages no pores at all are developed in these plates; at a size of $4{\cdot}5^{mm}$ (Pl. XIII. Fig. 8) I find the pores very faintly indicated in the posterior series of the antero-lateral ambulacra. In specimens of $5{\cdot}5^{mm}$ and $6{\cdot}5^{mm}$ they are distinctly developed in both series of these ambulacra (Pl. XIII. Figs. 10, 12). At a size of $7{\cdot}5^{mm}$ I find the pores of the posterior series of plates double, while those of the anterior series are still simple — a very interesting stage, which is kept for life by the genus *Agassizia*. In specimens of 9^{mm} the pores are double in both series, though the pores as well as the plates of the posterior series are still considerably larger. The antero-lateral ambulacra have thus attained the petaloid condition, and their further development consists only in the enlarging of the plates and pores and the gradual deepening (already at ca. 6^{mm} the deepening is rather distinctly seen), besides, of course, the adding of new plates at their upper end. — The development of the posterior petals begins somewhat later, on account of the original position of the transverse fasciole close behind the apical system. In a specimen of $5{\cdot}5^{mm}$ (Pl. XIII. Fig. 10) I find the first plates to have appeared within the fasciole; in a specimen of $6{\cdot}6^{mm}$ a single pore has already appeared, and in the next stage (Pl. XIII. Fig. 13), $7{\cdot}5^{mm}$, three pairs of plates have developed between the fasciole and the ocular plates, each with a single pore. In a specimen of 9^{mm} length (Pl. XIII. Fig. 14) four pairs of plates have developed; they are already a little widened and deepened, and the pores are double, the petaloid condition thus being reached. In the plates between the transverse and the latero-anal fasciole no pores are seen, but each has a rather large tubercle.

In the apical system also important changes take place. In the youngest specimens only two large genital plates are present, viz. the two anterior ones, the right one with a single madreporic pore. All the ocular plates are developed, though only that of the anterior ambulacrum is quite distinct. It is an important fact that the ocular plates of the posterior paired ambulacra are separated from the first beginning, at first by the anal area and later on by the two anterior genital plates; the apical system thus is ethmolytic from the beginning, not passing through an ethmophract stage, as might perhaps be expected from a phylogenetic point of view. — The same is shown by Lovén (On Pourtalesia. Pl. XVII) to be the case in *Echinocardium flavescens*, whereas the young stages examined by Lovén (and myself) of *Spatangus purpureus* and *Brissopsis lyrifera* are not young enough for proving the non-existence of an earlier ethmophract stage in these species. — The posterior genital plates cannot be discerned with full certainty, till the specimens have reached a length of ca. 7^{mm} (Pl. XIII. Fig. 13). The genital pores appear at a size of $9—11^{mm}$. The madreporic pores begin to increase in number in specimens of ca. 6^{mm}, but still at a size of $10—11^{mm}$, when the genital pores are already developed, the madreporic plate has not begun to develop into that large size, which it obtains in grown up specimens.

On the actinal side the only more important change occurs in the actinostome, the labrum widening at the anterior end until it has taken the place of the posterior half of the actinostome and at last covers the mouth-opening. Other changes occurring on the actinal side are mainly due to simple enlargement of the plates.

The identification of these young specimens of *Sch. fragilis* is beyond doubt, both on account of all intermediate stages being found, and on account of the pedicellariæ; it is especially to be noticed that globiferous pedicellariæ are developed already in the youngest specimens and of the same form as in the grown specimens, but no other species of Echinoids of the Northern Atlantic, as far as I know, has that type of pedicellariæ — except «*Hemiaster zonatus*», which cannot be taken into consideration here, as it has (as far as known) no latero-anal fasciole. Now, on the other hand, these young specimens closely agree with the genus *Spatagodesma* A. Ag. (Panamic Deep-Sea Echini. p. 198—202. Pl. 106—7), founded by Professor Agassiz upon some young specimens, about 5^{mm} in length. A comparison of the figures given here with those of *Spatagodesma Diomedæ* seems to leave no doubt that the latter is only the young of some *Schizaster*-species from the Southern Atlantic[1], or perhaps of a species of the genus *Abatus*, whose development is quite similar to that of *Schizaster fragilis*.[2] The pedicellariæ might probably have given a definite answer to the question of the genus to which *Spatagodesma Diomedæ* really belongs, but, unfortunately Professor Agassiz does not give any information thereof. Be that as it may; the genus *Spatagodesma* must certainly be withdrawn as a synonym of one of these genera. Professor Agassiz thinks *Spatagodesma* most nearly related to *Agassizia;* this need not be further discussed, in view of the fact that *Spatagodesma* is really only the young of some other well known genus, whether *Schizaster* or *Abatus* — but, of course, I will not deny that the structure of the young may be of importance for judging of the relation of these genera.

In the description of *Spatagodesma* Professor Agassiz points out that «there is a central apical plate, composed of the four ankylosed genitals»; but the left anterior ocular plate is, nevertheless, not in direct contact with this ankylosed plate, it is separated therefrom »by the intercalation of a row of lateral interambulacral plates». This intercalation of interambulacral plates in the apical system is something quite new in the Amphisternous Spatangoids, and probably Professor Agassiz has been lead to this interpretation by his supposition of a close relation to *Agassizia*, in which genus all the genital plates are really ankylosed together. A comparison of the figure 2. Pl. 106 (Pan. Deep-Sea Ech.) with the figures given here of the apical system of the young *Sch. fragilis* seems to me to leave no doubt that the so-called intercalated interambulacral plates are really the two posterior genital plates, the large central apical plate being not the ankylosed genital plates, but the single right anterior genital plate and madreporite.

The young stages of *Sch. fragilis* here described are especially important for the interpretation of the lateral fasciole. Professor Agassiz («Chall».-Ech. p. 200) takes the fact, that the latero-anal fasciole of *Schizaster japonicus* is sometimes interrupted on the sides of the test, as a proof »evidently showing that the lateral fasciole is an extension of the anal fasciole«. The development of the fascioles in

[1] It was taken off the Atlantic coast of Patagonia, not off San Francisco, as stated in «Bronn» p. 1406.

[2] The development of *Abatus cavernosus* will be treated in my Report on the Echinoidea of the Swedish South-Polar Expedition.

Sch. fragilis, and even more the quite similar development of the fascioles in *Abatus cavernosus*, where both lateral and anal fasciole generally disappear with age, shows that the latero-anal fasciole is part of the primary fasciole.

Sch. fragilis was taken by the «Ingolf»-Expedition at the following stations:

St. 25	(63° 20′ Lat. N.	54° 25′ Long. W.	582 fathoms	3°3 C. Bottom temp.)	5 specimens.
— 27	(64° 54′ —	55° 10′ —	393 —	3°8 — —)	10 —
— 28	(65° 14′ —	55° 42′ —	420 —	3°5 — —)	Numerous specimens.
— 32	(66° 35′ —	56° 38′ —	318 —	3°9 — —)	35 —
— 35	(65° 16′ —	55° 05′ —	362 —	3°6 — —)	5 —
— 54	(63° 08′ —	15° 40′ —	691 —	3°9 — —)	1 —
— 81	(61° 44′ —	27° 00′ —	485 —	6°1 — —)	2 —
— 85	(63° 21′ —	25° 21′ —	170 —	— —)	1 —
— 89	(64° 45′ —	27° 20′ —	310 —	8°4 — —)	4 —
— 97	(65° 28′ —	27° 39′ —	450 —	5°5 — —)	2 —

The species was further taken in the Davis Strait by Wandel 1889 (63° 56′ Lat. N. 53° 12′ Long. W. 130 fathoms. 1 specimen). Several specimens were taken at the Faroe Islands (150—190 fathoms) by the author in 1899 and by Ad. S. Jensen («Michael Sars». 1902).

The bathymetrical distribution of this species is ca. 35—700 fathoms. In the «Challenger»-Echinoidea, p. 221 it is stated to have been taken (by the «Blake») at a depth of 955 fathoms at the «Caribbean Islands». I cannot find in the Preliminary Report on the «Blake»-Echini (Bull. Mus. Comp. Zool. VIII. 1880. Nr. 2. p. 84) or in Professor Rathbun's works any locality to which this statement might refer. — The geographical distribution of *Sch. fragilis* is: from the Northern Norway to the Faroe Channel, South of Iceland, Davis Strait and along the American coast down to Florida. On the European side of the Atlantic it is not known farther south than the Faroe Channel, and it is not known from the Mediterranean or the Azores.

Sars (loc. cit.) and recently Grieg (loc. cit.) point out that *Sch. fragilis* is both more common and reaches a considerably larger size at Northern Norway than farther South; thus it reaches a size of 90mm length at the Northern Coasts, whereas the largest specimens known from Bergen are only 55mm. (A specimen from the Faroe Islands has the same size, and a specimen from the American Coast (S. of Long Island, 302 fathoms) is 60mm in length). «It is therefore without doubt to be regarded as an arctic form». It is certainly a remarkable fact that the largest specimens are from the most northern locality, but nevertheless *Sch. fragilis* is evidently no arctic form. It is not found in the cold area of the Norwegian Sea, occurring only where the bottom temperature is positive. It is one of those rather numerous species, which belong to the Northern Atlantic, the warm area, but, on account of the peculiar hydrography of the Norwegian Sea, proceed far North along the Norwegian Coast.

In the «Challenger»-Echinoidea (p. 201—2) *Sch. fragilis* is recorded from the Cape of Good Hope, and recently Professor Bell[1] likewise records the species from South of Africa. Döderlein (Op. cit. p. 250) supposes that these specimens are really *Sch. capensis* Studer, of which species a careful description and figures are given. Having myself examined the type specimen of the *Sch. capensis* in

[1] The Echinoderma found off the Coast of South Africa. I. Echinoidea. Marine Investigations in South Africa. III. 1904. p. 175.

the Berlin Museum and the specimens of the «Challenger» (St. 142), I must fully join Professor Döderlein herein. As pointed out by Döderlein this species recalls *Sch. philippii* very much by the shape of the test; there is no distinct abactinal crest formed by the posterior interambulacrum, the test slopes gently towards the posterior end. The posterior petals are a little shorter than in *Philippii*, but above all it is very easily distinguished from that species by its globiferous pedicellariæ, which are like those of *fragilis* with a single, large endtooth. On the other hand it differs from *fragilis* in the broad shape of the tridentate pedicellariæ, besides by the shape of the test. It may be expressly stated that I have found the pedicellariæ of both the type specimen of *S. capensis* and of the «Challenger»-specimen quite like those figured by Döderlein (Op. cit. Pl. L. Fig. 3). (Pl. XIV. Figs. 33, 48) In the former I have further found a short and broad pedicellaria (Pl. XIV. Fig. 42) which may perhaps represent the rostrate pedicellariæ, which have otherwise not been found in this species. Ophicephalous pedicellariæ have not been found either, and as in *S. fragilis* they will probably be found only in quite small specimens.

I have further seen in the British Museum two specimens, labelled *Sch. fragilis*, from the Cape of Good Hope Government, (No. 29), evidently the specimens mentioned by Professor Bell (Op. cit.), who states on account of them that the species attains a much greater size here than in the Northern waters. They are, however, certainly not *Sch. fragilis*, but belong to the *canaliferus*-group, and probably represent a new species. The shape of the test is as in *Sch. canaliferus*, and the pores of the frontal ambulacrum are arranged in double series as in that species. I have found only rostrate pedicellariæ, both specimens being almost naked; they differ considerably from those of *canaliferus*, being much less elongated and with quite smooth edges; the blade is curved in the usual way, a little widened at the point, which is closely serrate (with ca. 16 teeth); the basal part is rather narrow (Pl. XIV. Fig. 30, comp. with Pl. XIV. Fig. 26 which represents the corresponding form of pedicellariæ from *Sch. canaliferus*). The spicules (Pl. XIV. Fig. 38. a—c) likewise differ very considerably from those of *canaliferus*; they are of two kinds: small, rounded, fenestrate plates, and numerous simple rods of the usual form, arranged in 3—4 longitudinal rows, the fenestrate plates occurring mainly between these series. The rosette-plates as in *canaliferus*. — By the double row of pores in the anterior ambulacrum this form agrees with *Sch. canaliferus* and *Savignyi* alone. It is probably a new species; however, so long as *S. Savignyi* and the var. *major* Fourtau[1] are not sufficiently known as regards their pedicellariæ, I think it preferable not to establish it definitely as a new species — the more so, as it is itself insufficiently known as regards the pedicellariæ.

Of the rather numerous recent species of *Schizaster* hitherto described three more belong to the Atlantic (and the Mediterranean), viz. *Sch. canaliferus* (Lmk.), *orbignyanus* A. Ag. and *Edwardsi* Cotteau. I may take the occasion to give here some additional information of these species, which may not prove superfluous. *Schizaster canaliferus* is so well known and well described, especially by Agassiz and Koehler, that I have only very little to add. It may be worth noticing that there are found 5—6 large tubefeet on each side along the anal area, the first of these placed in the 5th ambulacral plate; the subanal fasciole passes over the 12th ambulacral plate. (In *S. fragilis* there are 4—5

[1] R. Fourtau: Contribution à l'étude des Échinides vivant dans le Golfe de Suez. Bull. Inst. Égyptien. 4. Sér. Vol. IV. 1904.

large subanal tubefeet, the first on the 6th plate; the subanal fasciole passes over the 10—11th ambulacral plate). The pedicellariæ have been described and partly figured by Koehler (Ech. des Côtes de Provence) but not in a sufficiently detailed manner. Recently Professor Döderlein (Op. cit. p. 255) has given a short, but correct description of the pedicellariæ. It is, however, not accompanied by figures, so that I think it will not be found superfluous, when I give here a fuller description and figures of these pedicellariæ. — The globiferous pedicellariæ have the terminal opening of the valves surrounded by a circle of teeth, generally 3 on each side, and outside these one or two more on each side (Pl. XIV. Figs. 8, 40). The blade is almost equally wide in its whole length; the gland-space in the interior reaches down to the articular surface. The rostrate pedicellariæ (Pl. XIV. Fig. 26) have long and slender valves; the edges are inrolled, sometimes with a few serrations. The point of the blade with ca. 6 teeth, not widened (in the larger ones). At the peristome rather large specimens of these pedicellariæ may occur (ca. 0·6^{mm} head), with the neck well developed; rostrate pedicellariæ may occur more numerously on the anal area, but these are upon the whole much smaller, with the point of the blade a little widened (Pl. XIV. Fig. 19), and without distinctly developed neck. As a whole the rostrate pedicellariæ are rather poorly developed; the tridentate pedicellariæ are the more prominent (Pl. XIV. Figs. 22, 41, 45). In the simplest form the blade is leafshaped, the edges joining in their whole length, finely serrate. This form is generally quite small. In larger specimens the valves become more and more apart, the free edge being more or less regularly and coarsely serrate; the blade is here quite narrow and flat. In the extreme form the valves join only with the very point. These large pedicellariæ (head up to a little more than 1^{mm}) have generally four valves (as figured by Koehler. Op. cit. Pl. VII. 55), but specimens with three or even with five valves may be found. (This is, I think, together with the 5-valved tridentate pedicellaria of *Salenia hastigera* figured by Döderlein (Op. cit. Pl. XLV (XXXVII) 3. i) the only case of 5-valved pedicellariæ made known as yet; a case of 8-valved pedicellariæ is described sub *Brissopsis lyrifera*). The triphyllous pedicellariæ without prominent features, like small tridentate ones. — The spicules (Pl. XIV. Fig. 34) are very small, irregular plates; they are found only near the sucking disc and are arranged rather regularly in 4 longitudinal series. The rosette-plates of the frontal pedicellariæ well developed, reaching the point of the lobes.

This species is known only from the Mediterranean; only in Rathbun's Catalogue (337) p. 291 it is mentioned from the American Coast of the Atlantic (40° 02′ N. 70° 37′ W. 101 fathoms). Professor Rathbun has done me the very great service to send me this specimen for examination. I find it to be *S. orbignyanus*.

Sch. orbignyanus is figured and described by Professor Agassiz in the «Blake»-Ech. p. 76. Pl. XXVIII. Agassiz points out that there is a considerable difference between the specimens from the Caribbean Sea and those from the northern coasts (off Marthas Vineyard), the peripetalous fasciole being »much broader» in the northern form. His fig. 5 probably represents the northern form (in any case it agrees with the specimen from off Marthas Vineyard, which Professor Rathbun has sent me for examination), and the Fig. 2 probably the southern form. Judging from these figures it is not especially the breadth of the fasciole in which they differ, but more in its shape. In the northern form it is narrow in the anterior part, from the point of the anterior petals; the median part of the fasciole is thus much broader than its anterior part. In the southern form it is broadest in front, passing almost straight across the anterior ambulacrum from the end of the anterior lateral petals. The latter are in the northern form about twice and a half as long as the posterior petals; in the southern form (to judge from the fig. 2 of Agassiz) they are 4 times as long. It might then well seem a little doubtful whether they are really the same species — at least they deserve to be carefully examined and compared. In case they prove to be different species, the southern form must keep the name *orbignyanus,* as the species was established on specimens from the Caribbean Sea (Prel. Rep. Blake Ech. p. 84). Unfortunately I could not examine this question during my visit to America, as I could not get access to the Collections of the Museum of Comparative Zoology, and specimens from the Caribbean Sea were not in the Collections of the U. S. National Museum or the Museum of Yale College.

S. orbignyanus is upon the whole very like *canaliferus;* a careful examination, however, shows several more important differences. Agassiz notices as «a character which readily distinguishes the specimens of the two species thus far compared» the closer tuberculation of *orbignyanus.* In the specimens, I have examined, this is, however, a very little prominent feature; I can indeed scarcely find any difference between the two species in this respect. — Perhaps the statement cited was founded on the southern form. — In the structure of the test I find the most important difference between the two species in the arrangement of the pores in the odd anterior ambulacrum. In *canaliferus* the pores are arranged in two, close, irregular series, a feature which I find distinct already in a specimen of 23^{mm} length; in *orbignyanus* these pores form only a single almost regular series (the examined specimens ca. 50^{mm}); the ambulacral plates are thus much higher than in *canaliferus.* The form of the labrum is a little different, the posterior part being comparatively longer and narrower in *orbignyanus,* but as in *canaliferus* it does not reach the 2. ambulacral plate. The first of the large subanal tubefeet is found on the 6th ambulacral plate (on the 5th in *canaliferus*); the subanal fasciole passes over the 11—12th plate, as in *canaliferus.* Agassiz points out that the latero-anal fasciole varies greatly in distinctness; my observations are in accordance with this; of the two specimens before me one has it very distinct, whereas in the other it is totally wanting.

The pedicellariæ give very good specific characters. The globiferous pedicellariæ (Pl. XIV. Figs. 2, 32) are upon the whole very like those of *canaliferus;* the terminal opening of the valves is surrounded only by a single circle of teeth, 4 (seldom 3) on each side. The second tooth from the point may sometimes be placed a little more laterally from the others. The form of the valves is otherwise like that of *canaliferus.* The stalk has at its lower end some free, upwards projecting rods (Pl. XIV. Fig. 29); such are not found in *canaliferus.* The rostrate pedicellariæ (Pl. XIV. Figs. 23, 49) are rather like those of *canaliferus;* the blade is long and slender, with smooth, somewhat inrolled edges, which may be united by a few crossbeams in the lower part. The point of the blade is rather broad, with about 10—16 rather strong teeth. They may reach a length of head of ca. 1^{mm}. The neck is very short. Small forms like those of *canaliferus* also occur. The tridentate pedicellariæ (Pl. XIV. Figs. 12, 17) have rather elongate, narrow leafshaped valves, which join in almost their whole length; some of them have a few coarse serrations along the edge in the lower part (Pl. XIV. Fig. 17); (up to ca. $0{\cdot}7^{mm}$ length of head). Only these forms have been found, the tridentate pedicellariæ thus far from reaching the rich development of the tridentate pedicellariæ in *canaliferus;* but it may be remarked that I have seen only a few, not very perfectly preserved specimens — a better material will probably show that the tridentate pedicellariæ are richer developed. — The triphyllous pedicellariæ are as usual, like small tridentate ones. The spicules are long, spinulose rods (Pl. XIV. Fig. 27 a-b), in striking contrast to the very small spicules of *canaliferus;* they lie transversely to the longitudinal axis of the tubefeet, indistinctly arranged in two or three series. The plates of the rosette of the frontal tube-feet are well developed, reaching to the point of the lobes.

Schizaster Edwardsi Cotteau is nearly related to *canaliferus* and *orbignyanus*. Professor Joubin has with the greatest liberality, for which I cannot thank him enough, sent me one of the type-specimens for examination; I am thus able to give some additional information of characters which are not mentioned in Cotteau's diagnosis of the species. The shape of the test is upon the whole like that of *canaliferus;* only the anterior ambulacral furrow is a little broader, its sides being almost perpendicular, whereas in *canaliferus* they bend somewhat over the furrow. The pores are arranged in a single regular series — the most prominent difference from *canaliferus*. The labrum does not reach the second ambulacral plate of the adjoining series; there are 5—6 large subanal tubefeet, the first of these being on the 5th ambulacral plate. The lateral fasciole passes over the 13th ambulacral plate. Only two genital pores, as pointed out by Cotteau. Of the pedicellariæ I can give but very little information, having found only a single small tridentate pedicellaria with simple, leafshaped valves, and another small form (Pl. XIV. Fig. 10) which is probably a small rostrate pedicellaria. The spicules and rosette-plates as in *canaliferus*. — Though insufficiently known this species is easily distinguished from *canaliferus* by its single series of pores in the odd anterior ambulacrum and from *orbignyanus* (the northern form) by its spicules. But it is not possible for the present to say, if it is not perhaps identical with the Caribbean form of *orbignyanus*, which might, from a zoogeographical point of view, not be improbable. Also it has a very great likeness to *Sch. lacunosus*, and it is impossible for the present to give other distinguishing characters between these two species than their geographical distribution: one in the Indo-Pacific Ocean, the other at the Coast of Guinea; (*S. lacunosus* also has a single series of pores in the anterior ambulacrum and quite small spicules). Before the Caribbean form of *S. orbignyanus* has been closely examined and the pedicellariæ of *S. Edwardsi* have likewise been made sufficiently known, it is impossible to judge of the specific value of these two forms and their mutual relations.

Professor Döderlein (Op. cit. p. 255) has pointed out that among the (recent) species referred to the genus *Schizaster* two groups may be distinguished, differing markedly by their globiferous pedicellariæ: in one group (*S. fragilis, capensis, antarcticus* and *ventricosus*) the valves of the globiferous pedicellariæ end in a single long, sharp tooth, in the other (*S. philippii, canaliferus* and *japonicus*) they end in 4—6 short teeth. Though the number of genital pores is not in accordance with this grouping, as might have been expected, Professor Döderlein thinks that »nach Untersuchung auch der anderen Arten von *Schizaster* die Aufteilung dieser Gattung in mindestens zwei Gattungen nach den Merkmalen der globiferen Pedicellarien zu erwarten sei(n)«. — In »Revision of Echini« Agassiz says of *Sch. ventricosus* that it is »intermediate between the species of the group of the genus to which *S. fragilis* and *S. Philippii* belong and that formed by *S. canaliferus* and *S. gibberulus*«. It follows from this that also Agassiz is inclined to divide the species into two groups, but he does not work out this grouping more exactly. Recently Fourtau (Op. cit. p. 433) establishes two groups in the genus *Schizaster,* founded on the arrangement of the pores of the anterior ambulacrum, viz. 1. the *Sch. canaliferus*-group with these pores biserially arranged, and 2. the *Sch. fragilis*-group with the pores arranged in a single series. He does not mention which species he refers to each group.

Before entering on a discussion of this question of the subdivision of the genus *Schizaster* I must give a few synonymic remarks on some of the species. As pointed out by Lovén (Echinoidea descr. by Linnæus. p. 168) the *Schizaster japonicus* A. Ag. is identical with Linné's *Echinus lacunosus;* the species will then have to be named *Schizaster lacunosus* (L.). With this species I find further to be synonymous the *Sch. ventricosus* Gray. This seems, indeed, quite improbable, judging from the figures of *Sch. japonicus* and *ventricosus* given in the «Challenger»-Echinoidea Pl. XXXVI; the two forms figured there are, I quite agree, distinct species, but the species represented in Figs. 1—3 is not *ventricosus* Gray, it is probably identical with the *Sch. latifrons* A. Ag. described in the «Panamic Deep-Sea Echini». (This will be verified in Part II of the «Siam-Echinoidea»). On the other hand I cannot agree with Professor Agassiz in regarding *Sch. Jukesii* Gray as a synonym only of *lacunosus (ventricosus).* I even think it more probable that it will have to be referred to another genus *(Periaster),* as has been pointed out above (p. 108). — The matter: *Schizaster gibberulus* — *Savignyi* has been cleared up by Fourtau (Op. cit.); I quite agree with him in this question. Finally I may notice that the *Sch. affinis* Studer named in «Bronn» p. 1392, is, according to a communication to me in a letter from Dr. Meissner, the same as *Sch. capensis* Studer. The recent species hitherto known of the genus *Schizaster* are thus: *Sch. lacunosus* (L.), *canaliferus* (Lmk.), *orbignyanus* A. Ag., *Edwardsi* Cott., *Savignyi* Fourtau, *gibberulus* Ag., *Philippii* (Gray), *fragilis* (Düb. Kor.), *Moseleyi* A. Ag., *capensis* Studer, *antarcticus* Döderl., *latifrons* A. Ag., *Townsendi* A. Ag.

If we regard the shape of the test of the different *Schizaster*-species, we will at once find them to form two distinct groups. In the one the test is high and the ambulacra rather much deepened, in the other the test is low and the ambulacra only slightly deepened. To the former group belong: *S. canaliferus, orbignyanus, Edwardsi* and *lacunosus;* to the latter: *S. fragilis, Moseleyi, capensis, latifrons, Townsendi, antarcticus* and *Philippii.* A third group is perhaps formed by the species *gibberulus* and *Savignyi.* If we now review the more important characters of these species, we shall find the species of these groups to agree also in other important features, viz. the number of genital pores and the structure of the globiferous pedicellariæ. In the *canaliferus*-group there are two, in the *fragilis*-group three genital pores. To be sure the statements of Agassiz regarding the genital pores of «*Sch. ventricosus*» and «*Sch. japonicus*» do not agree with this; but these statements are based partly on wrong determinations. Desor (Synopsis des Éch. foss. Pl. 43. 2 a) figures the apical system of a *Sch. canaliferus* with three large genital pores; but this is evidently an abnormal and seldom occurring case: the third pore is in the posterior interambulacrum, not in the anterior left genital plate as in the other species with 3 genital pores. (To declare the figure to be wrong, as is done by Tornquist[1] seems rather hardy, as the figure is evidently very carefully drawn). In «Catalogue raisonné» (p. 121, Note) L. Agassiz says: «Je connais des individus d'une même espèce *(Schizaster lacunosus),* dont les

[1] Die Beschaffenheit des Apicalfeldes von *Schizaster* und seine geologische Bedeutung. Zeitschr. deutsch. geol. Gesellsch. 55. 1903. p. 377.

uns ont trois, les autres quatre et d'autres deux pores»; but in the first place it is, as remarked by Lütken (Bidr. til Kundsk. om Ech. p. 115), uncertain which species is really meant, and in the second place there is no certainty at all that these specimens have really all been of the same species. — For the *fragilis*-group no case is known of the occurrence of more or fewer than three genital pores. It is thus beyond doubt that the number of genital pores is an important and constant character, distinguishing the two groups of species. — This feature has been shown by Tornquist (Op. cit.) to be of importance from a palæontological point of view. The oldest (Cretaceous) *Schizaster*-species have all 4 pores; from these the development goes in two separate directions: to the symmetrical 2-pored and the asymmetrical 3-pored species; the latter form is not known before the Miocene. The recent *Sch. gibberulus* and *Savignyi* thus seem to be comparatively primitive forms. Pomel (Op. cit. p. 36) makes *Sch. gibberulus* the type of a separate genus, *Paraster*, which may perhaps be correct; as long as the pedicellariæ of this species (and *Savignyi*) are unknown, it seems, however, better to leave the question undecided; but it is worth noticing that these two species differ from the *canaliferus*-group also in the lower shape of the test, besides in having four genital pores.

Another character uniting the species of each group much in the same way is found in the structure of the globiferous pedicellariæ, as emphasized by Professor Döderlein (loc. cit.). In the *canaliferus*-group the valves have the terminal opening surrounded by a circle of teeth, in the *fragilis*-group the valves end in a single, large tooth with the opening at its base on one side; *S. Philippii* alone makes an exception here, the valves having four teeth round the terminal opening. Professor Döderlein finds the globiferous pedicellariæ of this species to belong to the *canaliferus*-type; I cannot quite agree with him herein, finding those of *S. Philippii* to form a separate type. (For a more detailed account thereof I must refer to the Report on the Echinoidea of the Swedish South Polar Expedition). Other characters of importance distinguishing these groups I have not been able to find. The latero-anal fasciole passes over the 10—11th plate of the posterior ambulacra in *fragilis* and *Philippii*, over the 12—13th in *canaliferus* and *lacunosus* — but in *orbignyanus* it may also pass over the 11th plate. The first of the large subanal tubefeet is found on the 5th ambulacral plate in *canaliferus* and *lacunosus*, on the 6th in *fragilis, Philippii, orbignyanus* and *gibberulus*. The character taken by Fourtau (Op. cit.) to distinguish the two groups, viz. the arrangement of the pores in the anterior ambulacrum in a single or double series, does not hold good either. In *orbignyanus, lacunosus* and *Edwardsi* they are arranged in a single series — but nobody, I think, will deny that these species belong to the same group as *canaliferus*, which has the pores arranged in a double series. — The other pedicellariæ as well as the spicules do not afford characters by which to distinguish the groups. But the three characters pointed out above: the form of the test, the number of genital pores and the structure of the globiferous pedicellariæ agree in the most beautiful manner and show that the species *canaliferus, orbignyanus, Edwardsi* and *lacunosus* form one distinct group, the species *fragilis, Moseleyi, antarcticus, capensis, Townsendi* and *latifrons* another group.[1] — To the latter group *Sch. Philippii* can scarcely be reckoned. It differs from the other species in having the apical system and vertex almost central, the shape of the test thus differing considerably from that of the other species of the *fragilis*-

[1] It may be noticed that the globiferous pedicellariæ of *S. Edwardsi* are unknown. Those of *S. Moseleyi, Townsendi* and *latifrons* I have examined and found to be of the *fragilis*-type.

group (except *capensis*), in which the apical system and vertex is decidedly posterior. Further the globiferous pedicellariæ differ from those of the other species, as pointed out above. It might perhaps not be unreasonable to regard the form of globiferous pedicellariæ in this species as a more primitive form which has developed into the form found in the *fragilis*-group. The fact that in this group sometimes pedicellariæ occur with two endteeth instead of one (Pl. XIV. Fig. 24) might then perhaps be a case of atavism. The central position of the apical system likewise seems to indicate that this species is more primitive than the *fragilis*-group. — Accordingly I think it reasonable to regard this species as the representative of a special group, besides the *fragilis*- and *canaliferus*-group.

The question now arises, if these three or four groups must be regarded as distinct genera. Gray (Cat. rec. Ech.) groups the species in nearly the same way as is here shown to be the natural grouping; he regards the groups as subgenera, proposing for the *canaliferus*-group the name *Nina*, for the *fragilis*-group (to which *S. gibberulus* is incorrectly referred) the name *Brisaster*, whereas the name *Schizaster* s. str. is retained for *S. (Moira) atropos*. The species *Philippii* is referred to the genus *Tripylus*, which is certainly not correct (see Echinoidea of the Swedish South Polar Expedition); but on the other hand it is certainly not correct either to regard this species as a typical *Schizaster*, a «Southern representative» of *S. fragilis* as is done by Agassiz (Rev. of Ech. p. 612). Fourtau (Op. cit.) emphasizes that his *canaliferus*- and *fragilis*-group must really be considered only as groups of species within the genus *Schizaster*, not as sections — «et surtout je me garde bien de donner un nom à ces groupes, car ils passeraient vite à l'état de genre pour certains taxonomistes plus desireux d'obtenir des coupes nouvelles que d'étudier à fond les variations d'un type». — Though I agree that when a separate name of a group of species is proposed it will easily be made to rank as a generic name, I think the present case is so distinct that it is necessary to give the groups names as subgenera — I would even not be very horrified in seeing them made genera. Otherwise Gray has, as said above, already given such names, viz. *Nina* for the *canaliferus*-group, *Brisaster* for the *fragilis*-group. The latter name is excellent and must be taken into use again; on the other hand the name *Nina*, which is quite without meaning, need not be used for the *canaliferus*-group; this group may simply be termed *Shizaster* s. str. — For *S. Philippii* the name **Tripylaster** n. subgen. may be proposed. If the species *gibberulus* and *Savignyi* are rightly made a separate group the name *Paraster* Pomel will be kept by it.

Unfortunately the name *Schizaster* is perhaps not rightly assigned to this genus. The type of the genus *Schizaster*, established by L. Agassiz in his «Prodrome d'une Monogr. des Radiaires» is *S. atropos*, now named *Moira*. This name is a changing of the original name *Moera* Michelin, which was preoccupied for a Crustacean. Strictly speaking *Moira* is the same name as *Moera* and ought not to be used for the Echinid, which ought then to have its original name *Schizaster* — if not the yet older name *Echinocardium* Gray! — In his paper in «Annals of Philosophy» 1825 Gray establishes the genus *Echinocardium* with *E. atropos* as the first species. According to a strict interpretation of the rules of nomenclature the name *Echinocardium* ought to be used for *Moira atropos* etc. and the names *Schizaster* Ag., *Moera* Mich. and *Moira* A. Ag. would be synonyms thereof. Instead of *Schizaster* the name *Ova* Leske (van Phelsum) ought to be used, Gray (loc. cit.) naming only the species *canaliferus* under this genus. Instead of *Echinocardium* in its present use a new name ought to be given, if the name *Amphidetus* can not be retained, which seems not impossible, though Agassiz (Rev. of Ech. p. 15) thinks it could not be retained, as it is a synonym of *Echinocardium* Gray — but of *Echinocardium* in its later modified sense. — These are, indeed, so disagreeable changes in nomenclature that I will not propose to make them, the more so as so eminent authorities as Prof. Ludwig and Dr. F. A. Bather, before whom I have put the whole question, are of opinion that it is not absolutely needed. I will then retain the names in the sense in which they are used in «Revision of Echini», but I fear it is not in accordance with the strict rules, and I, for my part, sincerely regret that Agassiz, who has traced the history of these names and given it fully in his most excellent Chronological List in the «Revision», did not make these changes in the nomenclature on that occasion. It might have been done at that time without causing much trouble. To now change *Moira* to *Echinocardium* or *Schizaster*, and *Schizaster* in its present sense to *Ova* or even to *Spatangus*[1] would not fail to cause a great deal of confusion.

The genus *Schizaster* should then be thus subdivided:

Subgen. *Paraster* Pomel. Test not very high. Petals and frontal ambulacrum much deepened, apical system posterior; four genital pores. (Globiferous pedicellariæ unknown.)

Species: *gibberulus* Ag., *Savignyi* Fourtau.

Subgen. *Schizaster* s. str. (Syn. *Nina* Gray). Test very high; petals and frontal ambulacrum much deepened; apical system posterior; two genital pores. The globiferous pedicellariæ with a circle of teeth round the terminal opening.

Species: *canaliferus* (Lmk.), *lacunosus* (L.), *orbignyanus* A. Ag., *Edwardsi* Cott.

Subgen. *Tripylaster* Mrtsn. Test low; petals and frontal ambulacrum not much deepened; apical system subcentral; three genital pores. Globiferous pedicellariæ with four teeth round the terminal opening.

Species: *Philippii* Gray.

Subgen. *Brisaster* Gray. Test low; petals and frontal ambulacrum not much deepened; apical system posterior (or subcentral); three genital pores. Globiferous pedicellariæ with a single large tooth at the point of the valves at one side of the terminal opening.

Species: *fragilis* (Düb. Kor.), *capensis* Stud., *Moseleyi* A. Ag., *latifrons* A. Ag., *Townsendi* A. Ag., *antarcticus* Döderlein.

28. **Spatangus purpureus** O. F. Müller.

Pl. II. Figs. 8, 12, 14, 16. Pl. XVI. Figs. 1—2, 5—10, 22, 24—25, 27, 29, 31—32, 34.

Synonyms: *Spatangus meridionalis* Risso.
— *spinosissimus* L. Agass.
— *Reginæ* Gray.

[1] Lambert: Description des Échinides fossiles de la province de Barcelona. Mém. Soc. géol. de France. IX. 1902. p. 55. Note.

Principal Literature: O. Fr. Müller: Zoologiæ Danicæ Prodromus. 1776. (No. 2850).[1] Zoologia Danica. 1788. p. 5. Tab. VI. — Leske: Additamenta ad J. Th. Kleinii Nat. Disp. Ech. 1788. p. 170 (235). Tab. XLIII. Figs. 3—5. XLV. Fig. 5. — Philippi: Beschreibung einiger neuen Echinodermen etc. Arch. f. Naturgesch. 1845. I. p. 350. — Gray: Catalogue of the Recent Echinida in the Collection of the Brit. Mus. I. Echinida Irregularia. 1855. p. 47. Pl. III. 1. — L. Agassiz & Desor: Catalogue raisonné. p. 112. — Sars: Norges Echinodermer. p. 99. Middelhavets Littoralfauna. p. 118. — A. M. Norman: Shetland Final Dredging Report. II. Crustacea ..... Echinodermata etc. Rep. Brit. Assoc. 1868. p. 315. — H. Bolau (82). p. 3. — A. Agassiz: Revision of Echini. p. 158, 565 (Numerous figures). — Lovén: Études sur les Échinoidées. Pl. XXXVI. On Pourtalesia. Pl. X. Fig. 109. XII. 145. XVIII. 209—19. — Koehler (217). p. 127. — Perrier: Recherches sur les Pédicellaires. p. 178. Pl. VII. Figs. 4, 7. — Mazzetti: Catologo degli Echinidi fossili d. Coll. Mazzetti esistente nella R. Univ. di Modena. Mem. Acad. Modena. (2) XI. 1896. p. 425. Fig. 6. — Grieg: Oversigt nordl. Norges Echinodermer. p. 33. — Ludwig: Echinodermen d. Mittelmeeres. p. 560. — Bell: Catalogue British Ech. p. 165. Pl. XVI. 10. — Hoyle: Revised List British Ech. p. 424. — Döderlein: Arktische Seeigel. Fauna Arctica. IV. p. 383. Die Echinoiden der deutschen Tiefsee-Expedition. p. 260. Taf. XXXIII. 2. XLVIII. 1.

Non: A. Agassiz: «Challenger»-Echinoidea. p. 171. — Verrill: Results of the Explorations .... «Albatross» in 1883. p. 551.

Several other less important literary references are found in the works quoted of Bell and Ludwig, and in the «Revision of Echini».

Of this very well known and often described and figured species I have only a little to remark. The test is very often unequally developed, one side (always (?) the right) being somewhat prominent in front of the other (Pl. II. Fig. 8); the specimens from the Faroe Islands especially show this feature very distinctly and almost constantly, but I have seen it just as distinct in specimens from the Kattegat and from the Mediterranean. Even in a specimen only 16^{mm} in length this obliquity is already distinctly seen. — The largest specimen I have seen (from Roscoff) is 115^{mm} long, 117^{mm} broad (60^{mm} high); though differing from the usual form in being broader than long it undoubtedly belongs to this species. Some specimens from the Doggerbank show a remarkable deformity, the actinal plastron being quite hollow. (Similar deformities also occur in *Brissopsis lyrifera* and *Echinocardium flavescens* from the North Sea).

The pedicellariæ are rather well known. Perrier (loc. cit.) and Agassiz (Rev. of Ech. Pl. XXVI. Figs. 24–27) have described and figured the two forms of tridentate pedicellariæ. Another form, the triphyllous pedicellariæ, has been described, but not figured, by Koehler (loc. cit.). The most important contribution, however, is given by Döderlein (Op. cit.), who gives good photographic figures of the different forms of tridentate and of the triphyllous pedicellariæ. My figures of these forms were made a long time before Professor Döderlein's work was published; as they show several minute details more distinctly than Döderlein's figures, I think it not superfluous to publish some of them. — Besides these forms of pedicellariæ I have also found ophicephalous ones, whereas globiferous pedicellariæ have not been found. Döderlein (Echinoiden d. deutsch. Tiefsee-Exp. p. 262) has found a

[1] Agassiz puts a question mark at this quotation; there cannot, however, be the slightest doubt that this species is really meant, since Müller in «Zoologia Danica» himself refers to this place, and the diagnosis is the same.

single globiferous pedicellaria, resembling those of *Schizaster Philippii,* in a young specimen from the Mediterranean.

The tridentate pedicellariæ occur, as has been said already, in two distinct forms, one with elongate, slender valves, the other with short and robust valves. The slender form occurs in very different sizes, from ca. $0{\cdot}2^{mm}$ to ca. 2^{mm} (length of head). The shape of the head is well seen in Perrier's Pl. VII. 4. a. The valves (Pl. XVI. Figs. 1, 9) are long and narrow, widely apart, joining only at the point which is a little widened, spoonshaped, with the edges finely and closely serrate. The edge of the lower, narrow part of the blade is more or less coarsely serrate, but it may sometimes be quite smooth. The bottom of the blade is abruptly deepened in a narrow stripe along the median line, with some crossbeams passing over it. In side view this deepening is seen as a narrow crest along the back of the blade, in dorsal view of the blade it is seen as a sharply defined longitudinal keel, formed by two knotted edges. The basal part is remarkably narrow; the apophysis is large, mostly with smooth edge. The three points looking downwards from the basal part, mentioned and figured by Perrier, I have never seen.

In smaller specimens of this kind of pedicellariæ the valves join to a larger extent, in quite small ones they join in their whole length. The blade is comparatively broad, simply leafshaped (Pl. XVI. Fig. 27). All transitional forms are found between the largest and the smallest specimens, as is very well shown in the figures given by Döderlein. Two-valved specimens sometimes occur. The neck is well developed, though rather short in the largest specimens. The stalk is an irregularly fenestrated tube, with a small milled ring at the lower end for the attachment of the muscles, just as in the spines, only, of course, much more feebly developed. Such a ring is found on the stalk of all the pedicellariæ except the ophicephalous ones.

The second form of tridentate pedicellariæ (Pl. XVI. Fig. 8) is much coarser, with a thick head and a short neck. The valves (Pl. XVI. Figs. 7, 10) are much narrowed in the middle, but the basal part passes evenly into the blade (a rather conspicuous difference from *Macropneustes spatangoides,* (comp. p. 128. Pl. XVI. Figs. 3, 13). The edge of the outer part of the blade makes an obtuse angle with the narrowed part; it is finely serrate. The point of the blade is generally somewhat produced inwards. There is a more or less developed meshwork in the lower part of the blade. The dorsal side of the blade is uneven, knotted (Pl. XVI. Fig. 10). In larger specimens of this kind of pedicellariæ the narrowed median part of the blade may be rather long (Pl. XVI. Fig. 25), such valves looking more like usual tridentate pedicellariæ. Perrier (Op. cit. p. 278)[1] names this kind ophicephalous pedicellariæ in spite of the fact that no bow is found below the valves. Now, to be sure, it may well be maintained that it is no absolutely necessary criterion for ophicephalous pedicellariæ that these arcs must be present (see also de Meijere. Siboga-Ech. p. 244—45) — as well as, on the other hand, that such arcs may occur also on undoubtedly tridentate pedicellariæ, as has been shown both by de Meijere and by myself. In this case, however, it cannot be doubted that these pedicellariæ are tridentate and not ophicephalous, because true ophicephalous pedicellariæ of quite typical structure are also found. —

[1] At this place reference is made to a figure of a large tridentate pedicellaria (Pl. VII. 4. a), but the text and the explanation of the plates leave no doubt that the Fig. 4. b is meant, which evidently represents a pedicellaria of this second tridentate form.

Agassiz (Rev. p. 666) rightly refers this form to the tridentate form, though I might not strictly call them »ordinary tridactyle» which is better said of the form with the slender valves. Koehler (217) follows Perrier in regarding them as ophicephalous pedicellariæ.

The ophicephalous pedicellariæ (Pl. XVI. Fig. 6) are generally few in number and have only been found on young specimens; probably, however, it would also be possible to find some few among the small abactinal spines in larger specimens; they are found only on the abactinal side and in the posterior ambulacra on the actinal side. The valves are rather elongate, very narrow above the articular surface, the side parts of the basal part being very small; the blade widens towards the point which bends inwards; rather strong teeth along the edge, continuing along the sides of the apophysis almost down to the articular surface. The blade is deepened in the middle part, with very few holes and no keel continuing over it from the apophysis. There is a small process from the bow which is the outermost of the three. There is no neck, and the upper end of the rather compact stalk is cupshaped.

The triphyllous pedicellariæ (Pl. XVI. Figs. 2, 22) are very small and delicate (the head ca. 0·14^{mm} long). The valves are simply leafshaped, the basal part being a little narrower than the blade, whose lower corners are rather sharp; the edge is finely serrate on a small part at the lower end. On the outer side there is a slightly prominent keel at the lower end. — This kind of pedicellariæ has first been seen by Koehler; what Agassiz mentions as »typical trifoliate» pedicellariæ (Rev. p. 666, Pl. XXVI. 24) are evidently small tridentate pedicellariæ and cannot be said to be »characteristic of the Spatangoids proper».

The spicules of the tubefeet have been described and figured by Perrier; it may only be mentioned here that no spicules are found in the transformed tubefeet (gills) of the paired abactinal ambulacra — as upon the whole spicules are generally wanting in these tubefeet in the irregular Echini. As for the structure of the penicillate tubefeet round the mouth I may refer to the very beautiful researches of Lovén. The intestine and genital organs do not contain spicules in their walls.

A young specimen of this species, ca. 12^{mm} in length, has been figured and described by Agassiz (Revision of Ech. p. 331. Pl. XI. f. Figs. 19—22), and further Lovén has given very important information especially of the development of the apical system (On Pourtalesia. p. 74, 77. Pl. XVIII. Figs. 209—219); the smallest specimen examined by Lovén was 5·4^{mm} in length. From the St. 86 of the »Ingolf» there are some small specimens, the youngest only 4^{mm} in length, which enable me to give some additional information of the changes during growth in this species.

The specimen of 4^{mm} length (Pl. XVI. Fig. 29, 31, 34) differs very considerably in outline, especially in side view, from the grown specimens. The anal system is on the abactinal side, rather near the vertex; the actinal plastron forms a rather prominent hood, the point of which is surrounded by the fasciole, which is, in the spine-covered specimen, very conspicuous. Only one ambulacral plate the 6th,[1] reaches within the fasciole; the 7th is just traversed by the fasciole. No pores are accordingly as yet developed within the fasciole (Pl. XVI. Fig. 24). The actinostome is as yet almost quite embryonal, the labrum only just beginning to widen anteriorly. The abactinal ambulacra are very simple;

[1] In this specimen it is abnormally the 5th plate in Ambulacrum I. a, which reaches within the fasciole. In V. b it is the 6th, as is the normal case.

in the frontal ambulacrum the plates are rather elongate, with single pores; in the antero-lateral ambulacra small, single pores have just begun to appear, in the postero-lateral no pores are seen as yet. The actinal tubefeet are already penicillate, though only with few filaments; the frontal tubefeet are small, by no means very prominent, which is repeatedly said by Agassiz to be an embryonic feature (comp. above p. 96). Only ophicephalous and triphyllous pedicellariæ are developed, the former being especially numerous.

Agassiz points out that the specimen figured by him is »remarkable for its globular shape», which is likewise repeatedly emphasized as an embryonic character. As shown by the figures given here the specimen of 4^{mm} is by no means of globular shape, and it does not suit better for the later stages. Specimens of 9 and 14^{mm} length are comparatively not more elevated or even globular than that of 4^{mm}. If the figure 22. Pl. XI. f of »Revision of Ech.» is correct in outline, it scarcely represents *Spat. purpureus*, but perhaps *S. Raschi*, or (if it be an American specimen — comp. below) *Macropneustes spatangoides*. — In the specimen of 9^{mm} length the actinostome has nearly its definitive shape, only the labrum is not yet prominent over the mouth-opening. The posterior end is nearly vertical, the actinal plastron being only a little prominent beyond the anal area. The abactinal ambulacra are not much more developed than in the specimen of 4^{mm} length, but double pores have appeared in all of them, though only in the posterior series in the paired ambulacra. The subanal plastron (Pl. XVI. Fig. 32) has almost reached its definite form, the seventh plate reaching well within the fasciole and the eighth being traversed by the fasciole and just reaching a little into the enclosed area. The pore in plate 7 has not yet appeared. — At a size of 14—16^{mm} the specimens have upon the whole the characters of the grown specimens, except that the frontal ambulacrum is much less deepened and the petals are still much narrower than in the adult specimens. — Regarding the development of the apical system, and the appearance of the genital pores I may refer to Lovén (loc. cit.), with whose results my own quite agree.

This species was taken by the »Ingolf» at the following stations:

St. 86	(65° 03' Lat. N.	23° 47' Long. W.	76 fathoms	? C.	Bottom temp.)	9 specimens.
— 87	(65° 02' —	23° 56' —	110 —	? —	—)	6 —
— 98	(65° 38' —	29° 00' —	138 —	5°9 —	—)	1 —

Numerous specimens were taken by the author at the Faroe Islands, 13 miles W. by S. of »Munken», ca. 150 fathoms, and E. off »Fuglö», ca. 70 fathoms.

Bell (Catalogue. p. 166) gives a bathymetrical distribution of this species of 5—530 fathoms; I cannot find in the literature the species recorded from a greater depth than 458 fathoms (»Porcupine», Faroe-Channel. Bell loc. cit.). It seems most common at lower depths, down to about 200 fathoms. Its geographical distribution is: along the whole west Coast of Europe, from the Mediterranean and the Azores to the Northern Coast of Norway (Tromsö) and the South Coast of Iceland, but not the North Coast, and it is not found in the cold area of the North Atlantic. Further it is said to occur at the Bermudas (»Challenger»-Ech. p. 171) and at the East Coast of North America (Rathbun. Catalogue (337). p. 288); Verrill, loc. cit.). The statement of its occurring at the Caribbean Islands (Prel. Rep. »Blake»-Echini (6). p. 83) was corrected by Agassiz himself (»Blake»-Echini. p. 64) as being caused by a wrong identification of *Macropnestes spatangoides* A. Ag. But also the other statements of the occurrence of *Spatangus purpureus* in American waters are due to confusion with *Macropneustes.* One of the specimens in the U. S. National Museum Professor Rathbun most liberally sent me to Copenhagen for examination, the others I examined during my visit to America last summer. I likewise had then occasion to examine specimens in the collection of Yale College. All these specimens I found to be *Macropneustes,* though perhaps not all *Macr. spatangoides* (see below). The specimen from the Bermudas, taken by the «Challenger», I have examined in the British Museum; it is likewise *Macropneustes* (the characteristic branching fasciole is distinctly developed). It may then be taken as rather certain that *Spatangus purpureus* does not occur at the American side of the Atlantic; in any case it has not hitherto been found there.

That the *Spatangus* of the Mediterranean (*S. meridionalis* Risso, *S. reginæ* Gray) is identical with the *Spat. purpureus* of the Northern Atlantic I quite agree with Agassiz, Ludwig, Koehler, Bell a. o. In the pedicellariæ no difference between the Mediterranean and the northern form is found. To be sure, Perrier (Op. cit. p. 180) states that those of *S. meridionalis* are a little more elongate; but he has certainly seen only a few pedicellariæ, otherwise he must have found them elongate in various degrees. The differences in the shape of the test pointed out by Philippi and Sars (Op. cit.) are not constant, though I agree that the Mediterranean form is generally a little more arched than the northern form; the latter is often as high as the Mediterranean form, but it is generally more sloping towards the ambitus. Norman (Op. cit.) points out several other characters, which would certainly distinguish the Mediterranean form as a good species — but, as is already pointed out by Hoyle (Op. cit.), it is *Spatangus Raschi,* which Norman has mistaken for the Mediterranean form. — Judging from the material at my disposal of the Mediterranean form of *Spat. purpureus* it can at most be regarded as a rather indistinct variety. — The type of *S. spinosissimus* Ag. I have not seen; but it cannot be doubted that it is identical with *purpureus,* since no other low species of the genus *Spatangus* is known from the European seas to which it might be referred. («Espèce deprimée»).

A few words may here be said on *Macropneustes spatangoides* A. Ag. The pedicellariæ are upon the whole very like those of *Spat. purpureus,* but some differences may be noticed. The tridentate pedicellariæ are quite like those of *S. purpureus* except the largest forms (Pl. XVI. Figs. 20, 33) which have the outer, widened end of the blade shorter and more spoonshaped; the edge is bent strongly inwards at the lower end of the widened part; the keel of the blade is not distinct. The stalk is very short and thick, the neck quite short. This large form (2^{mm} head) I have not found in *Spat. purpureus.* The second form of tridentate pedicellariæ (Pl. XVI. Figs. 3, 13) differs from the corresponding form in *S. purpureus* in having the basal part sharply limited from the blade, the edge forming a distinct angle between the basal part and the blade, whereas in *S. purpureus* the one continues evenly into the other without a distinct angle. The blade is rather small, though not so small, generally, as in the figured one. Elongated specimens of this kind of pedicellariæ (1^{mm} head) (Pl. XVI. Fig. 30) are found as in *Spat. purpureus.* The ophicephalous pedicellariæ (Pl. XVI. Fig. 4) are rather different from those of *purpureus,* the blade being shorter and the basal part being more developed than in that species. The triphyllous pedicellariæ (Pl. XVI. Fig. 15) are mainly like those of *S. purpureus.* The spicules are irregular, more or less branched rods. — The pedicellariæ mentioned here were taken from the «Challenger-specimen from Bermudas — in the »Albatross«s specimens the short form of tridentate pedicellariæ differs a little from that of the »Challenger«-specimen, the outer, widened part of the blade being a little shorter and sharper set off from the narrow lower part (Pl. XVI. Fig. 14); quite short specimens of this form, corresponding to that figured in Pl. XVI. Fig. 3, I have not seen in any of these specimens; neither were ophicephalous pedicellariæ found in any of them. This difference in the pedicellariæ is certainly too unreliable for regarding the «Challenger»-specimen as specifically distinct from the »Albatross«-specimens. Nevertheless I am not quite sure, whether or not more than one species of *Macropneustes* is found in the American waters. So considerable differences are found among the specimens in the outline of the test, in the development of the petals, in the number and size of the primary tubercles of the abactinal side, that it might well deserve a close investigation, if all these different looking specimens are really one and the same species. I may mention here that in a specimen from »Albatross« St. 1109 in the Museum of Yale College, there is no trace of the peripetalous fasciole; the specimen otherwise agrees with *Macropneustes*, and in any case it is no *Spatangus purpureus*, as might otherwise be inferred from the wanting of the fasciole.

The genera *Spatangus* and *Macropneustes* are evidently very closely related. In the structure of the test, pedicellariæ and tubefeet they agree almost completely; in fact, the only essential difference is the presence of the peripetalous fasciole in *Macropneustes*.

29. Spatangus Raschi Lovén.

Pl. I. Figs. 4—5. Pl. II. Fig. 19. Pl. XVI. Figs. 17, 23, 28.

Literature: Norman: Shetland Dredging Report II. Rep. British Assoc. 1868. p. 315. (»Spatangus meridionalis«). — Lovén: En ny Art af Slægtet Spatangus från Nordsjön. Öfvers. Vet. Akad. Förhandl. 1869. p. 733. Tafl. XVIII. — Agassiz: Revision of Echini. p. 159, 567. Pl. XXV. Fig. 35. XXVI. Fig. 23. — Wyville Thomson: »Porcupine«-Echinoidea. p. 750. — Grieg: Overs. nordlige Norges Echinodermer. p. 33. — Bell: Echinodermata off the S.W. Coast of Ireland (69). 1889. p. 442. — Catalogue Brit. Echinoderms. p. 167. Pl. XVI. Fig. 11. — Hoyle: Revised list of British Echinoidea. p. 426. — Döderlein: Arktische Seeigel. Fauna Arctica. IV. p. 383. Echinoiden d. deutschen Tiefsee-Exped. p. 262. Taf. XXXIII. Fig. 4. XLVIII. Fig. 2.

Non.: Agassiz: «Challenger»-Echinoidea. p. 171. — Bell: Echinoderma of South Africa. I. Echinoidea. p. 173.

This species is, like the preceding one, very well described, so that only a few remarks have to be added. — Like *Sp. purpureus* it may have the two sides of the test unequally developed, though not so much as in that species, judging from the specimens before me. — Photographic figures are here given of a large, beautiful specimen, quite typical, except in the curious fact that the two pores included by the subanal fasciole are present only on one side. — The subanal fasciole is evidently apt to disappear in this species. Of 8 specimens examined by me the fasciole is completely developed only in two; in three of them it is more or less rudimentary, and in three of them it has quite disappeared.

The pedicellariæ have been figured by Agassiz in »Rev. of Ech.« (the short tridentate form) and by Döderlein (Echinoidea d. deutsch. Tiefsee-Exp. Pl. XLVIII. 2, the slender form of tridentate pedicellariæ). The same kinds of pedicellariæ occur as in *Sp. purpureus*, only the ophicephalous and globiferous forms have not been found, but it can scarcely be doubted that they occur in this species too, at any rate in quite young specimens. The long and slender form of tridentate pedicellariæ figured by Döderlein I have not seen; on the other hand I have found a form, which differs rather much from those of *purpureus* (Pl. XVI. Fig. 28). They are short and rather broad, with faintly serrate edge and some meshwork in the bottom of the blade; a median dorsal keel is slightly developed, the basal part is wide, and the apophysis not very prominent. In larger specimens of this kind (up to 1^{mm} length of head) the valves are apart in the lower half of their length; small specimens have simply leaf-shaped valves and are like those of *purpureus*. The second form of tridentate pedicellariæ (Pl. XVI. Figs. 17, 23) resembles that of *purpureus* very much, only the outer edge of the basal part is generally somewhat serrate; as in *purpureus* the valves may be rather elongate, thus resembling more the slender form. A rather extreme case of this form is shown in Döderlein's Fig. 2. a; I have not seen such elongate specimens. The triphyllous pedicellariæ are like those of *purpureus;* the stalk of the pedicellariæ as in that species.

The tube-feet and their spicules do not differ from those of *purpureus*. No spicules are found in the walls of the intestine and genital organs. A small difference from *purpureus* is found in the terminal portion of the spines of the actinal plastron; in *Raschi* the widened terminal portion is rather broad, but short, whereas in *purpureus* it is little broader than the spine itself but occupying a larger portion of the spine. The edges of this terminal widening are generally serrate in *purpureus*, smooth in *Raschi*.

One specimen was taken by the "Ingolf"-Expedition at Stat. 55 (63° 33′ Lat. N., 15° 02′ Long. W. 316 fathoms; bottom temperature 5°9). Further I have myself dredged a specimen at the Faroe Islands, (East of Suderö, 150 fathoms). 3 specimens were taken at 61° 7′ Lat. N., 9° 30′ Long. W. 835 M. 1904.

This species is a decided warm-area form. The Norwegian North Sea-Exped. has dredged it at several places with a bottom temperature of about 6° — with one remarkable exception: St. 96, where the temperature was only — 1·1; also the depth of this station (805 fathoms) is remarkably greater than where this species has elsewhere been taken (ca. 100—500 fathoms). Otherwise this case is quite analogous to what is recorded for *Echinus Alexandri*. Both species undoubtedly belong to the warm area, but may thus occasionally occur in places with negative bottom temperature, probably only on the edge of the warm area, on the slope towards the great cold basin of the Norwegian Sea.

The geographical distribution of *Spat. Raschi* is in the whole North Atlantic from Norway to the Azores, but not on the American side. It is further stated in the "Challenger"-Echinoidea to occur at the Cape of Good Hope, and recently Professor Bell likewise mentions this species from the South African Sea (Echinoderma of South Africa. I. Echinoidea. p. 173). Professor Döderlein, however, suggests that these specimens will prove to belong to the species *S. capensis*, described by him. I have examined these specimens in the British Museum, and can thus state that they are really *S. capensis*. Thus *S. Raschi* is not known from the South African Sea.

Bell (69) mentions some specimens intermediate between the typical *purpureus* and *Raschi*, and he finds it reasonable that the two species may form hybrids. I think he is right in suggesting that. Figures are here given (Pl. II. Figs. 12, 14, 16) of a specimen from the Faroe Islands (13 Miles W. to S. of "Munken", ca. 150 fathoms) which would on account of the high shape of the test decidedly be referred to *S. Raschi*; but the other characters (especially the subanal fasciole and the pedicellariæ) are quite those of *purpureus*. The petals are somewhat shorter than usual, especially the posterior ones. The measurements of this specimen are: Length: 54^{mm}, height: 34^{mm}, length of posterior petals: 16^{mm}. Those of an equal-sized specimen of *purpureus* are: Length: 60^{mm}, height: 29^{mm}, length of posterior petals: 21^{mm}. I think it rather certain that we have here a hybrid of *S. purpureus* and *S. Raschi*.

I may here take the occasion to give some remarks on *Spat. Lütkeni* A. Ag., based on the type specimen of *Spat. altus* Lütken (M. S.), which is stated by Agassiz (Revision of Echini p. 158) to be a synonym of *S. Lütkeni*. There are, however, some points in the description given by Agassiz in Revis. of Ech. p. 564, which do not suit with this specimen, so that it may perhaps be doubtful, whether it is really identical with *S. Lütkeni*. Unfortunately Agassiz has given no figures of the species. Recently Professor Döderlein (Echinoiden d. deutsch. Tiefsee-Exp.) has given some figures and descriptive remarks of *S. Lütkeni* — they do not agree with the present specimen either. I am unable to decide the question and can only give a description and figures of the type specimen of *S. altus* Ltk., leaving it to somebody who has access to the true *S. Lütkeni* to decide, if they are really identical; in that case the specimen figured by Döderlein will probably represent a new species. In case the present specimen proves to be another species than *S. Lütkeni*, it will have to keep the name *S. altus* Ltk.

This species shows a remarkable union of features characteristic of both *S. purpureus* and *Raschi*, much in the same way as *S. capensis*. The test (Pl. I. Figs. 1—3) is high as in *S. Raschi*, but the tuberculation is more like that of *purpureus*, no primary tubercles occurring in the ambulacra on the abactinal side. In the paired abactinal interambulacra the primary tubercles form a very distinct transverse series on each plate except one or two at the ambitus, an arrangement which is not in accordance with the descriptions of Agassiz and Döderlein, but rather closely agreeing with the arrangement in *S. capensis*. In the description of *S. Lütkeni* Agassiz says (p. 565): the small tubercles covering the abactinal surface are much larger and more closely crowded than in the other species; perhaps »larger« is a lapsus calami for »smaller« — in any case they are very small in the present specimen, smaller than in the other species. The actinal plastron is somewhat broader than in *S. Raschi*; the test is rather sunken towards the actinostome as in *Raschi*, but the labrum is short and broad as in *purpureus*. The area enclosed by the subanal fasciole is not much larger than in *Raschi*; three pairs of pores (four ambulacral plates) are enclosed within the fasciole, a character most decidedly distinguishing this species from *purpureus*, *Raschi* and *capensis*[1], in which only two pairs of pores (three ambulacral plates) are included by the fasciole. The petals are decidedly broader than in *purpureus* and *Raschi*, whereas *S. capensis* comes rather near to it also in this respect. According to the description in Rev. of Ech. the lateral petals are proportionally shorter than in the other species, which does not hold good either of the present specimen. In the specimen figured by Döderlein the petals are much narrower than in the present specimen.

[1] Döderlein does not give any information of this feature in *Sp. capensis*; of the specimens of this species examined by me in the British Museum I find in the »Challenger«-specimen only one pair of pores enclosed in the subanal area, in the other specimen 2 pairs (or at least on one side 2 pores).

The two usual forms of tridentate pedicellariæ have been found in this specimen. The slender form is essentially like that of *purpureus*, but only small specimens were found, so it cannot be taken for certain that the larger ones are also alike to those of *purpureus*. The short form of tridentate pedicellariæ (Pl. XVI. Fig. 11) has a remarkably small blade, with the edge very faintly serrate (only to be seen in side view); the upper edge of the basal part is generally a little serrate as in *Raschi*, and there may be some irregular prominences from the lower side of the articular surface. Small specimens of this form have the blade comparatively larger (Pl. XVI. Fig. 19). Specimens with elongate valves I have not seen, and neither were ophicephalous pedicellariæ found. The triphyllous pedicellariæ are like those of the other species. — Spines, tube-feet and spicules do not seem to present characteristic differences from the other species. (No spines are preserved on the actinal plastron). — The locality of this specimen is given as »China Sea« (Salmin).

One more recent species is referred to the genus *Spatangus*, viz. *S. (Loncophorus) interruptus* described by Studer (386). I have examined the type specimen in the Berlin-Museum and can state that it is no *Spatangus* at all. To what genus it belongs I do not venture to say definitely for the present.

Lambert in his »Description des Échinides fossiles de la province de Barcelone« (Mém. Soc. Géol. de France. IX. 1902. p. 54—55)[1] has called attention to the fact that the genus *Spatangus* in its present conception is not the same as Klein's *Spatangus*, which is characterized as having deepened ambulacra (»insignem habentes lacunam in dorso, sulcosque in vertice«). He then proposes to change the name of the present genus *Spatangus* into *Prospatangus*, and — if I understand him rightly — to make *Schizaster canaliferus* the type of the genus *Spatangus* Klein. It does not seem to me necessary thus to change the name into *Prospatangus* (Leske himself includes *Spatangus purpureus* in Klein's genus *Spatangus*), though Lambert, is probably right that the present use of the name *Spatangus* »repose sur une erreur«, and especially I would find it extremely unfortunate to give the name *Spatangus* to *Schizaster*. It would not fail to create an extreme confusion, and — as far as I can see — the rules of nomenclature do not at all necessitate this unfortunate changing of the names.

30. **Echinocardium flavescens** (O. Fr. Müller).

Pl. II. Figs. 2, 10. Pl. XVI. Fig. 26. Pl. XVII. Figs. 4, 7—8, 10—11, 17, 27, 31, 40—41, 45, 50.

Principal synonyms: *Spatangus ovatus* Leske.
Amphidetus ovatus (Agass.).
Echinocardium ovatum (Gray).
Amphidetus roseus Forbes (?)

Principal Literature: O. Fr. Müller: Prodromus Zool. Dan. 1776. p. 236. — (Non: Zoologia Danica (Abildgaard). III. p. 17. Tab. XCI. 4.[2]) — Leske: Additam. ad J. Th. Kleinii. Nat. Disp. Echinod. p. 252. Tab. 49. 12—13. — Forbes: Brit. Starfishes. p. 194. — L. Agassiz & Desor: Cat. raisonné des

[1] Comp. also Lambert: Étude sur les Échinides de la Molasse de Vence. Ann. soc. des Alpes Maritimes. XX. 1906. p. 48.

[2] See: Düben & Koren: Skand. Ech. p. 283—4.

Éch. p. 12. — Düben & Koren: Skandinaviens Echinod. p. 283. Tab. X. 50. — M. Sars: Beskrivelser og Iagttagelser. 1835. p. 46. Pl. IX. 23. Norges Echinod. p. 98. — Gray: Catal. Rec. Echinida. p. 43. — Perrier: Rech. sur les pédicellaires. p. 175. Pl. VII. 2. a.—f. — Th. Barrois: Echinod..... Acores (30). p. 12. Catal. Ech. Concarneau (29). p. 46. — Bolau: Spat. Hamburger Mus. (82). p. 10. — A. Agassiz: Revision of Echini. p. 110, 351. Pl. XX. 3—4. XXV. 26. — Lovén: Études sur les Éch. Pl. III. 33—37. On Pourtalesia. Pl. XI. 127—30. Pl. XV, XVII. — Ludwig: Echinodermen d. Mittelm. p. 561. — Bell: Catalogue Brit. Echinoderms. p. 171. Pl. XVI. 6—7. — Hoyle: Revised List Brit. Echinoidea. p. 428. — Koehler: Recherches s. les Échinides de Provence. p. 129. Pl. VII. 57, 59—60. Sur les Echinocardium de la Méditerranée (231). p. 180. Pl. IV. 5—13. — Grieg: Overs. nordlige Norges Echinod. p. 34. — Döderlein: Arktische Seeigel. Fauna Arctica. p. 384. Echinoiden d. deutschen Tiefsee-Exped. p. 268.

Non.: A. Agassiz: Challenger-Echinoidea. p. 175. — Bell: Echinoidea. South Africa. p. 174. — Gasco: Descrizione Ech. nuovi (159). p. 6. Fig. 3.

For other literary references see: Revision of Echini, Bell: Catalogue Brit. Ech., Ludwig: Echinod. d. Mittelmeeres, and Koehler: Sur les Echinocardium de la Méditerranée.

This species has been so very often described and figured that little new can be added, especially after the elaborate comparative study of the European species of the genus *Echinocardium* given by Koehler. Some few remarks, however, may be made, and especially the pedicellariæ of this and the other species need a closer examination than has hitherto been made of them.

Eminently characteristic of this species are, as pointed out by Koehler, the large tubercles outside the fasciole, along the anterior ambulacrum and in the lateral interambulacra. Koehler finds these tubercles more numerous in the small than in the larger specimens. This is not in accordance with my observations. In a small specimen of 8·5^{mm} length I find only a few larger tubercles in the anterior interambulacra; in a specimen of 10^{mm} length there is also a single large tubercle in the posterior interambulacrum. A specimen of 15^{mm} length has, besides several large tubercles in the anterior and in the odd posterior interambulacrum, a single large tubercle in the left lateral interambulacrum, just behind the left anterior petal. Later on more large tubercles appear, especially along the posterior edge of the anterior petals, large specimens having here generally several close-set large tubercles, besides more or fewer spread on the upper plates of these Interambulacra. I have seen no specimens agreeing with that figured in Pl. 4. Fig. 10 by Koehler (Echinocard. de la Méditerranée), and the suggestion that this figure represents, really, another species, seems not quite unfounded. (Comp. below, p. 143—4)

The labrum reaches the anterior end of the second adjoining ambulacral plates; sometimes it reaches to the middle of these plates, but generally their anterior, inner corner is produced to meet the labrum. In young specimens (comp. Pl. XV. Fig. 172 in Lovén's On Pourtalesia) it does not reach beyond the first ambulacral plate; in a specimen of 8·5^{mm} I find it still reaching only to the end of the first ambulacral plate. — The anterior edge of the labrum is straighter than in the other species, (except *pennatifidum*) as pointed out by Agassiz (Rev. of Ech. p. 351). — The number of pores included by the subanal fasciole is, as stated by Bell, one or two pairs, both cases occurring almost equally frequently. In one case I have found the first ambulacral plate reaching within the fasciole to be the 7th (on the left side only); otherwise it is the 6th as found by Lovén to be a general rule. (For an interesting exception to this rule, see sub *Brissopsis*, p. 163).

Regarding the development of the petals I may notice that the large pores in the anterior series of the antero-lateral petals do not appear before the specimens have reached a length of ca. 15^{mm}. From the table given here it is further seen that no small variation may occur in this respect. (The specimen of 14^{mm} is a little higher than usual).

Number of pores in the petals.

Size	Anterior petals		Posterior petals	
	Anterior series	Posterior series	Anterior series	Posterior series
8^{mm}	0	6	3—4	4—5
10 —	0	6—8	3—4	5—6
14 —	1—2	5—8	3—4	4—5
15 —	2—3	6—8	7—8	8

The tube-feet and spicules have been described by Perrier and Lovén and need not be further described. I may only recall the curious subanal tube-feet, with the thick, clubshaped supporting rods of the filaments, described and figured by Lovén (On Pourtalesia. p. 48. Pl. VIII. 57); they are characteristic of all the species of *Echinocardium* (as well as of *Lovenia*).

The pedicellariæ have been partly described already by Sars, and later on by Perrier, A. Agassiz and Koehler. In his »Beskrivelser og Iagttagelser etc.» (1835) M. Sars mentions and figures (Pl. IX. 23. a.—b.) a kind of pedicellaria which can only be the globiferous. Perrier (loc. cit.) describes and figures a globiferous pedicellaria (wrongly regarding it as a kind of tridentate pedicellaria), and Agassiz (Rev. of Ech. Pl. XXV. 26) a tridentate pedicellaria. A closer examination has been given by Koehler (loc. cit.), who describes four kinds of pedicellariæ, evidently corresponding to the globiferous, tridentate, rostrate and triphyllous. Besides these I also find, in young specimens ophicephalous pedicellariæ. A renewed examination of all these forms is necessary, especially as the structure of the valves has not been hitherto described or figured in a detailed manner.

The globiferous pedicellariæ (Pl. XVII. Figs. 4, 10, 45) are said by Sars to be arranged in five imperfect series, though somewhat disorderly. I find them, in accordance with Koehler, distributed quite irregularly over the abactinal side, in very different numbers, sometimes quite wanting. The valves (Pl. XVII. Figs. 4, 10) terminate in 6—8 long, slender teeth (not two, as stated by Perrier), 4—6 of which are at the point, two being placed lower down, one on each side. The latter are generally somewhat larger than those at the outer edge; sometimes there are two lateral teeth on one side, and sometimes there is a tooth in the median line, just below the terminal slit. The blade is a narrow, closed tube, with a small slit at the point. There is evidently no gland in the interior of the blade; the edges of the basal part, as well as of the apophysis, are smooth. There is no neck; the stalk has a small thickening at the upper and lower end. The size is rather variable, but generally they are rather large (ca. 0·5^{mm} length of head), and the thick, probably glandular,[1] dark pigmented skin makes them very conspicuous objects.

The rostrate pedicellariæ (Pl. XVII. Figs. 17, 40, 50) have very short valves, joining in the outer half (or more) of the blade. In fact, it is rather difficult to recognize the rostrate type of pedicellariæ in this form, but a comparison with the corresponding form in the other species leaves no doubt thereof. The edge is very finely serrate in the outer part of the blade, smooth in the lower part, as is also the edge of the basal part. The form of the basal part is not always as shown in the figure 40, Pl. XVII, it is equally often without the narrowing towards the articular surface. The neck is well developed, and is sometimes found somewhat retracted over the upper end of the stalk, in a manner recalling the globiferous pedicellariæ of *Strongylocentrotus* (comp. Part I. p. 163 Pl. XX. Figs. 25, 29). There may be a small ring at the lower end of the stalk. They are rather small, scarcely more than ca. 0·2—0·3^{mm} length of head. — It is probably this form which Koehler mentions and figures under the name of »pédic. gemmiforme» (Sur les Echinocard. de la Méditerr. p. 184. Pl. 4. 12), though I have not found any pedicellariæ resembling that figure very closely; probably it is not really of *Ech. flavescens*.

The tridentate pedicellariæ (Pl. XVII. Figs. 11, 27, 31, 41) have broad, leafshaped valves, differing somewhat in outline, as seen in the figures; in the small specimens the valves join in their whole length, in larger ones the lower part is more or less narrowed, the edges being apart in about the lower half of their length. The edge of the narrowed part is rather coarsely serrate, often with the teeth placed in rather distant transverse series of 2—3 teeth in each; the edge of the outer part, where the valves join is closely and finely serrate in the usual way. There may be some meshwork at the bottom of the blade in the larger specimens. Sometimes four-valved specimens occur. The apophysis may be finely serrate at its upper end. The neck is well developed; the stalk may have a rather distinct ring below for the fastening of the muscles. They reach a considerable size, up to ca. 1·5^{mm} length of head. — It is to be remarked that the stalk of the tridentate, rostrate and triphyllous pedicellariæ in the species of *Echinocardium* consists of slender rods, which are almost not at all connected by transverse rods, except above and below; they differ herein from most other Spatangoids. — The large tridentate pedicellaria figured by Koehler (Echinocard. de la Méditerr. Pl. 4. 13) differs considerably from those figured here; in fact, I have never seen any tridentate pedicellaria resembling that figure in any of the numerous specimens of *Echinocard. flavescens* which I have examined. On the other hand I have found a quite similar form in a specimen received from Professor Koehler under the name of *Echinocard. pennatifidum* from Tamaris s. Mer (Var). There seems to be some mistake here. (Comp. below, p. 142—4).

The ophicephalous pedicellariæ (Pl. XVII. Figs. 7, 8) I have found only in young specimens (up to a size of 18^{mm}); they occur only on the actinal side in the naked posterior (bivial) ambulacra, and may be very numerous. As is usual in Spatangoids they have no neck, the head resting directly on the upper end of the stalk which is cupshaped widened; the stalk otherwise is composed of a rather close, irregular meshwork. The valves are elongate, slender, widened towards the point, the basal part

[1] Koehler (Rech. sur les Éch. des Côtes de Provence. p. 130) however, states that no »substance muqueuse» is found here.

being very narrow. As is usual the blade is simply deepened, the edge thick and rather strongly serrate; the lowermost arc has a small prolongation in the middle.

The triphyllous pedicellariæ (Pl. XVI. Fig. 26) have only a few serrations in the edge at the lower end of the blade, a remarkable difference from *Ech. cordatum* (comp. below, p. 146). It is evidently this form which is figured by Koehler (Rech. s. l. Éch. de Provence. Pl. VII. 57); but the valves are there represented as being dentate along their whole edge, which is scarcely correct — at least I have never seen them so.

This species does not generally reach a large size, in which respect it differs from *Ech. pennatifidum.* One of the specimens before me, however, has a length of 54mm («M. Sars». 4—5 miles S. E. of Svinö, Faroe Isl., 50—60 fathoms). Sars (Norges Echinod.) describes the curious monstrosities which occur among the specimens of this species (as also in *Spat. purpureus* and *Brissopsis lyrifera*). I give here some figures of such remarkable monstrosities (Pl. II. Figs. 2, 10). — On several of the specimens from the «Ingolf» St. 6 some Ostracods were found between the spines; (parasitic?).

By the «Ingolf» this species was taken at the following stations:

St. 6	(63° 43' Lat. N.	14° 34' Long. W.	90 fathoms	7°0 C. Bottom temp.)	28 specimens.
— 86	(65° 03' —	23° 47' —	76 —	? — —)	7 —
— 87	(65° 02' —	23° 56' —	110 —	? — —)	10 —
— 98	(65° 38' —	26° 27' —	138 —	5°9 — —)	1 —
— 129	(66° 35' —	23° 47' —	117 —	6°5 — —)	1 —

The geographical distribution is from the Coast of Northern Norway and South of Iceland to the Mediterranean and the Azores; the bathymetrical distribution is ca. 5—150 fathoms.

Specimens from the Mediterranean and the Azores I have not seen; it seems, however, certain that not all the Mediterranean specimens referred to *Ech. flavescens* are really this species. Thus Gasco (Op. cit.) points out that in his specimens primary tubercles are found only along the borders of the anterior ambulacrum. This recalls the figure 10, Pl. 4 of Koehler (Echinocard. de la Méditerr.), in which likewise no large tubercles occur except along the anterior ambulacrum. Adding hereto the fact that pedicellariæ such as those figured by Koehler (Op. cit. Pl. 4. Figs. 12, 13) have not been met with in any of the numerous specimens of *flavescens* examined, but in some specimens of a distinct species described below, p. 142—4 (sub *Echinocardium pennatifidum*), it will probably not be held too hazardous, when I venture to suggest that at least not all the specimens of «*Ech. flavescens*» from the Mediterranean are really that species.

Ech. flavescens is further stated to occur on the American side of the Atlantic and at the Cape of Good Hope, but these statements evidently need a renewed examination. I have myself not seen any American specimens, but in view of the results obtained by the examination of the American specimens of «*Spatangus purpureus*» and «*Brissopsis lyrifera*», I think it not too hardy if I venture to say that the American *Echinocardium flavescens* might also well deserve a renewed careful examination in the light of the characters pointed out for the *Echinocardium*-species by Koehler and myself. The description and figures in «Revis. of Echini.» do not speak against the identity, but they are not sufficiently detailed for proving definitely that the American form is really *Ech. flavescens,* and in the description there is one point which is not in accordance with the *flavescens* of our seas, viz. that the colour in the living animal is pinkish. As pointed out already by Düben & Koren (Op. cit.) the colour of the species in the Scandinavian seas is yellowish. To be sure, Forbes (Op. cit.) states the species to be rose-coloured when alive; but I do not feel convinced that his *Amphidetus roseus* is really synonymous with *Ech. flavescens*. Barrois (Catalogue des Crust. Podophthalm. et Echinodermes rec. à Concarneau, p. 46) regards *A. roseus* as a distinct species, but, as far I can see, the colour is the only real distinguishing character hitherto pointed out, in spite of Barrois' statement that it is distinguished from *flavescens* »par sa forme plus allongée et moins élevée; par sa taîlle moindre« —; the form is too variable to be relied upon alone, and the size is evidently not to be stated to be smaller upon the whole from the single specimen taken by Barrois. — In any case, when the rose-coloured form comes to hand, it ought to be examined closely, also regarding the pedicellariæ; till it is thus proved to agree in all essential characters with *flavescens* I cannot consider *A. roseus* as a mere synonym of *flavescens*. Another thing is that the true *flavescens* is probably also included in the description given by Forbes, but in case two species are confounded, the name *roseus* must, of course, be kept by the rose-coloured species.

The specimens from the Cape of Good Hope are certainly not *flavescens*. I have examined in the British Museum the specimens from the »Challenger« (St. 142) as well as some of the specimens referred by Professor Bell to that species (Echinoidea of South Africa. p. 174), and further I have had the great pleasure to receive from Dr. Gilchrist in Capetown three specimens of the same form; (they were, evidently by a mistake, labelled *Echinocardium australe*). These specimens are certainly very like the *Ech. flavescens* as regards their habitus, but a close examination shows them to be a distinct species, which I shall describe here under the name of **Echinocardium capense** n. sp.

The shape of the test (Pl. II. Figs. 5, 6, 11) is a little different from that of *flavescens;* it is comparatively broader and lower, the apex and the part with the fasciole is especially almost saddle-like depressed. The fasciole is comparatively smaller and more oval (not straight in front) than in *flavescens* (Figs. 22—23). The apical system is like that of *flavescens*, only the madreporite is perhaps a little more elongate in the Cape species. The spines seem to be a little more slender than in *flavescens*, and especially it is a prominent feature that no large spines (and tubercles) are found along the posterior side of the anterior petals; only in the largest specimen (26^{mm} length) I find 1—2 larger tubercles at the lower end of these petals; likewise no large tubercles are found in the posterior interambulacrum on the abactinal side.

The peristome is somewhat broader but shorter than in *flavescens*. As in that species the labrum reaches the middle of the second adjoining ambulacral plates; its anterior border is almost straight, very little prominent. — The subanal fasciole has, as in *flavescens*. distinct anal branches. Two or three pairs of pores are included by the fasciole, whereas only 1—2 pairs are included by it in *flavescens*. Since both species may thus have 2 pairs of pores included by the subanal fasciole, this character might seem rather useless as a distinctive feature; but it is, really, not so useless. In the Cape specimens with only two pairs of pores included, I find also the following ambulacral plate transversely elongated, reaching to the fasciole; there are thus in this species four transversely elongated ambulacral plates on each side of the fasciole, whereas in *flavescens* there are only three such elongated plates; likewise it is a distinct feature that these plates, which reach within the fasciole, are considerably narrower than in *flavescens*. — In the anterior petals the number of pores in the anterior series is larger than in *flavescens*, viz. 6—7, whereas in *flavescens* of a corresponding size there are only 2—6, the number varying rather much. As the pore-bearing plates of the petals are rather large, this difference is fairly conspicuous. In the posterior series of the anterior petals and in both series of the posterior petals the number is the same in both species. The odd anterior ambulacrum narrows conspicuously where the fasciole traverses it, which is not the case in *flavescens;* the number of plates within the fasciole is smaller than in *flavescens*, specimens of equal size being compared (7 in *capense*, ca. 10 in *flavescens*).

The tubefeet and their spicules do not present any distinct differences from *flavescens;* to be sure, I have not seen any such large spicules, as are found in *flavescens* below the disk, but they are not always met with in the latter species either, and they may well be found in larger specimens of

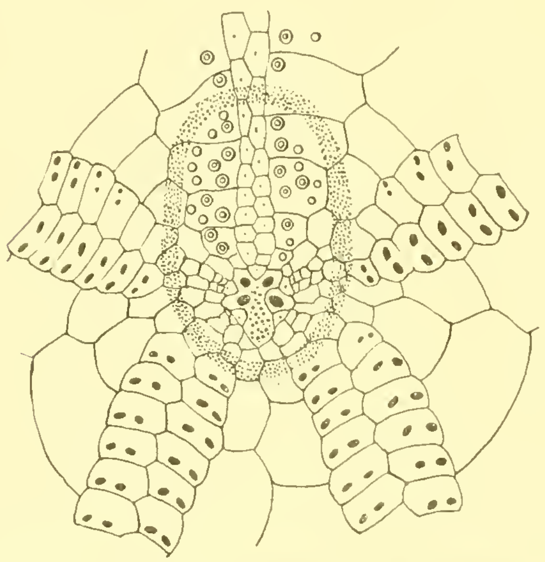


Fig. 22. Apical area of *Echinocardium capense;* the specimen 25mm in length. 5/1.

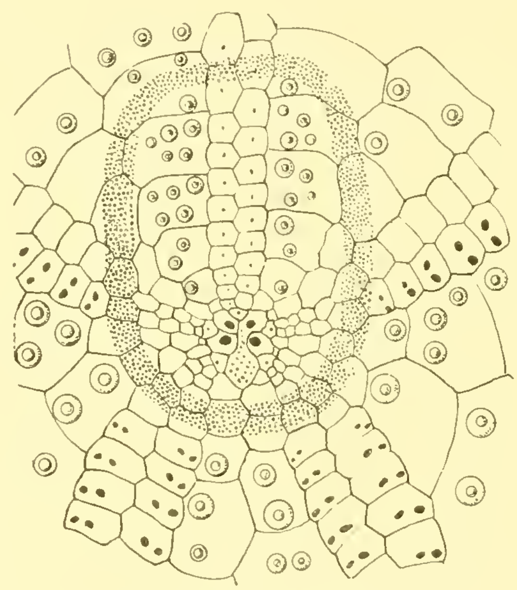


Fig. 23. Apical area of *Echinocardium flavescens;* the specimen 24mm in length. 5/1.

capense. — The pedicellariæ show partly some differences. The globiferous and ophicephalous pedicellariæ (the latter rather numerous on the naked actinal part of the bivial ambulacra) are like those of *flavescens*. The rostrate (Pl. XVII. Figs. 6, 16) are more slender, the outer, widened part shorter than in *flavescens;* but small ones of the same form as those of *flavescens* (Pl. XVII. Fig. 9) also occur. The tridentate pedicellariæ (Pl. XVII. Figs. 5, 35, 39) have the edges of the blade more or less inrolled or even coalesced in the lower part, the outer part being more spoon-shaped widened; in quite small specimens the valves are simply leafshaped (Pl. XVII. Fig. 13). Some of the larger specimens (Pl. XVII. Fig. 39) recall somewhat the larger rostrate pedicellariæ. The largest tridentate pedicellariæ seen were only 0·3mm (length of head); doubtless larger ones will occur in larger specimens, and probably they will prove to differ yet more from those of *flavescens*. The triphyllous pedicellariæ (Pl. XVI. Fig. 12) differ from those of *flavescens* in being serrate almost all round the edge of the blade, only the point being smooth; the outline of the blade is also more rounded than in that species.

The differences pointed out here: in the shape of the test, the form and size of the internal fasciole, the peristome, the petals, the pores included by the subanal fasciole, the tuberculation and the pedicellariæ seem to me to leave no doubt that the Cape specimens hitherto referred to *Ech. flavescens* make a well characterized species, certainly nearly related to *flavescens*, but easily distinguished from this species. The differences in the shape of the test and the form of the peristome, to be sure, do not appear very clearly from the measurements given below of *capense* and some equal-sized specimens of *flavescens:* these characters also are probably rather variable, but in connection with the other differences they get some value. The difference in the size of the internal fasciole is very clearly seen in these measurements. It will be remarked that the measurements of the fasciole in *flavescens* are not quite in accordance with those given by Koehler (Echinocard. de la Méditerr. p. 182); this may be due perhaps to these measurements being taken from the interior borders of the fasciole or to the specimens from the Mediterranean having upon the whole the internal fasciole somewhat smaller than the specimens from the northern seas. Nevertheless the measurements given by Koehler also show the fasciole to be distinctly larger than in *capense*.

Echinocardium capense.							*Echinocardium flavescens.*						
Length	Breadth	Height	Fasciole*		Peristome*		Length	Breadth	Height	Fasciole*		Peristome*	
			Length	Breadth	Length	Breadth				Length	Breadth	Length	Breadth
26	23·5	14	7·5	5	2	5·5	27	22·5	17	11·5	8	3	4·5
22	19	12·5	7	4	2	5	22	18	13	8·5	5·5	2	4
19	16	10·5	6	4	2	3·5	19	15·5	11·5	9	6	2·5	3·5

* The fasciole is measured from the outer borders of the fasciole, the length of the peristome is taken from the point of the labrum. All the measurements are in mm.

31. **Echinocardium pennatifidum** Norman.

Pl. II. Figs. 3, 7, 9, 13, 15, 17. Pl. XVI. Fig. 18. Pl. XVII. Figs. 1, 18, 20, 24—26, 28—29, 32—33, 42, 44.

Literature: Barrett: On two species of Echinodermata new to the Fauna of Great Britain. Ann. Nat. Hist. 2. Ser. XIX. 1857. p. 33. Pl. VII. Fig. 2. a—c. (*Amphidotus gibbosus*» Ag.). — A. M. Norman: Last Report on Dredging among the Shetland Islands. Rep. Brit. Assoc. 1868. p. 315. — Hodge: Catalogue of the Echinodermata of Northumberland and Durham. Nat. Hist. Transact. Northumberl. and Durham. IV. 1872. p. 142. Pl. V. Figs. 1—5. — Agassiz: Revision of Echini. p. 111, 351. Pl. XX. Figs. 1—2(?) — F. Jeffr. Bell: On a species of Echinocardium from the Channel Islands. Ann. Nat. Hist. 5 Ser. XVII. 1886. p. 516—17. Catalogue Brit. Echinoderms. p. 170. Pl. XVI. Fig. 5. — Hoyle: Revised List Brit. Echinoidea. p. 428. — Koehler: Échinides et Ophiures .... de l'«Hirondelle» (229). Monaco. Fasc. XII. 1898. p. 24. Pl. III. Fig. 7, IV. Figs. 9—11. VIII. Figs. 40—42. Sur la présence en Méditerranée de l'Asterias rubens et de l'Echinocardium pennatifidum Norm. Zool. Anz. XXI. 1898. p. 471—4. Sur les Echinocardium de la Méditerranée (231). Pl. 4. Fig. 15. — Stanley W. Kemp: Echinoderms of Ballynakill and Bofin Harbours, Co. Galway, and of the Deep Water off the West Coast of Ireland. Ann. Rep. Fish. Ireland. 1902—03. Pt. II. App. VI (1905). p. 199.

Very little has to be added to the careful descriptions of the test of this species given by Bell and, especially, by Koehler. — The labrum is very short, not reaching beyond the middle of the first adjoining ambulacral plates (Pl. II. Fig. 15), a prominent difference from *flavescens*, in which species it reaches the second ambulacral plate. (This feature is well seen in Koehler's Fig. 11. Pl. IV (Op. cit. Monaco) but not mentioned in the text; the division of the plate I. a. 1 in two small plates, shown in this figure, is an abnormal case). The subanal fasciole according to Bell (Catalogue. p. 171) «seems to include only one pair of plates, which are triangular in form and have a pair of pores at the outer apex of each triangle». Koehler (Op. cit. Pl. IV. 10) figures two pairs of pores. Both cases may occur, but whether there be one or two pairs of pores included, three ambulacral plates reach within the fasciole, viz. Nr. 6—8; the last of them may reach scarcely beyond the fasciole — in that case only one pair of pores is developed within the fasciole, or it may reach farther within — then also the second pair of pores is developed. The periproct has a circle of larger plates all round, not only at the lower edge as in the other species.

The tube-feet of the anterior ambulacrum within the fasciole are quite rudimentary, only very few of them or even none at all with a few rosette-plates, — a rather conspicuous difference from *flavescens* and *capense*, which have these tubefeet well developed. Accordingly the pores of these ambulacral plates are very small. The spicules are few and small, irregular rods; often none at all are found in the tube-feet. The very large spicules below the disk, so characteristic of *Ech. cordatum*, are not found here. The subanal tube-feet with the usual clubshaped rods. The rosette-plates, when present, like those of *flavescens*. — According to Koehler (Op. cit. Monaco. p. 26) the tubercles within the internal fasciole «diminuent à mésure qu'on se rapproche de la ligne médiane». I find the inverted case, that they increase in size towards the median line, and the same is seen in Koehler's Pl. IV. Fig. 9 and especially in the fig. 15 of «Sur les Echinocardium de la Méditerr.», so that there is evidently a lapsus calami here. Otherwise these larger tubercles continue along the anterior ambulacrum, beyond the fasciole towards the ambitus and gradually pass into the larger tubercles of the actinal side. But no larger tubercles are found scattered on the antero-lateral interambulacra on the abactinal side — a very good character by which to distinguish this species from *flavescens*. — In two of the specimens before me the test is distinctly unequally developed, the right side projecting in front of the left. (Pl. II. Fig. 15, 17).

The pedicellariæ have received some attention, being partly very conspicuous. Thus the large, strongly serrate, tridentate pedicellariæ were seen by Norman and have given rise to the name *pennatifidum*. Hodge (Op. cit.) figures the valves of three forms of pedicellariæ, viz. a large, slender form of tridentate pedicellariæ, a short, coarsely dentate (the rostrate) and a small, simply leafshaped form, thought to be the «immature form» of the former. Koehler describes and figures (Pl. VIII. Figs. 40—42) three forms of pedicellariæ, viz. a large tridentate pedicellaria with strongly serrate edges, a smaller form, equally strongly serrate (rostrate?) and a third form which must certainly be a globiferous pedicellaria. — I have found all these forms and further triphyllous pedicellariæ, whereas ophicephalous pedicellariæ have not been met with in any of the specimens seen by me.

The globiferous pedicellariæ (Pl. XVII. Figs. 18, 29) are not very copiously represented; only in one of the 8 specimens examined have I found a single one on the abactinal side. In Professor

Koehler's specimens they were evidently more numerous. The valves have a very wide basal part; the blade is a short, narrow tube, with a small terminal opening surrounded by some short teeth, 5—6 on either side; the point is straightly cut. The difference between the globiferous pedicellariæ of this species and *flavescens* is very conspicuous.

The rostrate pedicellariæ (Pl. XVII. Figs. 20, 28, 32, 44) are very richly developed. The simpler forms are very like those of *Spatangus*, recalling somewhat, as pointed out by Koehler, the ophicephalous type of the *Echinidæ*, with which they have, however, nothing to do. The blade is in these forms simply rounded, the narrowed part being very short, with quite smooth edges (Pl. XVII. Figs. 32, 44); the edge of the widened part is finely serrate. Other specimens have a larger narrowed part, the edge generally being provided with one or more very large teeth (Pl. XVII. Figs. 20, 28). The larger of these forms are like the tridentate pedicellariæ, only shorter — indeed, it is impossible in this case to draw a definite distinction between rostrate and tridentate pedicellariæ. The larger ones of these pedicellariæ are ca. 1^{mm} (length of head); they have a well developed neck, and the stalk, as usual in *Echinocardium*, consists of long, very loosely connected fibres. They occur both on the actinal and abactinal side. — Also small specimens are found, which are more like the usual type of rostrate pedicellariæ.

The tridentate pedicellariæ occur in two very distinct forms, viz. a large form (up to 2·5^{mm} length of head) with strongly serrate edges (Pl. XVII. Figs. 1, 33), and a more slender form with narrow, leaf-shaped valves, joining in most of their length; in the part where the valves join, the edges are very finely serrate, in the lower part the serrations are coarser (Pl. XVII. Figs. 25, 26, 42); in some specimens the valves are more slender and the serrations of the lower part larger (Pl. XVII. Fig. 24); this form evidently corresponds to the Pl. VIII. 40 of Koehler. Otherwise all transitional forms are found between these two forms. The basal part is very narrow. Fourvalved specimens occur. This form, which has already been figured by Hodge (Op. cit.) does not reach the size of the first form, it scarcely exceeds 1·5^{mm} length of head. — The triphyllous pedicellariæ (Pl. XVI. Fig. 18) are rather elongate, with the whole edge, except the very point, finely serrate; the serrations increase a little towards the point of the blade.

On the younger stages of this species I cannot give much information, having seen besides larger specimens only a specimen of 9^{mm} length and one of 18^{mm} length. In the latter the genital pores have appeared, not in the former. The petals are distinct already in the specimen of 9^{mm}, viz. 4 double pores in the anterior, 10 in the posterior series of the anterior petals, 9 in both series of the posterior petals. In the specimen of 18^{mm} the anterior series in the anterior petals is less developed, having only one or two small double pores.

This species is known from the British Seas, from the Færoe Islands to the Bay of Biscay. From the Danish Seas it was hitherto unknown, but recently Dr. A. C. Johansen has taken a specimen (the above mentioned small one of 9^{mm}) in 35 M. off Thyborön („Thor". IV. 1905). Evidently the species is rare in our seas, otherwise it would scarcely have been overlooked. — By the „Ingolf" it was not taken, but I have myself dredged some specimens at the Faroe Islands in ca. 80—150 fathoms. (16 Miles W. of Nolsö, and 13 Miles W. of „Munken", a small rock at the South end of

Suderö). The bathymetrical distribution of the species is, as far as hitherto known, from shallow water to ca. 150 fathoms.

Ech. pennatifidum is further stated to occur in the Mediterranean and at the American Coasts of the Atlantic (Florida and West-Indies). The presence of the species in the Mediterranean at Tamaris-sur-Mer[1] was announced by Professor Koehler, who has done me the very great service to send me one of these specimens. A close examination thereof, however, shows that this specimen differs in several respects considerably from *pennatifidum*. — The labrum reaches to the second adjoining ambulacral plates as in *flavescens*, whereas in *pennatifidum* it ends off the middle, or (in the largest specimen examined) even at the anterior end of the first ambulacral plate. Four ambulacral plates reach within the subanal fasciole, which accordingly includes three pairs of pores; in *pennatifidum* three plates reach within the fasciole, with two or only one pair of pores. The periproct is like that of *flavescens*, very different from that of *pennatifidum*. The anal opening is rather eccentric, lying near the upper edge, surrounded by small, irregular plates. The lower part of the anal area is bordered by a series of large, regular plates, which diminish in size towards the upper edge; they are closely covered by a fine granulation. The anal fasciole is in direct connection with the subanal fasciole, whereas in *pennatifidum* it is separated from the latter by a rather broad band of coarser tubercles, as is well seen in Koehler's Fig. 10. Pl. IV (Monaco); in young specimens this is, however, not the case, the granulation of the two fascioles uniting in the median line.

The number of pores in the petals differs considerably from what is found in *pennatifidum* of a corresponding size. I give here the measurements of the test and the number of pores in the petals of this specimen, and, for comparison, of specimens of *pennatifidum* and *flavescens* of a corresponding size.

	Length	Breadth	Height	Number of pores			
				Anterior petals		Posterior petals	
				Anterior series	Posterior series	Anterior series	Posterior series
Specimen from Tamaris	50^{mm}	45^{mm}	32^{mm}	9	13—14	10	9—10
Ech. pennatifidum	52 —	52 —	31 —	4	12—15	13—14	13—14
Ech. flavescens	55 —	49 —	32 —	9	13—14	10—11	10—12

The internal fasciole seems to be larger than in *pennatifidum* (— unfortunately the anterior part of the test is damaged, so that I cannot state that exactly —); in any case it is more remote posteriorly from the apical system than in the specimen of 52^{mm} length, of which the above measurements are given — in the latter the fasciole passes over the second plate in the posterior interambulacrum, in the Mediterranean specimen it passes over the 4th—5th plate of the posterior interambulacrum. The greatest width of the fasciole is 10^{mm} in the said specimen of *pennatifidum*, 13^{mm} in the Mediterranean specimen; it is further to be remarked that one or two large tubefeet of the posterior series of the anterior petals are within the fasciole, which is not the case in either *pennatifidum* or

[1] Sur la présence, en Méditerranée, de l'Asteras rubens Linné et de l'Echinocardium pennatifidum Norman. Zool. Anzeiger. XXI. Nr. 567. 1898.

flavescens. — The tubefeet of the odd anterior ambulacrum seem to be very well developed. The pedicellariæ differ very essentially from those of *pennatifidum*; they are, indeed, quite like those of *flavescens*, only the rostrate pedicellariæ are a little more slender than in that species (Pl. XVII. Figs. 36, 46), and I find here the form of tridentate pedicellariæ figured by Koehler (Sur les Echinocard. de la Méditerr. Pl. 4. 13) as characteristic of *flavescens*, a form which I have, otherwise, not found in that species (Pl. XVII. Fig. 14, comp. above p. 135). Ophicephalous pedicellariæ were not found. — The spicules do not present peculiar features; I do not find any large spicules just below the disk.

From what is here pointed out I think it is proved beyond doubt that this specimen is not *pennatifidum*, and the presence of that species in the Mediterranean thus remains problematic, no other instances of its occurring there being recorded, as far as I know.

From the Zoological Station at Naples I have received under the name of *Ech. mediterraneum* two (smaller) specimens, which evidently belong to the same species as the above described specimen from Tamaris. In one of them the labrum does not reach beyond the first adjoining ambulacral plates, in both of them only two pairs of pores are enclosed by the subanal fasciole. Otherwise they agree with the specimen from Tamaris. In the larger of them (34^{mm} in length) one large tubefoot of the anterior petals (posterior series) is developed within the fasciole, in the smaller specimen (32^{mm} in length) no such larger tubefeet are as yet developed within the internal fasciole. — There is a faint violet tint seen on the abactinal spines.

After all I think it must be admitted that this form must be regarded as a separate species, which I propose to name **Echinocardium intermedium** n. sp.[1] It is nearly related to *Ech. flavescens*, and, especially, *Ech. capense*, whereas it is not more nearly related to *Ech. pennatifidum* or *mediterraneum*, to which two species the specimens known to me have wrongly been referred. It differs from *flavescens* mainly in having no larger tubercles on the lateral and posterior interambulacra on the abactinal side, and those of the anterior interambulacra are much smaller than in *flavescens*. Further the rostrate and large tridentate pedicellariæ differ not inconsiderably from those of *flavescens*. For the larger specimens it may perhaps prove a constant feature that the large tubefeet of the anterior petals, posterior series, continue within the fasciole, which is not the case even in the largest specimens of *flavescens*. If other constant characters are to be found distinguishing it from *flavescens* cannot be stated from the present scarce material. From *Ech. capense* it is distinguished mainly by its much larger internal fasciole, and the shape of the test which is much more like *flavescens*, without the almost saddlelike depression of the apex, so characteristic of *capense*. Regarding the pedicellariæ it is to be remarked that their triphyllous pedicellariæ differ rather considerably, being as in *flavescens* in the Mediterranean species, with only a few serrations at the lower end of the edge of the blade, whereas in *capense* they are serrate almost along the whole edge of the blade. Ophicephalous pedicellariæ are known only from *capense*, while globiferous and large tridentate pedicellariæ are not known from this latter species. A comparison of the number of pores in the petals cannot be made, as only small specimens of *capense* have been examined, and only larger specimens of *intermedium*.

[1] Possibly it will prove identical with the *A. roseus* Forbes; in that case this name will, of course, have to be retained and the name *intermedium* will be dropped as a synonym thereof. For the present it is, however, necessary to give the species a new name, since it is still uncertain which species is really the *A. roseus* Forbes.

To this species evidently belongs the specimen figured by Koehler (Sur les Echinocardium de la Méditerranée. Pl. 4. 10) as well as that figured by Gasco (Op. cit.), and it may perhaps be allowed to suggest that in several other instances the two species *flavescens* and *intermedium* have been confounded. The existence of *flavescens* in the Mediterranean is proved by Figs. 4 and 5 of the paper quoted by Koehler which are certainly true *flavescens* and have been made after specimens from the Mediterranean, as expressly stated by Professor Koehler in a letter to me.

The American specimens referred to *Ech. pennatifidum* will probably be found not to belong to that species either. From the description in the «Rev. of Echini» p. 351 it appears that the American form differs from *pennatifidum* in several regards. The periproct[1] is said to be somewhat pear-shaped; in *pennatifidum* it is more or less transversely elongate. The internal fasciole is «very elongated, elliptical, including an extremely narrow space»; in *pennatifidum* it is more angular, as is very well seen in Koehler's Fig. 9. Pl. IV. (Monaco). The apex is «anterior, and placed at a distance of about one fourth the longitudinal diameter of the test from the anterior extremity, thus differing strikingly from either E. flavescens or E. cordatum, in which the junction of the ambulacra is either almost central or eccentric posteriorly»; in *pennatifidum* the apical system is, however, not anterior but central or even a little eccentric posteriorly. «The posterior ambulacra are much shorter than in E. flavescens». To illustrate this feature I give here some measurements; they show clearly that the posterior petals (which is evidently the meaning) are distinctly longer in *pennatifidum* than in *flavescens*, the reverse case to what is found is Agassiz' specimens.

Ech. pennatifidum.			*Ech. flavescens.*		
Length of test	Posterior petals		Length of test	Posterior petals	
	Length	Number of pores		Length	Number of pores
52 mm	20 mm	13—15	55 mm	18 mm	10—12
30 —	10 —	11—12	30 —	8 —	7—8
18 —	5·5 —	10—12	19 —	5 —	6—7

Also the form of the test seems to be different, judging from the figures given in the «Revision» (Pl. XX. 1), the posterior end being more pointed in the American form, whereas in the European form it is rounded. Unfortunately nothing is known of the labrum, the number of ambulacral plates reaching within the subanal fasciole, the number of pores in the petals, the pedicellariæ and spicules. But the differences pointed out here seem scarcely to leave any doubt that the American specimens referred by Agassiz to *Ech. pennatifidum* are really a distinct species; if that proves to be so, this species must keep the name *Ech. lævigaster* A. Ag., by which it was first described (unless it turns out to be identical with the pliocene *Ech. orthonotus* Conrad). In any case it cannot be regarded as an established fact that *Ech. pennatifidum* occurs in the American waters, before it has been stated by a renewed careful examination that the American specimens really belong to this species.

[1] Strictly speaking it is said of the anal opening, but I suppose I am not mistaken in taking it to mean the whole anal area.

32. **Echinocardium cordatum** (Penn.).

Pl. XVI. Fig. 21. Pl. XVII. Figs. 15, 21—23, 30, 34, 37—38, 43, 48—49.

Principal Synonyms: *Spatangus arcuarius* Lmk.
Echinocardium Sebæ Gray.
Amphidetus cordatus Forbes, etc.
— *Kürtzii* Gir.

Principal literature: Pennant: British Zoology. 1777. IV. p. 69. Pl. XXXIV. Fig. 75. — Leske: Additamenta ad Kleinii Nat. Disp. Echinod. p. 230. Tab. XXIV. c. d. e. Tab. XXXVIII. 5. — Abildgaard: Zoologia Danica. III. p. 17. Tab. XCI. (Spat. flavescens — non Müll.) — Lamarck: Animaux sans vertêbres. 1816. III. p. 32. — Forbes: British Starfishes. p. 190. — Düben & Koren: Skandin. Echinodermer. p. 285. — Agassiz & Desor: Catalogue raisonné. p. 117. Pl. XVI. 8. — Gray: Catalogue of recent Echinida. p. 43. — Joh. Müller: Bau d. Echinodermen. p. 29. Taf. III. Fig. 3—5. — Desor: Synopsis des Échinides fossiles. p. 407. Pl. XLIII. Fig. 4—5. — Sars: Norges Ech. p. 97. — Agassiz: Revision of Echini. p. 109, 349. Pl. XIX. 10—17, XX. 5—7, XXV. 27—28. — Lovén: Études s. l. Échinoidées. Pl. I. 2—7, III. 38, XII. 107, XXXIX. 222—226. On Pourtalesia. Pl. VIII. 57—58, XI. 120—126, XII. 148. — Koehler: Rech. s. les Échinides d. côtes de Provence. p. 130.—(230) p. 473. — Bell: Cat. Brit. Echinoderms. p. 169. Pl. XVI. 1—4. — Hoyle: Revised List Brit. Echinoidea. p. 427. — Grieg: Nordlige Norges Echinodermer. p. 33. — Döderlein: Arktische Seeigel. Fauna arctica. IV. p. 384. — Stanley W. Kemp: Echinoderms of Ballynakill .... Ann. Rep. Fish. Ireland. 1902—3. Pt. II. App. VI. (1905) p. 182.

For other literary references I may refer to the «Revision of Echini» and to Professor Bell's Catalogue.

This species has been so often described and is so well known that I find very little to remark except on the pedicellariæ and the postlarval development. — Regarding structural features of the test it may be noticed that the labrum reaches the second adjoining ambulacral plates, viz. a narrow forward prolongation of the latter. Three or four ambulacral plates reach within the subanal fasciole, two or three pairs of pores being included (— in the specimens from the Danish Seas there are, almost without any exception, only two pairs of pores included —). The periproct varies greatly in shape (Figs. 24. *a—c*); generally it is transverse-oval, but it may also be found more or less elongate, sometimes (in specimens from Roscoff) even very elongate and narrow, like that of *Ech. mediterraneum*. It may also be pointed out that in the anterior interambulacra there are several larger tubercles scattered on the 2—3 vertical plates just beyond the ambitus; also in the lateral interambulacra there are a few larger tubercles on a pair of the plates just above the ambitus, but only in the anterior series, at the edge of the ambulacrum. This feature, which is distinct already in specimens of ca. 15^{mm} length, is one more good distinguishing character from *mediterraneum*, in which species such larger tubercles are not found beyond the ambitus.

The spicules, especially those very peculiar large ones below the disk of the tube-feet have been carefully described and figured by Lovén; I have nothing to add. — The pedicellariæ, on the other hand, need a more close examination, a tridentate pedicellaria alone having been figured by

Agassiz (Rev. of Ech. Pl. XXV. 27—28). Globiferous, rostrate, tridentate and triphyllous pedicellariæ have been found; ophicephalous ones do not seem to occur.

The globiferous pedicellariæ (Pl. XVII. Figs. 37, 49) are very conspicuous, with a thick, brownish head; the valves are very short, with a very large basal part and a short, tubeshaped blade, which has 5—6 teeth along each side of the elongate terminal opening and often an outer median one. The stalk has a whorl of free projecting rods at its lower end; the upper end is attenuated. These pedicellariæ I have found only on the actinal side, and only in specimens from the Mediterranean, never in any specimen from the northern seas. In some specimens from Tamaris (Var), which Professor Koehler has most kindly lent me for examination I find them thus represented: in one specimen (the largest) they are very numerous and well developed; in four specimens there are very few of them, at the mouth or on the anal area, and they are small, the basal part being not very large and the whorl on the stalk little developed; in two specimens I find no globiferous pedicellariæ at all —

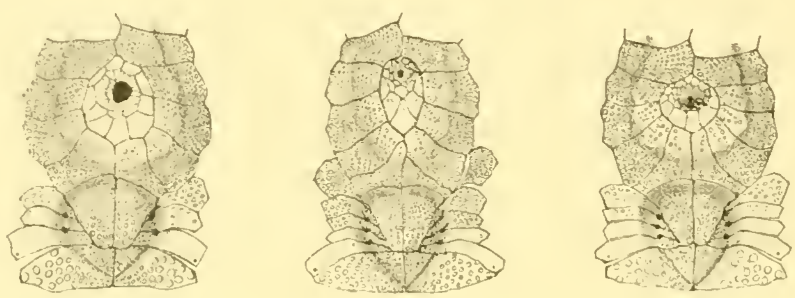


Fig. 24, *a—c*. Anal and subanal region of *Echinocardium cordatum*: *a* specimen from Skagerrak; *b* from Roscoff; *c* from Naples.

in these latter specimens, on the other hand, the tridentate pedicellariæ seem comparatively more richly developed than usually.

The rostrate pedicellariæ (Pl. XVII. Figs. 15, 21, 38) are rather like those of *flavescens*, only still more like tridentate pedicellariæ; the blade generally is somewhat pointed, and may have a prominent tooth in the point. In some specimens from the Mediterranean I find such with the blade much narrower (Pl. XVII. Fig. 34), recalling very much those of *Spatangus*. — The tridentate pedicellariæ (Pl. XVII. Figs. 22, 23, 30, 43, 48) have leafshaped valves, in the smaller ones joining with their whole edge; in the larger forms the blade is more or less narrowed in the lower part, the edge being irregularly serrate; there is generally some meshwork in the bottom of the blade in these larger pedicellariæ. In the specimens from Tamaris I find the tridentate pedicellariæ unusually broad (Pl. XVII. Fig. 30). The largest ones seen were ca. 1·5^{mm}, length of head. — The triphyllous pedicellariæ (Pl. XVI. Fig. 21) are very peculiar; in the outer part there is a series of broad teeth inside along the edge; the serrations pass a little way up together with these teeth. In about the outer half of the blade the edge is smooth. — Ophicephalous pedicellariæ unknown.

This species, which was not taken by the "Ingolf", is very common in the Danish Seas, and along the Atlantic coasts of Europe, from Northern Norway to the Mediterranean. It is not known from the Faroe-Islands or Iceland. From the American side of the Atlantic it is recorded from

North Carolina to Bahia. The bathymetrical distribution is rather small, from shallow water to 85 fathoms.

The specimens from the Kattegat are rather small, evidently the species reaches a more considerable size at the Atlantic Coasts. Forbes (Op. cit.) thus mentions a specimen of 3 inches diameter, and from the Biological Laboratory of Roscoff I have received specimens of a little over 60^{mm} length.

The specimens from the Mediterranean differ from the northern specimens in the peculiar feature that they alone appear to have globiferous pedicellariæ, and even sometimes very richly developed. Further they have four ambulacral plates reaching within the subanal fasciole, whereas generally only three reach within the fasciole in the northern specimens. Otherwise I cannot see any reliable differences, so that I must regard them as belonging to the same species; at most the Mediterranean form can be made a separate variety of *Ech. cordatum.*

The American specimens were originally described as a distinct species, *Amphidetus Kürtzii* Girard,[1] which was later on by Agassiz (Revis. of Echini) made a synonym of *Ech. cordatum* After a careful comparison of a single specimen from the Coast of North Carolina with equal-sized European specimens of *cordatum*, I must fully join Professor Agassiz in regarding the American form as identical with the European *Ech. cordatum.* In all the more important structural features of the test they are in complete accordance (in the specimen before me there are 2 pairs of pores within the subanal fasciole, but the ninth ambulacral plate also reaches within the fasciole, so that specimens with three pairs of pores within the fasciole will probably be met with). Regarding the shape of the test the specimen in hand is a little broader than is generally the case in the European specimens, and also the front end is perhaps a little more perpendicular; but it is, of course, impossible to judge of the real value of these apparently trifling differences from a single specimen alone. It may be remarked that the very few pedicellariæ seen, viz. triphyllous, tridentate and rostrate (but no globiferous) are also in accordance with those of the European specimens.

Agassiz (Revision of Echini. p. 350. Pl. XIX. 10—15) describes and figures young stages of this species of $6{\cdot}3—7{\cdot}9^{mm}$ length. From the Kattegat I have specimens of all sizes from such as are just metamorphosed and only $0{\cdot}5^{mm}$ long.[2] Also the larva I have described from here[3]; it occurs in great numbers, making an essential portion of the Plankton in the months of June—July. No other species of *Echinocardium* occurring in the inner parts of the Kattegat, the identification of the young specimens is beyond doubt. I am thus able to give a rather full account of the postlarval development of this species, which may prove of some interest. Also the comparison with the development of *Brisaster fragilis*, described above p. 111—114, Pl. XIII, is certainly not without interest.

The youngest stages I find to agree very closely with those of *Ech. flavescens* figured by Lovén (On Pourtalesia. Pl. XV). The development of the apical system follows much the same course

[1] Account of a new species of Spatangidæ from the Atlantic Coast of the United States. Proc. Boston Soc. Nat. Hist. 1852. Vol. IV. p. 213.

[2] From »Thor» St. 112. 1905 (56° 33′ Lat. N. 1° 47′ Long. E. 89 M.) there are immense numbers of quite young *Echinocardium*, which quite agree with those of *Ech. cordatum* from the Kattegat. I do not, however, venture to decide, whether they belong to *Ech. cordatum* or *flavescens*, both of these species occurring there. In none of them have pedicellariæ appeared as yet.

[3] Die Echinodermenlarven der Plankton-Expedition. Ergebn. d. Plankton-Exp. d. Humboldt-Stiftung. Bd. II. J. 1898. p. 102. Taf. IX. 5—11.

as in *flavescens*, where it has been worked out so very accurately by Lovén; it is, however, to be noticed that the two left genital plates and the right posterior one are generally distinctly separated from the left anterior (with the madreporite). The genital pores I have not found in specimens smaller than 14^{mm} length (in *flavescens* Lovén has found them already at a size of $10{\cdot}5^{mm}$.) — The labrum only reaches a little over the middle of the 1. adjoining ambulacral plates in specimens up to ca. $1{\cdot}5^{mm}$ length. In a specimen of 2^{mm} length it reaches the 2. ambulacral plate on the right side, and from a size of ca. 3^{mm} it reaches the 2. ambulacral plate on both sides as in the grown specimens. The regular pentagonal form of the peristome begins to alter at a size of ca. 3^{mm}; in specimens of 4^{mm} length the labrum is rather prominent, reaching the edge of the mouth-opening. The definitive form of the peristome is found in specimens of ca. 10^{mm} length. — The front ambulacrum is distinctly sunken already in specimens of $2—3^{mm}$ length; in yet smaller specimens the outline of the front end is almost straight, like what is seen in the figures 172 and 173 of Lovén. The tube-feet of the anterior ambulacrum appear very early, as found by Lovén in *flavescens*, but they are in no way especially large in the young specimens, which fact is not in accordance with the view of Agassiz that very large suckers are an embryonic feature (comp. above p. 96 sub *Aëropsis rostrata*). The large spicules of the frontal tubefeet are distinct already in specimens of 3^{mm} length. The paired petals, as usual, are considerably later in their development than the anterior ambulacrum. Single pores begin to appear in the posterior series of the anterior petals at a size of ca. $2{\cdot}5^{mm}$; at ca. 3^{mm} they begin to appear in the posterior petals, both series, and a little later (at ca. 4^{mm} length) they begin to appear in the anterior series of the anterior petals, the pores of the posterior series at the same time beginning to elongate transversely. At a size of scarcely 5^{mm} I find the pores (6—7 in number) of the posterior series of the anterior petals double, this condition of the pores evidently being reached through the formation of a transverse ridge over the elongated single primary pore. At a size of ca. $5{\cdot}5^{mm}$ the petals are fully formed, only the number of the double pores being smaller than in the grown specimens, viz. in the anterior petals 3—4 in the anterior, 7—8 in the posterior series, and in the posterior petals 6 in the anterior, 7 in the posterior series.

The fascioles make their appearance very early. At a size of only $0{\cdot}7—0{\cdot}8^{mm}$ the subanal fasciole is distinct, consisting to begin with of only a single circle of clavulæ. The spines within the fasciole are comparatively long, as long as the test, pointing directly backwards, which gives to these small specimens a characteristic appearance. The anal branches from the subanal fasciole appear at a size of ca. $2{\cdot}5^{mm}$. The inner fasciole is later in its appearance than the subanal fasciole, not beginning to form until the animal has reached a size of ca. $1{\cdot}5^{mm}$. It likewise consists at first only of a single circle of clavulæ. — The development of the subanal area also affords some features of interest. In quite small specimens only the 6th ambulacral plate of the series I. a. and V. b. reaches within the fasciole; at a size of ca. $2{\cdot}5^{mm}$ the 7th plate begins to expand towards the fasciole and by and by it reaches within. From a size of ca. 8^{mm} the 8th plate begins to expand in the same manner. Only at a size of $14—15^{mm}$ does the first pair of pores appear within the fasciole; the second pair (in the 8th plates) I have not found developed at a smaller size than 18^{mm}.

Pedicellariæ do not appear till rather late, at a size of ca. 2^{mm}, the triphyllous being the first to appear; they show the structure so characteristic for the species already from their first appearance.

The sphæridiæ, on the contrary, are very early developed, viz. the first 5 of them. Already in the youngest specimens of only 0·5^{mm}, where remnants of the larval skeleton are still quite distinct within the abactinal skeleton, they have appeared.

In the smallest specimens, of only 0·5^{mm}, there are already bottom-particles in the intestine, which shows that they begin the diet of the grown specimens as soon as their pelagic life has come to end.

Very nearly related to *Ech. cordatum* is *Ech. australe* Gray, so nearly, indeed, that it may be doubted, whether they are not identical. Agassiz, though recognizing its close affinity to *Ech. cordatum*, (»Revision of Echini» p. 580) states that »specimens of this species are readily distinguished from the Atlantic E. cordatum ..... Seen in profile the test rises somewhat more gradually from the anterior extremity towards the apical system; the abactinal pole is more central, and the anal system is elliptical, slightly transverse, instead of being longitudinal, as in E. cordatum. The bare abactinal posterior ambulacral areas extend to the ambitus, remaining of the same width, instead of becoming narrow as in E. cordatum; the pores of the poriferous zones are more distant than in E. cordatum». — In the »Challenger»-Echinoidea (p. 174) these characters are stated to be quite constant in the specimens examined, but Professor Agassiz adds that they »seem very slight ground for maintaining the specific distinctness of the Pacific and the Atlantic representatives of the genus, and I should expect that additional material will prove this species to be identical with the European species». — This suggestion is probably quite correct. I have examined several specimens from Australia, Japan and (one) from the Cape, and I find them to agree with *cordatum* in all essential features: the labrum, the number of pores included within the subanal fasciole, the shape of the anal area (as shown above it is of rather variable form in *cordatum*, so that no reliable difference is to be found herein), the form and size of the petals as well as the number of their pores (— the difference in the posterior petals said to exist by Agassiz I am quite unable to see —), the arrangement of the pores of the odd anterior ambulacrum in double series, the position of the apical system (— I do not find it more central in *australe* than in *cordatum* —), the larger tubercles in the anterior interambulacra — in short, I find them to agree completely in all essential features, so that they are, indeed, contrary to the original statement of Agassiz, extremely difficult to distinguish. To be sure, I find the *Ech. australe* somewhat lower at the anterior end, thus rising »somewhat more gradually from the anterior extremity towards the apical system», and perhaps also the pores of the anterior ambulacrum do not become arranged in double series so early as in *cordatum*.[1] These, however, are so inconsiderable differences that I doubt, whether it would be possible to distinguish with certainty tests of the two »species», if they were put together and the localities of the specimens not marked. In the pedicellariæ I do not find any reliable differences — but it is to be remarked that I have not found any globiferous pedicellariæ in *australe;* upon the whole pedicellariæ seem to be very scarce in this form. Regarding the spicules I find the large rods below the terminal disk to be generally somewhat smaller than in *cordatum;* on the other hand the spicules of the frontal tubefeet are generally somewhat larger and

[1] Hutton (Catalogue of the Echinodermata of New Zealand. 1872. p. 14) says of *Amphidetus zealandicus* (= *Ech. australe*) that it has four genital pores on each side; this is, of course, a mistake, caused by the ocular pores having been taken to be genital pores.

more numerous than in *cordatum*. It may be remarked that *australe* reaches the same considerable size as *cordatum*. A specimen of 74^{mm} length, from Victoria, is in the Museum of Copenhagen. — After all, the conclusion seems inevitable that *Ech. australe* is really synonymous with *Ech. cordatum*, which species thus has an almost cosmopolitan distribution; only along the Pacific Coast of America it does not seem to occur.

In the Challenger -Echinoidea (p. 174) *Ech. australe* is recorded from a depth of no less than 2675 fathoms (St. 234), which seems, indeed, very curious, the species being otherwise a littoral form of rather small bathymetrical distribution. I have examined the specimens from this station in the British Museum, and I must agree that they really seem to be identical with the littoral specimens. Perhaps the actinostome is a little more central than in the littoral specimens, but otherwise they seem to agree in all essential points. That the pores of the odd ambulacrum are as yet only placed in a single series does not give any distinguishing character, since the same is the case in *cordatum* and *australe* of a similar size (the largest of the deep-sea specimens is only 15^{mm} with the genital pores just about to appear). Of pedicellariæ only a small tridentate and some triphyllous were found; they agree with *australe*, and the same is the case with tubefeet and spicules. Since, however, only small specimens are represented, I think it safer to regard it as not beyond doubt that these deep-sea specimens are really the same species as the littoral *australe*. And upon the whole it might well be thought possible that by a very careful examination of a large material of this form from the different localities in the Atlantic and the Indo-Pacific, characters might be found by which it might be divided into different recognisable species. In that case this group might well be regarded as a distinct genus, characterized by its deep anterior ambulacrum, with the pores arranged in double series. Also the peculiar triphyllous pedicellariæ would then form one of the generic characters. For the present, however, it seems that this group forms really only one species — the only littoral species of Echinoidea hitherto known with such extensive, almost cosmopolitan distribution. (The *Diadema saxatile* and *Echinus norvegicus* hitherto regarded as almost cosmopolitan are really not so widely distributed, as I have shown)[1].

A few remarks may here also be given of the last of the *Echinocardium*-species hitherto known, the *Ech. mediterraneum* Forbes. A very careful description has been given of this species by Koehler (Sur les Echinocardium de la Méditerr. p. 175. Pl. 4. 1—4, 14), but a few points of some importance may still be added. The labrum reaches the second adjoining ambulacral plates, which send a narrow forward prolongation to meet its corners. Three pairs of plates (one or two pairs of pores) are included by the subanal fasciole. The pores of the odd anterior ambulacrum are small and distant; the plates included by the internal fasciole are very narrow. The fasciole goes rather far behind the apical system, passing over the 5—6th plates of the odd interambulacrum in a specimen of 28^{mm} length. These interambulacral plates within the fasciole are very narrow, especially those traversed by the fasciole, and there is a rather abrupt widening of the plates just outside the fasciole (Fig. 25). It may also be expressly stated that no larger tubercles are found above the ambitus in the anterior interambulacra. A curious feature, which I have not seen in any of the other species of this genus, is that the clavulæ end in two small lobes of skin, the point otherwise being almost not widened (Pl. XVII. Fig. 51). The pedi-

[1] Ingolf-Echinoidea. Part I. Siam-Echinoidea. Part I.

cellariæ were hitherto very insufficiently known; a few figures are given in Revision of Echini Pl. XXV. 29—30 and Pl. XXVI. 19, and Koehler (Op. cit. Pl. 4. 14) gives a figure of one kind of pedicellariæ. I have found globiferous, rostrate, tridentate and triphyllous pedicellariæ, but no ophicephalous. The globiferous pedicellariæ (Pl. XVII. Figs. 12, 47) are rather like those of *cordatum*, only the blade is generally more elongate (though not always so elongate as in the figured valve), and the basal part is narrower. 3—4 teeth are found on either side of the terminal opening, and there may be one in the middle of the outer edge; the terminal opening may sometimes be quite covered by the teeth. As is usual the valves are covered by a thick skin (Pl. XVII. Fig. 47); the stalk is rather thick and compact, knotted, with a distinct thickening above and below, the latter without free projecting rods. — The Fig. 19. Pl. XXVI of Revision of Echini, in the explanation of plates termed an open-headed actinal» pedicellaria, evidently represents the valve of a globiferous pedicellaria. — The rostrate pedicellariæ are rather large and very characteristic (Pl. XVII. Figs. 3, 52); the valves are coarsely dentate along the side edges, the point, which is more or less rounded, finely serrate. They reach a rather considerable size, ca. 1—1·2mm length of head. The Fig. 29, Pl. XXV of Rev. of Ech. (long-headed pedicellaria), as well as the Pl. 4. Fig. 14 (pedicellaire gemmiforme) of Koehler (Op. cit.) evidently represent this form. Anything nearly resembling the Pl. XXV. Fig. 30 of Rev. of Ech. I have not seen.

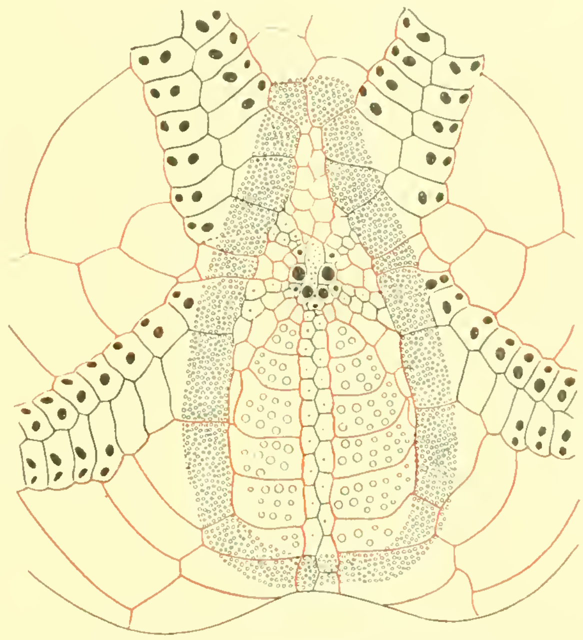


Fig. 25. Apical area of *Echinocardium mediterraneum* $^{4}/_{1}$.

The tridentate pedicellariæ occur in two, not very sharply distinguishable forms; the one (Pl. XVII. Fig. 2) has slender, leafshaped valves, the larger ones joining only in the outer half; the lower part is more or less coarsely serrate, the basal part rather narrow. The other form (Pl. XVII. Fig. 19) has short valves, generally a little inrolled in the lower part, and sometimes ending in a distinct tooth. This form to some extent recalls the form, which I have termed rostrate pedicellaria in *Ech. flavescens* — and it is, indeed, rather difficult to determine with certainty to which kind it ought really to be reckoned, the rostrate pedicellariæ being, as repeatedly pointed out, essentially a special form of tridentate pedicellariæ. — The triphyllous pedicellariæ (Pl. XVI. Fig. 16) are rather like those of *cordatum*, with similar teeth inside along the edge of the blade. — Spicules seem to be almost wholly wanting in the tubefeet, and no large spicules are found below the disk of the frontal tubefeet which are otherwise well developed and like those of *cordatum*.

After the revision of the species of *Echinocardium* given here it will perhaps not be found useless to give an analytical table of all the species hitherto recognized with certainty.

Analytical table of the Echinocardium species.

1.	Anterior ambulacrum deepened	2.
	— — not deepened, flush with the test	3.
2.	The furrow continuing to the apical system; the pores within the internal fasciole in close, double series. Larger tubercles are found scattered on the anterior interambulacra above the ambitus	*cordatum.* *(australe).*
	The furrow ending abruptly at the anterior end of the internal fasciole; the pores within this fasciole distant and in single series. No larger tubercles above the ambitus	*mediterraneum.*
3.	No larger primary tubercles in the interambulacra above the ambitus; the labrum very short, not reaching beyond the middle of the first adjoining ambulacral plates..	*pennatifidum.*
	Larger primary tubercles are found at least in the anterior interambulacra above the ambitus; the labrum generally reaching the second adjoining ambulacral plates	4.
4.	Very prominent primary tubercles in all the interambulacra above the ambitus	*flavescens.*
	The primary tubercles above the ambitus little prominent, and occurring only in the anterior interambulacra	5.
5.	Internal fasciole very small; a distinct saddle-shaped depression in the apical region	*capense.*
	Internal fasciole large; no saddle-shaped depression in the apical region ...	*intermedium.*

33. Brissopsis lyrifera (Forbes).

Pl. III. Figs. 2—3, 7, 11—12, 18, 20—23. Pl. IV. Figs. 2—3, 9, 14—17. Pl. XVIII. Figs. 1, 6, 12, 18, 25—26. Pl. XIX. Figs. 3, 6, 10, 15, 18—21, 29, 34.

Synonyms: *Schizaster incertus* Aradas.
Brissus pulvinatus Phil.
Brissopsis parma Val.

Principal literature: Forbes: British Starfishes. 1841. p. 187. — Düben & Koren: Skandinav. Echinodermer. p. 280. Tab. X. 46. — Philippi: Beschreibung einiger neuen Echinod. Arch. f. Naturg. 1845. p. 347. — L. Agassiz & Desor: Catalogue raisonné. p. 121. Pl. XVI. 12. — Sars: Norges Echinodermer. p. 96. — A. Agassiz: Revision of Echini. p. 95, 354. Pl. XIX. Figs. 1—8 (non Fig. 9), XXI. Figs. 1—2, XXXVIII. 36—38. — Perrier: Recherch. s. les pédicell. p. 173. Pl. VII. 9. — Lovén: Études s. les Echinoidées. Pl. I. 1, II. 27—31, III. 32, XII. 100—101, XXXVII. 213—18. On Pourtalesia. Pl. VIII. 66, IX, XIX. 223—31. — Wyv. Thomson: Porcupine -Echinoidea. p. 750. — A. Agassiz: Challenger -Echinoidea. p. 189. — Koehler: Recherches s. les Échinoidées des côtes de Provence. p. 135. Meissner & Collin: Beitr. z. Fauna d. südöst. u. östl. Nordsee. II. Echinodermen. p. 334. (Figure.) — Ludwig: Echinodermen d. Mittelmeeres. p. 562. — Bell: Catalogue Brit. Echinoderms. p. 172. —

Hoyle: Revised List Brit. Echinoidea. p. 422. — Bell: Echinoidea of South Africa, p. 175. — Grieg: Nordlige Norges Echinodermer. p. 34. — Döderlein: Arktische Seeigel. Fauna Arctica. IV. p. 384. Echinoiden d. deutschen Tiefsee-Exped. p. 256. Taf. XXXIV. 4—8. XLIX. 1—2.

Non: A. Agassiz: Preliminary Rep. Echini & Starfishes dredged in deep water between Cuba and the Florida Reef by L. F. de Pourtalés. I. Catalogue of the Echini. p. 275, 294. Bull. Mus. Comp. Zool. 1869. Blake -Echinoidea. p. 69. Pl. XXVI. 7—18. — Verrill (418). p. 139.

Other less important literary references are found in Revision of Echini, Ludwig: Echinodermen d. Mittelmeeres and Bell's Catalogue.

As appears from the numerous literary references this species has been mentioned and figured very often. Nevertheless, something still remains to be done. — Regarding the structure of the test I may only point out that the hinder prolongation of the labrum is narrow and reaches only to the middle of the first adjoining ambulacral plates. (In one specimen, however, I have found it to reach the second ambulacral plates, and in a few specimens to the second ambulacral plate on one side only). The first plate which reaches within the subanal fasciole is, as is usually the case among the Prymnodesmic Spatangoids, the 6th, and only three pairs of pores are found inside the fasciole. These features are of importance for the comparison with the species described below.

The pedicellariæ were first mentioned by Koehler (Op. cit.), who finds three kinds of them, which do not, however, present aucun caractère saillant, qui permette d'en faire une déscription spéciale (Op. cit.). I cannot agree with Koehler herein; on the contrary I find the pedicellariæ of the *Brissopsis*-species, especially the globiferous ones, very characteristic and of great importance for distinguishing the different species. Quite recently Professor Döderlein (Echinoiden d. deutschen Tiefsee-Exped.) has described and figured the pedicellariæ of the form of *Br. lyrifera* which occurs at the Cape of Good Hope. Though his figures are, most of them at least, very good, I think it will not be found to be superfluous, when I give some figures of the pedicellariæ of this species also — — partly because the Cape-specimens of *Br. lyrifera* ought, in my opinion, at least to be regarded as a distinct variety, and partly because these figures are wanted for the comparison with those of the new species here separated from *lyrifera*. Several details will also be found more clearly represented than in the photographic figures given by Döderlein. — For the rest both descriptions and figures were prepared a long time before Döderlein's work had appeared. — I have found the same four kinds of pedicellariæ as found by Döderlein, ophicephalous pedicellariæ not having been found by either of us.

The globiferous pedicellariæ (Pl. XVIII. Figs. 1, 6, 25, 26) are rather conspicuous. The thick skin that invests the valves is probably of a glandular nature; in the living animal it is of a vivid yellow colour. The blade is a narrow tube with a small opening at the point, bordered by two long teeth. The basal part is rather wide, somewhat variable in form. At the lower end of the stalk there is a whorl of rather long, projecting thorns, but apparently never on more than half the circumference of the stalk. Not always a distinct thickening at the upper end of the stalk. This kind of pedicellariæ I have found on almost all the specimens examined from the Mediterranean; on those from the Danish Seas it is not so common. They are generally found on the abactinal side between the fasciole and the periproct, sometimes at the periproct and in the hinder lateral ambulacra at the sides of the anal area; only once have I seen them in the anterior ambulacrum near the mouth. They seldom occur in great numbers; 4-valved specimens may occur. Also in young specimens this kind of pedicellariæ may occur, I have found them in a specimen of 11^{mm} length. — What Koehler calls "pédicellaires gemmiformes" are evidently not the globiferous but the rostrate pedicellariæ, the expression "la tîge calcaire de la hampe est peu éloignée de la tête" not being in accordance with the globiferous pedicellariæ.

The rostrate pedicellariæ (Pl. XIX. Figs. 6, 15, 18, 20, 21, 34) occur in very different sizes (up to $0{\cdot}8^{mm}$ length of head). The valves are wide apart, joining only with the point; they are not covered with a thick glandular skin like the globiferous pedicellariæ. The blade is narrow, with smooth incurved edges, leaving a narrow median slit; the outer part of the blade is quite open, a little widened. The point is rather abruptly cut, with 8—10 rather large serrations in the edge (in small ones only 6 such serrations), those in the middle being the largest. No meshwork in the blade, but there may be in the lower part a few crossbeams uniting the edges. The edges of the basal part are smooth. The valves may be very strongly curved towards the point or only quite little so; sometimes there is a distinct hump at the point (Pl. XIX. Fig. 20). — The figures give an idea of how much they may vary in shape. — The neck is generally well developed; the stalk is rather long, with only a small "milled" ring below. Also of this kind of pedicellariæ 4-valved specimens may occur. They are found over the whole test, but are especially numerous round the mouth and anal opening and in the anterior ambulacrum on the abactinal side.

The tridentate pedicellariæ are generally richly developed and occur in two or three rather different forms, though not very sharply distinguished, transitional forms (among the small specimens) being found. The largest form (Pl. XIX. Fig. 29) (head up to ca. 1^{mm} long) has the valves rather wide apart in about the lower half of their length; the blade is narrow and somewhat compressed, with a rather sharp median keel on the outer side in the lower half, the outer part, where the valves join, being more or less spoonshaped widened, and the keel disappearing gradually. No meshwork in the blade, only just above the apophysis there may be a few crossbeams uniting the edges. The edge of the lower, narrow part has generally a few large irregular serrations, on the outer, widened part it is finely serrate. The edge of the basal part and the apophysis smooth. The holes of the outer part are often large and somewhat irregular. — The second form (Pl. XIX. Fig. 3) has the blade almost closed, with only a small part of the point widened; this form is, however, not very sharply distinguished from the first form and does not occur very commonly. Quite small specimens with the blade scarcely narrowed below sometimes occur — in one specimen ("Ingolf" St. 6) I found them especially developed (Pl. XIX. Fig. 19) but I have also seen them in other specimens. The third form (Pl. XIX. Fig. 10) is more distinct and is probably always present. The valves join in almost their whole length; the blade is simply leafshaped, and the edge is straight and finely serrate; there is a slight median keel along the dorsal side of the blade. This form attains almost the same size as the first one, up to ca. 1^{mm} (head). All the tridentate pedicellariæ have a well developed neck, and the stalk has a distinct milled ring below.

The triphyllous pedicellariæ (Pl. XVIII. Fig. 12) very much resemble small specimens of the third form of tridentate pedicellariæ, differing from them, however, in the blade being broader and the basal part narrower. — Ophicephalous pedicellariæ do not occur, at least I have not found them in any of the numerous specimens, which I have examined. — As for the tubefeet and the plates of the disk reference must be made to Lovén's very beautiful figures. Only a pair of spicules are figured here (Pl. XVIII. Fig. 18). In some specimens the inner tubefeet of the anterior series of the anterior petals are rather large, not of the shape of gills like the other tubefeet of the petals, and full of spicules, whereas spicules are wanting in the transformed feet. In most specimens these tubefeet are quite rudimentary. Genital papillæ are sometimes very distinct.

A few young specimens found among the vast numbers of larger specimens in our Museum enable me to give some information — though very far from complete — of the postembryonal development of this species. The youngest specimen is scarcely 3^{mm} long; it shows as yet no trace of the petals, and the same is the case in a specimen of 4^{mm} length. This is not in accordance with the statements of Agassiz, who finds the petals distinct already in a specimen of only $3{\cdot}6^{mm}$ length (Pl. XIX. Fig. 7. Revis. of Echini); only in specimens of ca. 8^{mm} I find the petals of a size corresponding to that figured by Agassiz for a specimen of $3{\cdot}6^{mm}$. There seems then to be some error in Agassiz' statement, either «3·6» is a printing error, or the specimen is not *Br. lyrifera* (comp. the following remarks on the American specimens of »*Br. lyrifera*»), as it can scarcely be supposed that so considerable variation occurs in the development of the same species. (My young specimens were taken in the Kattegat, where no other species of *Brissopsis* occurs, any error in the identification being thus excluded). The suckers of the odd ambulacrum are well developed in the youngest specimens, but can in no way be said to be enormous or even »gigantic». The form of the peripetalous fasciole is rectangular, as figured by Agassiz. In the youngest specimen the periproct is still close to the peripetalous fasciole. It may be emphasized that the peripetalous and subanal fascioles are quite without any connection even in the youngest specimen; no anal branches are developed from the subanal fasciole. The latter includes in a specimen of $8{\cdot}5^{mm}$ as yet only three ambulacral plates and, accordingly, only two pairs of pores. In the specimen of 4^{mm} length only two ambulacral plates reach within the fasciole, the third reaching only the border of the fasciole; no pores (or tubefeet) are as yet developed within the fasciole. How it is in the specimen of 3^{mm} I have been unable to see with certainty.

This species often shows curious monstrosities in the Danish Seas, as is also the case with *Spatangus purpureus* and *Echinocardium flavescens* (Comp. above p. 124, 136). Meissner & Collin (Op. cit.) have figured a comparatively slightly monstrous specimen from the North Sea, and another is figured by Döderlein (Op. cit. Pl. XXXIV. Fig. 7). Often the actinal plastron is formed in the shape of a deep furrow in the bottom of which the spines are placed, the adjoining ambulacra forming a high ridge on either side. Also the odd anterior ambulacrum on the abactinal side or even the anterior half of the test may be quite sunken. In Pl. III. Figs. 2, 7, 11 some of these monstrosities are represented. The suggestion that they are caused by some kind of parasitic organism seems not improbable, but I have been unable to ascertain the fact.

This species was taken by the »Ingolf» at three stations only, viz.:

St. 6	(63° 43′ Lat. N.	14° 34′ Long. W.	90 fathoms	7°0 C.	Bottom temp.)	1 specimen.
— 8	(63° 56′ —	24° 40′ —	136 —	—	—)	1 —
— 85	(63° 21′ —	25° 21′ —	170 —	—	—)	1 —

Br. lyrifera is very common in the European Seas, from Northern Norway and Iceland (the South Coast) to the Mediterranean. It is further stated to occur at the Cape of Good Hope and in the American Seas, from Greenland to the West Indies. The bathymetrical distribution is stated to be from shallow water to 2435 fathoms. — This wide geographical and bathymetrical distribution looks somewhat suspicious, the more so, as the species is said to be very variable. A close examination shows that the great »variation« is mainly due to different species having been confounded, and the wide geographical and bathymetrical distribution of *Br lyrifera* must be considerably restricted.

The Mediterranean form of *Br. lyrifera* has been described as a distinct species *(Brissus) pulvinatus* by Philippi (Op. cit.), evidently without knowledge of the *Brissus lyrifer*» described by Forbes (1841). All later authors agree in uniting *Br. pulvinatus* with *lyrifera*, and probably they are right herein, though certain differences can be pointed out as distinguishing the Mediterranean from the northern form. The specimens from the Mediterranean are generally more elongate, and especially the posterior end of the test is more vertical than in the northern form and a little hollowed. The posterior petals are a little more parallel than in the northern form, and the figure formed by the peripetalous fasciole is somewhat narrower. The odd anterior ambulacrum is narrower and its sides more vertical than in the northern form. When comparing specimens from the Mediterranean with specimens from the Skagerrak the difference is very considerable (Pl. III. Figs. 12, 20, 23 and Pl. IV. Fig. 9 — comp. with Pl. III. Figs. 3, 18, 21—22, further Pl. IV. Figs. 2—3, 16, comp. with Pl. IV. Figs. 14—15, 17); but these, evidently, are the extreme forms. All transitional forms may be found, and specimens of both forms may occur in the same locality; I have both forms from Bergen and from the Bay of Biscay. Other more reliable characters in the structure of the test, by which they might be distinguished, I have been unable to find, nor are reliable characters found in the pedicellariæ, though they are upon the whole more slender in the Mediterranean form. All the specimens from the Mediterranean, which I have seen, are white, whereas all the specimens of the northern form, with a very few exceptions, are dark coloured. If this is the case also in the living specimens and does not depend on the preservation, it is certainly a difference worth noticing, and in that case I would think it right to distinguish the Mediterranean form as a variety of *lyrifera*, var. *pulvinata*. I can only state, that all the very numerous living specimens of the northern form of *lyrifera* which I have seen, were dark brownish.

What the *Brissopsis parma* Val. named by Perrier (Rech. s. les pédicellaires p. 174) really is, cannot be settled, the type specimen not being found any longer in the Paris Museum. Since, however, it has (according to a communication from Professor E. Perrier) come from Stockholm (through Malm), it can scarcely be doubted that Agassiz was right in making it a synonym of *lyrifera*. At any rate we must be satisfied with the statement.

The occurrence of *Brissopsis lyrifera* at the Cape of Good Hope was first recorded in the »Challenger«-Echinoidea (St. 141, 142; Simons Bay, Agulhas Bank), Agassiz (Op. cit. p. 189) stating that he was unable to distinguish specimens of this genus collected at St. 142 from *Brissopsis lyrifera* except by such indifferent characters as a somewhat more compact test with a slight keel from the apex to the anal system, a closer tuberculation and a slightly sharper peripetalous fasciole; characters which are found in specimens coming from such distant localities as the Coast of Norway and the western shore of Spain». The species has further been recorded from that region by Bell (Echinoidea of South Africa. p. 175) and recently by Döderlein (Echinoidea d. deutsch. Tiefsee-Exp. p. 256), both authors likewise regarding the Cape-specimens as specifically identical with the *B. lyrifera* from the Northern Atlantic; Professor Döderlein, however, points out as differences between the two forms that in the northern specimens the anterior end is considerably lower than the posterior, the odd interambulacrum rising somewhat («kräftig»), which is not the case in the Cape-form. Further the anterior petals are straight in the northern form, whereas in the Cape-specimens the petals are slightly curved (but only in the larger specimens). In the pedicellariæ Döderlein finds no essential difference between the two forms.

Any further differences in the structure and the shape of the test between the Cape-specimens and the northern form of *Brissopsis lyrifera* I have been unable to find by a brief examination of the «Challenger»-specimens in the British Museum. In the pedicellariæ, however, I find some small differences. The globiferous pedicellariæ often, though not always, show the peculiar feature of the edge of the basal part of the valves being very irregular (Pl. XVIII. Fig. 3);[1] the upper end of the stalk is mostly irregular with a projection on one side (Pl. XVIII. Fig. 23); otherwise they agree with those of the northern form of *lyrifera*. The larger forms of tridentate pedicellariæ do not show any reliable differences from those of the northern form, whereas the second, smaller form differs rather considerably from the corresponding form in the northern specimens (Pl. XIX. Fig. 2, comp. with Pl. XIX. Fig. 3), the outer part of the blade being more rounded and the lower part less narrowed. The rostrate pedicellariæ are also very like those of the northern form, only the quite small specimens of this form (Pl. XIX. Fig. 9) have the valves lower and broader than is generally the case in those of the northern specimens. I have found no form corresponding to the simply leafshaped tridentate pedicellariæ of the northern specimens. Ophicephalous pedicellariæ I have not found. In the triphyllous pedicellariæ and the spicules no differences are found between the Cape-specimens and those from the northern seas. — The differences in the shape of the test and the form of the petals pointed out by Döderlein together with the differences in the pedicellariæ shown here seem to me to justify separating the Cape-specimens at least as a distinct variety, which I may name **capensis** n. var. But I should not be surprised, if on a careful comparison of a larger material of the Cape-form with the northern form the former should prove a distinct species.

In the British Museum I have further examined a «Challenger»-specimen of «*Brissopsis lyrifera*» from Simon's Bay, which is, however, not this species. (There are two labels in the glass, one with *Br. lyrifera*, the other with *Br. luzonica*, which seems to indicate that Agassiz was in doubt of the right identification; nothing is, however, said thereof). The specimen is ca. 18^{mm} in length. The labrum reaches to the suture between the first and second adjoining ambulacral plates. Only two pairs of pores are included within the subanal fasciole, the first plate included being the 6th. The anterior petals are scarcely longer than the posterior ones; they point almost directly out-

[1] In the valve figured here one of the terminal teeth is abnormally curved inwards.

wards. The petals are not deepened. The apical system is somewhat anterior. The frontal tubefeet are small, without a large sucking disk, whereas in a specimen of *lyrifera*, var. *capensis* from St. 142, scarcely half that size, the frontal tubefeet are larger and provided with a distinct disk. The peripetalous fasciole is not reenteringly curved between the petals, but almost round as in *Hemiaster*. Tubercles and spines are comparatively large, within the peripetalous fasciole especially there are rather conspicuous primary tubercles scattered among the small ones in all the interambulacra. The pedicellariæ are rather sparingly developed, except the ophicephalous ones, which differ considerably from those of other *Brissopsis*-species (Pl. XVIII. Figs. 7, 8, 14). The basal part is quite rudimentary, as in the *Br. atlantica* described below; the blade is rather elongate, the outer part distinctly narrower than the articular surface (in *Br. atlantica* the outer part is as broad as or broader than the articular surface — Pl. XVIII. Fig. 10). Otherwise only triphyllous and very small tridentate pedicellariæ were seen, which do not show characteristic features. — That this specimen does not belong to *Br. lyrifera* var. *capensis* is certain. If it be a true *Brissopsis*, it is a new species; but perhaps it is no *Brissopsis* at all — it reminds one very much of *Metalia*. But I shall not try to decide to which genus and species it really belongs, only state that it is not *Br. lyrifera*.

The statement of the occurrence of *Br. lyrifera* at Greenland dates from »Rev. of Ech.« (p. 96), where among other localities are named »Great Britain; Greenland, Clyde (Forbes)«. This statement is reproduced by the later authors, but no new original statements are added. This seems strange, as the marine fauna of Greenland has been much investigated, especially by Danish naturalists; but among the vast collections from Greenland in our Museum there is not a single specimen of *Br. lyrifera*. It seems also rather curious that Forbes is given as the authority for the locality »Greenland«; but Forbes never was in Greenland (I suppose that E. Forbes is meant). When further it is noticed that the locality »Greenland« is placed among the British localities; that it is separated from the following locality »Clyde« by a comma only, whereas the other British localities named are separated by a semicolon; that there is on the Clyde a town named Green: then it seems not quite unreasonable to suppose that this »Greenland« is only a small locality on the Clyde. To be sure, Mr. W. T. Gibson, Curator of the Biological Station at Millport, asserts that no locality of that name is found on the Clyde; but there may have been at the time, when Forbes dredged there; or there may have been some mistake with the label (the specimens are not found any longer). Professor Bell told me, on my pointing out this matter before him, that he was quite of my opinion. However this may be, the occurrence of *Br. lyrifera* at Greenland cannot be regarded as an ascertained fact, before the species is recorded from there through new researches. That it will be found at the East Coast of South Greenland seems rather probable, since, as has been shown by the »Ingolf«-Expedition, it occurs in the Denmark Strait.

From the East Coast of North America *Br. lyrifera* is recorded from numerous localities (»Revision of Echini«, »Blake«-Echinoidea, Verrill (426), Rathbun (335, 336), Clark (Echinoderms of Portorico)[1]. I have examined rather many of these specimens (especially in the U. S. National Museum and the Museum of Yale College) and found them to belong to three distinct species, whereas not a single true *Br. lyrifera* was found among them. I think then, it will not be found quite unreasonable

[1] Bulletin of the U. S. Fish Comm. 1900. II.

when I venture to suppose that *Br. lyrifera* is not at all found on the American side of the Atlantic. In any case it cannot be taken as proved by any of the statements hitherto made of its occurrence there.

From the U. S. National Museum I have received a specimen of »*Brissopsis lyrifera*» from »Albatross» St. 2401 (142 fathoms; Gulf of Mexico. Rathbun 336. p. 616), which is evidently identical with the »globular type» figured by Agassiz in »Blake»-Ech. Pl. XXVI. Figs. 13—18. Specimens of the same form I have further seen in the U. S. National Museum, the Museum of Yale College and in the British Museum from the »Albatross» St. 2400 and 2401 and from the »Blake» St. 49. From the latter station there are three specimens of this form in the British Museum wrongly identified as *Periaster limicola* A. Ag. — A close examination of this form shows that it is not *Br. lyrifera*, but a very distinct species, which I shall describe here under the name of **Brissopsis alta** n. sp.

The shape of the test (Pl. III. Figs. 5, 8, 9, 13, 16) is distinctly higher and more globular[1] than in *lyrifera*, as is also well seen in the figures in the »Blake»-Echinoidea quoted above. The actinostome is very near the anterior end of the test, distinctly more so than in *lyrifera*. The labrum is prominent, with a rather broad posterior prolongation, not reaching the second adjoining ambulacral plates. The first ambulacral plate reaching within the subanal fasciole is the 6th; three pairs of pores are enclosed within the fasciole. No anal branches of the fasciole are developed. The rather small anal area is placed near the upper side on the high, beautifully arched posterior end. The petals are short and rather broad, the posterior about two thirds as long as the anterior ones; in larger specimens they are rather deepened. The posterior petals are completely separated, though scarcely so widely as is generally the case in *lyrifera*: the tubercles appear already on the second—third plate of the posterior interambulacrum (as in *lyrifera*), and only the three inner pores of the inner series of the posterior petals are rudimentary. The area enclosed by the peripetalous fasciole is somewhat smaller than in *lyrifera*; it is rather broad, not much narrowed in the posterior lateral interambulacra, produced somewhat backwards in the odd posterior interambulacrum. The odd anterior ambulacrum is only slightly sunken, the front end of the test being almost regularly rounded, especially in the smaller specimens. In the specimen received from the U. S. National Museum there are only three genital pores, which is, however, evidently an abnormal case, all other specimens seen by me having four genital pores. — The tubefeet and their spicules are as in *lyrifera*, the spicules only may be a little more thorny. Some of the rosette-plates may be coalesced.

The pedicellariæ give very good characters distinguishing this species from *lyrifera*. The globiferous pedicellariæ (Pl. XVIII. Figs. 27, 29) have the terminal opening of the valves surrounded by 6 or 8 short teeth; the blade is a quite closed tube, somewhat curved. The basal part has a rather close meshwork at the bottom; the edges are smooth as is also the apophysis. The valves are as in *lyrifera* enclosed by a thick skin, probably glandular, but without glandular sack. There is no neck. The stalk is provided with an irregular, sometimes very large limb with numerous free, upwards directed

[1] In the »Blake»-Echinoidea (p. 70) Agassiz sets forth the opinion that the »globular test» is an »embryonic feature». I cannot see the reason for regarding this shape of the test as more embryonic than the oval, elongate form. If it be proved that a species like the *Br. elongata* described below is globular in its young stages, there may be some reason for seeing a more primitive feature therein. But, as far as my experience goes, it cannot be said to be a general character of young Spatangoids that their test is comparatively more globular than the test of the grown specimens.

points. On the lower edge of this limb the muscles of the stalk are inserted. At the upper end the stalk is somewhat pointed. The head is ca. 0·6—0·8^{mm}, the stalk ca. 1—1·5^{mm} long; the part above the limb may be considerably longer than in the figured specimen. The rostrate pedicellariæ (Pl. XIX. Fig. 7) have long and slender valves, only slightly curved, except towards the point; the edge may be quite smooth or more or less serrate; the point not much widened, finely serrate; the neck is generally well developed, no limb on the stalk. Length of head ca. 1^{mm}. The tridentate pedicellariæ (Pl. XIX. Fig. 24, 26, 27) differ rather much in shape according to size, but only one form can be distinguished. Large specimens (up to ca. 0·8^{mm} head) have short stalk and neck, and may be 3—4-valved. The valves are rather wide apart, joining only for about the outer third of the length of the blade. In the lower part the blade is narrow, more or less keeled on the dorsal side. The edge is coarsely and more or less irregularly serrate; the serrations are generally bent outwards. No meshwork in the bottom of the blade; often a few crossbeams unite the edges in the lower part, just above the apophysis. The outer part of the blade, where the valves join, is somewhat spoonshaped widened, the edge being finely and regularly serrate. The basal part is rather small, with smooth or faintly serrate edges; the apophysis is smooth. The short stalk is rather thick and compact, with a rather distinct milled ring below. — Small specimens generally have a long neck and a longer, slender stalk, consisting of distinct longitudinal fibres connected by crossbeams; the valves join in almost their whole length, and may have a single large serration in the lower part, or this part may be quite smooth, the edge otherwise being as usual finely serrate. The blade is simply leafshaped. — The triphyllous pedicellariæ (Pl. XVIII. Figs. 4, 11) may be rather variable in shape, but otherwise do not present special features. — The sphæridiæ with rather numerous longitudinal ridges (Pl. XVIII. Fig. 22) which is, however, scarcely a constant feature.

In the »Blake«-Echinoidea, Pl. XXVI. Figs. 7—8 Professor Agassiz figures an elongated type of *Br. lyrifera,* which differs very considerably from both *lyrifera* and *alta* through its confluent petals. After having examined a number of specimens of this form — I am especially indebted to Professor Rathbun for sending me several specimens to Copenhagen for study — I can show beyond doubt that this form is not at all a mere local form of *Br. lyrifera,* but a very distinct species, which I shall describe here under the name of **Brissopsis atlantica** n. sp.

The general shape of the test is shown in Pl. III. Figs. 6, 10, 17. Also the figures cited of the »Blake«-Echinoidea show it rather well, only the posterior end of the test is generally almost vertical, not sloping as in the Fig. 8, but there is some variation in this respect. The test is upon the whole rather low, rising somewhat towards the posterior end; the width is rather variable (see below, p. 162). The actinostome is considerably more distant from the anterior border of the test than is the case in *Br. alta;* it is more as in *lyrifera,* but on the other hand the labrum is less prominent than in that species. The narrow posterior prolongation of the labrum does not reach the second adjoining ambulacral plates. The first ambulacral plate reaching within the subanal fasciole is the 6th, and there are generally 4 pairs of pores enclosed within the fasciole; sometimes, however, only 3 pairs are included, which case may be found also in large specimens, while already in the smaller specimens 4 pairs of pores may be found within the fasciole. I have also seen a specimen with 4 pores on one side and 3 on the other within the fasciole. Anal branches from the subanal fasciole may be distinct, but it is not a constant feature; in one case the anal branch was quite distinct on one side and not at all discernible on the other.

The peripetalous fasciole is narrow and elongate. The petals, which may be rather deepened are so directed as to form a crescent-shaped figure on each side — the character hitherto thought characteristic of the genus *Toxobrissus* (comp. below, p. 166-7). The posterior petals are (confluent), the posterior interambulacrum forming only a narrow separating bridge, with the primary tubercles not beginning before about halfway out, whereas in *lyrifera* and *alta* the primary tubercles begin close behind the apical system. In the inner (median) series of the posterior petals the large pores are found only in the outer half, from about the 9th, whereas in *lyrifera* and *alta* the large pores begin near the inner end, from the 4th—6th. The odd interambulacrum is very narrow on the part between the peripetalous fasciole and the anal area. The madreporic plate is scarcely longer than in the two other species, but it is somewhat narrower. There are four genital pores in the usual position. — Spines, tubefeet and spicules do not afford any distinguishing characters.

The pedicellariæ are very richly developed; globiferous, rostrate, tridentate, ophicephalous and triphyllous pedicellariæ have been found. The globiferous pedicellariæ occur, rather surprisingly, in two very different forms. One form (Pl. XVIII. Figs. 20, 24) has very elongate, narrow valves, ending in two long, somewhat diverging, inward bent teeth. The valves are clad in a rather thick coat of skin; the stalk is very short. Length of head ca. 1·5—1·8^{mm}.[1] The other form (Pl. XVIII. Figs. 5, 9, 19) is like the type found in *alta*, but there are generally only two teeth on either side of the terminal opening. The stalk has a rather small circlet of thorns below. Length of head ca. 0·5^{mm}. It may be expressly noticed that I have found both kinds of globiferous pedicellariæ in the same specimen, though certainly not in all of them. It may not seem unreasonable to suggest that both kinds of globiferous pedicellariæ may also prove to occur in other species, as e. g. *Br. alta* and *columbaris* (in which latter species the slender form occurs, as I have been able to prove on specimens examined in the U. S. National Museum). — The tridentate pedicellariæ likewise occur in two distinct forms. One form (Pl. XIX. Figs. 11, 33) has very elongate, slender valves, very wide apart, joining only for a very short space at the point. This outer part is widened, with finely serrate edges; all the rest of the blade is quite narrow, with smooth edges or with one or a few teeth near the outer end. A few crossbeams are generally found in the lower part of the blade. The valves are almost straight. Length of head up to ca. 1·5^{mm}. The neck is very well developed, the stalk long and slender. The other form (Pl. XIX. Figs. 1, 28, 32) is very like that found in *Br. alta*, and may likewise occur four-valved. There are large teeth in the lower, somewhat narrowed part, whereas the outer part, where the valves join, has the edges finely serrate. In smaller specimens of this form the valves join for a considerably larger part of their length, only one or two large teeth occurring in the lower narrowed part. I have not seen specimens of this form larger than 1·2^{mm} length of head. Neck and stalk as in the first form; the neck may be much longer than in the specimen figured, in which it is somewhat contracted. — The rostrate pedicellariæ (Pl. XIX. Fig. 5) remind one very much of the slender form of tridentate pedi-

[1] A quite similar form of globiferous pedcellariæ was described and figured by Dr. de Meijere (Siboga-Echinoidea. p. 189. Pl. XXIII. Fig. 474), from some specimens wrongly referred to *Brissopsis luzonica*; through the kindness of Professor M. Weber I have received one of these specimens and can thus state definitely that it is not *Br. luzonia* but a new species, which I intend to describe in Part II of the Siam-Echinoidea.

cellariæ, only the widened part at the point is smaller, the blade is more curved, and, generally, the edges of the basal part are distinctly serrate for a short space. This form reaches a size of ca. 1^{mm} length of head; it is, indeed, not sharply distinguished from the tridentate pedicellariæ, transitional forms being found, which may almost with equal right be referred to either of these kinds. On the other hand a smaller form of rostrate pedicellariæ (Pl. XIX. Fig. 4) may also be found, which is more like the form known from *lyrifera*. In quite small specimens the widened part in the point of the blade is comparatively larger (Pl. XIX. Fig. 25) — if upon the whole this form ought to be regarded as a rostrate pedicellaria; it might perhaps as well be termed tridentate. The ophicephalous pedicellariæ (Pl. XVIII. Fig. 10), which are only occasionally found in the larger specimens, are rather characteristic. The basal part is quite small; the blade is rather broad in the outer end, its edges are serrate almost down to the articular surface; the apophysis is sometimes very broad. (Pl. XVIII. Fig. 13).[1] — The triphyllous pedicellariæ are like those of *lyrifera*.

This species is evidently rather common and widely distributed along the American side of the Atlantic. I have seen specimens from the following stations of the «Albatross»: 2077 (1255 fathoms) 2230 (1168 fms.), 2343 (279 fms.), 2378 (68 fms.), 2401 (142 fms.), 2562[2] (1434 fms.), 2571 (1356 fms.), 2684 (1106 fms.), 2748 (1163 fms.). I have further dredged a specimen myself off Christiansted, St. Cruz, in ca. 200 fathoms. It may not be too hazardous to prophesy that probably many more of the American specimens referred to *Br. lyrifera* will prove to belong to this species, while the rest will be *Br. alta* or the species described below, *Br. elongata*, or even *Periaster limicola*, whereas I doubt if there are any true *Br. lyrifera* among them.

Some specimens from the stations 2077, 2208, 2230, 2571, 2684 and 2748 are somewhat broader than those from the other stations named; some of them are narrowed towards the posterior end. Also the posterior petals may be more sunken than is generally the case in the narrower form; the colour seems to be darker and the test more fragile than in the narrow form. (The species has upon the whole a rather fragile and thin test). Generally, but not always, this broad form has only three pairs of pores within the fasciole; the labrum is also somewhat more prominent. As, however, the other features, especially the petals and pedicellariæ are alike, I do not think it possible to keep the broad form as a distinct variety, or even a distinct species, the more so, as there are transitional forms. That the broad and narrow form may occur together (e. g. from St. 2077) need not, of course, imply that they cannot be distinct species. After the material at my disposal I must regard them all as one species, which is rather variable in regard to the width of the test. In Pl. III. Fig. 17 is represented a specimen of the broad form.

In the Museum of the Yale College I found in a specimen from St. 2268 (68 fms.) a very curious kind of tridentate pedicellariæ (Pl. XIX. Figs. 14, 22, 30). It has no less than 8 valves, a case quite unparalleled. The valves are rather narrow and flat, the point bending inwards as a hook. The specimen otherwise agrees with *atlantica*, and both kinds of globiferous pedicellariæ are found on it. There

[1] This form of ophicephalous pedicellaria was found in a very young specimen, whose identification is not beyond doubt.

[2] The specimens (one and some fragments) from this station have the petals somewhat less distinctly crescent-shaped than is otherwise the case in this species; none of the more characteristic pedicellariæ were found. I dare not assert beyond doubt therefore that it is really this species, though I for my part think it really is.

can scarcely be any doubt that these curious eight-valved pedicellariæ are an abnormal case. If it should prove a constant feature, it would certainly be a sufficient character for distinguishing this form as at least a separate variety.

From the Paris Museum I have received a specimen of »*Br. lyrifera*« from the »Talisman«, 1550 M. It has confluent petals like *Br. atlantica*. and the shape of the test is as in that species (Pl. III. Fig. 1. Pl. IV. Figs. 5, 19), only the labrum is somewhat more prominent. There are only three pairs of pores within the subanal fasciole. The pedicellariæ, unfortunately, are very sparingly represented, only one form of tridentate, rostrate and triphyllous pedicellariæ being found. The tridentate differ somewhat from those of *atlantica* (Pl. XIX. Figs. 13, 31). Also the rostrate pedicellariæ (Pl. XIX. Figs. 8, 16, 23) show some minor differences, especially in the basal part having often irregularly serrate edges. I do not venture to state that this specimen belongs to *Br. atlantica;* but in any case it is not *Br. lyrifera.*

From Puerto Cabello we have in our Museum some specimens of a *Brissopsis* which prove to belong to another, very distinct, new species; I shall describe it here under the name of **Brissopsis elongata** n. sp. I have seen in the U. S. National Museum a specimen of this species from the »Albatross« St. 2145 (25 fms., Caribbean Sea), referred to *Br. lyrifera*. and further I have examined there the specimens from Porto Rico mentioned as *Brissopsis lyrifera* by Clark (The Echinoderms of Porto Rico. Bull. U. S. Fish. Comm. XX. Part II. 1900. p. 254) and find them likewise to belong to this species. Probably also the specimens from the Sea between Jamaica and San Domingo mentioned by Agassiz (»Blake«-Ech. p. 69) as »representing the extreme elongated form« of *Br. lyrifera* will turn out to be *Br. elongata*. In any case it is certain that this species also has been recorded as *Br. lyrifera.*

The shape of the test (Pl. III. Figs. 4, 14, 15, 19. Pl. IV. Figs. 1, 4, 13) is upon the whole like that of *Br. atlantica*, viz. the narrow form, only the posterior end is more vertical than is generally the case in that species. The labrum is very little prominent, its anterior edge almost straight; its posterior prolongation ends off the middle of the second ambulacral plate and it is much widened off the border between the first and second ambulacral plate (Pl. III. Fig. 19). The spines of the actinal plastron accordingly do not reach so near to the mouth as in the other species. The first of the ambulacral plates reaching within the subanal fasciole is the 7th.[1] This is a highly interesting case, showing that the number of »ventral« plates is not everywhere limited to five, as maintained by Lovén (On Pourtalesia. p. 33); the same case is found in *Toxobrissus pacificus*. (I know of one more case, viz. in a new species, which I am, however, not entitled to describe). There are 4 pairs of pores within the fasciole (Pl. IV. Fig. 18); sometimes the posterior one is indistinct and the tubefoot simple, not penicillate as the others. In one case I have found only 3 pores on one side, while on the other side all 4 pores were present. The spines of the subanal plastron are rather long and form two prominent tufts, separated by a median belt of small spines. The posterior petals are almost as long as the anterior ones; they are parallel in almost their whole length and very close together, separated only by some very narrow interambulacral plates without tubercles (and spines), the latter beginning only on the

[1] In the specimen figured in Pl. IV. Fig. 1 it is in the left ambulacrum exceptionally the 6th, which reaches the fasciole. On the right side it is the 7th.

5—6th plate (in *lyrifera* they begin on the 2—3rd plate). The peripetalous fasciole forms, in accordance with the great length of the posterior petals, a rather elongate figure. The subanal fasciole is very strongly developed, and a small anal branch extends from it along each side of the anal area towards the peripetalous fasciole. In none of the specimens before me, however, does it reach more than half way up.

With regard to the tubefeet a single feature must be noticed, viz. that the plates of the rosette are very broad in their outer part, and generally divided into 2—3 lobes (Pl. XVIII. Fig. 17). The spicules (Pl. XVIII. Fig. 16) are more spinous than in *lyrifera*.

The pedicellariæ are very characteristic and show at once this form to be very distinct from the other species. Globiferous, tridentate, rostrate, ophicephalous and triphyllous pedicellariæ are found. The globiferous pedicellariæ (Pl. XVIII. Figs. 15, 21, 28) are especially found in the posterior ambulacra, off the subanal plastron, where they may form a very conspicuous stripe, being generally dark brown and rather large — ca. 1^{mm} head. The stalk is very short, ca. $0{\cdot}2^{mm}$, with a small thickening on the middle, but no circlet of thorns. There is no neck. The valves bend a little inwards and are provided with mostly 2, sometimes 1 or 3, strong, upwards directed teeth, placed in the median line on the outer side, just above the basal part; sometimes these teeth are coalesced, sometimes the lower of them points downwards; I have found a single small globiferous pedicellaria, where they are wanting. The blade is narrow, quite closed, ending in two very long teeth. The basal part is rather small, the edge is smooth, as is also the case with the almost straight edge of the apophysis. There is a thick skin around the valves. Evidently this form corresponds to the long, narrow form of globiferous pedicellariæ in *Br. atlantica*. Probably also the other form will prove to occur in this species.

The tridentate pedicellariæ (Pl. XIX. Fig. 12) may reach a considerable size, up to $1{\cdot}5^{mm}$ (head), but otherwise occur in all sizes down to quite small ones. They are mostly, the larger ones exclusively, found around the mouth and on the posterior ambulacra on the actinal side. The valves are widely separated, joining only towards the point. The blade is narrow in the lower part, not very deep, but generally with a well developed meshwork at the bottom. No distinct longitudinal keel along the outer side. The edge is smooth, only with 1—4 large, a little outwards directed, teeth towards the outer part. The end of the blade, where the valves join, is somewhat widened, the edge being finely but rather deeply serrate. The basal part is rather small; the edges are smooth, as is also the edge of the apophysis. The smaller specimens have the edge of the lower (shorter), narrow part of the blade quite smooth; there is no meshwork at the bottom. Otherwise they do not differ essentially from the larger ones, and only one form of tridentate pedicellariæ can be distinguished. Even in the smallest ones the valves join only with the outer half of the blades. The neck is very well developed; the stalk is long, consisting of rather loosely connected fibres. The milled ring at the lower end is rather indistinct. — The rostrate pedicellariæ (Pl. XIX. Fig. 17) which I have found only in the specimen from Albatross 2145, are very characteristic; the blade is narrow, rounded in the point and closely serrate some way down the side edges. The point is not widened. Only quite small specimens were found. The ophicephalous pedicellariæ (Pl. XVIII. Fig. 2), which occur almost exclusively on the naked posterior ambulacra on the actinal side, are small, without neck, as usual among the Irregular Echinoids; the stalk is irregularly fenestrated, not distinctly fibrous; its upper end is cupshaped; no milled ring below. The valves are much narrowed in the middle, the basal part being very narrow. The blade is wide, deep in the middle and with sharp corners; the edge is strongly serrate almost down to the articular surface. There is a small prolongation on the outermost of the three arches. — The triphyllous pedicellariæ do not differ from those of *lyrifera*.

After what has been pointed out here it is evident that the geographical and bathymetrical distribution of *Brissopsis lyrifera* has to be considerably restricted from what was previously generally accepted. The species is known with certainty only from the European Seas, from Norway to the Mediterranean, from the British Seas, the Faroe Islands, South of Iceland and Denmark Strait. The bathymetrical distribution is from shallow water to ca. 200 fathoms.[1] It is, of course, quite possible that it does really go down to considerably greater depths, like other sublittoral species of Echinoids, as e. g. *Echinus esculentus* and *Strongylocentrotus dröbachiensis*. Likewise it is quite possible that it will prove really to occur at the American side of the Atlantic; but we cannot accept that on the previous statements; renewed investigations are needed in the light of the facts made known here. That the small specimens from the »Porcupine» from 2090[2] fathoms (Wyv. Thomson. »Porcupine»-Ech. p. 750) are not really *Br. lyrifera*, may be said with rather great certainty.

The true *Br. lyrifera* certainly shows considerable variation in the shape of the test, but by no means so much as assumed by Agassiz, who has regarded the two very distinct species *Br. alta* and *atlantica* (I cannot prove that *Br. elongata* was also confounded with *lyrifera* by Agassiz) as variations only of *lyrifera*.[3] The »additional light» said by Agassiz to be »thrown on the changes we may expect to find among Spatangoids of this group in one and the same species» by all the very different looking specimens of »*Brissopsis lyrifera*» from the »Blake» was, indeed, only additional confusion. In the »Revision of Echini» p. 356 Agassiz states of *Brissopsis lyrifera* that »with age the lateral pairs of ambulacra gradually tend to unite, passing from a strictly Brissopsis outline (Pl. XIX. f. 8) to one considered hitherto characteristic of Toxobrissus (Pl. XIX. f. 9)». And further (p. 355): »The character of continuity of the adjoining pairs of ambulacra, which Desor assigns to Toxobrissus as a distinguishing feature, becomes more and more apparent according to the size of the specimens; so much so, that we should place Brissopsis lyrifera, when young, in Brissopsis, but when full grown it would most decidedly pass for a Toxobrissus». — It must be decidedly maintained that among the true *Brissopsis lyrifera* there is no tendency in the posterior petals to unite with age; they are in the full grown specimens at least as distant as in the young ones, if not more. Even the figures given by Agassiz himself in the »Revision of Echini» show sufficiently that the continuity of the posterior petals is not a feature developed with age. Pl. XIX. Fig. 9 is from a specimen $27{\cdot}9^{mm}$ long, with very confluent ambulacra; but in Pl. XXI. Fig. 2, representing a specimen of 49^{mm}, the ambulacra do not show the slightest tendency to unite. Evidently the specimen figured in Pl. XIX. 9 is a *Br. atlantica*

[1] In IX. Report from the Danish Biological Station 1899, it is recorded from 210 fathoms from the Skagerrak.

[2] In the Challenger-Ech. p. 220 the greatest depth is stated to be 2435 fathoms.

[3] In the Preliminary Report on the Echini of the »Albatross» (Bull. Mus. Comp. Zool. XXXII. 1898. p. 82) Agassiz expresses some doubt of the correctness of referring to *Brissopsis* such forms as the elongate type figured in the »Blake»-Ech. Pl. XXVI. Fig. 7, but in the »Panamic Deep Sea Echini» p. 191 he again speaks of »the elongated and globular specimens of the West Indian *Brissopsis lyrifera*».

(or *elongata*),[1] the confusion of this species with *lyrifera* having caused the erroneous statement of the development of the petals. — It is also a curious fact that in the «Blake»-Ech. p. 70 Agassiz speaks of the confluent ambulacra as an «embryological character», in direct opposition to the above citations, where this character is said to be developed with age.

The subanal fasciole is also said (Rev. of Ech. loc. cit.) to be subject to very great changes, due to different stages of growth; in the «Blake»-Echinoidea it is even stated to have disappeared completely in some specimens, viz. in the globular specimens from off Missisippi. That none of these globular specimens are really *Br. lyrifera*, I think beyond doubt; they will probably turn out to be partly *Br. alta* and partly, viz. those without a subanal fasciole, *Periaster limicola*. (To be sure, I have not myself seen any specimens of *Periaster limicola* identified as «*Brissopsis lyrifera*», but I have seen specimens of *Brissopsis* «*lyrifera*» (*alta*) identified as *Periaster limicola* (comp. above p. 159), so it may not seem very hazardous to suggest that the reverse case may also be found). Until by a renewed examination of these globular specimens without a subanal fasciole it is shown definitely to which species they belong, I must doubt that they belong to the genus *Brissopsis*. So far as my experience goes — and I have examined a considerable number of specimens, especially of the species *lyrifera* and *luzonica* — the subanal fasciole is very constant in this genus, as upon the whole this fasciole is one of the most constant features in the Amphisternous Spatangoids. That it may, however, sometimes really disappear I have shown above (p. 129) for *Spatangus Raschi*. — On the other hand there is really considerable variation in the anal branch, the small fasciole running from the subanal fasciole along the sides of the anal area straight towards the peripetalous fasciole in the *Brissopsis*-species, as pointed out by Agassiz. But this fasciole must, of course, not be confounded with the subanal fasciole. In the true *Br. lyrifera* the anal branch is very seldom developed; only in a single specimen («Ingolf» St. 6) they were both distinctly developed, reaching the peripetalous fasciole; in a very few instances I have found slight traces thereof.

In the «Panamic Deep Sea Echini» (p. 193) Professor Agassiz maintains the old genus *Toxobrissus* Desor, pointing out the following characters as distinguishing it from *Brissopsis*: The genital plates of *Toxobrissus* do not extend into the interambulacral areas, which they do in *Brissopsis*. The extremities of five ambulacral plates are included in the «anal» (viz. subanal) fasciole of *Toxobrissus*, whereas only four are so included in *Brissopsis*. The labrum of *Brissopsis* is shorter and more T-shaped than in *Toxobrissus*. Further «the arrangement of the apical interambulacral plates of the odd interambulacrum shows at once the radical difference existing between Toxobrissus and Brissopsis». The confluence of the posterior petals is not recognised as a character of the genus *Toxobrissus*, the West Indian specimens of «*Brissopsis lyrifera*» with confluent ambulacra being expressly stated not to belong to the genus *Toxobrissus* (p. 191. Note); on the other hand it is said (p. 193) after pointing out the characters mentioned above as distinguishing *Toxobrissus* and *Brissopsis* — «that we are

[1] Bittner (Über Parabrissus und einige andere alttertiäre Echiniden-Gattungen. Verhandl. d. K. K. geol. Reichsanstalt. 1891. p. 137) has already suggested that these figures do not represent one and the same species — «eine Umwandlung von Taf. XIX. Fig. 8 durch Taf. XIX. Fig. 9 in Taf. XXI. Fig. 2 anzunehmen, dürfte sehr gewagt sein». Also Pomel has perhaps seen that; in any case he says (Classif. méth. p. 33): «le prétendu *Brissopsis lyrifera* de la Floride est probablement une autre espèce vivante», viz. of the genus *Kleinia*, which he maintains as a separate genus.

justified .... in establishing genera based upon the coalescence of ambulacra — which seems rather contradictory.

The question of the two genera is, however, by no means solved by the remarks of Agassiz, and the characters pointed out by him are of very slight value. The character that the genital plates are a little longer in *Brissopsis* than in *Toxobrissus* can scarcely be taken to be meant seriously; at least I am unable to see the generic difference in the extension of the genital plates in the Figures 278 *(Br. lyrifera)* and 279 *(T. pacificus)* given by Agassiz (Op. cit. p. 191 and 193). Further as regards the characters of the labrum and the five ambulacral plates included within the subanal fasciole *Brissopsis elongata* agrees exactly with *T. pacificus*. (In the specimen represented in Pl. 105. 4 (and Text-figure 280) the labrum is abnormal, not reaching beyond the 1. ambulacral plate of I. a; in the specimen represented in Pl. 103. 3 it is symmetrical, reaching the middle of the second ambulacral plate on both sides, exactly as in *Br. elongata*). Also in the important character that the first ambulacral reaching within the fasciole is the 7th, the two species agree (that it is so in *T. pacificus* is not mentioned in the text, but it is distinctly seen in Pl. 103. 3). *Brissopsis elongata* thus agrees with *Toxobrissus pacificus* in three of its distinguishing characters, the form and extension of the labrum, number and numero of ambulacral plates reaching within the subanal fasciole, and the confluent posterior petals,[1] but according to Agassiz[2] it cannot be referred to the genus *Toxobrissus* on account of the »radical difference in the odd interambulacrum, viz. that in *Toxobrissus* the fourth abactinal series (of the odd interambulacrum) is reduced to a single plate».[3] Now this structure seems to be quite abnormal, and it is not stated expressly to occur in all the specimens, though this might well have been worth stating of a character thought to be so important; indeed, it does not seem to be so in the specimen figured in Pl. 103. 4 — as far as can be seen it is here quite as usual, and in any case in the fig. 279 the fourth plate is seen to be double. The odd interambulacrum is thus evidently quite normal also in *Toxobrissus pacificus* and no character distinguishing this genus and *Brissopsis* is to be found therein. If the species *pacificus* is really a *Toxobrissus* the *Br. elongata* then evidently also belongs to that genus — but its characters are not those pointed out by Agassiz.

A short revision of the more important characters in the *Brissopsis*-species must be given and the grouping of the species after these characters shown, before the value of the genus *Toxobrissus* can be appropriately discussed. The following characters must be taken as the more important, after which generic divisions might possibly be made: the posterior petals, confluent or divergent; the number of plates included within the subanal fasciole; the numero of the first plate reaching within this fasciole; the posterior extension of the labrum; finally the structure of the globiferous pedicellariæ. Other features can scarcely come into consideration for use eventually as a foundation for generic divisions.

[1] Whether the pedicellariæ of *T. pacificus* are like those of *elongata*, I cannot say. I have found on the specimens examined in the U. S. National Museum only tridentate pedicellariæ, which are very different from those of *elongata*, the valves being rather flat, provided with numerous long, coarse, outwards directed teeth in the lower part of the blade (in larger specimens; having no complete valves I shall not give any figure of these). The more important globiferous pedicellariæ are unknown; it may well be supposed that they will prove to resemble those of *elongata*.

[2] I may expressly note that I do not maintain that Professor Agassiz has known the form established by me as *Br. elongata*. In the present connection this is, however, without importance.

[3] This, I suppose, must be the character meant; at least I am unable to see what else it could be.

Confluent posterior petals are found in *Brissopsis luzonica, atlantica, elongata, Oldhami* and *Toxobrissus pacificus.*

Divergent — — - — - — *lyrifera, alta, columbaris* and *n. sp.*[1]

5 ambulacral plates are included in the subanal fasciole in *Brissopsis luzonica, Oldhami, elongata, n. sp.* and *T. pacificus.*

4 — — - — - - — — - — *lyrifera, alta, columbaris* and *atlantica.*

The first ambulacral plate reaching within the subanal fasciole the 7th: *Brissopsis elongata, n. sp.* and *T. pacificus.*

— — — — — — - — — - 6th: — *lyrifera, alta, atlantica, luzonica, Oldhami, columbaris.*

The labrum ends off the 1st adjoining ambulacral plates: *Br. lyrifera, alta, atlantica, luzonica, Oldhami, columbaris* and *n. sp.*

— — — - - 2nd — — — : - *elongata* and *T. pacificus.*

Globiferous pedicellariæ with the valves ending in two long hooks: *Br. lyrifera* and *luzonica.*

— — — several short teeth surrounding the terminal opening: *Br. alta.*

— — of two kinds, one with long and slender valves, ending in two long hooks, the other with short valves with several teeth round the terminal opening: *Br. atlantica, columbaris* (? only the slender form known), *elongata* (? only the slender form known).

— — unknown: *T. pacificus, Br. Oldhami* and *n. sp.*

From this summary it is evident that none of the characters give the same grouping of the species; there is such a mingling of all the characters that it seems quite hopeless to distinguish different genera among them. If different genera be maintained, they can only be characterised by one of the characters named above. In that case it would perhaps be the most natural thing to take the confluent ambulacra as the distinguishing character; but then the name *Kleinia* Gray would have the priority and would have to be revived instead of *Toxobrissus* — the more so as the name *Toxobrissus* can in no case become more than a synonym of *Brissopsis,* as Lambert informs me in a letter. I, for my part, find it preferable to keep all the recent species in one genus, *Brissopsis,* instead of dividing them in a rather artificial way into two (or more) genera.

[1] The species mentioned above p. 163. The *Brissopsis circosemita* described by Agassiz and Clark in their recently published Preliminary Report on the Echini collected, in 1902, among the Hawaiian Islands (Bull. Mus. Comp. Zool. L. 1907. p. 257) has confluent petals like those of *luzonica* and only three ambulacral plates included by the subanal fasciole. The numero of the first plate reaching within the fasciole is unknown. The labrum is only stated to be nearly straight; the pedicellariæ are unknown.

ADDENDA ET CORRIGENDA.

Porocidaris purpurata W. Th. Several specimens were taken by the »Thor« at 62° 57′ Lat. N. 19° 58′ Long. W. 957 M. (off South Iceland) in 1903 and at 49° 25′ Lat. N. 12° 20′ Long. W. 1270—1180 M. (off Southwest Ireland) in 1905. — The *Porocidaris elegans* mentioned by Koehler in »Échinodermes .... du Caudan« (226. p. 89) is, as Professor Koehler kindly informs me, *P. purpurata*.

In Part I. p. 173 I have established a var. *Talismani* of this species, characterised by the upper primary radioles having the neck swollen in a fusiform manner and of a fine violet colour. The specimens taken by the «Ingolf» have not the neck of the spines thus swollen, so that the specimens from the «Talisman», which show that feature exceedingly developed must necessarily appear to me at least a distinct variety. The additional material from the »Thor«, however, shows that this variety cannot be upheld. Among these specimens all transitions may be found from such specimens with the neck of the spines not at all swollen to such with the neck of most of the upper spines considerably swollen, and this swollen part of the spines is of a beautiful violet colour, which sometimes continues almost to the point of the spines. The specimens upon which the var. *Talismani* was established thus cannot be regarded as more than extraordinary beautiful specimens of *P. purpurata*. — For the rest the swelling of the spines has been sufficiently represented by Wyv. Thomson (»Porcupine«-Echinoidea. Pl. LXI. Figs. 1, 4, 6) though he does not mention this peculiar feature in the text. — It may be remarked that the neck is much longer in the upper spines than in those at the ambitus and on the actinal side.

Tretocidaris annulata Mrtsn. The examination of some specimens of *Tr. Bartletti* (A. Ag.) in the U. S. National Museum has convinced me that *Tr. annulata* is only a synonym of the latter species. The description of this species given in the «Blake»-Echinoidea is so very insufficient that it is scarcely possible to recognise the species thereby, and even the Fig. 16. Pl. II of the »Blake«-Ech. gives a quite wrong representation of the ambulacra. In the description (»Blake«-Echinoidea. p. 10) it is said: »the poriferous zone is somewhat flexuous, the furrows more distant, and the median ambulacral granulation finer, than in the other West India species of the genus«, and the figure shows the ambulacra closely covered by tubercles, three on each plate, without any naked space in the middle. But the ambulacra of this species are really as I have described for *Tr. annulata* (Part I. p. 17), each plate bearing only one small tubercle at the lower edge, inside of the primary tubercle, leaving a broad naked space along the median line. Only in the largest specimen (68mm) is there in some of the median ambulacral plates a third small tubercle inside the second tubercle, but still the naked median space is very conspicuous. Also the interambulacra are represented in this figure as having no naked median line, whereas *Tr. Bartletti* really has a conspicuous naked median line in the interambulacra. — A specimen from the «Blake» St. 272, examined in the Museum of Yale College, also agrees with the specimens in the U. S. National Museum, not with the said figure Pl. II. 16. It thus seems that the said figure has been made from another species, the figure being otherwise evidently very carefully drawn. In case the figure really represents *Tr. Bartletti* correctly *Tr. annulata* must be retained as a distinct species, to which the specimens seen by me in the U. S. National Museum and the Museum of Yale College would have to be referred.

To the description of the species may be added, besides the peculiar feature already pointed out in the description of *Tr. annulata* that the radioles are spinous almost exclusively along their upper side, that the actinal radioles are almost smooth, slightly flattened, but not serrate along the edge, and not widened towards the point. The primary ambulacral spines are narrow and pointed, only about half as large as the spines round the radioles, not nearly of the same size as the latter, as is stated in the description in the «Blake»-Echinoidea. The inner ambulacral spines have a distinct «ampulla» on the upper edge. The differences in the globiferous pedicellariæ of *Bartletti* and *annulata* shown in Part I. Pl. X. Figs. 22, 31 and Figs. 23, 30 are certainly not sufficient for maintaining two species, the more so as this species has been shown by Agassiz and Clark in the recently published work on the *Cidaridæ*[1] to vary considerably in regard to the pedicellariæ. — As regards the genus *Tretocidaris* which is rejected in this latter work I cannot take up the discussion here, but I hope to have occasion soon to rediscuss the matter.

Hygrosoma Petersii (A. Ag.). Several specimens were taken by the «Thor» in 1906 at 49° 20′ Lat. N. 12° 39′ Long. W. 1520 M. To this species must also be referred the specimens from the Bay of Biscay mentioned by Koehler (Échinod. du «Caudan». p. 92) under the name of *Phormosoma luculentum,* as Professor Koehler informs me in a letter.

Sperosoma Grimaldi Koehler. In Part I (p. 77. Pl. IV. Figs. 4, 5) was described and figured a young specimen of this species, 27^{mm} in diameter. The figures (which were not drawn by myself) are, however, too little detailed and do not show the structure of the test exactly. As it will be of considerable interest to get some knowledge of the development of this very interesting genus, I give here some detailed figures of parts of the test of the specimen mentioned. It would, of course, have been desirable to have some younger stages, but such have not yet been found, and the present specimen is still young enough to be of value for the study of the development of this form.

The ambulacra on the actinal side already show the structure typical of the genus, the larger primary plate of each set being divided into an outer, smaller, pore-bearing plate and an inner, larger one without pore; this is the case also with those nearest the actinostome. As is well known the inner ambulacral plates with the growth of the specimen pass on to the buccal membrane and there develop into very broad, but short plates, which cover the whole buccal membrane. In the small specimen 4 such plates, besides the inner one, the true buccal plate, are counted in each series; in a

[1] A. Agassiz and H. Lyman Clark: Hawaiian and other Pacific Echini. The Cidaridæ. Mem. Mus. Comp. Zool. XXXIV. 1. 1907. — This work was not received before most of the present work was printed, so that I was unable to take it into consideration in my introductory remarks.

larger specimen (130mm) I count 7—8 such plates in each series, all being provided with a pore. Of the inner plate without pore no trace is seen, and since there is otherwise such a plate for each three pore-bearing plates, this fact must mean that the poreless plate becomes absorbed on passing to the buccal membrane. On the abactinal side it is seen that the larger primary plate is from the beginning undivided; but already from the third or fourth the dividing line has appeared, though not easily discernible before nearer to the ambitus. All the pores are distinct, only that of the inner small plate distinctly the larger, corresponding to the larger size of the tubefoot of this plate.

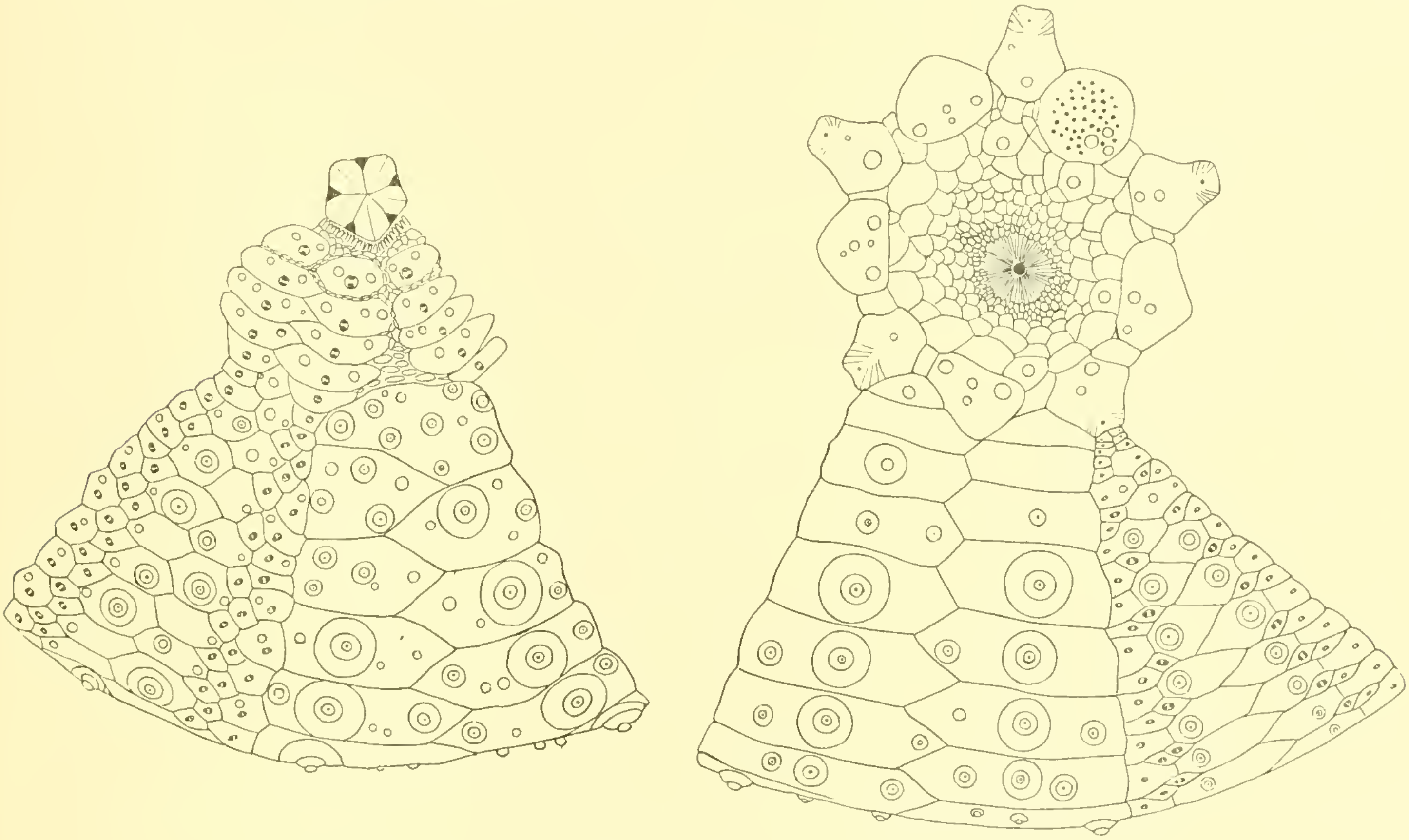


Fig. 27. Part of the actinal and abactinal side of the test of *Sperosoma Grimaldi*; 27mm.

The genital and ocular plates are already separated by small anal plates, except the ocular plate III which is still in contact with the adjoining genital plates. In younger stages the apical plates will undoubtedly form a closed ring. The genital pores have not yet appeared; in a specimen of 40mm diameter from the Færoe Channel they have appeared, but the genital organs are still very small. The ocular plates are rather large, with a peculiar radiating striation in the outer part. The anal area is closely covered by numerous small plates, those at the outer edge being somewhat larger; the inner ones are narrow and elongated, radially arranged round the anal opening. — The gills have not yet appeared in this specimen, but in the specimen of 40mm they are present, though still very small.

This species was taken by the «Thor» at 62° 57' Lat. N. 19° 58' Long. W. 957 M. in 1903 and at 61° 15' Lat. N. 9° 35' Long. W. 900 M. in 1904.

Phormosoma placenta W. Th. In the «Echinoidea d. deutschen Tiefsee-Expedition» (p. 126—28) Döderlein points out that the specimens of *Phormosoma placenta* from the Davis Strait as well as that figured in the «Blake»-Echinoidea differ from the specimens from the European side of the Atlantic, in having fewer abactinal plates in the ambulacra and interambulacra; in the European form, the typical *placenta*, there are 10—11 interambulacral and 14—16 ambulacral plates in each series, in the specimens from the Davis Strait there are only 7—8 interambulacral and 9—10 ambulacral plates. The latter form is thus maintained as a distinct species, *Ph. sigsbei* A. Ag., though it is suggested that on examination of a richer material it will, together with the «species» from the Indian Ocean: *Ph. adenicum, indicum* and *bursarium*, prove to be only a variety of *Ph. placenta*. This suggestion is no doubt correct, as regards *Ph. sigsbei* at least. Several specimens before me from the Faroe Channel («Michael Sars» 1902) as well as some from the «Thor» are quite intermediate as regards the number of abactinal plates, so that it is impossible to decide thereby to which form they should be referred. I give here some instances. The tridentate pedicellariæ in these specimens, however, are of the slender form, the character derived from the form of these pedicellariæ, viz. narrow in the typical *placenta*, broad in *sigsbei* (comp. Pl. XII. Figs. 2—3 and 7 of the Part I) thus apparently being more constant. To distinguish *Ph. Sigsbei* as a separate species from *placenta* seems then scarcely justified, but it may be correct to maintain it as a variety besides the typical form of *Ph. placenta*, the latter belonging to the European side of the Atlantic, the var. *sigsbei* to the American side, from the Davis Strait to the West Indies.

Diameter	Number of abactinal plates	
	Interambulacra	Ambulacra
80 mm	8	12
80 —	9	12
85 —	9	11—12
88 —	8—9	13
90 —	8—9	11—12
90 —	8	12

Mr. R. T. Jackson has called my attention to the fact that in the figure of a young *Phormosoma placenta* given in the Siam-Echinoidea I. (p. 54) the teeth are represented as situated in the ambulacra. I take the occasion here to correct the error, which I can scarcely account for. The teeth are distinctly interambulacral also in the smallest specimens, as might, of course, be expected.

Hypsiechinus coronatus Mrtsn. Mr. R. T. Jackson likewise suggests to me that the plate outside the buccal plates, between the terminal plates, shown in Pl. VII. Fig. 6 of Part I ought not to be interpreted as the basal (genital) plate as I have done (p. 89), but as the first interambulacral plate. Mr. Jackson is right in this suggestion. I have examined the specimen figured there and find that the genital plates are also present, and easily discernible, when examining the specimen from the abactinal side, so there is no excuse for the error.

Echinus gracilis. In the «Echinoderms of Ballynakill and Bofin Harbours, Co. Galway and of the Deep water off the West Coast of Ireland» by Stanley W. Kemp (Ann. Rep. Fish., Ireland. 1902—3. Pt. II. App. VI. 1905) is named (p. 199) «*Echinus gracilis* (Düb. and Kor.).» As Düben and Koren have described no *Echinus gracilis* and the *Ech. gracilis* A. Ag. was hitherto known only from the American side of the Atlantic, I wrote to Mr. Stanley Kemp about the matter, and he informed me that it was an error for *Ech. elegans* Düb. Kor. I take the occasion to correct the error here to prevent introducing in literature *Ech. gracilis* as occurring on the European side of the Atlantic.

Echinus esculentus L. The variety of this species mentioned in Part I. p. 162, and further mentioned by Appellöf (Havbundens Dyreliv. Norges Fiskerier. I. Norsk Havfiske, 1. Del. Havforskning og Havfiske. 1906. p. 82) certainly deserves to be named as a distinct variety; I propose to name it var. **fuscus** n. var. As pointed out (loc. cit.) it differs from the typical form in the lower form of the test and in the uniformly red coloured spines, the spines of the typical form being generally violet at the point, white in the lower part (occasionally the spines are green). According to Appellöf the spines of this variety may vary considerably in colour, from beautifully cinnabar-red to green; in all the specimens seen by me they are uniformly red. The spines are somewhat longer than is generally the case in the typical form. The pedicellariæ do not show any differences from those of the typical form. The measurements given here show the considerable difference in height between the variety and the typical form, though there is certainly some variation in this regard also.

	Diameter	Height	Longest spines
Typical form	31^{mm}	22^{mm}	$8{\cdot}5^{mm}$
Var. *fuscus*	31^{mm}	16^{mm}	$10-11^{mm}$

This variety seems to be found exclusively in the North Sea. The specimens in our Museum are from the following localities: 55° 30′ N. 1° E. 75 M., 56° 40′ N. 2° 16′ E. 73 M. and 57° 55′ N. 1° 20′ E. 105 M. — It is evidently the same form which is mentioned by Th. Scott (Notes on some Scottish Echinodermata. Ann. Scott. Nat Hist. 1892. p. 49), who also gives a figure of the naked test (Pl. II. Fig. 1). He does not mention the colour of the spines. — In a specimen of this variety, which I examined in the Berlin Museum, the spines on the buccal plates were partly transformed into sphæridiæ, all transitional stages being found between common spines and true sphæridiæ. In my paper »Echinoderms from East Greenland« (Medd. om Grønland. XXIX. 1903. p. 77—78) I have taken the occasion to mention that and given some figures thereof.

In the beautiful work of J. Lambert: Description des Échinides fossiles de la Province de Barcelone. II—III. Échinides des Terrains miocène et pliocène,[1] which I received after the printing of the main part of the present work, so that it could not be taken into consideration there, some important critical remarks are given, on which a few words may be said here.

The genus *Parechinus*, established by me in Part I of this work for »*Echinus*« *miliaris, microtuberculatus* and *angulosus*, is not accepted by Lambert, who maintains that the name *Psammechinus* must be retained for this group, whereas the name *Anapesus* Holmes has to be used for the group to which I have limited the genus *Psammechinus*, viz. *P. variegatus* (or *Blainvillei* Desm., as Lambert shows to be its right name), *semituberculatus* etc. Lambert's reasons for maintaining this are, that the older authors have taken *miliaris* as the type of the genus *Psammechinus*, and that *variegatus (Blainvillei)* and the species of that group are not quite in accordance with the original diagnosis. To this may be remarked that none of the previous authors have understood the real characters of the genera of the *Echinidæ* and allied groups.[2] I was the first to give exact diagnoses of these

[1] Mém. Soc. Géol. de France. XIV. 1906.

[2] Even Lambert himself has not the right conception of these genera. »Ce qui distingue *Psammechinus*«, he says (p. 67. note), »ce n'est pas seulement la présence de plaquettes imbriquées sur la membrane buccale, c'est la forme de son péristome plus large, subdecagonal, c'est surtout l'homogénéité de ses majeures ambulacraires, toutes tuberculifères, tandis que chez *Echinus* adulte les majeures alternent, successivement tuberculifères et granulifères, comme celles de *Toxopneustes*«. This is not correct; several species of *Echinus*, e. g. *elegans*, *Alexandri* a. o. have a primary tubercle on every ambulacral plate — but scarcely anybody, who knows these species in nature, not from literature alone, would think of excluding them

genera and limit them to the species really belonging together, as shown by the combined characters of the test and the microscopical features of pedicellariæ and spicules. I therefore thought and still think that I was justified in retaining for the first group included under the subgen. *Psammechinus* in Agassiz & Desor's «Catalogue raisonné» the name *Psammechinus*, neglecting the previous authors' rather confused use of the name. It is true that the expression «point de fortes entailles buccales» in the original diagnosis does not suit well with *P. variegatus*, — when large specimens are considered. But if we take specimens of medium size (and such were, I think, the specimens cited in the said work) the diagnosis suits fairly well, the mouth-slits being really comparatively small. The fact that Professor Döderlein has accepted the name *Parechinus* also makes me confident that I was right in taking *variegatus (Blainvillei)* as the type of *Psammechinus*. In the other case it is right that the name *Anapesus* would have to be used for the latter genus; but it seems to me that, if there is no necessity for reviving such a rather unfortunate name, it ought not to be done. And though it is certainly no absolute claim that the first named species in a group has to retain the name of this group in case of further subdivision (and, of course, in case that none of the species are designated as the type) it seems to me a natural thing to do so, and in any case, the author who first characterises the divisions of the old group is entitled to do so.

On the genus *Brissopsis* Lambert has given a careful study (p. 104—8), the results of which, at first, appear to differ very much from the results of my studies. In reality they do not differ so much, only Lambert has, from want of sufficient material of the recent species, been led to a wrong interpretation of «*Brissus lyrifer*» and thereby induced to use the names incorrectly. As the true «*Brissus lyrifer*» Lambert takes the form described above as *Brissopsis atlantica*, the «elongated type of *Brissopsis lyrifera*» of Agassiz. The form described above as *Br. alta*, the «globular type of *Br. lyrifera*» of Agassiz, Lambert identifies with «*Brissus pulvinatus*» including within this species also the form from the Northern Seas, the true *Brissopsis lyrifera*. These erroneous premises given (— and from the study of literature alone it would perhaps scarcely be possible to get any other result —), the conclusion is quite right, that *Brissopsis lyrifera* and *pulvinatus* must be sharply distinguished. If the right names are put in, viz. *Br. atlantica* instead of Lambert's *Br. lyrifera* and *Br. lyrifera* and *alta* instead of Lambert's *Br. pulvinatus*,[1] it will be seen that Lambert's and my opinion are thus far quite in accordance as regards these forms. Lambert refers them to different subgenera, viz. the true *lyrifera* (his *pulvinatus*) to the subgenus *Brissoma* Pomel, the *Br. atlantica* (his *Br. lyrifera*) together with *Br. luzonica* to the subgenus *Kleinia* Gray. The latter name, however, ought to be regarded only as a synonym of *Brissopsis*. This name was first used for the fossil species *Br. elegans*, with its petals of the same form as in *luzonica* etc. Lambert maintains *Brissopsis* and *Kleinia* as two subgenera, distinguished by the character that one has the subanal fasciole «en anneau simple»

from the genus *Echinus*. The main character of the genus *Parechinus* (Lambert's *Psammechinus*) is to be found in the peculiar globiferous pedicellariæ. But Lambert, the eminent specialist in fossil Echinoids, is not inclined to recognize the microscopical characters, which cannot be used for the fossil forms. I think, however, that I am right in maintaining that the recent species, which alone can be fully studied, must form the basis of our knowledge of the characters important for classification. If microscopical structures like spicules and pedicellariæ prove to be of the highest importance for distinguishing the recent forms, we are certainly not entitled to ignore them on account of their not being preserved in the fossil forms. We must, on the contrary, acknowledge that the fossil forms are thus far not preserved in a condition fit for complete study.

[1] It is well worth emphasizing that in the European Seas only one form of *Brissopsis* occurs, viz. that with divergent petals, so that there cannot be the slightest doubt of the interpretation of the «*Brissus lyrifer*» of Forbes.

the other has it »en anneau appendiculé par deux branches latérales«, viz. the anal branches. Now these anal fascioles are of very unconstant character, as repeatedly pointed out above — (they may also occur in the true *Br. lyrifera*), and it is evidently impossible to ascribe to them any great systematic importance. But then it follows that both *Toxobrissus* and *Kleinia* are synonyms only of *Brissopsis* in its original meaning. If we have to subdivide the genus *Brissopsis* in its wide meaning, it must then be as follows:

Subgenus *Brissopsis* s. str. (Syn. *Toxobrissus, Kleinia.*) Type *Br. elegans; Br. luzonica, atlantica, Oldhami, circosemita.*

— *Brissoma.* Type *Br. lyrifera: Br. alta, columbaris.*

Further *Br. pacifica* and *elongata* would make a separate subgenus, and perhaps one more separate subgenus would have to be established for the new species mentioned above, in which the first of the plates included within the subanal fasciole is the 7th as in *pacifica* and *elongata.* However, as pointed out above (p. 168), it seems to me the most natural thing to keep them all together in one genus on account of the peculiar intermingling of all the more important characters.

Lambert further includes under *Brissopsis* as subgenera: *Plesiaster* Pomel and *Diplodetus* Schlüter, which have the apex ethmophract. Though it is beyond doubt that the ethmolytic condition of the apex in the true *Brissopsis* has developed from an ethmophract condition, it seems to me inappropriate to unite these different types in the same genus. I do not see, why we should be unable to keep in mind their close relation without uniting them into the same genus. The fact that *Hemiaster batnensis* shows all transitional stages from an ethmophract to an ethmolytic condition can scarcely justify uniting *Plesiaster* and *Diplodetus* with *Brissopsis.* (I am not aware that such transitional forms are known in these genera.)

Also the genus *Schizaster* is made the object of a careful analysis by Lambert. *Sch. canaliferus* is made the type of a distinct genus, with the character of the pores of the anterior ambulacrum in double series. The rest of the old genus *Schizaster* is subdivided into the two (recent) subgenera: *Paraster,* with 4 genital pores *(P. gibberulus),* and *Brisaster* with 2 genital pores *(Br. fragilis, lacunosus).* — This subdivision again is the result of the lack of sufficient material of the recent forms. If Lambert had had occasion to make a careful comparative study of the recent forms, he would undoubtedly have seen that it is quite irrational to separate *Sch. canaliferus* as a distinct genus from *lacunosus, orbignyanus* etc. on account of the single feature of the double pores in the anterior ambulacrum; these species otherwise agree so closely in all other features that it is evidently quite artificial to separate them into different genera. Further, to unite *lacunosus* and *fragilis* in the same subgenus can in no way be justifiable; I trust I have shown that beyond doubt (p. 120-123); probably Lambert has not seen these species himself, otherwise he could scarcely have come to this conclusion. (The fact alone that he characterises the subgenus *Brisaster* with type species: *Br. fragilis* as having two genital pores seems to show this.)

I have above repeatedly alluded to the opinion of Lambert, that the names *Spatangus* and *Schizaster* are not rightly used in the way generally accepted. Here he finally makes the change: *Schizaster canaliferus* is made the type of the genus *Spatangus* (the former genus *Spatangus* is called

Prospatangus), the name *Schizaster* is retained for the rest of the species of this group. Further *Echinocardium* is restored for *(Moira) atropos.* — I may refer to my remarks above, p. 132, regarding these unfortunate changes.

It is, indeed, quite discouraging with all the changes of the generic names, and it seems impossible to reach an arrangement which can be unanimously accepted. I think there is only one way to get out of this almost insupportable condition of the nomenclature, viz. if all the Echinologists of the present time meet to form an international committee and come to an agreement regarding all the names of Echinoidea, one by one, and then publish a complete list of all the names finally adopted, with their synonyms and complete history. From the date of publication of such a list the endless and annoying discussions and the perplexing changes would cease — they will scarcely cease before. Perhaps it would be necessary to do so also for other difficult groups; for a first trial the Echini would be an excellent group, as the number of species and names is not so exceedingly great.

Geographical distribution of the Echinoidea of the Northern Atlantic.

The revision of the Echinoidea of the Northern Atlantic given in this work leads to some zoogeographical results which differ not inconsiderably from those laid down in the careful and extensive studies on the geographical distribution of Echinoidea in the works of Professor Agassiz, the differences mainly resulting from the many corrections in the interpretation of the species and genera of Echinoids, not from a disagreement in the principles and general treatment of the zoogeography of this group of animals. In fact, I quite agree with Ortmann (Grundzüge der marinen Tiergeographie. 1896) in regarding Professor Agassiz' zoogeographical work on the Echinoids as «den Gipfelpunkt der bisherigen tiergeographischen Forschung, wenigstens auf dem Gebiete des marinen Litorals» (p. 6). — Quite recently Professor Döderlein has treated the distribution of the arctic and subarctic Echinoidea (Arktische Seeigel. Fauna Arctica. IV. 2. 1905) very carefully, but in a way which differs considerably, and, as it seems to me, not fortunately, from that in which Agassiz treats the matter. My views thereof are far more in accordance with those of Professor Agassiz.

The study of the geographical distribution of the Atlantic species of Echini leads us to recognize the following regions or districts: **The Arctic littoral** and **abyssal, the European boreal, the Mediterranean, the West African tropical littoral** and **the East American littoral**; further **three Atlantic Deep-Sea regions: the European, West African** and **East American.** Each of these regions is characterised by some species peculiar to it and by the absence of a number of species occurring in the adjoining regions.

What limits these different regions is not the latitude and longitude, but the physical conditions of the sea, above all the temperature. To take the Polar circle or a line from the North Point of New Foundland to the point of the Norwegian Coast which lies on the Polar circle as the limit of the arctic or subarctic region, as is done in Döderlein's work, is arbitrary; it will scarcely be possible to produce scientific reasons for this limitation of the regions, which leads to such results as to count e. g. *Phormosoma placenta* to the Arctic Fauna. — Just as the marine fauna of the Bermudas really belongs to the tropical West Indian Fauna, though the islands are situated on 32° Lat. N., the Gulf Stream making the physical conditions suitable for tropical animals, in the same way the fauna of the warm area of the Atlantic proceeds far towards the North, and conversely, the arctic fauna far South, if the conditions are only suitable. Along the European side of the Atlantic the Gulf Stream, as is well known, proceeds along the Coast of Norway even to the White Sea and produces such physical conditions as to enable forms of the warm area to proceed to the North Cape, 71° Lat. N., whereas on the American side the cold Labrador Stream passes far towards the South, enabling the arctic fauna to proceed to Cape Cod, on 42° Lat. N., the latitude of Northern Spain. The study of the geographical distribution of marine animals therefore must rest on the study of the physical conditions of the sea.

It is a natural thing that it is upon the whole impossible to fix the limits of the different regions very definitely. Most species pass over the limits, and very few species occur exclusively within the limits of one region, whereas very many species are common to two or more regions. There is thus generally a rather extensive area between the adjoining districts, where the species peculiar to each district meet and intermingle, the fauna thus being composed of elements from the two adjoining regions, without any forms peculiar to it. Such areas are e. g. the tract from the Channel to Morocco on the European side and from Cape Cod to Cape Hatteras on the American side of the Atlantic. — It is the same with the depth-limits of the regions. Most of the species have a very extensive range in depth, several of them ranging even from quite shallow water down to the great abysses (though it is generally easy to decide if a species is mainly littoral or abyssal) The bathymetrical limits of the regions must then necessarily look somewhat arbitrary, from a systematic point of view. But, on the other hand, Agassiz may thus far be fully justified in saying («Challenger»-Echinoidea. p. 222) that «the divisions into littoral, continental and abyssal or oceanic are not arbitrary; they represent in the present state of our knowledge of the depths of the oceans, bathymetrical lines of great physical importance. The littoral fauna extends over that shallow area of the shores which is merely the extension under water of the shores themselves (to 100 or 150 fathoms); the continental line represents the extent to which we may fairly assume that the lines of continents have been modified, the limits within which probably subsidence and elevation as affecting continental masses, or rather their shores, have taken place, to 450 or 500 fathoms, while the third region beyond this, that which has been called abyssal or oceanic, undoubtedly represents those large areas of the ocean floor which have remained unaffected through long geological periods».

In Part I (p. 28) I have distinguished between the littoral belt, the sublittoral, archibenthal and abyssal belts. The littoral is reckoned from 0—ca. 50 fathoms, the sublittoral from ca. 50—ca. 300 fathoms, the archibenthal from ca. 300—ca. 1500 fathoms, and depths greater than 1500 fathoms are called abyssal. These divisions are certainly not so fortunate as those maintained by Agassiz, and I therefore give them up and follow Agassiz, recognizing only three main bathymetrical divisions. The littoral region I prefer to limit to the 100 fathoms; the next region then goes from 100 to 500 fathoms, viz. the archibenthal region (— this name seems to me preferable to the name «continental», which has also another meaning in Zoogeography), and the depths below 500 fathoms make the abyssal region. — There is, however, no reason for maintaining these depth regions for all the districts. The European boreal and the Mediterranean regions have in so far the same faunistic character throughout their whole bathymetrical extension that not a single species is characteristic for the greater depths alone, below the 100 fathoms line (except *Spatangus Raschi*, which is, however, probably only an immigrant into the European boreal region). The only difference is that the greater depths in these regions are much poorer in Echinoids than the littoral regions, several species being strictly littoral, as far as hitherto known. This especially holds good for the Mediterranean. — In a more detailed account of each region there is reason for distinguishing between the strictly littoral, sublittoral regions etc., as is done excellently by Appellöf (Op. cit.); but in this more summary review of the main regions there is no reason for entering on these minor subdivisions.

It is the merit of Professor H. F. E. Jungersen to have shown definitely that also in the deep-sea separate regions may be distinguished.[1] Already on the Expedition of the «Lightning» in 1868 Wyville Thomson was struck with the physical and faunistic differences in the Faroe-Channel between the «cold area» and the «warm area» («Depths of the Sea»); the discovery of the submarine ridge across the Faroe-Channel thus far explained the fact that two so different areas could exist close by one another without a mixing up of their characters. But the «Ingolf»-Expedition brought evidence for the highly interesting fact that the whole of the deep basin of the sea North of Iceland (the «Norwegian Sea») forms a separate deep-sea region, distinguished by its low (negative) bottom-temperature and by a peculiar deep-sea fauna, quite distinct from that of the Atlantic deep sea South of Iceland. A submarine ridge across the Denmark Strait, from Greenland to Iceland, with a depth of only ca. 300 fathoms, another ridge between Iceland and the Faroe Islands with about the same depth, and finally the ridge across the Faroe Channel (330 fathoms) limit this large cold area from the deep sea of the Atlantic South of Iceland, where the bottom-temperature is considerably higher (the warm area). The «cold area» of Wyville Thomson is only the southernmost extension of the large cold deep-sea area of the Norwegian Sea. — Probably also other parts of the deep sea will prove to form definite regions; but our knowledge is still insufficient to state that definitely.

The Arctic littoral region comprises the whole of the Arctic Sea along the Northern Coasts of Europe, Asia and America, being thus circumpolar; it extends towards the South as far as the ice-cold polar water extends. On the European side the Gulf Stream restricts its limits very much, so that it does not pass beyond a line from about the South end of Nova Zemlja to the South end of Spitsbergen, except along the Northern Coast of Russia, where it proceeds to the White Sea. All Greenland and the North American Coast down to Cape Cod belongs to this region. — Only two species of Echini occur in this region, viz. *Strongylocentrotus dröbachiensis* and *Echinarachnius parma*, the latter only at the American Coast; both of them proceed far towards the South, beyond the Arctic region, *Str. dröbachiensis* to the Channel on the European, to New Jersey on the American side, *Echinarach. parma* to Chesapeake Bay. As pointed out by Döderlein (Op. cit.) both of them probably must have come from the Northern Pacific, wandering towards the East from the Behrings Strait. While *Echinarachnius parma* has still not reached beyond the American Coast, not even to Greenland, *Str. dröbachiensis* has reached as far as Taimyr on the Siberian Coast; between Taimyr and the Behring Strait it has not been found. It is thus not strictly circumpolar. — It would be very interesting to learn if *Echinarachnius parma* does really occur along the whole North Coast of North America. It is known as far North as Labrador (Belle Isle Strait) on the Atlantic Coast, as far as Point Belcher on the Alaskan Coast. The fact that it does not occur at Greenland might perhaps indicate that it is not found along the whole of the North American Coast. In that case the explanation of its occurring in two isolated places, on the Atlantic and on the Pacific Coast of North America, would probably have to be sought for in the oscillations of the climate after the Ice Period. It has been

[1] Fra «Ingolf»-Expeditionen. Bemærkninger om Dybhavsfaunaen og dens Fordeling i de nordlige Have. Geografisk Tidsskrift. Bd. XIV. 1897.

shown by Ad. S. Jensen[1] that in postglacial time Greenland has had a period of milder climate, when forms such as *Zirphæa crispata* occurred along the Greenland Coast; this bivalve now has its Northern limit at the Gulf of St. Lawrence — as seems also to be the case with the Atlantic *Echinarachnius parma*. During that milder period the extension of this species along the Northern Coast of America from the Pacific to the Atlantic may have taken place (— or it may even have taken place before the Ice Period —). Until a careful zoological exploration of the waters to the North of America has been undertaken, it is impossible to state anything more definitely about this question.

Echinus esculentus also occurs at Spitsbergen, according to Lütken.[2] This statement is regarded as very doubtful by Michailovskij.[3] In any case this occurrence would not justify counting *Ech. esculentus* among the species of the Arctic littoral region. The Gulf Stream still makes itself felt even at the Southwestern end of Spitsbergen, which would account for the presence of this species here. It will certainly not be found at the East and North Coast, to which the Gulf Stream does not reach.

The Arctic abyssal region comprises the deep basin of the sea to the North of Iceland, where the bottom temperature is negative. It is limited from the deep-sea of the Atlantic South of Iceland by the three submarine ridges: one passing over the Denmark Strait from Iceland to Greenland, another from Iceland to the Faroe Islands and the third from the Faroe Islands to the Hebrides. The northern limits of this region are still unknown. — Only one species of Echini occurs in this region, viz. *Pourtalesia Jeffreysi*. It is true that *Echinus Alexandri* and *Spatangus Raschi* have been recorded a single time each from a considerable depth and negative bottom temperature off Norway; but these cases are undoubtedly quite exceptional, the former species decidedly belonging to the Atlantic deep-sea Fauna, the latter to the boreal and the Atlantic Fauna.

Pourtalesia Jeffreysi has been recorded several times from the Atlantic, both the European and the American side, but, as has been shown above, this is due to a confusion with the nearly related *Pourt. Wandeli*. In reality *Pourt. Jeffreysi* is known only from the arctic abyssal region. Its bathymetrical extension is rather great, from 125—1300 fathoms; but it scarcely ever occurs where the bottom temperature is positive.

Pourtalesia Jeffreysi is nearest related to *P. Wandeli*, the species widely distributed in the warm area of the Atlantic Deep Sea; it may be said with certainty that *P. Jeffreysi* has been developed from a form very much like this species (perhaps the ancestor of both *P. Wandeli* and *Jeffreysi*), which was probably distributed over the whole of the Northern Atlantic, thus north of the ridges also, at a time when a more uniform climate prevailed there. When the recent conditions developed the specimens to the North of the ridges were thus isolated and developed into a separate species. Or perhaps the ancestor of the species wandered into the northern region, after its physical conditions had become like those now prevailing there. This, of course, cannot be decided; but in any case *P. Jeffreysi* was

[1] Ad. S. Jensen. On the Mollusca of East Greenland. I. Lamellibranchiata. With an Introduction on Greenlands fossil Mollusc-Fauna from the quaternary time. Meddelelser om Grønland. Vol. XXIX. 1905.

[2] Chr. Lütken. Et Bidrag til Kundskab om Spitzbergens Echinoderm-Fauna. (Vidensk. Medd. Naturh. Foren. København. 1871. p. 305.)

[3] M. Michailovskij. Zoologische Ergebnisse der Russischen Expedition nach Spitsbergen. Echinodermen. (Ann. Mus. Zool. de l'Acad. Imp. St. Petersbourg. VII. 1902.)

certainly developed here and appears as a typical example of a species which has developed in an isolated locality with very special physical conditions. It is quite in accordance with this that *P. Jeffreysi* is among the most specialized species of the group of Pourtalesiæ to which it belongs.

The European boreal region comprises the Atlantic littoral regions of Europe, from the Channel to Northern Norway (East-Finmark), Iceland, Faroe-Islands and Great Britain; including, of course, both the North Sea, Skagerrak, Kattegat and the Baltic, as far as Echinoderms occur there, further the large plateau along the Norwegian Coast as far out as to where the negative bottom temperature occurs (the arctic abyssal region), which is very nearly coincident with the 500 fathoms line.

The littoral tract from the Channel to Gibraltar might thus far be reckoned to the boreal region, as some of the species characteristic of that region also occur here; but on the other hand several of the species characteristic of the Mediterranean region extend along this tract towards the Channel and the Southern Coasts of Britain. Thus two faunas meet here and intermingle, this tract representing, in fact, a transitional region. It is by the Malacologists generally called the Lusitanian region or province; from an echinological point of view there is no reason to accept it as a distinct region.

The following species are known from this region:

Dorocidaris papillata	Paracentrotus lividus	Spatangus Raschi
Parechinus miliaris	Strongylocentrotus drobachiensis	Echinocardium flavescens
Echinus esculentus	Sphærechinus granularis	— pennatifidum
— acutus	Echinocyamus pusillus	— cordatum
— elegans	Hemiaster expergitus	— mediterraneum
— tenuispinus	Brisaster fragilis	Brissopsis lyrifera.
— Alexandri	Spatangus purpureus	

Of these species the following are characteristic of this region: *Parechinus miliaris*, *Echinus esculentus*, *tenuispinus* and *Echinocardium pennatifidum*. The first named extends to the African Coast and perhaps a little into the Mediterranean. *Ech. esculentus* probably has its southern limit in the Bay of Biscay. (The statements of its occurrence in the Mediterranean, at South Africa and Brazil are probably all erroneous). *Echinus tenuispinus* is hitherto known only from the Porcupine Bank and the Shetlands, *Echinocardium pennatifidum* is known from the Faroe Islands to the Gulf of Gascogne. (The statement of its occurrence in the Mediterranean has been shown above to be erroneous, and probably also the statement of its occurrence at the American Coast will turn out to be due to a confusion with another species). That these four species have originated within this region seems beyond doubt.

The following species are common to the boreal and the Mediterranean region: *Echinus acutus*, *Echinocyamus pusillus*, *Spatangus purpureus*, *Echinocardium flavescens*, *cordatum* and *Brissopsis lyrifera*. Most of them show a tendency towards developing a special Mediterranean variety, but the characters are still upon the whole not very prominent. All these species have also been recorded from the American Coast, but with the exception of *Echinocardium cordatum*, which seems to be almost cosmopolitan, the statements are, as far as I have been able to ascertain, all founded on wrong determinations. (Of *Echinocardium flavescens* I have not myself seen American specimens, but the descriptions point towards the American form representing a distinct species; comp. above p. 136).

One species, *Spatangus Raschi,* is common to the boreal and the European and West African Atlantic regions. The following species have a wide distribution in the whole of the Northern Atlantic: *Dorocidaris papillata, Echinus Alexandri, elegans, Brisaster fragilis* and *Hemiaster expergitus.* Two of these species have as yet only been found a single time in the boreal region, viz. *Echinus Alexandri* and *Hemiaster expergitus,* and are perhaps only occasional visitors there. *Dorocidaris papillata, Echinus elegans* and *Brisaster fragilis* are widely distributed on the Norwegian plateau, but they must evidently be regarded as intruders from the Atlantic region, which may perhaps also hold good for *Spatangus Raschi.* To suppose that they should have originated in the comparatively small area along the Norwegian Coast and from there have spread over most of the Northern Atlantic (*Dorocidaris papillata* also to the Mediterranean) would not seem very reasonable, whereas on supposing their home to be the Atlantic region their extension over the Norwegian Coast-Plateau becomes easily intelligible on account of the considerable influence of the Gulf Stream there. One of them at least, *Dorocidaris papillata,* has pelagic larvæ, which must facilitate the spreading over wide areas.

One of the species occurring in the boreal region, *Strongylocentrotus dröbachiensis,* is beyond doubt an intruder from the Arctic littoral region. In the same way *Paracentrotus lividus* and *Sphærechinus granularis,* which occur in the southernmost part of the regions are intruders from the Mediterranean and West African regions.

On the American side there is no region corresponding to the European boreal region. The Arctic region here proceeds so far southwards and the tropical region so far northwards that there is no room for another region. The short tract from Cape Cod to Cape Hatteras forms an intermediate zone, where the faunas of the two regions meet and intermingle, corresponding to the Lusitanian district on the European side of the Atlantic.

The Mediterranean region comprises, besides the whole Mediterranean Sea, the littoral zone of West Africa down to about Cape Bojador, the Canaries, Madeira and the Azores. On account of our very insufficient knowledge of the littoral fauna of West Africa it is for the present impossible to give the southern limit of this region more exactly. Perhaps it ought really to go down to Cape Verde; it seems, however, more probable that the tract from Cape Verde towards Cape Bojador will prove to be the intermediate zone between this and the West African tropical region.

It may be concluded from the fact that the connection between the Mediterranean and the Atlantic through the Gibraltar Strait is of comparatively very recent origin, that several forms of its present fauna of Echinoids have immigrated from the Atlantic. In accordance with this is the fact that no true deep-sea Echinoids are found in the Mediterranean; they have not been able to pass the Gibraltar Strait, where the greatest depth is only about 300 M., as is also the case with the cold water from the deeper layers of the Atlantic, the bottom temperature in the Mediterranean being 13° even to the greatest depths, more than 4000 M.

The following species of Echinoids are known from this region:

Dorocidaris papillata	Echinus acutus	Spatangus purpureus
Cidaris affinis	— melo	Echinocardium flavescens
Diadema antillarum	Paracentrotus lividus	— intermedium
Centrostephanus longispinus	Sphærechinus granularis	— mediterraneum
Arbacia pustulosa	— roseus	— cordatum
Genocidaris maculata	Echinocyamus pusillus	Brissus unicolor
Parechinus miliaris	Neolampas rostellata	Brissopsis lyrifera
— microtuberculatus	Schizaster canaliferus	Metalia Costæ.

The Mediterranean region is characterized by the following species: *Centrostephanus longispinus, Arbacia pustulosa, Paracentrotus lividus, Sphærechinus granularis, roseus, Parechinus microtuberculatus, Echinus melo, Schizaster canaliferus, Echinocardium mediterraneum, intermedium* and *Metalia Costæ.* Three of these species: *Schizaster canaliferus, Echinocardium intermedium* and *Metalia Costæ* are hitherto known only from the Mediterranean (*Sphærechinus roseus* it is better to leave out of consideration, as its specific value is not beyond doubt). Whereas *Echinocardium intermedium* may well turn out to occur also outside the Mediterranean, being not so easily distinguished, this can scarcely be the case with *Schizaster canaliferus*[1] and *Metalia Costæ,* since they are so very characteristic that it seems hardly possible that they can have been overlooked. It seems then certain that these species have developed in the Mediterranean in earlier times, before the recent conditions of this sea were arrived at, and are thus survivors from its previous fauna. This is, at all events, the case with *Sch. canaliferus,* which is known as fossil from the Miocene of Italy.[2] Mazzetti further records as occurring in the Miocene of Italy: *Spatangus purpureus* and *Brissopsis lyrifera,* as also *Echinolampas depressa,* now known only from the American side of the Atlantic. On the other hand no *Echinus*-species is recorded; it thus seems that *Echinus acutus* and *melo* must have immigrated from the Atlantic into the Mediterranean after the formation of the Straits of Gibraltar. — The recent immigration through the Suez Canal from the Red Sea of *Heterocentrotus mamillatus* recorded by Gauthier (160. p. 403) and Ludwig (Echinodermen d. Mittelmeeres. p. 556) is shown by Fourtau (Contribution à l'étude des Échinides vivant dans le Golfe de Suez. p. 414) to be very improbable.

Centrostephanus longispinus is not known to occur outside this region, whereas the rest of the species named above proceed into the adjoining regions: *Paracentrotus lividus, Sphærechinus granularis, Echinus melo* and *Echinocardium mediterraneum* more or less into the boreal region, *Arbacia pustulosa, Sphærechinus granularis, Parechinus microtuberculatus* and *Echinus melo* into the West African tropical region, at least to the Cape Verde Islands. Finally *Arbacia pustulosa* also occurs at the Brazilian Coast. These species must probably all have originated in this region — and probably in the Atlantic part of it — from which they have then spread more or less widely into the adjoining regions.

The following species are common to the Mediterranean region and the East American region: *Dorocidaris papillata, Cidaris affinis, Diadema antillarum, Arbacia pustulosa, Genocidaris maculata, Neolompas rostellata, Echinocardium cordatum* and *Brissus unicolor.*[3] Of these *Diadema antillarum*

[1] The record of the occurrence of this species at the American Coast of the Atlantic is caused by a confusion with *Sch. orbignyanus,* as has been shown above, p. 117.

[2] Mazzetti: Catalogi degli Echinidi fossili della collezione Mazzetti. Mem. Acad. Modena. 2. Ser. XI. 1895.

[3] The occurrence of *Echinocardium flavescens* at the American Coast is not beyond doubt.

undoubtedly has its home in the East American region, but has crossed the Atlantic, its pelagic larvæ having been transported by the streams. (It is true that the larva of this species is still unknown, but the occurrence of the species on both sides of the Atlantic makes it almost beyond doubt that it must have pelagic larvæ). *Arbacia pustulosa*, on the other hand, has its home in the Mediterranean region and has from there crossed the Atlantic to the Brazilian Coast. The course of the Gulf-Stream from Florida to the Azores, and of the Northern Passat-Stream from West Africa to Brazil and the West Indies naturally explains this extension of the two species in opposite directions. *Echinocardium cordatum* probably also has its home at the European side of the Atlantic, where its main distribution is; for the rest of the species: *Dorocidaris papillata, Cidaris affinis, Genocidaris maculata, Neolampas rostellata* and *Brissus unicolor* it is scarcely possible to state more precisely, where their original home must be sought for, as they seem to be equally widely distributed in both regions, the first of them even ranging over the whole of the Northern Atlantic.

The rest of the species occurring in this region, viz. *Parechinus miliaris, Echinus acutus, Echinocyamus pusillus, Spatangus purpureus, Echinocardium flavescens* and *Brissopsis lyrifera* are common to this region and the European boreal region. *Parechinus miliaris* is certainly only an intruder from the boreal region. The fact that *Spatangus purpureus* and *Brissopsis lyrifera* are found already in the Miocene of Italy makes it rather probable that their original home is in the Mediterranean, from which they have extended over a considerable part of the Atlantic, though probably not to the American side. For *Echinus acutus, Echinocyamus pusillus* and *Echinocardium flavescens* it is scarcely possible to say more definitely which of the two regions must be regarded as their original home; it can only be said that *Echinus acutus* has probably immigrated into the Mediterranean after the formation of its recent connection with the Atlantic.

The West African tropical region comprises the tract from Cape Verde and the Cape Verde Islands to about the mouth of the Congo; it is, however, comparatively little known, and possibly its southern limit will prove to go somewhat farther down towards the Cape, the littoral fauna of this southern part of the African Coast being almost completely unknown. — Perhaps also St. Helena and Ascension rightly belong to this region. Their littoral fauna is, however, too imperfectly known to say anything certain thereof at present.[1]

The following species are recorded from this region:

Dorocidaris nuda	Echinus melo	Echinolampas Hellei
Cidaris tribuloides	Sphærechinus granularis	Echinoneus cyclostomus
— metularia	Tripneustes esculentus	Schizaster Edwardsi
Tretocidaris spinosa	— gratilla (angulosus)	Brissus unicolor
Diadema antillarum	Echinometra lucunter	Rhabdobrissus Jullieni
Arbacia pustulosa	Clypeaster subdepressus	Metalia Africana
Genocidaris maculata	Rotula Augusti	Meoma ventricosa.
Parechinus microtuberculatus	— Rumphii	

[1] In the Report on the Fauna of Ascension (Ann. Mag. Nat. Hist. 5. Ser. VIII. 1881) the following Echinoids are named (identified by Professor F. J. Bell): *Cidaris metularia, Diadema setosum, Tripneustes angulosus, Echinometra subangularis, Echinoneus cyclostomus* and *Rotula dentata*. It seems, indeed, very remarkable that no less than three Indo-Pacific forms are represented in this locality, viz. *Cidaris metularia, Tripneustes angulosus* (= *gratilla*) and *Echinoneus cyclostomus*, and one can scarcely suppress a doubt, whether they are not really *Cidaris tribuloides, Tripn. esculentus* and *Echinoneus*

Of these species the following are known from this region alone: *Dorocidaris nuda, Rotula Augusti, Rumphii, Echinolampas Hellei* (the *Ech. Blanchardi* Cotteau is probably only a synonym of this species), *Schizaster Edwardsi, Rhabdobrissus Jullieni* and *Metalia africana;* whilst *Tretocidaris spinosa* is known only from St. Helena.

From the Mediterranean region have probably immigrated: *Arbacia pustulosa, Parechinus microtuberculatus, Echinus melo* and *Sphærechinus granularis,* from the East American region: *Cidaris tribuloides, Diadema antillarum, Tripneustes esculentus. Echinometra lucunter. Clypeaster subdepressus* and *Meoma ventricosa.* The two species *Genocidaris maculata* and *Brissus unicolor,* as stated above, occur both in the Mediterranean and East American region. It is worth noticing that the species *Cidaris tribuloides, Tripneustes esculentus, Echinometra lucunter, Clypeaster subdepressus* and *Meoma ventricosa* are not known from the Mediterranean region. Judging from the currents they (viz. the larvæ) must have passed through the latter region; it is then probably the temperature which is not high enough here to suit them.

The East American littoral region comprises the whole, very extensive tract from the mouth of La Plata in the South to Cape Hatteras in the North. Certainly many of the species of this region do not proceed so far towards North or South, but it is scarcely possible to distinguish more than one region here. Its centre is the West-Indies; from here the species extend more or less in both directions, the North American and Brazilian Coast thus having upon the whole a considerably poorer Echinoid-Fauna than the West Indies, without species peculiar to them (except *Paracentrotus Gaimardi* which is hitherto known only from the Coast of Brazil).

This region, together with the East American deep-sea region, is by far the richest of all the Atlantic regions and among the richest of the world. No less than 48 species are known from the East American littoral region against 24 species from the Mediterranean, 23 from the West African tropical, and 20 from the European boreal region. The following species are known from the East American littoral region:

Dororidaris papillata	Genocidaris maculata	Mellita testudinata
— abyssicola	Echinus gracilis	Encope marginata
Cidaris affinis	Paracentrotus Gaimardi	— Michelini
— tribuloides	Psammechinus variegatus	Echinoneus semilunaris
Tretocidaris Bartletti	Tripneustes esculentus	Echinolampas depressa
Aspidodiadema Jacobyi	Echinometra lucunter	Conolampas Sigsbei
Diadema antillarum	— viridis	Rhyncopygus caribbæarum
Arbacia punctulata	Clypeaster latissimus	Palæotropus Josephinæ
— pustulosa	— Ravenellii	Palæopneustes cristatus
Coelopleurus floridanus	— subdepressus	— hystrix
Salenia Pattersoni	Echinanthus rosaceus	Linopneustes longispinus
Trigonocidaris albida	Mellita sexforis	Palæobrissus Hilgardi

semilunaris As long, however, as we know almost nothing of the littoral fauna of St. Helena and the West Coast of Africa South of Congo, we cannot deny the possibility of the occurrence of these species at Ascension; the streams of the Southern Atlantic at least would easily account for their occurrence there, if they were only found off South Africa. But only *Cidaris metularia* has been recorded from there, and only from older collections (Rev. of Ech.).

Agassizia excentrica	Moira atropos	Metalia pectoralis
Periaster limicola	Macropneustes spatangoides	Meoma ventricosa
Brisaster fragilis	Echinocardium cordatum	Brissopsis elongata
Schizaster orbignyanus	Brissus unicolor	— atlantica.

A considerable part (31) of these species exclusively belongs to this region, not occurring elsewhere, viz.

Dorocidaris abyssicola	Mellita sexforis	Palæopneustes hystrix
Tretocidaris Bartletti	— testudinata	Linopneustes longispinus
Aspidodiadema Jacobyi	Encope marginata	Palæobrissus Hilgardi
Arbacia punctulata	— Michelini	Agassizia excentrica
Echinus gracilis	Echinoneus semilunaris	Periaster limicola
Paracentrotus Gaimardi	Echinolampas depressa	Schizaster orbignyanus
Psammechinus variegatus	Conolampas Sigsbei	Moira atropos
Echinometra viridis	Rhyncopygus caribbæarum	Macropneustes spatangoides
Clypeaster latissimus	Palæotropus Josephinæ	Metalia pectoralis
— Ravenellii	Palæopneustes cristatus	Brissopsis elongata
Echinanthus rosaceus		

Several of these species also occur in the deeper regions, the limit between the littoral and archibenthal zones being here especially arbitrary and not expressed in the bathymetrical distribution of the species.

Besides the above named 31 species the following are also really characteristic of the region, but have crossed the Atlantic, thus occurring in the Mediterranean or West African tropical region: *Cidaris tribuloides, Diadema antillarum, Tripneustes esculentus, Echinometra lucunter,*[1] *Clypeaster subdepressus* and *Meoma ventricosa.* Two species, viz. *Salenia Pattersoni* and *Coelopleurus floridanus* also occur at South Africa; it is scarcely possible to say, where their original home is.

Among the rest of the species occurring in this region one, *Arbacia pustulosa,* is an intruder from the Mediterranean region, while the remaining are either widely distributed over the Northern Atlantic, viz. *Dorocidaris papillata, Brisaster fragilis,* or at least common to two or more regions, viz. *Cidaris affinis, Trigonocidaris albida, Genocidaris maculata, Echinocardium cordatum, Brissus unicolor* and *Brissopsis atlantica* (?). For the present, at least, it is impossible to say whether these belong originally to one or the other of the regions.

The Atlantic deep-sea regions. Though the physical conditions of the deeper regions appear to be of a very uniform character over the whole Atlantic, it is evident that the Echinoids occurring in the deeper regions are not all uniformly distributed over the whole Atlantic within the limits of their bathymetrical distribution. Some species appear to occur exclusively at the European side of the Atlantic, others only at the American side, while others still are known only from the Southern part of the Atlantic. It seems therefore necessary to distinguish three Atlantic deep-sea regions, viz. the European, the East American and West African. Undoubtedly several of the species hitherto known from only one of these regions will prove to be more widely distributed, but on the other hand several of the species are so well known and characteristic that it may be regarded as certain that they can-

[1] A very nearly related species, *Echinometra prisca,* is described by Cotteau from the Miocene of Anguilla. (Description des Échinides tertiaires des Iles St. Barthélemy et Anguilla. Sv. Vet. Akad. Handl. XIII. 1875.)

not have been overlooked in the regions, from where they are hitherto not recorded. It seems then really to be the case, that also the Atlantic deep sea comprises several distinct regions, though it seems impossible for the present to point out special physical characters, which distinguish the separate regions. As seen in Gerh. Schott's admirable »Oceanographie und maritime Meteorologie»[1] the bottom temperature is in the whole Atlantic, in depths beyond 1000 M., over 2°. Only in the Davis Strait and in the large Brazilian basin to the West of the midatlantic ridge (from near St. Paul down to the antarctic sea) the temperature is below 2°. But this difference in the temperature does not seem to be sufficient to cause corresponding marked differences in the deep-sea Echinoid-fauna.

The subdivision of the deep-sea regions into an archibenthal and abyssal zone is upon the whole not supported by the bathymetrical distribution of the species; most of the species occurring in the abyssal zone also occur in the archibenthal zone, and probably several of the species hitherto not known beyond the archibenthal zone will ultimately prove to have a greater bathymetrical distribution. Still it is worth noticing that the Meridosternata almost exclusively belong to the abyssal zone.

The European Atlantic deep-sea region comprises the Northern Atlantic, to the East of a line from the Denmark Strait to the Gibraltar Strait.[2] It is limited from the cold area of the Norwegian Sea by the ridges across the Denmark-Strait, the Faroe-Channel and between Iceland and the Faroe Islands.

The following species are known from this region:

Dorocidaris papillata	Trigonocidaris albida	Urechinus naresianus
Stereocidaris ingolfiana	Hypsiechinus coronatus	Plexechinus hirsutus
Porocidaris purpurata	Echinus esculentus	Pourtalesia Wandeli
Phormosoma placenta	— acutus	Echinosigra (Pourtalesia) phiale
Calveria hystrix	— elegans	— — paradoxa
Aræosoma fenestratum	— Alexandri	Hemiaster expergitus
— violaceum	— affinis	Brisaster fragilis
Hygrosoma Petersi	Strongylocentrotus drõbachiensis	Spatangus purpureus
Sperosoma Grimaldi	Sphærechinus granularis	— Raschi
Echinosoma uranus	Echinocyamus pusillus	Echinocardium flavescens
Salenia hastigera	Neolampas rostellata	Brissopsis lyrifera.

Of these species we may first eliminate the following as occasional intruders from the boreal and Mediterranean regions: *Echinus esculentus, Strongylocentrotus dröbachiensis, Sphærechinus granularis* and *Echinocardium flavescens.* Of the rest the following are known from this region only: *Aræosoma violaceum, Echinosoma uranus, Hypsiechinus coronatus, Plexechinus hirsutus, Echinosigra (Pourtalesia) phiale* and *paradoxa. Porocidaris purpurata* and *Sperosoma Grimaldi* are known only from this and the West African region. These species are, however, (except *Porocidaris purpurata* and *Sperosoma Grimaldi*) either small or easily confused with other species. It is certainly not much to characterize the region by, but especially *Porocidaris purpurata* and *Sperosoma Grimaldi* are so magnificent and peculiar forms that they can certainly not have been confused with other species; the

[1] Wissensch. Ergebn. d. deutsch. Tiefsee-Exp. I. 1902.

[2] The limit between the European and the East American Atlantic deep-sea regions will undoubtedly prove not to be a straight line of the course here indicated. For the present, however, our knowledge of the deep-sea fauna of the Mid-Atlantic is too insufficient for pointing out the limit between these regions more exactly.

presence of these species and the absence of several remarkable American forms then really seems to mark this part of the Atlantic deep-sea as a separate region, distinct from the American deep-sea region. It is also worth noticing that the *Phormosoma placenta* of this region appears to be somewhat different from the American form (the Var. *Sigsbei*).

The West African Atlantic deep-sea region comprises the tract from the Azores to about St. Helena. With the exception of the sea off the Azores it is very imperfectly known, and the whole region will perhaps prove to be untenable, though it now appears to have several species peculiar to it. — The following species are known from this region:

Dorocidaris papillata	Genocidaris maculata	Aceste bellidifera
— nuda	Echinus atlanticus	Palæotropus Hirondellei
Porocidaris purpurata	— Alexandri	Peripatagus cinctus
Phormosoma placenta	— affinis	Homolampas fragilis
Hygrosoma Petersi	Echinocyamus pusillus	Hemiaster expergitus
Sperosoma Grimaldi	— grandiporus	Spatangus purpureus
Dermatodiadema antillarum	— macrostomus	— Raschi
Salenia hastigera	Calymne relicta	Brissus Damesi
Trigonocidaris albida	Cystechinus clypeatus	Brissopsis atlantica (?)

Of these the following species are known from this region only: *Dorocidaris nuda* (also littoral), *Echinus atlanticus, Echinocyamus macrostomus, Calymne relicta, Cystechinus clypeatus, Palæotropus Hirondellei* and *Peripatagus cinctus*. Probably, however, several of these species will prove to have a considerably wider geographical range, and this region upon the whole is very problematic; especially it might be more natural to include the Sea off the Azores in the European atlantic region.

The East American Atlantic deep-sea region comprises the whole western half of the Atlantic, from the Davis Strait to at least off La Plata, and perhaps even farther southwards. Also the Caribbean Sea and the Mexican Gulf belong to this region. It is, of course, not sharply limited from the East American littoral region, several species ranging from the littoral to the abyssal zone.

No less than 74 species are known to occur in this region, which is thus by far the richest of all the Atlantic regions. These species are:

Dorocidaris papillata	Hygrosoma Petersi	Salenia hastigera
— abyssicola	Tromikosoma Koehleri	Trigonocidaris albida
— Blakei	Aspidodiadema Jacobyi	Genocidaris maculata
— micans	— tonsum	Echinus elegans
Cidaris affinis	Dermatodiadema antillarum	— gracilis
— tribuloides	Diadema antillarum	— Alexandri
Tretocidaris Bartletti	Hemipedina cubensis	— affinis
Stereocidaris ingolfiana	Arbacia punctulata	Strongylocentrotus dröbachiensis
Histocidaris Sharreri	Podocidaris scutata	Psammechinus variegatus
Phormosoma placenta	— sculpta	Tripneustes esculentus
var. Sigsbei	Coelopleurus floridanus	Echinometra lucunter
Calveria hystrix	Salenia goësiana	Pygastrides relictus
Aræosoma fenestratum	— Pattersoni	Echinocyamus grandiporus
— Belli	— varispina	Clypeaster latissimus

Clypeaster subdepressus	Aëropsis rostrata	Periaster limicola
Echinanthus rosaceus	Aceste bellidifera	Brisaster fragilis
Echinarachnius parma	Palæotropus Josephinæ	Schizaster orbignyanus
Mellita sexforis	— Thomsoni	Macropneustes spatangoides
Neolampas rostellata	Homolampas fragilis	Brissus unicolor
Echinolampas depressa	Palæopneustes cristatus	— Damesi
Conolampas Sigsbei	— hystrix	Metalia pectoralis
Rhyncopygus caribbæarum	Linopneustes longispinus	Meoma ventricosa
Urechinus naresianus	Palæobrissus Hilgardi	Rhinobrissus micrasterioides
Pourtalesia miranda	Hemiaster expergitus (Mentzi)	Brissopsis alta
— Wandeli	Agassizia excentrica	— atlantica.

Of these species two may be eliminated as intruders from the Arctic littoral region, viz. *Strongylocentrotus dröbachiensis* and *Echinarachnius parma,* while some other species are only occasional visitors from the littoral region, viz. *Cidaris tribuloides, Diadema antillarum, Arbacia punctulata, Clypeaster subdepressus, Echinanthus rosaceus, Rhyncopygus caribbæarum, Metalia pectoralis, Meoma ventricosa* and *Brissus unicolor.* The same probably holds good for *Psammechinus variegatus, Tripneustes esculentus, Echinometra lucunter* and *Mellita sexforis.* Of the rest the following species are known also from the European or African side of the Atlantic:

Dorocidaris papillata	Trigonocidaris albida	Urechinus naresianus
Cidaris affinis	Genocidaris maculata	Pourtalesia Wandeli
Stereocidaris ingolfiana	Echinus elegans	Aceste bellidifera
Phormosoma placenta	— Alexandri	Homolampas fragilis
Calveria hystrix	— affinis	Hemiaster expergitus
Aræosoma fenestratum	Echinocyamus grandiporus	Brisaster fragilis
Hygrosoma Petersi	Clypeaster subdepressus	Brissus Damesi
Dermatodiadema antillarum	Neolampas rostellata	Brissopsis atlantica (?).
Salenia hastigera		

Further two species, *Salenia Pattersoni* and *Coelopleurus floridanus,* are known also from the South African Sea, and one, *Aspidodiadema tonsum,* occurs also in the Pacific.

The remaining 32 species are known only from this region (and partly from the East American littoral region, which cannot be sharply limited against the deep-sea region). These species are the following:

Dorocidaris abyssicola	Salenia goësiana	Palæopneustes cristatus
— Blakei	— varispina	— hystrix
— micans	Echinus gracilis	Linopneustes longispinus
Tretocidaris Bartletti	Pygastrides relictus	Palæobrissus Hilgardi
Histocidaris Sharreri	Clypeaster latissimus	Agassizia excentrica
Aræosoma Belli	Echinolampas depressa	Periaster limicola
Tromikosoma Koehleri	Conolampas Sigsbei	Schizaster orbignyanus
Aspidodiadema Jacobyi	Pourtalesia miranda	Macropneustes spatangoides
Hemipedina cubensis	Aëropsis rostrata	Rhinobrissus micrasterioides
Podocidaris scutata	Palæotropus Josephinæ	Brissopsis alta.
— sculpta	— Thomsoni	

Leaving aside among these all rare, inconspicuous or not easily recognizable species, we still get a fair proportion of species peculiar to this region. It is certainly not likely that such species as *Dorocidaris Blakei*, *Echinus gracilis*, *Clypeaster latissimus*, *Echinolampas depressa*, *Conolampas Sigsbei*, *Palæopneustes cristatus*, *hystrix*, *Linopneustes longispinus*, *Agassizia excentrica*, *Periaster limicola*, *Schizaster orbignyanus* and *Macropneustes spatangoides* will ever be found to occur on the European side of the Atlantic, as, on the other hand, it is equally unlikely that *Porocidaris purpurata* and *Sperosoma Grimaldi* should prove to occur at the American side of the Atlantic. Thus it seems beyond doubt that also the Atlantic Deep-sea has its definite regions. — It must, however, be borne in mind that the distinction between littoral and deep-sea regions is mainly artificial, and marked limits between the deep-sea regions, such as between the cold and the warm area in the Northern Atlantic, do not exist.

In the «Blake»-Echinoidea (p. 79) Agassiz states that «the deep-sea Fauna of the Caribbean and of the Gulf of Mexico is far more closely allied to that of the Pacific than to that of the Atlantic». Though it may be emphasized that not a single species is common to the East and West Coast of America, it is certainly beyond doubt that a rather considerable portion of the West Indian Echini have been derived from the Pacific in previous times when Central-America did not yet exist. Such genera as *Diadema*, *Psammechinus*, *Tripneustes*, *Echinometra*, *Mellita*, *Encope*, *Rhyncopygus*, *Agassizia*, *Moira* and *Meoma* are most probably of pacific origin. But on the other hand an even larger number of genera are common to the West Indies and the African-European side of the Atlantic, but not known from the Pacific Coasts of America, such as: *Dorocidaris*, *Phormosoma*, *Calveria*, *Aræosoma*, *Hygrosoma*, *Trigonocidaris*, *Genocidaris*, *Echinus*, *Echinocyamus*, *Neolampas*, *Echinolampas*, *Palæotropus* and *Echinocardium*. Adding thereto the considerable number of species identical in the West Indian Seas and the Atlantic, it seems not too much to say that the above quoted statement of Agassiz is very exaggerated.

To enter on a discussion of the geographical distribution of the whole of the Echinoidea would carry us too far. I must limit myself to pointing out a few facts.

The South African fauna is, as pointed out by Döderlein, remarkable through the mixing up of Indo-Pacific with Atlantic species and not less for the peculiar resemblance to the European boreal fauna. This resemblance, however, is not so great as hitherto supposed, because on a closer examination the South African forms have proved to be distinct species, or at least distinct varieties; scarcely any species of Echinoids (except the almost cosmopolitan *Echinocardium cordatum*) will prove to be common to the South-African, and the European boreal region. Nevertheless these corresponding species: *Spatangus Raschi* — *capensis*, *Brisaster fragilis* — *capensis*, *Echinocardium flavescens* — *capense*, *Brissopsis lyrifera* — *capensis* seem to point definitely to a direct connection of the two regions during a former period.

The antarctic and subantarctic seas evidently form a distinct region, characterized mainly by the several species of *Sterechinus* and *Abatus*. With the exception of *Sterechinus Neumayeri* they all seem to have a rather restricted distribution, probably on account of their not having pelagic larvæ

(*Sterech. Neymayeri*, on the contrary, has pelagic larvæ).[1] — That there are no bipolar Echini I have pointed out already in Part I of this work.

Perhaps also the Antarctic deep-sea will prove to form a distinct region; in any case it is a noteworthy fact that a number of very peculiar forms: *Pourtalesia ceratopyga, carinata, hispida, Spatagocystis Challengeri, Echinocrepis cuneata, Genicopatagus affinis,* are hitherto known only from these tracts of the ocean.

[1] This will be treated in the Report on the Echinoidea of the German South Polar-Expedition.

List of the Echinoidea occurring in the Atlantic

(North of a line from the Congo to La Plata), with their geographical and bathymetrical distribution.

Name	Range in depth (fathoms)	Arctic region		European boreal region	Mediterranean region		West African tropical region	East American littoral region	European Atlantic region		West African Atlantic region		East American Atlantic region		
		Littoral	Abyssal		Medi-terranean	West African			Archi-benthal	Abyssal	Archi-benthal	Abyssal	Archi-benthal	Abyssal	
Dorocidaris papilata (Leske)	30—800	..	..	+	+	+	..	+	+	+	+	+	+	+	
— abyssicola A. Ag.	40—270	..	..	..	..	..	..	+	..	..	..	..	+	..	
— Blakei A. Ag.	120—450	..	..	..	..	..	..	..	..	..	..	..	+	..	
— micans Mrtsn.	180—210	..	..	..	..	..	..	..	..	..	..	..	+	..	
— nuda Mrtsn.	35—225	..	..	..	..	..	+	..	..	..	+	..	..	..	
Cidaris affinis Phil.	20—425	..	..	..	+	+	..	+	..	..	..	..	+	..	
— tribuloides Lmk.	0—250	..	..	..	..	..	+	+	..	..	..	..	+	..	
— metularia Lmk.	Littoral	..	..	..	..	..	+[1]	..	..	..	..	..	..	..	[1] Ascension; otherwise Indo-Pacific.
Tretocidaris Bartletti (A. Ag.)	25—400	..	..	..	..	..	..	+	..	..	..	..	+	..	
— spinosa Mrtsn.	Littoral	..	..	..	..	..	+[2]	..	..	.	..	..	..	..	[2] Only St. Helena.
Stereocidaris ingolfiana Mrtsn.	170—635	..	..	..	..	..	..	..	+	+	..	..	+	..	
Porocidaris purpurata W. Th.	485—540	..	..	..	..	..	..	..	+	+	..	+	..	..	Also Indian Ocean, off the Nicobar Islands.
Histocidaris Sharreri (A. Ag.)	120—355	..	..	..	..	..	..	..	..	..	..	..	+	..	
Phormosoma placenta W. Th.[3]	150—1355	..	..	..	..	..	..	..	+	+	..	+	+	+	[3] Including *Ph. Sigsbei* A. Ag. Perhaps cosmopolitan.
Calveria[4] hystrix W. Th.	100—1000	..	..	..	..	..	..	..	+	+	..	..	+	+	[4] This name is kept here for conformity's sake (comp. p. 20).
Aræosoma fenestratum (W. Th.)	80—375	..	..	(+)	..	..	..	..	+	..	..	..	+	..	
— violaceum Mrtsn.	200	..	..	..	..	..	..	..	+	..	..	..	..	..	
— Belli Mrtsn.	135—265	..	..	..	..	..	..	..	..	..	..	..	+	..	
Hygrosoma Petersi (A. Ag.)	400—1225	..	..	..	..	..	..	..	+	+	+	+	+	+	
Echinosoma uranus (W. Th.)	470—1525	..	..	..	..	..	..	..	+	+	..	..	..	..	
Tromikosoma Koehleri Mrtsn.	1435	..	..	..	..	..	..	..	..	..	..	..	..	+	
Sperosoma Grimaldi Koehler	600—1250	..	..	..	..	..	..	..	..	+	..	+	..	..	
Aspidodiadema Jacobyi A. Ag.	95—340	..	..	..	..	..	..	(+)	..	..	..	..	+	..	
— tonsum A. Ag.	100—1700	..	..	..	..	..	..	..	..	..	..	..	..	+	Also Indo-pacific.
Dermatodiadema antillarum (A. Ag.)	420—1640	..	..	..	..	..	..	..	..	..	..	+	+	+	
Diadema antillarum Phil.	0—115	..	..	..	..	..	+	+	..	..	..	..	(+)	..	
Centrostephanus longispinus (Phil.)	Littoral	..	..	..	+	+	..	..	..	..	..	..	..	..	
Hemipedina cubensis A. Ag.	140—270	..	..	..	..	..	..	..	..	..	..	..	+	..	
Arbacia punctulata (Lmk.)	0—170	..	..	..	..	..	..	+	..	..	..	..	+	..	
— pustulosa (Leske)	Littoral	..	..	..	+	+	+	+	..	..	..	..	..	..	
Podocidaris scutata A. Ag.	580	..	..	..	..	..	..	..	..	..	..	..	..	+	
— sculpta A. Ag.	140—400	..	..	..	..	..	..	..	..	..	..	..	+	..	
Coelopleurus floridanus A. Ag.	50—1325	..	..	..	..	..	..	+	..	..	..	..	+	+	Also off South Africa.
Salenia goësiana Lov.	180	..	..	..	..	..	..	..	..	..	..	..	+	..	
— Pattersoni A. Ag.	50—450	..	..	..	..	..	..	+	..	..	..	..	+	..	Also off South Africa and in the Sulu Sea.
— hastigera A. Ag.	100—1850	..	..	..	..	..	..	..	..	+	..	+	..	+	Also at the Philippines.
— varispina A. Ag.	270—1675	..	..	..	..	..	..	..	..	..	..	..	+	+	
Trigonocidaris albida A. Ag.	40—450	..	..	..	..	..	..	+	+	..	+	..	+	..	
Genocidaris maculata A. Ag.	25—600	..	..	..	+	+	+	+	..	..	..	+	+	..	
Hypsiechinus coronatus Mrtsn.	450—800	..	..	..	..	..	..	..	+	+	..	..	..	..	

Name	Range in depth (fathoms)	Arctic region: Littoral	Arctic region: Abyssal	European boreal region	Mediterranean region: Mediterranean	Mediterranean region: West African	West African tropical region	East American littoral region	European Atlantic region: Archibenthal	European Atlantic region: Abyssal	West African Atlantic region: Archibenthal	West African Atlantic region: Abyssal	East American Atlantic region: Archibenthal	East American Atlantic region: Abyssal	
Parechinus miliaris (Müll.)	0—50	..	..	+	(?)	+	..	..	..	..	..	..	..	..	
— microtuberculatus (Blv.)	2—40	..	..	..	+	+	+	..	..	..	..	..	..	..	
Echinus esculentus L.	0—690	..	..	+	..	..	..	..	(+)	(+)	..	..	..	..	
— acutus Lmk.	20—700	..	..	+	+	+	..	..	+	+	..	..	..	..	
— melo Lmk.	30—600	..	..	(+)	+	+	..	..	..	..	..	..	..	..	
— elegans Düb. Kor.	50—950	..	..	+	..	..	..	..	+	+	..	..	+	+	
— tenuispinus (Norm.)	90	..	..	+	..	..	..	..	..	..	..	..	..	..	
— gracilis A. Ag.	75—250	..	..	..	..	..	..	+	..	..	..	..	+	..	
— Alexandri Dan. Kor.	420—1350	..	(+)	..	..	..	..	..	+	+	..	+	..	+	
— affinis Mrtsn.	420—1120	..	..	..	..	..	..	..	+	+	..	+	..	+	
— atlanticus Mrtsn.	425	..	..	..	..	..	..	..	..	..	+[1]	..	..	..	[1] Only from Ascension.
Paracentrotus lividus (Lmk.)	0—20	..	..	(+)	+	+	..	..	..	..	..	..	..	..	
— Gaimardi (Blv.)	Littoral	..	..	..	..	..	..	+	..	..	..	..	..	..	
Strongylocentrotus dröbachiensis (O. F. M.)	0—640	+	..	+	..	..	..	..	(+)	(+)	..	..	(+)	(+)	Also in the North Pacific.
Sphærechinus granularis (Lmk.)	0—400	..	..	(+)	+	+	+	..	(+)	..	..	..	..	..	
— roseus Russo	15—50	..	..	..	+	..	..	..	..	..	..	..	..	..	
Psammechinus variegatus (Lmk.)	0—300	..	..	..	..	..	..	+	..	..	..	..	+	..	
Tripneustes esculentus (Leske)	0—450	..	..	..	..	..	+	+	..	..	..	..	+	..	
— gratilla (Leske)	0—15	..	..	..	..	..	+[2]	..	..	..	..	..	..	..	[2] Only from Ascension, otherwise Indo-pacific.
Echinometra lucunter (L.)	0—250	..	..	..	..	..	+	+	..	..	..	..	+	..	
— viridis A. Ag.	0—7	..	..	..	..	..	..	+	..	..	..	..	..	..	
Heterocentrotus mamillatus (Klein)	Littoral	..	..	..	?	..	..	..	..	..	..	..	..	..	Only in the Eastern Mediterranean(?), otherwise Indo-pacific.
Pygastrides relictus Lov.[3]	180	..	..	..	..	..	..	..	..	..	..	..	+	..	[3] Perhaps only the young of *Conolampas Sigsbei*.
Echinocyamus pusillus (O. F. Müll.)	0—400	..	..	+	+	+	..	..	+	..	+	..	..	..	
— grandiporus Mrtsn.	100—700	..	..	..	..	..	..	..	..	..	+	+	+	+	
— macrostomus Mrtsn.	700—1100	..	..	..	..	..	..	..	..	..	..	+	..	..	
Clypeaster latissimus (Lmk.)	90—1950	..	..	..	..	..	..	+	..	..	..	..	+	+	
— Ravenellii (A. Ag.)	15—100	..	..	..	..	..	..	+	..	..	..	..	..	..	
— subdepressus (Gray)	0—1950	..	..	..	..	..	+	+	..	..	..	..	+	+	
Echinanthus rosaceus (L.)	0—120	..	..	..	..	..	..	+	..	..	..	..	+	..	
Echinarachnius parma (Lmk.)	2—890	+	..	..	..	..	..	(+)	..	..	..	..	(+)	(+)	Also in the North Pacific.
Mellita sexforis (Lmk.)	0—270	..	..	..	..	..	..	+	..	..	..	..	+	..	
— testudinata (Klein)	0—25	..	..	..	..	..	..	+	..	..	..	..	..	..	
Rotula Augusti Klein	Littoral	..	..	..	..	..	+	..	..	..	..	..	..	..	
— Rumphii Klein	Littoral	..	..	..	..	..	+	..	..	..	..	..	..	..	
Encope marginata Agass.	0—70	..	..	..	..	..	..	+	..	..	..	..	..	..	
— Michelini Agass.	0—30	..	..	..	..	..	..	+	..	..	..	..	..	..	
Echinoneus semilunaris (Lmk.)	0—80	..	..	..	..	..	..	+	..	..	..	..	..	..	
— cyclostomus Leske	Littoral	..	..	..	..	..	+	..	..	..	..	..	..	..	Only Ascension, otherwise Indo-pacific.
Neolampas rostellata A. Ag.	75—690	..	..	..	..	+	..	..	+	+	..	..	+	..	
Echinolampas depressa Gray	35—160	..	..	..	..	..	..	+	..	..	..	..	+	..	
— Hellei Val.	Littoral	..	..	..	..	..	..	..	..	..	..	..	..	..	
Conolampas Sigsbei A. Ag.	75—450	..	..	..	..	..	..	+	..	..	..	..	+	..	
Rhyncopygus caribbæarum (Lmk.)	2—105	..	..	..	..	..	..	+	..	..	..	..	(+)	..	
Urechinus naresianus A. Ag.	420—1715	..	..	..	..	..	..	..	+	+	..	..	+	+	Also off South Africa.
Plexechinus hirsutus Mrtsn.	450—1300	..	..	..	..	..	..	..	+	+	..	..	..	..	

Name	Range in depth (fathoms)	Arctic region: Littoral	Arctic region: Abyssal	European boreal region	Mediterranean region: Mediterranean	Mediterranean region: West African	West African tropical region	East American littoral region	European Atlantic region: Archibenthal	European Atlantic region: Abyssal	West African Atlantic region: Archibenthal	West African Atlantic region: Abyssal	East American Atlantic region: Archibenthal	East American Atlantic region: Abyssal	
Calymne relicta W. Th.	620—2650	..	..	..	..	..	..	..	..	..	..	+	..	..	
Cystechinus clypeatus A. Ag.	1900—1915	..	..	..	..	..	..	..	..	..	..	+	..	..	
Pourtalesia miranda A. Ag.	350	..	..	..	..	..	..	..	..	..	..	..	+	..	
— Jeffreysi W. Th.	125—1300	..	+	..	..	..	..	..	..	..	..	..	..	..	
— Wandeli Mrtsn.	845—1715	..	..	..	..	..	..	..	..	+	..	..	..	+	
— (Echinosigra) phiale W. Th.	845—1975	..	..	..	..	..	..	..	..	+	..	..	..	..	Also off South Africa
— — paradoxa Mrtsn.	845—910	..	..	..	..	..	..	..	..	+	..	..	..	..	
Aëropsis rostrata (W. Th.)	1240—1750	..	..	..	..	..	..	..	..	..	..	..	..	+	
Aceste bellidifera W. Th.	620—1500	..	..	..	..	..	..	..	..	..	..	+	..	+	
Palæotropus Josephinæ Lov.	80—250	..	..	..	..	..	..	+	..	..	..	..	+	..	
— Thomsoni A. Ag.	235	..	..	..	..	..	..	..	..	..	..	..	+	..	
— Hirondellei Koehler	925	..	..	..	..	..	..	..	..	..	..	+	..	..	
Peripatagus cinctus Koehler	550	..	..	..	..	..	..	..	..	..	..	+	..	..	
Homolampas fragilis A. Ag.	300—1920	..	..	..	..	..	..	..	..	..	..	+	+	+	
Palæopneustes cristatus A. Ag.	55—450	..	..	..	..	..	..	+	..	..	..	..	+	..	
— hystrix A. Ag.	20—210	..	..	..	..	..	..	+	..	..	..	..	+	..	
Linopneustes longispinus A. Ag.	40—300	..	..	..	..	..	..	+	..	..	..	..	+	..	
Palæobrissus Hilgardi A. Ag.	80—185	..	..	..	..	..	..	+	..	..	..	..	+	..	
Hemiaster expergitus Lov.	220—1700	..	..	(+)	..	..	..	..	+	+	..	+	+[1]	+[1]	[1] *Hemiaster Mentzi.*
Agassizia excentrica A. Ag.	35—390	..	..	..	..	..	..	+	..	..	..	..	+	..	
Periaster limicola A. Ag.	70—140	..	..	..	..	..	..	+	..	..	..	..	+	..	
Brisaster fragilis (Düb. Kor.)	35—700	..	..	+	..	..	..	+	+	+	..	..	+	+	
Schizaster canaliferus (Lmk.)	20—35	..	..	..	+	..	..	..	..	..	..	..	..	..	
— orbignyanus A. Ag.	65—1505	..	..	..	..	..	..	+	..	..	..	..	+	+	
— Edwardsi Cotteau	Littoral	..	..	..	..	..	+	..	..	..	..	..	..	..	
Moira atropos (Lmk.)	0—80	..	..	..	..	..	..	+	..	..	..	..	..	..	
Spatangus purpureus O. F. M.	5—460	..	..	+	+	..	..	..	+	..	+	..	..	..	
— Raschi Lov.	100-500 (800)	..	(+)	+	..	..	..	..	+	..	+	..	..	..	
Macropneustes spatangoides A. Ag.	80—375	..	..	..	..	..	..	+	..	..	..	..	+	..	
Echinocardium flavescens (O. F. M.)	5—150	..	..	+	+	+	..	(?)	+	..	..	..	..	..	
— intermedium Mrtsn.	Littoral	..	..	..	+	..	..	..	..	..	..	..	..	..	
— pennatifidum Norm.	5—150	..	..	+	..	..	..	(?)	..	..	..	..	..	..	
— cordatum (Penn.)	0—85	..	..	+	+	+	..	+	..	..	..	..	..	..	Probably cosmopolitan.
— mediterraneum Forb.	2—20	..	..	(+)	+	..	..	..	..	..	..	..	..	..	
Brissus unicolor Klein	0—130	..	..	..	+	+	+	+	..	..	..	..	+	..	
— Damesi A. Ag.	350—450	..	..	..	..	..	..	..	..	..	+	..	+	..	
Rhabdobrissus Jullieni Cott.	10	..	..	..	..	..	+	..	..	..	..	..	..	..	
Metalia pectoralis (Lmk.)	0—155	..	..	..	..	..	..	+	..	..	..	..	+	..	
— Costæ Gasco	50—75	..	..	..	+	..	..	..	..	..	..	..	..	..	
— africana Verr.	Littoral	..	..	..	..	..	+	..	..	..	..	..	..	..	
Meoma ventricosa (Lmk.)	0—240	..	..	..	..	..	+	+	..	..	..	..	+	..	
Rhinobrissus micrasterioides A. Ag.	175—240	..	..	..	..	..	..	..	..	..	..	..	+	..	
Brissopsis lyrifera (Forb.)	5—210	..	..	+	+	+	..	..	+	+	..	..	..	..	
— alta Mrtsn.	120—170	..	..	..	..	..	..	..	..	..	..	..	+	..	
— atlantica Mrtsn.	68—1434	..	..	..	..	..	..	+	..	..	..	?	+	+	
— elongata Mrtsn.	—25	..	..	..	..	..	..	+	..	..	..	..	..	..	

Index to Parts I—II.

Plate I.

Fig. 1. *Spatangus altus* Ltk. Type-specimen, actinal side. $^1/_1$.

— 2. — — — abactinal side. $^1/_1$.

— 3. — — — side view. $^1/_1$.

— 4. — *Raschi*, the abactinal side. $^1/_1$.

— 5. — — - actinal — $^1/_1$.

— 6. *Brisaster (Schizaster) fragilis*, abactinal side. (Specimen from the «Ingolf»-St. 35.) $^1/_1$.

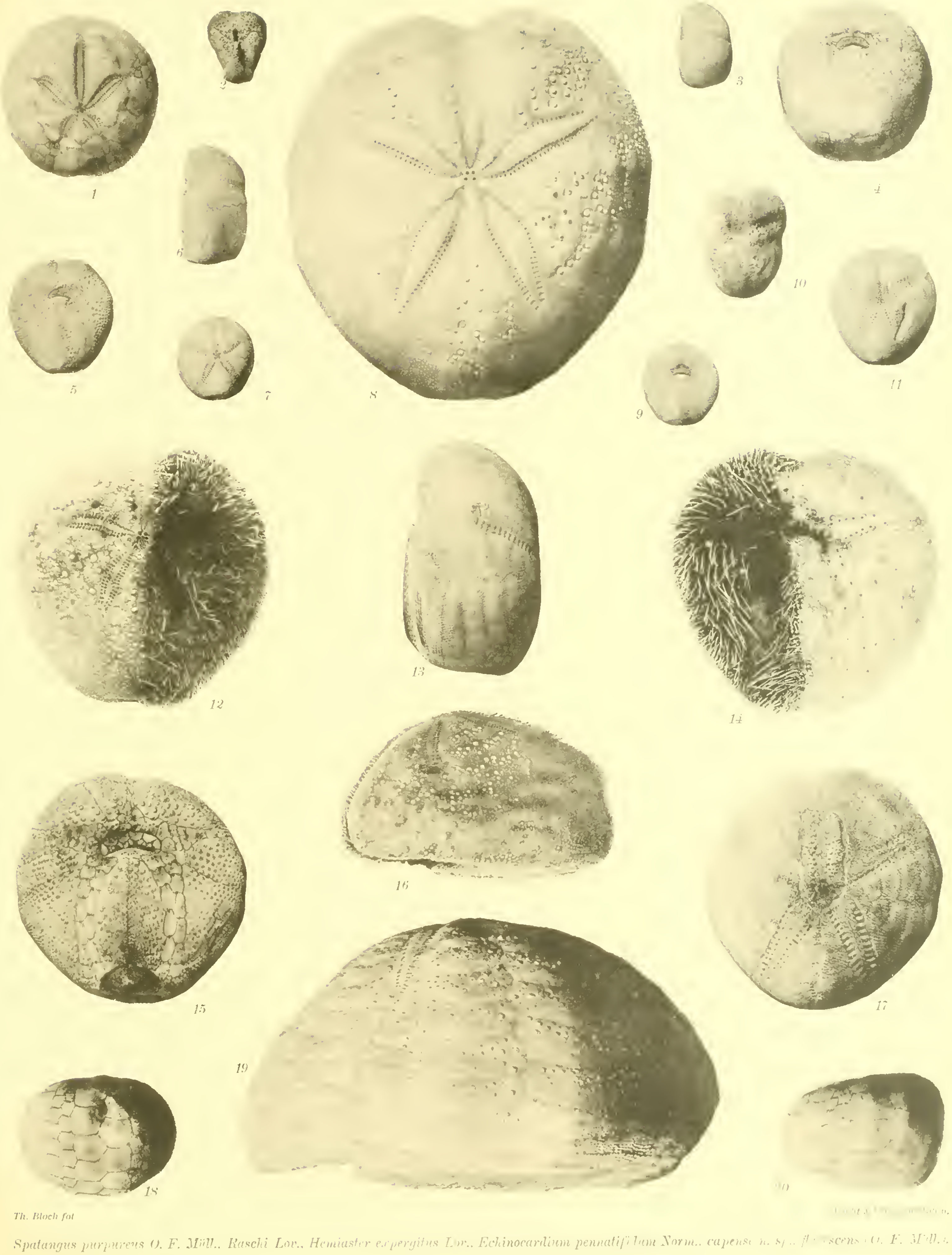
— 7. — — — abactinal side. (Specimen from Bergen.) $^1/_1$.

1—3 Spatangus altus Ltk. 4—5 Spatangus Raschi Lor. 6—7 Brisaster (Schizaster) fragilis (Düb. Kor.).

Plate II.

8 *Spatangus purpureus.* 19 *Spat. Raschi.* 12, 14, 16 Hybrid of *Spat. purpureus* and *Raschi.* 1, 4, 18, 20 *Hemiaster expergitus.* 3, 7, 9, 13, 15, 17 *Echinocardium pennatifidum.* 5, 6, 11 *Ech. capense.* 2, 10 *Ech. flavescens.*

Fig. 1. *Hemiaster expergitus,* abactinal side. $^1/_1$.
— 2. *Echinocardium flavescens,* abnormal specimen; actinal side. $^1/_1$.
— 3. — *pennatifidum,* young specimen; side view. $^1/_1$.
— 4. *Hemiaster expergitus,* actinal side. $^1/_1$.
— 5. *Echinocardium capense,* actinal side. $^1/_1$.
— 6. — — side view. $^1/_1$.
— 7. — *pennatifidum,* young specimen; abactinal side. $^1/_1$.
— 8. *Spatangus purpureus,* abactinal side. $^1/_1$.
— 9. *Echinocardium pennatifidum,* young specimen; actinal side. $^1/_1$.
— 10. — *flavescens,* abnormal specimen; abactinal side. $^1/_1$.
— 11. — *capense,* abactinal side. $^1/_1$.
— 12. *Spatangus purpureus,* hybrid; abactinal side. $^1/_1$.
— 13. *Echinocardium pennatifidum,* side view. $^1/_1$.
— 14. *Spatangus purpureus,* hybrid; actinal side. $^1/_1$.
— 15. *Echinocardium pennatifidum,* actinal side. $^1/_1$.
— 16. *Spatangus purpureus,* hybrid; side view. $^1/_1$.
— 17. *Echinocardium pennatifidum,* abactinal side. $^1/_1$.
— 18. *Hemiaster expergitus,* end view. $^1/_1$.
— 19. *Spatangus Raschi,* side view. $^1/_1$.
— 20. *Hemiaster expergitus,* side view. $^1/_1$.



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Spatangus purpureus O. F. Müll., Raschi Lov., Hemiaster expergitus Lov., Echinocardium pennatifidum Norm., capense n. sp., flavescens (O. F. Müll.).

Plate III.

2, 3, 7, 11, 12, 18, 20—23 *Brissopsis lyrifera.* 5, 8, 9, 13, 16 *Br. alta.* 6. 10, 17 *Br. atlantica.* 1 *Brissopsis* sp.
4, 14, 15, 19 *Br. elongata.*

Fig.	1.	*Brissopsis*	sp. («Talisman»), abactinal side. 1/1.
—	2.	—	*lyrifera,* abnormal specimen, actinal side. 1/1.
—	3.	—	— («Thor»), abactinal side. 1/1.
—	4.	—	*elongata,* young specimen, side view. 1/1.
—	5.	—	*alta* («Blake», St. 49), abactinal side. 1/1.
—	6.	—	*atlantica* («Albatross», St. 2378), abactinal side. 1/1.
—	7.	—	*lyrifera,* abnormal specimen, actinal side. 1/1.
—	8.	—	*alta* («Blake», St. 49), actinal side. 1/1.
—	9.	—	— («Albatross», St. 2401), actinal side. 1/1.
—	10.	—	*atlantica* («Albatross», St. 2378), actinal side. 1/1.
—	11.	—	*lyrifera,* abnormal specimen, actinal side. 1/1.
—	12.	—	— (Mediterranean), abactinal side. 1/1.
—	13.	—	*alta* («Albatross», St. 2401), abactinal side. 1/1.
—	14.	—	*elongata,* side view. 1/1.
—	15.	—	— abactinal side. 1/1.
—	16.	—	*alta* («Albatross», St. 2401), side view. 1/1.
—	17.	—	*atlantica* («Albatross», St. 2748); abactinal side. 1/1.
—	18.	—	*lyrifera* (Bergen), side view. 1/1.
—	19.	—	*elongata,* actinal side. 1/1.
—	20.	—	*lyrifera* (Mediterranean), actinal side. 1/1.
—	21.	—	— (Bergen), abactinal side. 1/1.
—	22.	—	— — actinal side. 1/1.
—	23.	—	— (Mediterranean), abactinal side. 1/1.

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Brissopsis lyrifera (Forb.), alta n. sp., atlantica n. sp., elongata n. sp.

Plate IV.

2, 3, 9, 14—17 *Brissopsis lyrifera.* 1, 4, 13, 18 *Br. elongata.* 5, 19 *Brissopsis* sp. 6—8, 10—12 *Hemiaster expergitus.*

Fig. 1. *Brissopsis elongata,* actinal side. $^1/_1$.
— 2. — *lyrifera* (Mediterranean), abactinal side. $^1/_1$.
— 3. — — — actinal side. $^1/_1$.
— 4. — *elongata,* abactinal side. $^1/_1$.
— 5. — sp. («Talisman»), side view. $^1/_1$.
— 6. *Hemiaster expergitus,* abactinal side. $^1/_1$.
— 7. — — side view. $^{3.5}/_1$.
— 8. — — actinal side. $^1/_1$.
— 9. *Brissopsis lyrifera* (Mediterranean), side view. $^1/_1$.
— 10. *Hemiaster expergitus,* abactinal side. $^{3.5}/_1$.
— 11. — — side view. $^1/_1$.
— 12. — — actinal side. $^{3.5}/_1$.
— 13. *Brissopsis elongata,* side view. $^1/_1$.
— 14. — *lyrifera* (Kattegat), side view. $^1/_1$.
— 15. — — (Kattegat), abactinal side. $^1/_1$.
— 16. — — (Mediterranean), side view. $^1/_1$.
— 17. — — (Kattegat), actinal side. $^1/_1$.
— 18. — *elongata,* subanal fasciole and adjoining parts of the test. $^2/_1$.
— 19. — sp. («Talisman»), actinal side. $^1/_1$.

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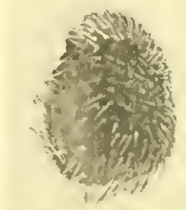

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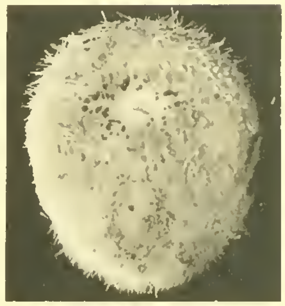

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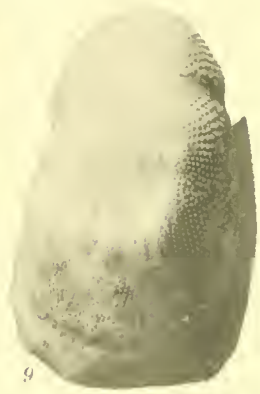

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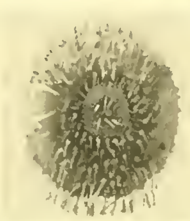

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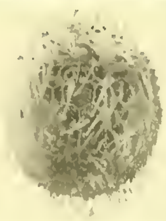

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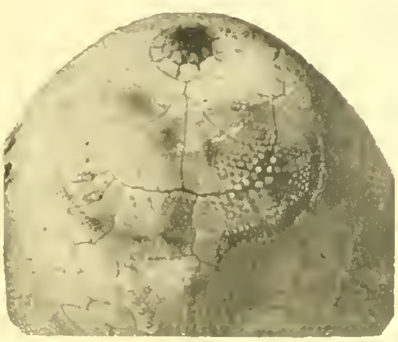

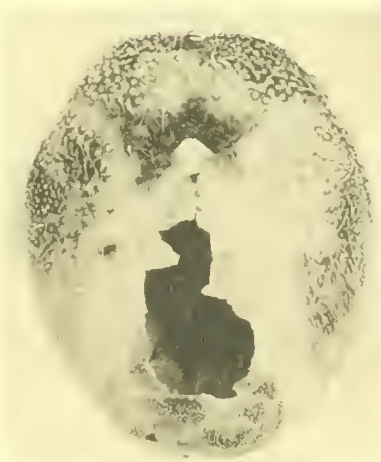

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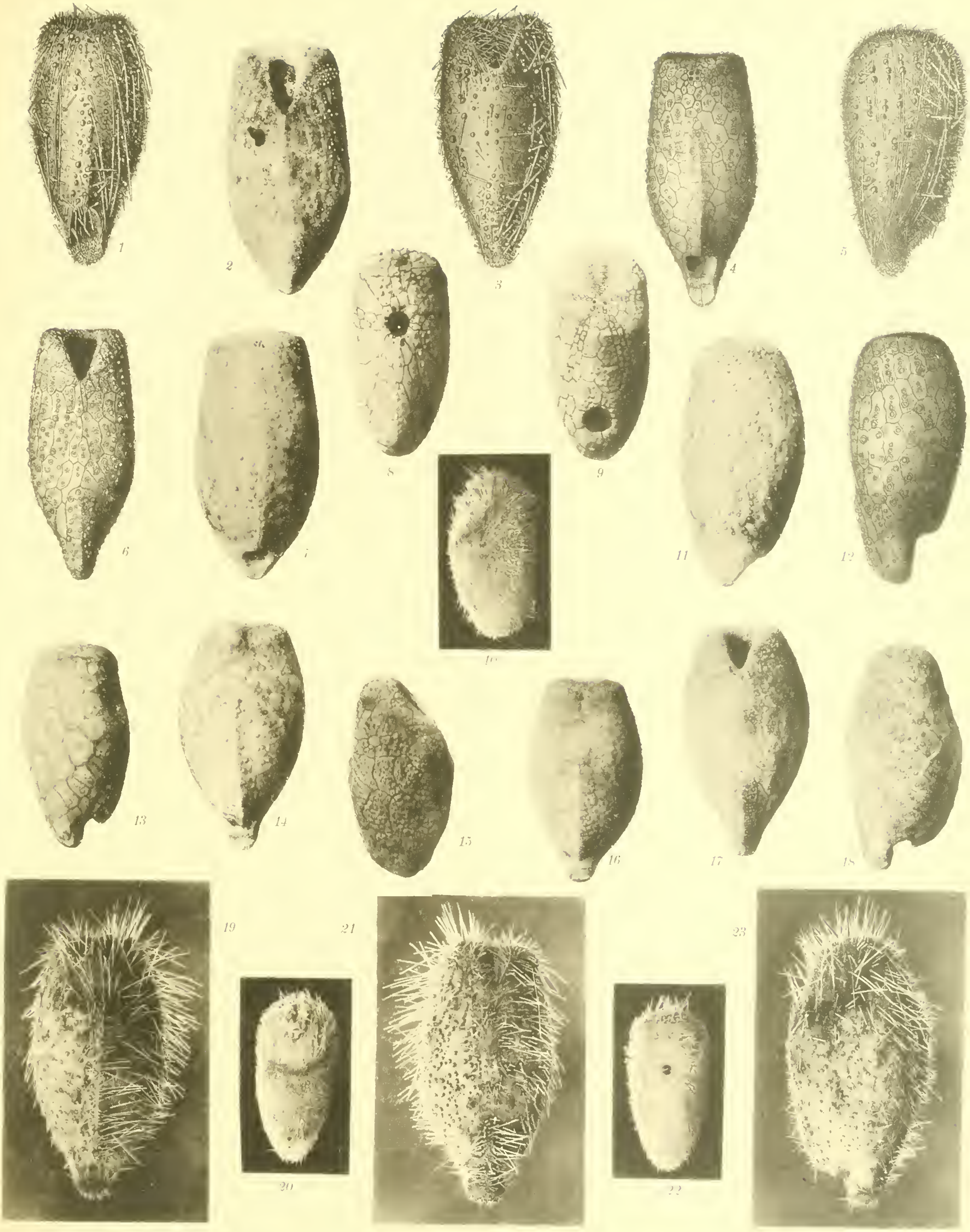
Brissopsis lyrifera (Forb.), elongata n. sp., Brissopsis sp. Hemiaster expergitus Lor.

Plate V.

Fig. 1. *Pourtalesia Wandeli,* abactinal side. $^2/_1$.
— 2. — — actinal side. (Not fully to be relied upon as regards the limits of the plates.) $^1/_1$.
— 3. — — actinal side. $^2/_1$.
— 4. — — abactinal side. $^{1 \cdot 8}/_1$. (The upper plates of ambulacra I and V and of interambulacrum 5 not quite correctly made out here. Comp. Pl. VIII. Fig. 2.)
— 5. — — side view. $^2/_1$.
— 6. — — actinal side. $^{1 \cdot 8}/_1$.
— 7. — — abactinal side. $^1/_1$.
— 8. *Aëropsis rostrata,* actinal side. $^2/_1$.
— 9. — — abactinal side. $^2/_1$.
— 10. — — side view. $^1/_1$.
— 11. *Pourtalesia Wandeli,* side view. $^1/_1$.
— 12. — — — — $^{1 \cdot 8}/_1$.
— 13. — *Jeffreysi,* — — $^1/_1$.
— 14. — — abactinal side. $^1/_1$.
— 15. *Aëropsis rostrata,* side view. $^2/_1$.
— 16. *Pourtalesia Jeffreysi,* abactinal side. $^1/_1$.
— 17 — — actinal side. $^1/_1$.
— 18. — — side view. $^1/_1$.
— 19. — — abactinal side. $^1/_1$
— 20. *Aëropsis rostrata,* abactinal side. $^1/_1$.
— 21. *Pourtalesia Jeffreysi,* actinal side. $^1/_1$.
— 22. *Aëropsis rostrata,* actinal side. $^1/_1$.
— 23. *Pourtalesia Jeffreysi,* side view. $^1/_1$.



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1—7, 11—12 *Pourtalesia Wandeli* Mrtsn., 13—14, 16—19, 21, 23 *Pourtalesia Jeffreysi* W. Th., 8—10, 15, 20, 22 *Aeropsis rostrata* (W. Th.).

Plate VI.

Fig. 1. *Echinosigra (Pourtalesia) phiale*, abactinal side. $^{7}/_{1}$. (For the apical system and adjoining plates, comp. Pl. VII. Fig. 7.)
— 2. — — — side view. $^{7}/_{1}$.
— 3. — — *paradoxa*, actinal side. $^{1.8}/_{1}$.
— 4. — — — side view. $^{1.8}/_{1}$.
— 5. — — — abactinal side. $^{1.8}/_{1}$.
— 6. — — — side view. $^{1.8}/_{1}$.
— 7. — — *phiale*, actinal side. $^{7}/_{1}$.
— 8. *Plexechinus hirsutus*, end view. $^{2}/_{1}$.
— 9. — — actinal side. $^{2}/_{1}$.
— 10. *Urechinus naresianus*, actinal side. $^{1.5}/_{1}$.
— 11. — — — — $^{1.5}/_{1}$.
— 12. *Plexechinus hirsutus*, abactinal side. $^{2}/_{1}$.
— 13. — — — — $^{2}/_{1}$.
— 14. — — side view. $^{2}/_{1}$.
— 15. — — — — $^{2}/_{1}$.
— 16. — — actinal side. $^{1.5}/_{1}$. (Not the same specimen as Figs. 12 and 15).
— 17. *Echinosigra (Pourtalesia) paradoxa*, abactinal side. $^{6}/_{1}$. (For the apical system and adjoining plates, comp. Text-fig. 14, p. 75.)
— 18. — — — abactinal side. $^{1.8}/_{1}$.
— 19. — — — side view. $^{6}/_{1}$.
— 20. — — — actinal side. $^{1.8}/_{1}$.
— 21. — — — — — $^{6}/_{1}$.

1-2, 7. Pourtalesia phiale W. Th., 3-6, 17-21. Pourtalesia paradoxa Mrtsn., 8-9, 12-16. Plexechinus hirsutus Mrtsn., 10-11. Urechinus naresianus A. Ag.

Plate VII.

Fig. 1. *Echinosigra (Pourtalesia) phiale,* the sub-oral region of the test. $^{13}/_{1}$. Not the same specimen as that represented in Pl. VI. Figs. 1—2, 7. The limitation of the ambulacral plates IV. a. 1. b. 1 could not be made out quite distinctly, but it is certain that a. 1 was larger than b. 1.

— 2. *Pourtalesia Jeffreysi,* opened from the side. The loop of the intestine has been bent backwards in order to show the course of the stone canal. g. Genital organs. $^{1}/_{1}$.

— 3. *Pourtalesia Jeffreysi,* part of the stone canal with the axial organ. $^{16}/_{1}$.

— 4. — — opened from the side, showing the intestine in its natural position; g. the genital organs of the right side, bent outwards. $^{1}/_{1}$.

— 5. *Echinosigra (Pourtalesia) paradoxa,* the suboral region of the test. $^{13}/_{1}$.

— 6. *Urechinus narcsianus,* female genital organs. $^{2}/_{1}$.

— 7. *Echinosigra (Pourtalesia) phiale,* apical system and adjoining parts of the test. $^{21}/_{1}$.

— 8. *Urechinus narcsianus,* opened from the side. The loop of the intestine has been bent backwards in order to show the course of the stone canal. $^{1}/_{1}$.

— 9. *Plexechinus hirsutus,* apical region of the test. From a specimen 6^{mm} in diameter. No pores to be distinguished in the ocular or ambulacral plates. $^{13}/_{1}$.

— 10. *Echinosigra (Pourtalesia) paradoxa,* female genital organs, g, and stone canal, s. $^{10}/_{1}$.

— 11. *Pourtalesia Jeffreysi,* female genital organs. $^{2}/_{1}$.

— 12. — — male genital organs. On the stone canal (s) is seen a little swelling, the axial organ. $^{2}/_{1}$.

— 13. *Urechinus narcsianus,* opened from the abactinal side; the intestine is represented in its natural position. $^{1}/_{1}$.

— 14. *Pourtalesia Jeffreysi,* opened from the actinal side; the intestine is represented in its natural position. The two siphones are distinct. $^{1}/_{1}$.

— 15. *Urechinus narcsianus,* opened from the abactinal side. The intestine bent aside in order to show the two siphones. $^{1}/_{1}$.

— 16. *Echinosigra (Pourtalesia) paradoxa,* anterior end of the test, opened from the side. g. Male genital organs, s. stone canal, œ. oesophagus. $^{6}/_{1}$.

— 17. *Spatagocystis Challengeri,* tube foot. $^{125}/_{1}$.

— 18. *Echinosigra (Pourtalesia) paradoxa,* tube foot. $^{125}/_{1}$.

— 19. *Plexechinus hirsutus,* actinostome and surrounding parts of the test. The plates of the actinostome have been drawn from another specimen; the specimen, from which the plates of the test were drawn, had the buccal membrane bent inwards, so that its plates could not be made out. $^{8}/_{1}$.

— 20. *Plexechinus hirsutus,* apical plate and part of the odd anterior ambulacrum. In the apical plate a small madreporic pore and two larger genital pores are seen. $^{15}/_{1}$.

— 21. *Pourtalesia Jeffreysi,* tube-foot. $^{175}/_{1}$.

1, 7. Pourtalesia phiale W. Th., 2-4, 11-12, 14, 21. Pourt. Jeffreysi W. Th. 5, 10, 16, 18. Pourt. paradoxa Mrtsn., 6, 8, 13, 15. Urechinus naresianus A. Ag., 9, 19-20. Plexechinus hirsutus Mrtsn., 17. Spatagocystis Challengeri A. Ag.

Plate VIII.

Fig. 1. *Pourtalesia Wandeli,* sub-oral region of the test. $^{9}/_{1}$.

— 2. — — apical system and adjoining parts of the test. The pores of the anterior paired ambulacra were rather indistinct and are perhaps not quite correctly placed.

— 3. *Pourtalesia Wandeli,* sub-oral region of the test. $^{11}/_{1}$.

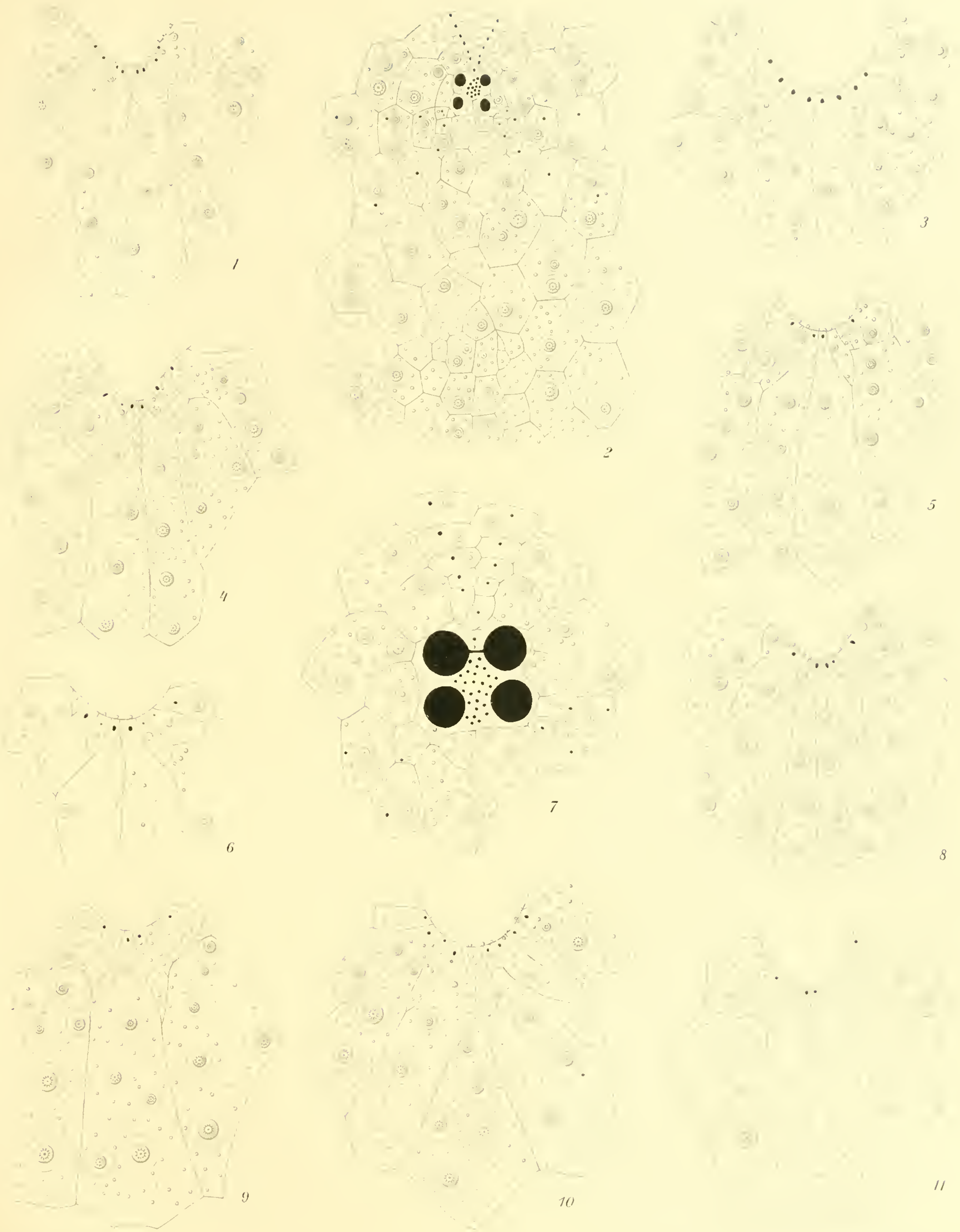
— 4. — *Jeffreysi,* — — - — — $^{9}/_{1}$.

— 5. — — — — - — — $^{10}/_{1}$.

— 6. — — — — - — — $^{12}/_{1}$.

— 7. — *Wandeli,* apical system and adjoining parts of the test. $^{13}/_{1}$.

— 8—11. — *Jeffreysi,* sub-oral region of the test. $^{9}/_{1}$. In the figure 8 the small interambulacral plate 1. 1 is not quite certain.



1–3, 7. Pourtalesia Wandeli Mrtsn., 4–6, 8–11. Pourtalesia Jeffreysi W. Th.

Plate IX.

4, 8, 9, 15, 16, 18, 21, 26, 30—39 *Urechinus naresianus.* 2, 6, 11, 12, 25, 27 *U. giganteus.* 3, 5, 17, 24 *U. Wyvillii.* 19 *U. Loveni.* 1, 7, 10, 13, 14, 20, 22, 23, 28, 29 *Cystechinus clypeatus.*

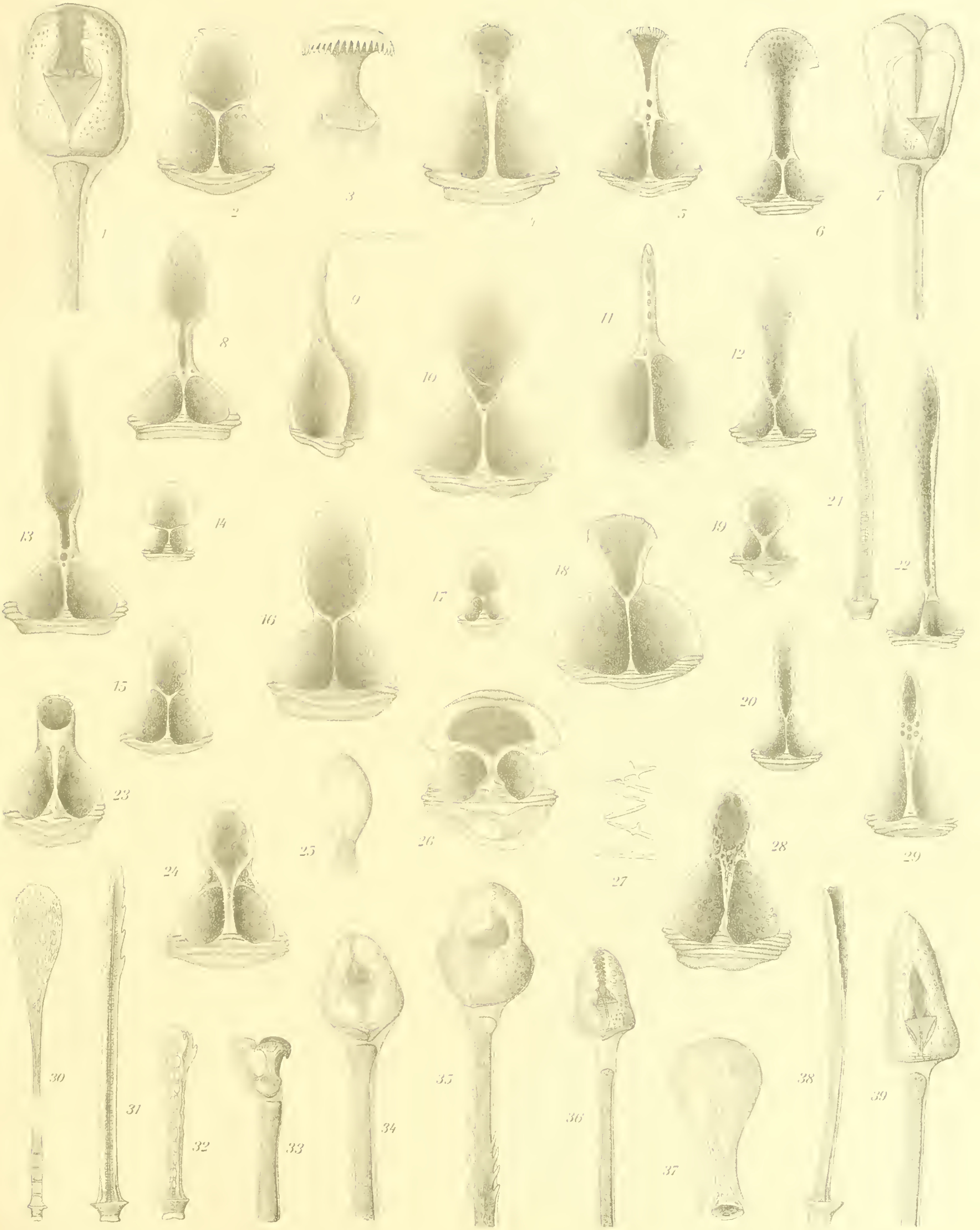
Fig. 1. *Cystechinus clypeatus* («Challenger» St. 133), globiferous pedicellaria. $^{70}/_{1}$.
— 2. *Urechinus giganteus*, valve of globiferous pedicellaria, side view. (Comp. Fig. 6). $^{125}/_{1}$.
— 3. — *Wyvillii*, — - — — — — $^{125}/_{1}$.
— 4. — *naresianus* («Challenger» St. 302), valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 5. — *Wyvillii*, valve of globiferous pedicellaria, from the inside. $^{125}/_{1}$.
— 6. — *giganteus*, — - — — — - — (Comp. Fig. 2). $^{125}/_{1}$.
— 7. *Cystechinus clypeatus* («Challenger» St. 205), ophicephalous pedicellaria. $^{37}/_{1}$.
— 8. *Urechinus naresianus*, spicule from tube-foot. $^{125}/_{1}$.
— 9. — — valve of globiferous pedicellaria, from the inside. $^{125}/_{1}$.
— 10. *Cystechinus clypeatus* («Challenger» St. 205), valve of ophicephalous pedicellaria. $^{50}/_{1}$.
— 11. *Urechinus giganteus*, valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 12. — — — - triphyllous — $^{125}/_{1}$.
— 13. *Cystechinus clypeatus* («Challenger» St. 334), valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 14. — — (— - 205), — - tridentate — $^{70}/_{1}$.
— 15. *Urechinus naresianus*, valve of tridentate pedicellaria, coarse form. $^{70}/_{1}$.
— 16. — — — - — — $^{70}/_{1}$.
— 17. — *Wyvillii*, — - — — $^{62}/_{1}$.
— 18. — *naresianus*, — - ophicephalous — $^{125}/_{1}$.
— 19. — *Loveni*, — - tridentate — $^{50}/_{1}$.
— 20. *Cystechinus clypeatus* («Challenger» St. 334), valve of tridentate pedicellaria. $^{70}/_{1}$.
— 21. *Urechinus naresianus* («Challenger» St. 302), valve of coarse tridentate pedicellaria. $^{70}/_{1}$.
— 22. *Cystechinus clypeatus* («Challenger» St. 205), valve of ophicephalous (?) pedicellaria. $^{70}/_{1}$.
— 23. — — (— - 133), — - short tridentate — $^{70}/_{1}$.
— 24. *Urechinus Wyvillii*, valve of globiferous pedicellaria. $^{125}/_{1}$.
— 25. — *giganteus*, — - large tridentate — $^{70}/_{1}$.
— 26. — *naresianus*, — - triphyllous — $^{125}/_{1}$.
— 27. — *giganteus*, — - small tridentate — $^{70}/_{1}$.
— 28. *Cystechinus clypeatus* («Challenger» St. 205), valve of small tridentate pedicellaria. $^{70}/_{1}$.
— 29. — — (— - 334), — - triphyllous — $^{125}/_{1}$.
— 30. *Urechinus naresianus*, primary spine from the abactinal side. $^{37}/_{1}$.
— 31. — — miliary — $^{70}/_{1}$.
— 32. — — tridentate pedicellaria, coarse form. $^{50}/_{1}$.
— 33. — — — — slender — $^{70}/_{1}$.
— 34. — — valve of tridentate pedicellaria, slender form. $^{125}/_{1}$.
— 35. — — globiferous pedicellaria. $^{70}/_{1}$.
— 36. — — valve of tridentate pedicellaria, slender form. $^{125}/_{1}$.
— 37. — — ophicephalous pedicellaria. $^{70}/_{1}$.
— 38. — — tridentate pedicellaria, slender form. $^{70}/_{1}$.
— 39. — — spine from the peristome. $^{37}/_{1}$.

Urechinus naresianus A. Ag., giganteus A. Ag., Wyvillii (A. Ag.), Loveni (A. Ag.), Cystechinus clypeatus A. Ag.

Plate X.

2, 15–17, 19, 21, 23, 25, 27, 31, 32, 34, 36–38 *Plexechinus hirsutus.* 8, 9, 11, 14, 22, 26 *Pilematechinus Rathbuni.* 1, 4, 7, 13, 24, 28, 29 *P. vesica.* 5, 6, 30 *Calymne relicta.* 39 *Echinocrepis cuneata.* 3, 12, 33 *Cystocrepis setigera.* 10, 18, 20, 35 *Spatagocystis Challengeri.*

Fig. 1. *Pilematechinus vesica,* tridentate pedicellaria (comp. Fig. 4). $^{50}/_{1}$.
— 2. *Plexechinus hirsutus,* valve of tridentate pedicellaria. $^{125}/_{1}$.
— 3. *Cystocrepis setigera,* — - ophicephalous — $^{125}/_{1}$.
— 4. *Pilematechinus vesica,* — - tridentate — (comp. Fig. 1). $^{50}/_{1}$.
— 5. *Calymne relicta,* valve of rostrate pedicellaria. $^{70}/_{1}$.
— 6. — — — - — — $^{70}/_{1}$.
— 7. *Pilematechinus vesica,* globiferous pedicellaria. $^{50}/_{1}$.
— 8. — *Rathbuni,* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 9. — — — - globiferous — side view. $^{125}/_{1}$.
— 10. *Spatagocystis Challengeri,* valve of tridentate pedicellaria. $^{50}/_{1}$.
— 11. *Pilematechinus Rathbuni,* — - globiferous — from the inside. $^{125}/^{1}$.
— 12. *Cystocrepis setigera,* valve of rostrate pedicellaria. $^{125}/_{1}$.
— 13. *Pilematechinus vesica,* — - tridentate — $^{50}/_{1}$.
— 14. — *Rathbuni,* valve of triphyllous pedicellaria. $^{125}/_{1}$.
— 15. *Plexechinus hirsutus,* valve of tridentate pedicellaria. $^{125}/_{1}$.
— 16. — — — - — — $^{125}/_{1}$.
— 17. — — — - triphyllous — $^{175}/_{1}$.
— 18. *Spatagocystis Challengeri,* valve of rostrate pedicellaria. $^{70}/_{1}$.
— 19. *Plexechinus hirsutus,* valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 20. *Spatagocystis Challengeri,* valve of small tridentate pedicellaria. $^{70}/_{1}$.
— 21. *Plexechinus hirsutus,* primary spine, side view. (Comp. Fig. 31). $^{40}/_{1}$.
— 22. *Pilematechinus Rathbuni,* valve of tridentate pedicellaria. $^{37}/_{1}$.
— 23. *Plexechinus hirsutus,* valve of globiferous pedicellaria. $^{175}/_{1}$.
— 24. *Pilematechinus vesica,* — - short tridentate pedicellaria. $^{50}/_{1}$.
— 25. *Plexechinus hirsutus,* sphæridia. $^{125}/_{1}$.
— 26. *Pilematechinus Rathbuni,* valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 27. *Plexechinus hirsutus,* spicules, represented in their relative position in the tube-foot. $^{175}/_{1}$.
— 28. *Pilematechinus vesica,* valve of buccal tridentate pedicellaria. $^{50}/_{1}$.
— 29. — — — - — — — $^{50}/_{1}$.
— 30. *Calymne relicta,* miliary spine. $^{50}/_{1}$.
— 31. *Plexechinus hirsutus,* primary spine, front view. (Comp. Fig. 21). $^{40}/_{1}$.
— 32. — — miliary — $^{125}/_{1}$.
— 33. *Cystocrepis setigera,* ophicephalous pedicellaria. $^{70}/_{1}$.
— 34. *Plexechinus hirsutus,* globiferous pedicellaria. $^{125}/_{1}$.
— 35. *Spatagocystis Challengeri,* rostrate pedicellaria. $^{50}/_{1}$.
— 36. *Plexechinus hirsutus,* tridentate pedicellaria. $^{50}/_{1}$.
— 37. — — filament of actinal tube-foot. $^{175}/_{1}$.
— 38. — — spine from the actinal plastron. $^{20}/_{1}$.
— 39. *Echinocrepis cuneata,* tridentate pedicellaria. $^{50}/_{1}$.

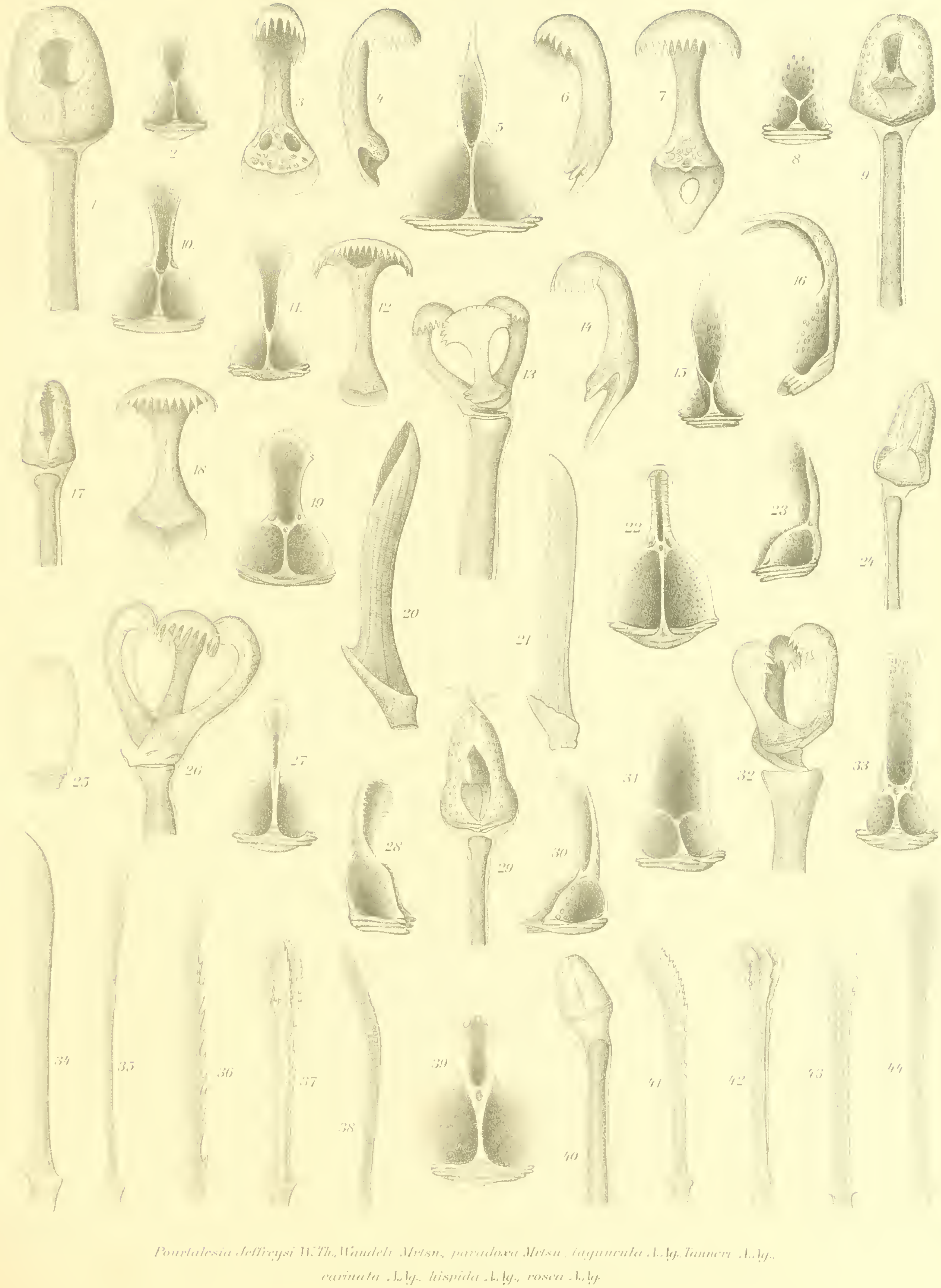


Plexechinus hirsutus Mrtsn., *Pilematechinus Rathbuni* A.Ag., *vesica* (A.Ag.), *Calymne relicta* W.Th., *Echinocrepis cuneata* A.Ag., *Cystocrepis setigera* (A.Ag.), *Spatagocystis Challengeri* A.Ag.

Plate XI.

4, 7—10, 30 *Pourtalesia Jeffreysi.* 1, 13, 14, 18—20, 23, 34—37, 40, 41 *P. Wandeli.* 2, 3, 5, 6, 17, 21, 24, 25, 27—29, 32, 42—44 *Echinosigra (Pourtalesia) paradoxa.* 12, 33 *P. laguncula.* 11 *P. Tanneri.* 31 *P. hispida.* 15, 26 *P. rosea.* 16, 22, 38, 39 *Helgocystis (Pourtalesia) carinata.*

Fig. 1. *Pourtalesia Wandeli,* rostrate pedicellaria. $^{70}/_{1}$.
— 2. *Echinosigra (Pourtalesia) paradoxa,* valve of tridentate pedicellaria, from the inside. $^{125}/_{1}$.
— 3. — — — — - ophicephalous — $^{125}/_{1}$.
— 4. *Pourtalesia Jeffreysi,* valve of ophicephalous pedicellaria, side view. $^{125}/_{1}$.
— 5. *Echinosigra (Pourtalesia) paradoxa,* valve of tridentate pedicellaria. $^{125}/_{1}$.
— 6. — — — — - ophicephalous — side view. $^{125}/_{1}$.
— 7. *Pourtalesia Jeffreysi,* valve of ophicephalous pedicellaria, from the inside. $^{125}/_{1}$.
— 8. — — — - tridentate — $^{175}/_{1}$.
— 9. — — rostrate pedicellaria. $^{50}/_{1}$.
— 10. — — valve of rostrate pedicellaria, from the inside. (Comp. Fig. 30). $^{70}/_{1}$.
— 11. — *Tanneri,* — - — — $^{70}/_{1}$.
— 12. — *laguncula,* — - ophicephalous pedicellaria. $^{125}/_{1}$.
— 13. — *Wandeli,* ophicephalous pedicellaria. $^{70}/_{1}$.
— 14. — — valve of ophicephalous pedicellaria, side view. $^{125}/_{1}$.
— 15. — *rosea.* — - tridentate — $^{125}/_{1}$.
— 16. *Helgocystis (Pourtalesia) carinata,* valve of globiferous pedicellaria, side view. (Comp. Fig. 22). $^{70}/_{1}$.
— 17. *Echinosigra (Pourtalesia) paradoxa,* rostrate pedicellaria. $^{70}/_{1}$.
— 18. *Pourtalesia Wandeli,* valve of ophicephalous pedicellaria. $^{125}/_{1}$.
— 19. — — — - rostrate — from the inside. (Comp. Fig. 23.) $^{70}/_{1}$.
— 20. — — primary spine, from the inner part of the buccal cavity. (Comp. Fig. 34). $^{30}/_{1}$.
— 21. *Echinosigra (Pourtalesia) paradoxa,* primary spine, from the inner part of the buccal cavity. $^{50}/_{1}$.
— 22. *Helgocystis (Pourtalesia) carinata,* valve of globiferous pedicellaria, from the inside. (Comp. Fig. 16). $^{70}/_{1}$.
— 23. *Pourtalesia Wandeli,* valve of rostrate pedicellariæ, side view. (Comp. Fig. 19.) $^{70}/_{1}$.
— 24. *Echinosigra (Pourtalesia) paradoxa,* tridentate pedicellaria. $^{70}/_{1}$.
— 25. — — — sphæridia. $^{125}/_{1}$.
— 26. *Pourtalesia rosea,* ophicephalous pedicellaria. $^{70}/_{1}$.
— 27. *Echinosigra (Pourtalesia) paradoxa,* valve of rostrate pedicellaria, from the inside. $^{125}/_{1}$.
— 28. — — — — - — — side view. $^{125}/_{1}$.
— 29. — — — tridentate pedicellaria. $^{70}/_{1}$.
— 30. *Pourtalesia Jeffreysi,* valve of rostrate pedicellaria, side view. (Comp. Fig. 10). $^{70}/_{1}$.
— 31. — *hispida,* — - tridentate — $^{125}/_{1}$.
— 32. *Echinosigra (Pourtalesia) paradoxa,* ophicephalous pedicellaria. $^{70}/_{1}$.
— 33. *Pourtalesia laguncula,* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 34. — *Wandeli,* primary spine, from the invagination, nearer the edge. (Comp. Fig. 20). $^{30}/_{1}$.
— 35. *Pourtalesia Wandeli,* — — from the actinal plastron. $^{18}/_{1}$.
— 36. — — the point of a primary abactinal spine. $^{30}/_{1}$.
— 37. — — miliary spine, front view. (Comp. Fig. 41). $^{125}/_{1}$.
— 38. *Helgocystis (Pourtalesia) carinata,* miliary spine. $^{40}/_{1}$.
— 39. — — — valve of rostrate pedicellaria. $^{70}/_{1}$.
— 40. *Pourtalesia Wandeli,* tridentate pedicellaria. $^{125}/_{1}$.
— 41. — — miliary spine, side view. (Comp. Fig. 37). $^{125}/_{1}$.
— 42. *Echinosigra (Pourtalesia) paradoxa,* clavula. $^{70}/_{1}$.
— 43. — — — miliary spine. $^{125}/_{1}$.
— 44. — — — primary abactinal spine. $^{35}/_{1}$.



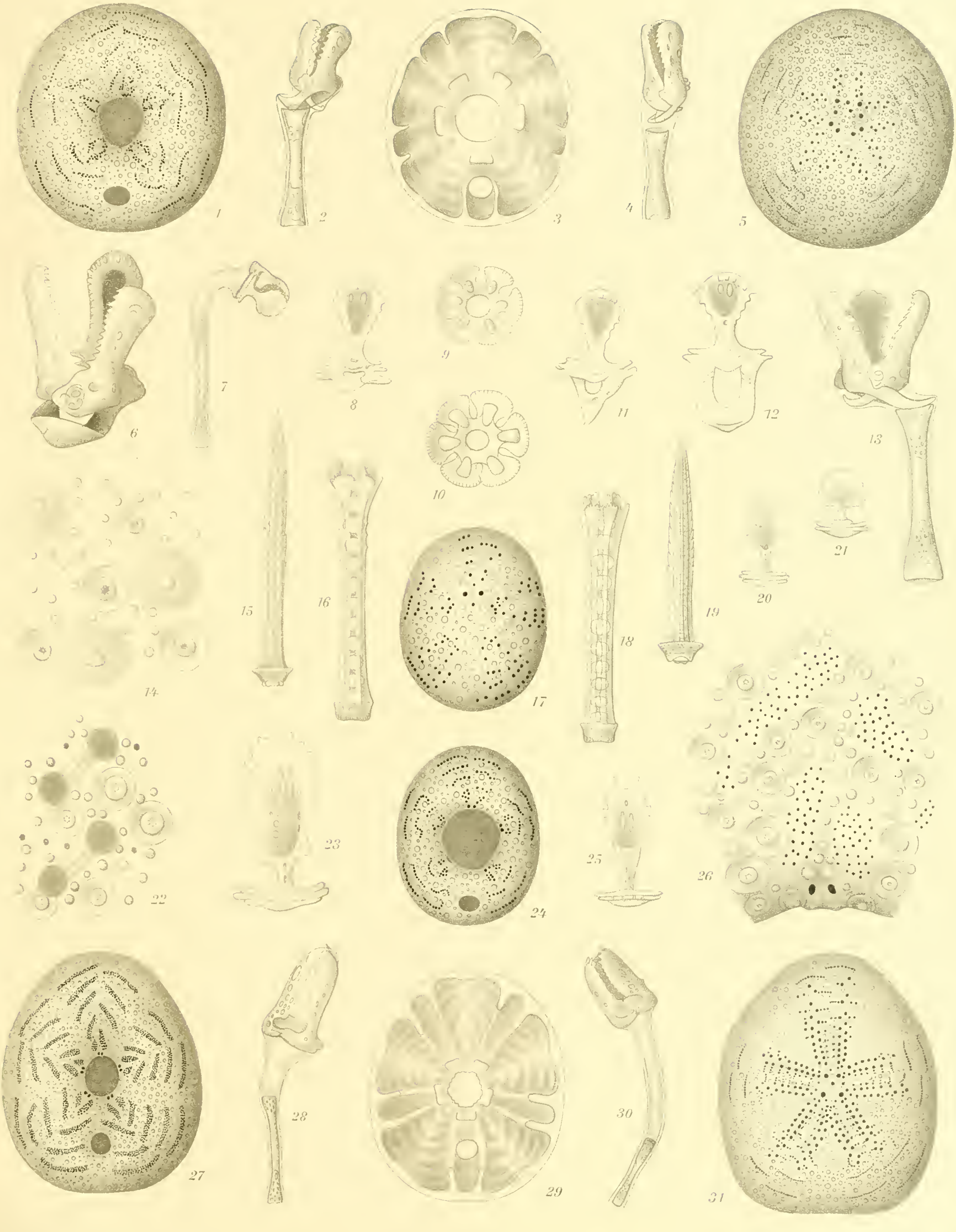
Pourtalesia Jeffreysi W. Th., Wandeli Mrtsn., paradoxa Mrtsn., laguncula A. Ag., Tanneri A. Ag., carinata A. Ag., hispida A. Ag., rosea A. Ag.

Plate XII.

4, 6, 9, 18—20, 22, 23, 26, 27, 29—31 *Echinocyamus pusillus.* 1, 3, 5, 8, 10—16, 21, 25, 28 *Ech. grandiporus.* 2, 7, 17, 24 *Ech. macrostomus.*

Fig. 1. *Echinocyamus grandiporus,* actinal side. $^{6.5}/_{1}$.
— 2. — *macrostomus,* ophicephalous pedicellaria. $^{325}/_{1}$.
— 3. — *grandiporus,* actinal part of the test, from the inside. $^{7}/_{1}$.
— 4. — *pusillus,* ophicephalous pedicellaria. $^{37}/_{1}$.
— 5. — *grandiporus,* abactinal side. $^{6.5}/_{1}$.
— 6. — *pusillus,* head of ophicephalous pedicellaria. $^{325}/_{1}$.
— 7. — *macrostomus,* triphyllous pedicellaria. $^{240}/_{1}$.
— 8. — *grandiporus,* valve of ophicephalous pedicellaria, (the two other valves of the same pedicellaria are represented in Figs. 11 and 12). $^{325}/_{1}$.
— 9. — *pusillus,* endcrown of miliary spine, from above. $^{325}/_{1}$.
— 10. — *grandiporus,* — - — — — — $^{325}/_{1}$.
— 11. — — valve of ophicephalous pedicellaria. (Comp. Figs. 8 and 12.) $^{325}/_{1}$.
— 12. — — — - — — (— — 8 — 11.) $^{325}/_{1}$.
— 13. — — ophicephalous pedicellaria. $^{325}/_{1}$.
— 14. — — part of the test, showing the glassy protuberances among the spine-bearing tubercles. $^{50}/_{1}$.
— 15. — — primary spine. $^{50}/_{1}$.
— 16. — — miliary — $^{175}/_{1}$.
— 17. — *macrostomus,* young specimen, abactinal side. $^{8}/_{1}$.
— 18. — *pusillus,* miliary spine. $^{175}/_{1}$.
— 19. — — primary — $^{50}/_{1}$.
— 20. — — valve of triphyllous pedicellaria. $^{325}/_{1}$.
— 21. — *grandiporus,* valve of triphyllous pedicellaria. $^{325}/_{1}$.
— 22. — *pusillus,* part of the test, showing the glassy protuberance between the pores of the petals. $^{50}/_{1}$.
— 23. — — valve of tridentate pedicellaria. $^{325}/_{1}$.
— 24. — *macrostomus,* actinal side. $^{8}/_{1}$.
— 25. — *grandiporus,* valve of tridentate pedicellaria. $^{325}/_{1}$.
— 26. — *pusillus,* part of the actinal side of the test, showing the two large buccal pores and groups of small pores. $^{37}/_{1}$.
— 27. — — actinal side. $^{6}/_{1}$.
— 28. — *grandiporus,* tridentate pedicellaria. $^{175}/_{1}$.
— 29. — *pusillus,* actinal part of the test, from the inside. $^{7}/_{1}$.
— 30. — — tridentate pedicellaria. $^{125}/_{1}$.
— 31. — — abactinal side. $^{6}/_{1}$.

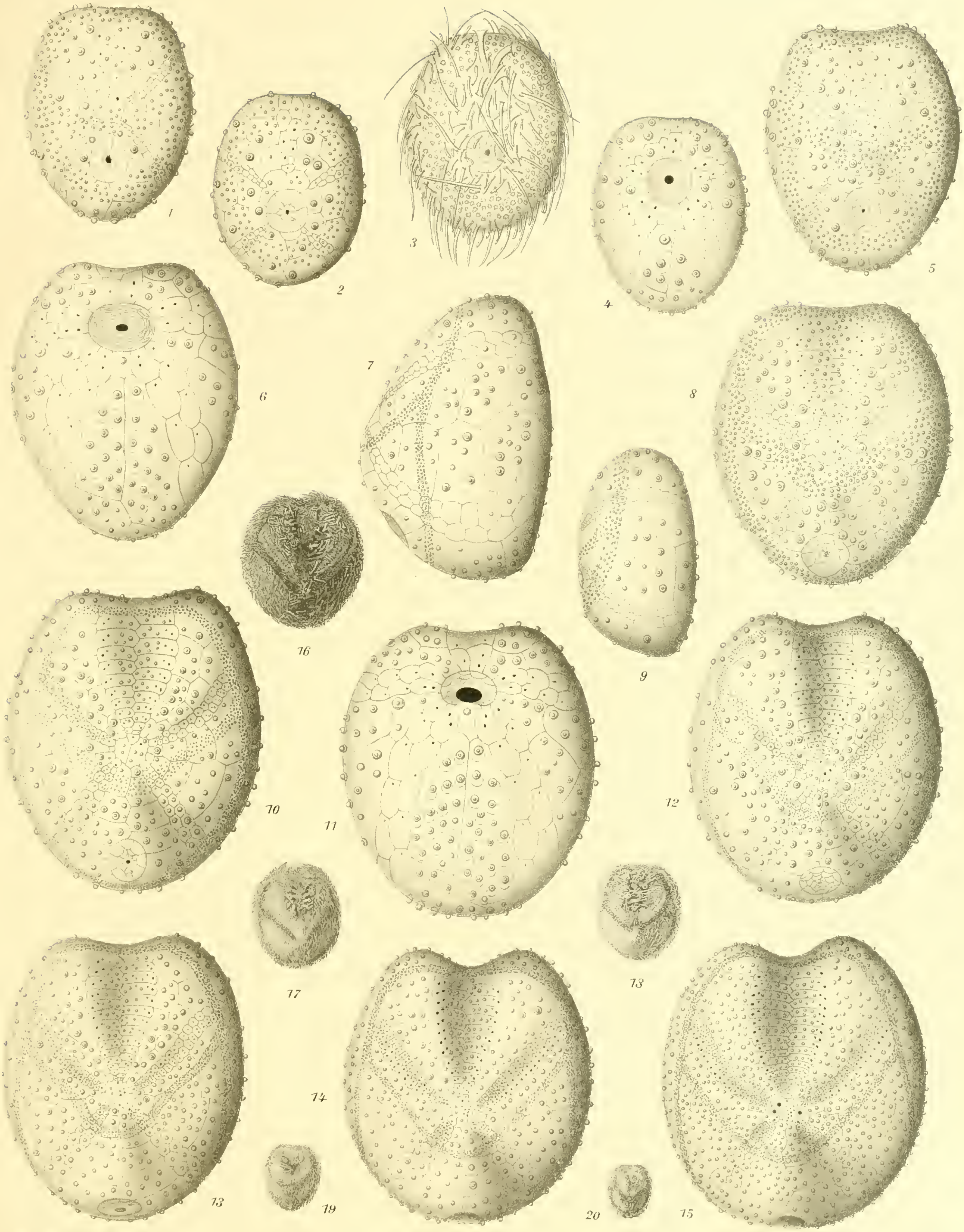
In the figures 1, 5, 17, 24, 16 and 31 the small pores are made somewhat more conspicuous than they are in nature.



Echinocyamus pusillus (O.F.Müll.), grandiporus n.sp., macrostomus n.sp.

Plate XIII.

Fig. 1.	*Brisaster (Schizaster) fragilis.*	3^{mm}. Abactinal side. The number of plates in the paired ambulacra could not be made out with certainty. $^{15}/_{1}$.
— 2.	— — —	2^{mm}. Abactinal side. The number of plates in the paired ambulacra not quite certain, likewise the upper plates of the paired interambulacra and the plates of the anal area a little uncertain. $^{20}/_{1}$.
— 3.	— — —	$2{\cdot}5^{mm}$. Abactinal side. $^{17}/_{1}$.
— 4.	— — —	2^{mm}. Actinal side. The plates of the three anterior ambulacra are a little uncertain. $^{20}/_{1}$.
— 5.	— — —	$3{\cdot}8^{mm}$. Abactinal side. The number of plates in the paired ambulacra not quite certain. $^{13}/_{1}$.
— 6.	— — —	$4{\cdot}5^{mm}$. Actinal side. $^{13}/_{1}$.
— 7.	— — —	— Side view. $^{13}/_{1}$.
— 8.	— — —	— Abactinal side. $^{13}/_{1}$.
— 9.	— — —	3^{mm}. Side view. $^{15}/_{1}$.
— 10.	— — —	$5{\cdot}5^{mm}$. Abactinal side. $^{11}/_{1}$.
— 11.	— — —	$6{\cdot}6^{mm}$. Actinal side. $^{9}/_{1}$.
— 12.	— — —	— Abactinal side. $^{9}/_{1}$.
— 13.	— — —	$7{\cdot}5^{mm}$. — — $^{8}/_{1}$.
— 14.	— — —	9^{mm}. — — $^{6}/_{1}$.
— 15.	— — —	11^{mm}. — — $^{5}/_{1}$.
— 16—20.	— — —	Abactinal side. $^{3{\cdot}5}/_{1}$.



Brisaster (Schizaster) fragilis (Düb. Kor.)

Plate XIV.

3, 7, 11, 13–16, 18, 20, 24, 25, 31, 37, 39, 43, 46, 50, 51 *Brisaster fragilis.* 33, 42, 48 *Br. capensis.* 9, 19, 22, 26, 34, 40, 41, 45 *Schizaster canaliferus.* 2, 12, 17, 23, 27, 32, 49 *Sch. orbignyanus.* 10 *Sch. Edwardsi.* 30, 38 *Schizaster* n. sp. (?) 6, 9, 28, 35, 44, 47 *Periaster limicola.* 4, 5, 21 «*P limicola*» (Arafura Sea, «Challenger»).

Fig. 1. «*Periaster limicola*» («Challenger», Arafura Sea). Globiferous pedicellaria. $^{50}/_{1}$.
— 2. *Schizaster orbignyanus*, valve of globiferous pedicellaria. (Comp. Fig. 32). $^{37}/_{1}$.
— 3. *Brisaster (Schizaster) fragilis*, valve of small tridentate (? rostrate) pedicellaria. $^{70}/_{1}$.
— 4. «*Periaster limicola*» («Challenger», Arafura Sea), valve of globiferous pedicellaria. $^{70}/_{1}$.
— 5. — — — — — ophicephalous pedicellaria. $^{70}/_{1}$.
— 6. *Periaster limicola*, valve of globiferous pedicellaria. $^{70}/_{1}$.
— 7. *Brisaster (Schizaster) fragilis*, valve of small tridentate (? rostrate) pedicellaria. $^{70}/_{1}$.
— 8. *Schizaster canaliferus*, valve of globiferous pedicellaria. (Comp. Fig. 40). $^{37}/_{1}$.
— 9. *Periaster limicola*, globiferous pedicellaria. $^{35}/_{1}$.
— 10. *Schizaster Edwardsi*, valve of tridentate (? rostrate) pedicellaria. $^{70}/_{1}$.
— 11. *Brisaster (Schizaster) fragilis*, valve of rostrate pedicellaria. $^{70}/_{1}$.
— 12. *Schizaster orbignyanus*, valve of tridentate pedicellaria. $^{50}/_{1}$.
— 13 a. b. *Brisaster (Schizaster) fragilis*, spicules of tube-foot. $^{125}/_{1}$.
— 14. — — — valve of globiferous pedicellaria, from the inside. (Comp. Fig. 16). $^{50}/_{1}$.
— 15. — — — rostrate pedicellaria. $^{37}/_{1}$.
— 16. — — — valve of globiferous pedicellaria, side view. (Comp. Fig. 14). $^{70}/_{1}$.
— 17. *Schizaster orbignyanus*, valve of tridentate pedicellaria. $^{70}/_{1}$.
— 18. *Brisaster (Schizaster) fragilis*, valve of tridentate pedicellaria. $^{37}/_{1}$.
— 19. *Schizaster canaliferus*, — - small rostrate pedicellaria. $^{70}/_{1}$.
— 20. *Brisaster (Schizaster) fragilis*, — - — tridentate — $^{70}/_{1}$.
— 21. «*Periaster limicola*» («Challenger», Arafura Sea), valve of tridentate pedicellaria. $^{70}/_{1}$.
— 22. *Schizaster canaliferus*, valve of tridentate pedicellaria. $^{50}/_{1}$.
— 23. — *orbignyanus*, — - rostrate — $^{37}/_{1}$.
— 24. *Brisaster (Schizaster) fragilis*, valve of globiferous pedicellaria, abnormally ending in two teeth, from the inside. $^{70}/_{1}$.
— 25. — — — valve of tridentate pedicellaria. $^{37}/_{1}$.
— 26. *Schizaster canaliferus*, valve of rostrate pedicellaria. $^{50}/_{1}$.
— 27 a. b. — *orbignyanus*, spicules from tube-foot. $^{175}/_{1}$.
— 28. *Periaster limicola*, valve of tridentate pedicellaria. $^{70}/_{1}$.
— 29. *Schizaster orbignyanus*, stalk of globiferous pedicellaria. $^{37}/_{1}$.
— 30. — n. sp. (?), valve of rostrate pedicellaria. $^{50}/_{1}$.
— 31. *Brisaster (Schizaster) fragilis*, valve of triphyllous pedicellaria. $^{175}/_{1}$.
— 32. *Schizaster orbignyanus*, terminal opening of the valve of globiferous pedicellaria. (Comp. Fig. 2). $^{70}/_{1}$.
— 33. *Brisaster (Schizaster) capensis*, valve of small tridentate pedicellaria. $^{37}/_{1}$.
— 34. *Schizaster canaliferus*, spicules from tube-foot. $^{175}/_{1}$.
— 35. *Periaster limicola*, valve of tridentate pedicellaria. $^{70}/_{1}$.
— 36. «*Periaster limicola*» («Challenger», Arafura Sea), valve of ophicephalous pedicellaria. $^{175}/_{1}$.
— 37. *Brisaster (Schizaster) fragilis*, valve of tridentate pedicellaria. $^{37}/_{1}$.
— 38 a-c. *Schizaster* n. sp. (?), spicules from tube-foot. $^{175}/_{1}$.
— 39. *Brisaster (Schizaster) fragilis*, valve of ophicephalous pedicellaria. $^{175}/_{1}$.
— 40. *Schizaster canaliferus*, terminal opening of valve of globiferous pedicellaria. (Comp. Fig. 8). $^{70}/_{1}$.
— 41. — — valve of small tridentate pedicellaria. $^{50}/_{1}$.
— 42. *Brisaster (Schizaster) capensis* (type specimen), valve of tridentate (? rostrate) pedicellaria. $^{70}/_{1}$.
— 43. — — *fragilis*, rostrate pedicellaria. $^{37}/_{1}$.
— 44. *Periaster limicola*, valve of large tridentate pedicellaria. $^{50}/_{1}$.
— 45. *Schizaster canaliferus*, valve of large tridentate pedicellaria. $^{50}/_{1}$.
— 46. *Brisaster (Schizaster) fragilis*, valve of tridentate pedicellaria. $^{37}/_{1}$.
— 47. *Periaster limicola*, large tridentate pedicellaria. $^{25}/_{1}$.
— 48. *Brisaster (Schizaster) capensis*, valve of large tridentate pedicellaria. $^{37}/_{1}$.
— 49. *Schizaster orbignyanus*, valve of rostrate pedicellaria. $^{50}/_{1}$.
— 50. *Brisaster (Schizaster) fragilis*, valve of large tridentate pedicellaria. $^{37}/_{1}$.
— 51. — — — globiferous pedicellaria. $^{37}/_{1}$.

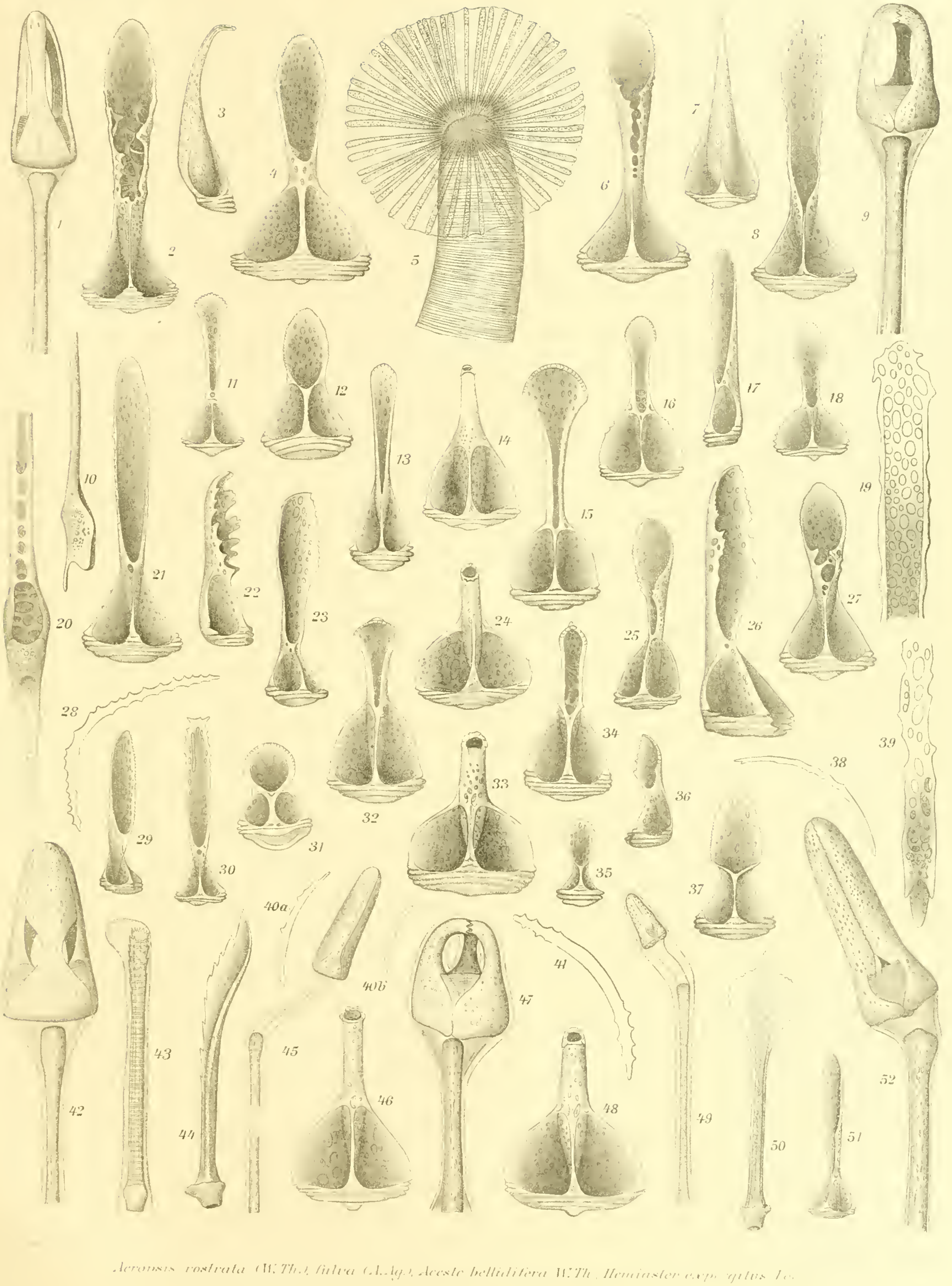
Morte... del.

Brisaster (Schizaster) fragilis (Düb. Kor.), capensis (Studer), Schizaster canaliferus (Lamk.), orbignyanus A. Ag.
Edwardsi Cotteau, n. sp.?, Periaster limicola A. Ag.

Plate XV.

1, 2, 5, 8, 13, 19—21, 29, 37, 40, 43, 52 *Aëropsis rostrata.* 6, 12, 27, 34 *A. fulva.* 10, 14, 15, 22, 25, 32, 36, 39, 41, 51 *Aceste bellidifera.* 9, 16—18, 24, 26, 30, 31, 35, 38, 44, 45, 47, 48, 50 *Hemiaster expergitus.* 42, 46 *H. gibbosus.* 3, 7, 11 «*H.*» *zonatus* 4, 33, 49 *H. tenuis.* 23, 28 «*H.*» *florigerus.*

Fig. 1. *Aëropsis rostrata,* rostrate pedicellaria. 50/1.
— 2. — — valve of tridentate pedicellaria. 50/1.
— 3. «*Hemiaster*» *zonatus* («Challenger», St. 126), valve of globiferous pedicellaria; side view. (Comp. Fig. 7). 50/1.
— 4. *Hemiaster tenuis,* valve of tridentate pedicellaria. 50/1.
— 5. *Aëropsis rostrata,* frontal tube-foot. 10/1.
— 6. — *fulva* («Challenger», St. 191), valve of tridentate pedicellaria. 50/1.
— 7. «*Hemiaster*» *zonatus* («Challenger», St. 126), valve of globiferous pedicellaria, from the inside. (Comp. Fig. 3). 50/1.
— 8. *Aëropsis rostrata,* valve of tridentate pedicellaria. 50/1.
— 9. *Hemiaster expergitus,* rostrate pedicellaria. 50/1.
— 10. *Aceste bellidifera,* rosette plate, proximal part, in side view. 140/1. (Comp. Fig. 39).
— 11. «*Hemiaster*» *zonatus,* valve of rostrate pedicellaria. 70/1.
— 12. *Aëropsis fulva* («Challenger», St. 191), valve of small tridentate pedicellaria. 125/1.
— 13. — *rostrata,* valve of rostrate pedicellaria. 70/1.
— 14. *Aceste bellidifera,* — - globiferous — 50/1.
— 15. — — — - rostrate — 50/1.
— 16. *Hemiaster expergitus,* valve of rostrate pedicellaria. 50/1.
— 17. — — — - small tridentate pedicellaria. 125/1.
— 18. — — — - rostrate pedicellaria. 50/1.
— 19. *Aëropsis rostrata,* rosette plate, outer end, from below. 50/1.
— 20. — — — — proximal end, from below. 125/1.
— 21. — — valve of tridentate pedicellaria. 50/1.
— 22. *Aceste bellidifera,* — - — — 50/1.
— 23. «*Hemiaster*» *florigerus* (type specimen), valve of tridentate pedicellaria. 125/1.
— 24. *Hemiaster expergitus* («Talisman»), valve of globiferous pedicellaria. 50/1.
— 25. *Aceste bellidifera,* valve of tridentate pedicellaria. 50/1.
— 26. *Hemiaster expergitus,* valve of tridentate pedicellaria. 125/1.
— 27. *Aëropsis fulva* («Challenger», St. 191), valve of tridentate pedicellaria. 70/1.
— 28. «*Hemiaster*» *florigerus* (type specimen), spicule from tube-foot. 175/1.
— 29. *Aëropsis rostrata,* valve of small tridentate pedicellaria. 70/1.
— 30. *Hemiaster expergitus,* valve of small tridentate pedicellaria. 125/1.
— 31. — — — - ophicephalous — 125/1.
— 32. *Aceste bellidifera,* — - rostrate — 50/1.
— 33. *Hemiaster tenuis,* — - globiferous — 50/1.
— 34. *Aëropsis fulva* («Albatross», St. 3393), valve of rostrate pedicellaria. 45/1.
— 35. *Hemiaster expergitus,* valve of triphyllous pedicellaria. 175/1.
— 36. *Aceste bellidifera,* valve of small tridentate (? rostrate) pedicellaria. 125/1.
— 37. *Aëropsis rostrata,* — - triphyllous pedicellaria. 125/1.
— 38. *Hemiaster expergitus,* spicule from tube-foot. 175/1.
— 39. *Aceste bellidifera,* rosette plate, inner part, from below. (Comp. Fig. 10). 140/1.
— 40 a. b. *Aëropsis rostrata,* spicules from tube-foot. 70/1.
— 41. *Aceste bellidifera,* spicule from tube-foot. 140/1.
— 42. *Hemiaster gibbosus,* tridentate pedicellaria. 70/1.
— 43. *Aëropsis rostrata,* miliary spine, with «ampulla». 50/1.
— 44. *Hemiaster expergitus,* primary spine, from the anterior end of the test, side view. 35/1.
— 45. — — small tridentate pedicellaria. 70/1.
— 46. — *gibbosus,* valve of globiferous pedicellaria. 50/1.
— 47. — *expergitus,* globiferous pedicellaria. 50/1.
— 48. — — valve of globiferous pedicellaria. 50/1.
— 49. — *tenuis,* small tridentate pedicellaria; (the skin dark coloured). 50/1.
— 50. — *expergitus,* primary spine, from the actinal plastron. 35/1.
— 51. *Aceste bellidifera,* valve of tridentate pedicellaria. 125/1.
— 52. *Aëropsis rostrata,* tridentate pedicellaria. 37/1.

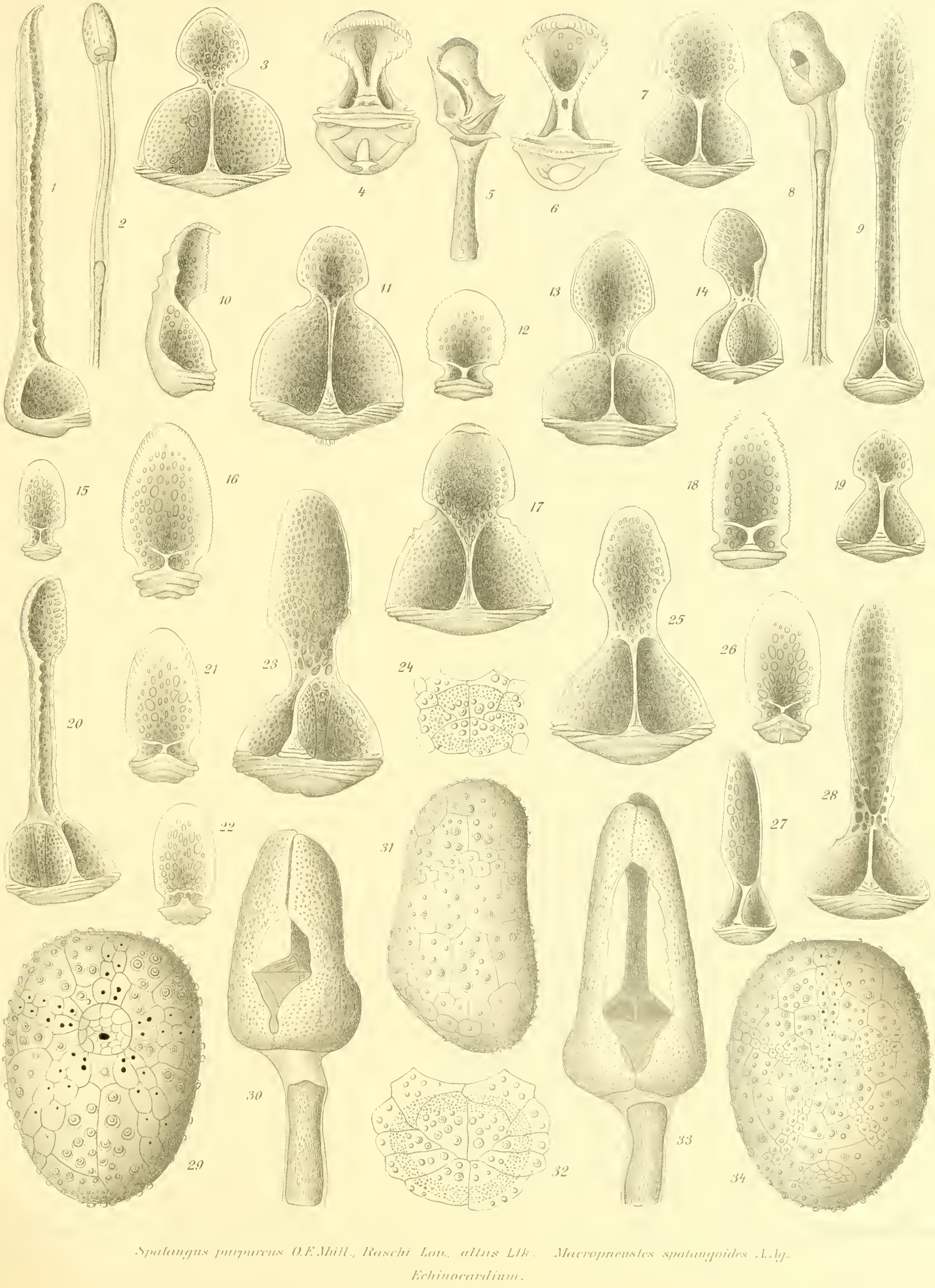


Aeropsis rostrata (W. Th.), fulva (A. Ag.), Aceste bellidifera W. Th., Hemiaster expergitus Lov., gibbosus A. Ag., zonatus A. Ag., tenuis (A. Ag.), florigerus Studer.

Plate XVI.

1, 2, 5—10, 22, 24, 25, 27, 29, 31, 32, 34 *Spatangus purpureus.* 17, 23, 28 *Spat. Raschi.* 11, 19 *Spat. altus (? Lütkeni).* 3, 4, 13—15, 20, 30, 33 *Macropneustes spatangoides.* 12 *Echinocardium capense.* 16 *Ech. mediterraneum.* 18 *Ech. pennatifidum.* 21 *Ech. cordatum.* 26 *Ech. flavescens.*

Fig. 1. *Spatangus purpureus,* valve of large tridentate pedicellaria, side view. (Comp. Fig. 9). $^{70}/_{1}$.
— 2. — — triphyllous pedicellaria. $^{62}/_{1}$.
— 3. *Macropneustes spatangoides* («Challenger», St. 33), valve of short tridentate pedicellaria. $^{50}/_{1}$.
— 4. — — — — — - ophicephalous — $^{70}/_{1}$.
— 5. *Spatangus purpureus,* ophicephalous pedicellaria. $^{70}/_{1}$.
— 6. — — valve of ophicephalous pedicellaria. $^{175}/_{1}$.
— 7. — — — - short tridentate — $^{70}/_{1}$.
— 8. — — short tridentate pedicellaria. $^{37}/_{1}$.
— 9. — — valve of large tridentate pedicellaria, from the inside. (Comp. Fig. 1). $^{70}/_{1}$.
— 10. *Spatangus purpureus,* — - short — — side view. $^{140}/_{1}$.
— 11. — *altus (Lütkeni?),* valve of short tridentate pedicellaria. $^{70}/_{1}$.
— 12. *Echinocardium capense,* — - triphyllous — $^{240}/_{1}$.
— 13. *Macropneustes spatangoides* («Challenger», St. 33), valve of short tridentate pedicellaria. $^{37}/_{1}$.
— 14. — — («Albatross», St. 2655), — - — — — $^{50}/_{1}$.
— 15. — — («Challenger», St. 33), — - — triphyllous — $^{175}/_{1}$.
— 16. *Echinocardium mediterraneum,* valve of triphyllous pedicellaria. $^{240}/_{1}$.
— 17. *Spatangus Raschi,* valve of short tridentate pedicellaria. $^{70}/_{1}$.
— 18. *Echinocardium pennatifidum,* valve of triphyllous pedicellaria. $^{240}/^{1}$.
— 19. *Spatangus altus (Lütkeni?),* valve of short tridentate pedicellaria. $^{70}/_{1}$.
— 20. *Macropneustes spatangoides* («Challenger», St. 33), valve of large tridentate pedicellaria. $^{37}/_{1}$.
— 21. *Echinocardium cordatum,* valve of triphyllous pedicellaria. $^{240}/_{1}$.
— 22. *Spatangus purpureus,* — - — — $^{125}/_{1}$.
— 23. — *Raschi,* — - tridentate — $^{50}/_{1}$.
— 24. — *purpureus,* subanal area of a specimen 4^{mm} in diameter. $^{15}/_{1}$.
— 25. — — valve of tridentate pedicellaria. $^{70}/_{1}$.
— 26. *Echinocardium flavescens,* valve of triphyllous pedicellaria. $^{240}/_{1}$.
— 27. *Spatangus purpureus,* valve of small tridentate pedicellaria. $^{140}/_{1}$.
— 28. — *Raschi,* — - large tridentate — $^{70}/_{1}$.
— 29. — *purpureus,* specimen 4^{mm} long, actinal side. $^{15}/_{1}$.
— 30. *Macropneustes spatangoides* («Challenger», St. 33), tridentate pedicellaria. $^{35}/_{1}$.
— 31. *Spatangus purpureus,* specimen 4^{mm} long, side view. $^{15}/_{1}$.
— 32. — — subanal area of a specimen 9^{mm} in diameter. $^{8}/_{1}$.
— 33. *Macropneustes spatangoides* («Challenger», St. 33), large tridentate pedicellaria. $^{30}/_{1}$.
— 34. *Spatangus purpureus,* specimen 4^{mm} long, abactinal side. $^{15}/_{1}$.

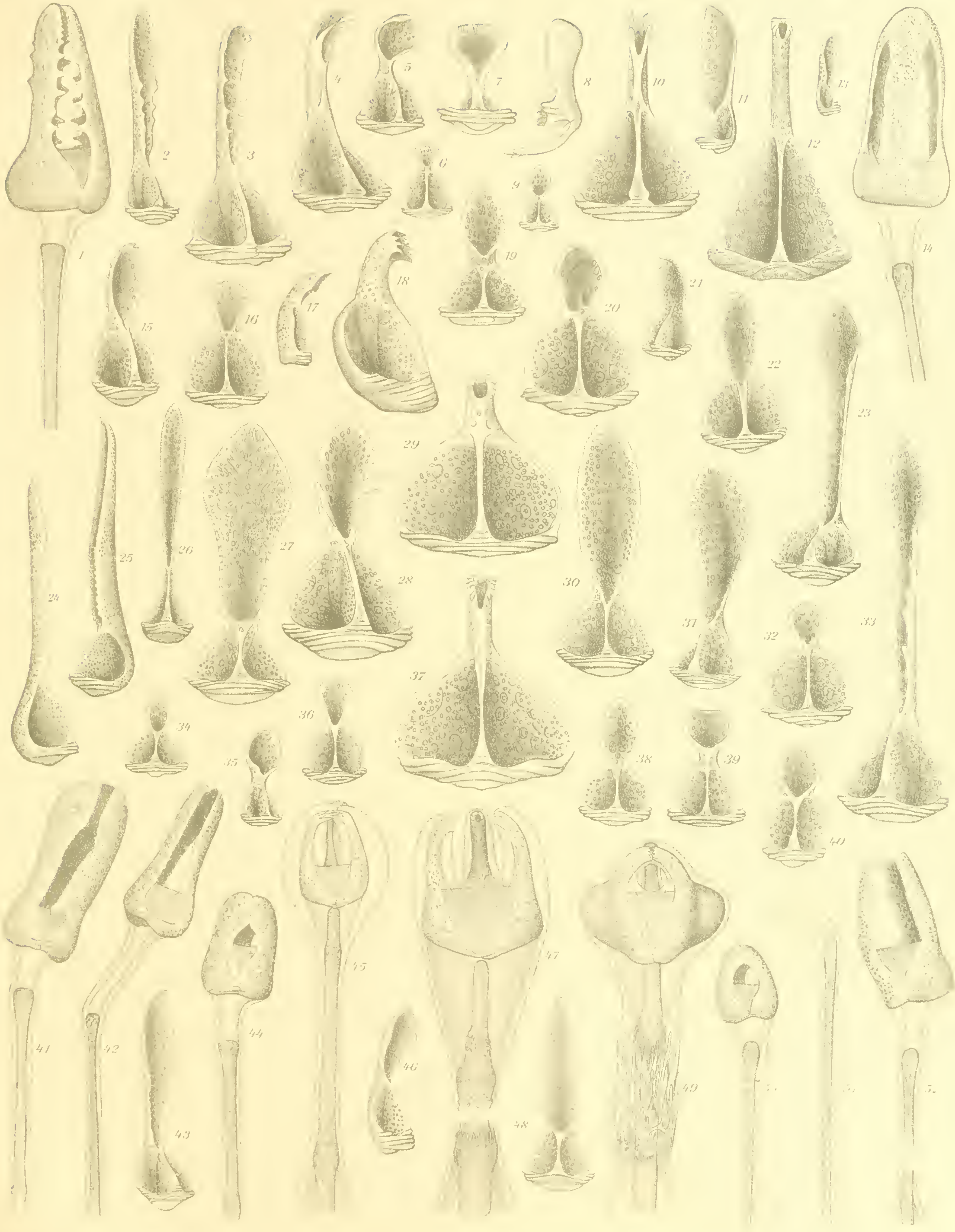


Spatangus purpureus O.F. Müll., Raschi Lov., altus Ltk. Macropneustes spatangoides A. Ag. Echinocardium.

Plate XVII.

15, 21—23, 30, 34, 37, 38, 43, 48, 49 *Echinocardium cordatum.* 4, 7, 8, 10, 11, 17, 27, 31, 40, 41, 45, 50 *Ech. flavescens.* 5, 6, 9, 13, 16, 35, 39 *Ech. capense.* 1, 18, 20, 24—26, 28, 29, 32, 33, 42, 44 *Ech. pennatifidum.* 2, 3, 12, 19, 47, 51, 52 *Ech. mediterraneum.* 14, 36, 46 *Ech. intermedium.*

Fig. 1.	*Echinocardium*	*pennatifidum,* tridentate pedicellaria. $^{25}/_{1}$.
— 2.	—	*mediterraneum,* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 3.	—	— — - rostrate — $^{50}/_{1}$.
— 4.	—	*flavescens,* — - globiferous — side view. (Comp. Fig. 10). $^{70}/_{1}$.
— 5.	—	*capense,* valve of small tridentate pedicellaria. (Comp. Figs. 35, 39). $^{70}/_{1}$.
— 6.	—	— — - — rostrate — (Comp Fig. 16). $^{70}/_{1}$.
— 7.	—	*flavescens,* — - ophicephalous — $^{175}/_{1}$.
— 8.	—	— — - — — side view. $^{175}/_{1}$.
— 9.	—	*capense,* — - small rostrate — $^{70}/_{1}$.
— 10.	—	*flavescens,* — - globiferous — from the inside. (Cmp. Fig. 4). $^{70}/_{1}$.
— 11.	—	— — - small tridentate — $^{70}/_{1}$.
— 12.	—	*mediterraneum,* valve of globiferous pedicellaria. $^{50}/_{1}$.
— 13.	—	*capense,* — - small tridentate — $^{70}/_{1}$.
— 14.	—	*intermedium,* tridentate pedicellaria. $^{35}/_{1}$.
— 15.	—	*cordatum,* valve of rostrate pedicellaria. $^{70}/_{1}$.
— 16.	—	*capense.* — - — — (Comp. Fig. 6). $^{70}/_{1}$.
— 17.	—	*flavescens,* — - — — side view. (Comp. Fig. 40). $^{70}/_{1}$.
— 18.	—	*pennatifidum,* valve of globiferous pedicellaria, side view. (Comp. Fig. 29). $^{70}/_{1}$.
— 19.	—	*mediterraneum,* — - small tridentate — $^{70}/_{1}$.
— 20.	—	*pennatifidum,* — - rostrate — (Comp. Figs. 28, 32). $^{50}/_{1}$.
— 21.	—	*cordatum,* — - — — (Comp. Fig. 34). Specimen from Øresund. $^{70}/_{1}$.
— 22.	—	— — - tridentate — (Mediterranean). $^{70}/_{1}$.
— 23.	—	— — - — — $^{37}/_{1}$.
— 24.	—	*pennatifidum,* — - — — $^{37}/_{1}$.
— 25.	—	— — - — — side view. (Comp. Fig. 26). $^{37}/_{1}$.
— 26.	—	— — - — — fr. the inside. (Cmp. Fig. 25). $^{37}/_{1}$.
— 27.	—	*flavescens,* — - — — $^{37}/_{1}$. («M. Sars»).
— 28.	—	*pennatifidum,* — - rostrate — (Comp. Figs. 20, 32). $^{37}/_{1}$.
— 29.	—	— — - globiferous — fr. the inside. (Cmp. Fig. 18). $^{37}/_{1}$.
— 30.	—	*cordatum* (Tamaris), valve of tridentate pedicellaria. $^{37}/_{1}$.
— 31.	—	*flavescens,* valve of tridentate pedicellaria. (Bergen). $^{37}/_{1}$.
— 32.	—	*pennatifidum,* valve of rostrate pedicellaria. (Comp. Figs. 20, 28). $^{50}/_{1}$.
— 33.	—	— — - tridentate — $^{50}/_{1}$.
— 34.	—	*cordatum,* — - rostrate — (Comp. Fig. 21). $^{70}/_{1}$. (Naples).
— 35.	—	*capense,* — - small tridentate pedicellaria. (Comp. Figs. 5, 39). $^{70}/_{1}$.
— 36.	—	*intermedium,* — - rostrate — (Tamaris). $^{70}/_{1}$.
— 37.	—	*cordatum,* — - globiferous — $^{70}/_{1}$.
— 38.	—	— — - rostrate — $^{70}/_{1}$.
— 39.	—	*capense,* — - small tridentate — (Comp. Figs. 5, 35). $^{70}/_{1}$.
— 40.	—	*flavescens,* — - rostrate — (Comp. Fig. 17). $^{70}/_{1}$.
— 41.	—	— large tridentate pedicellaria. $^{37}/_{1}$.
— 42.	—	*pennatifidum,* tridentate — $^{37}/_{1}$.
— 43.	—	*cordatum,* valve of tridentate pedicellaria. $^{37}/_{1}$.
— 44.	—	*pennatifidum,* rostrate pedicellaria. $^{37}/_{1}$.
— 45.	—	*flavescens,* globiferous — $^{35}/_{1}$.
— 46.	—	*intermedium,* valve of rostrate pedicellaria. $^{70}/_{1}$.
— 47.	—	*mediterraneum,* globiferous pedicellaria. $^{30}/_{1}$.
— 48.	—	*cordatum,* valve of tridentate pedicellaria. $^{37}/_{1}$.
— 49.	—	— globiferous pedicellaria. $^{35}/_{1}$.
— 50.	—	*flavescens,* rostrate — $^{50}/_{1}$.
— 51.	—	*mediterraneum,* clavula. $^{50}/_{1}$.
— 52.	—	— rostrate pedicellaria. $^{35}/_{1}$.



Echinocardium cordatum (Penn.), flavescens (O.F. Müll.), [illegible] sp. [illegible] mediterraneum (Gray), intermedium n.sp.

Plate XVIII.

1, 6, 12, 18, 25, 26 *Brissopsis lyrifera.* 3, 23 var. *capensis.* 7, 8, 14 «*Br. lyrifera*», Simon's Bay, «Challenger». 4, 11, 22, 27, 29 *Br. alta.* 5, 9, 10, 13, 19, 20, 24 *Br. atlantica.* 2, 15—17, 21, 28 *Br. elongata.*

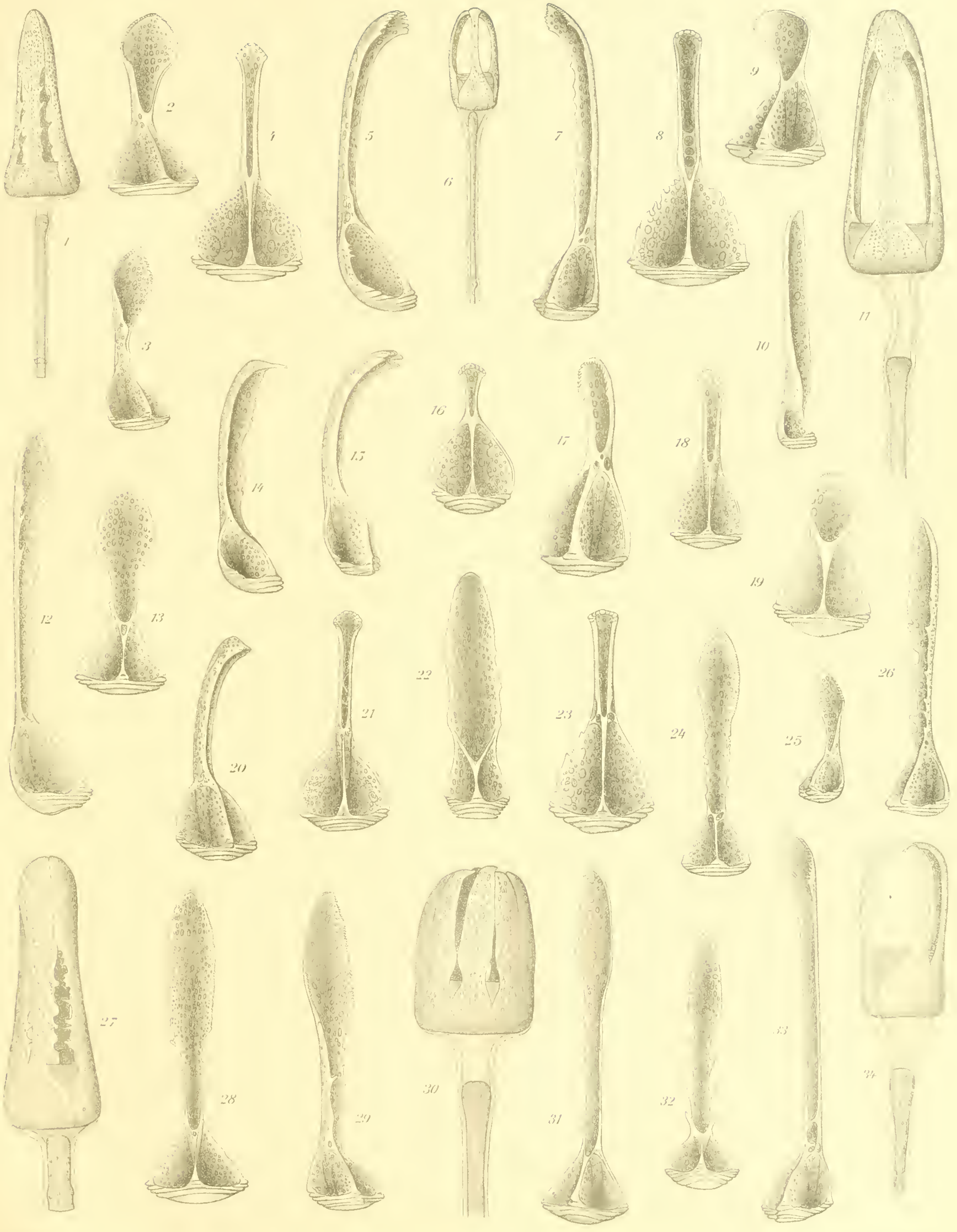
Fig. 1. *Brissopsis lyrifera*, valve of globiferous pedicellaria, side view. (Comp. Fig. 25). $^{50}/_{1}$.
— 2. — *elongata*, — - ophicephalous — $^{175}/_{1}$.
— 3. — *lyrifera*, var. *capensis*, valve of globiferous pedicellaria. $^{50}/_{1}$.
— 4. — *alta*, valve of triphyllous pedicellaria. $^{175}/_{1}$.
— 5. — *atlantica*, globiferous pedicellaria, short form. $^{37}/_{1}$.
— 6. — *lyrifera* (Mediterranean), valve of globiferous pedicellaria. $^{70}/_{1}$.
— 7. — «*lyrifera*» (Simon's Bay, «Challenger»), valve of ophicephalous pedicellaria. (Comp. Figs. 8, 14). $^{175}/_{1}$.
— 8. — «*lyrifera*» (— — — — - — — side view. (Comp. Figs. 7, 14). $^{175}/_{1}$.
— 9. — *atlantica*, valve of globiferous pedicellaria, short form. (Comp. Fig. 19). $^{50}/_{1}$.
— 10. — — — - ophicephalous — $^{175}/_{1}$.
— 11. — *alta*, — - triphyllous — (Comp. Fig. 4). $^{175}/_{1}$.
— 12. — *lyrifera*, — - — — $^{175}/_{1}$.
— 13. — *atlantica* (?, young specimen, Gulf Stream), valve of ophicephalous pedicellaria. $^{175}/_{1}$.
— 14. — «*lyrifera*» (Simon's Bay, «Challenger»), valve of ophicephalous pedicellaria. (Comp. Figs. 7, 8). $^{175}/_{1}$.
— 15. — *elongata*, valve of globiferous pedicellaria. (Comp. Fig. 21). $^{50}/_{1}$.
— 16. — — spicules from tube-foot. $^{175}/_{1}$.
— 17. — — rosette-plate of frontal tube-foot. $^{125}/_{1}$.
— 18. — *lyrifera*, spicules from tube-foot. $^{175}/_{1}$.
— 19. — *atlantica*, valve of globiferous pedicellaria, short form. (Comp. Fig. 9). $^{50}/_{1}$.
— 20. — — globiferous pedicellaria, slender form. $^{40}/_{1}$.
— 21. — *elongata*, valve of globiferous pedicellaria. (Comp. Fig. 15). $^{50}/_{1}$.
— 22. — *alta*, sphæridia. $^{175}/_{1}$.
— 23. — *lyrifera*, var. *capensis*, upper end of stalk of globiferous pedicellaria. $^{37}/_{1}$.
— 24. — *atlantica*, valve of globiferous pedicellaria, elongate form. $^{50}/_{1}$.
— 25. — *lyrifera*, — - — — (Comp. Fig. 1). $^{50}/_{1}$.
— 26. — — globiferous pedicellaria. $^{20}/_{1}$.
— 27. — *alta*, — — $^{37}/_{1}$.
— 28. — *elongata*, — — $^{37}/_{1}$.
— 29. — *alta*, valve of globiferous pedicellaria. $^{70}/_{1}$.

Brissopsis lyrifera (Forb.), capensis n.var., alta n.sp. atlantica n.sp., elongata n.sp.

Plate XIX.

3, 6, 10, 15, 18—21, 29, 34 *Brissopsis lyrifera.* 2, 9 var. *capensis.* 7, 24, 26, 27 *Br. alta.* 1, 4, 5, 8, 11, 13, 14, 16, 22, 23, 25, 28 30—33 *Br. atlantica.* 12, 17 *Br. elongata.*

Fig. 1. *Brissopsis atlantica.* tridentate pedicellaria. $^{50}/_{1}$.
— 2. — *lyrifera,* var. *capensis.* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 3. — — valve of tridentate pedicellaria. $^{37}/_{1}$.
— 4. — *atlantica,* — - rostrate — $^{50}/_{1}$.
— 5. — — — - — — larger form, side view. $^{50}/_{1}$.
— 6. — *lyrifera,* small, rostrate pedicellaria. (Comp. Fig. 34). $^{37}/_{1}$.
— 7. — *alta,* valve of — — $^{50}/_{1}$.
— 8. — *atlantica* (?), («Talisman») valve of rostrate pedicellaria. $^{50}/_{1}$.
— 9. — *lyrifera,* var. *capensis,* valve of small rostrate pedicellaria. $^{175}/_{1}$.
— 10. — — valve of tridentate pedicellaria. $^{70}/_{1}$.
— 11. — *atlantica,* tridentate pedicellaria. $^{37}/_{1}$.
— 12. — *elongata,* valve of tridentate pedicellaria. $^{50}/_{1}$.
— 13. — *atlantica* (?) («Talisman»), valve of tridentate pedicellaria. $^{70}/_{1}$.
— 14. — — (?), valve of 8-valved «tridentate» — $^{70}/_{1}$. (Comp. Figs. 22, 30).
— 15. — *lyrifera* (Mediterranean), valve of rostrate pedicellaria, side view. (Comp. Fig. 21). $^{50}/_{1}$.
— 16. — *atlantica* (?) («Talisman»), — - small rostrate pedicellaria. $^{70}/_{1}$.
— 17. — *elongata,* valve of rostrate pedicellaria. $^{175}/_{1}$.
— 18. — *lyrifera,* — - — — $^{70}/_{1}$.
— 19. — — — - small tridentate pedicellaria. $^{175}/_{1}$.
— 20. — — (Mediterranean), valve of rostrate pedicellaria. $^{37}/_{1}$.
— 21. — — — — - — — (Comp. Fig. 15). $^{50}/_{1}$.
— 22. — *atlantica* (?), valve of 8-valved «tridentate» pedicellaria. (Comp. Figs. 14, 30). $^{70}/_{1}$.
— 23. — — (?) («Talisman»), valve of rostrate pedicellaria. $^{50}/_{1}$.
— 24. — *alta,* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 25. — *atlantica,* valve of small rostrate (?) pedicellaria. $^{70}/_{1}$.
— 26. — *alta.* valve of tridentate pedicellaria. $^{70}/_{1}$.
— 27. — — tridentate pedicellaria, fourvalved. $^{70}/_{1}$.
— 28. — *atlantica,* valve of tridentate pedicellaria. $^{50}/_{1}$.
— 29. — *lyrifera,* — - — — $^{37}/_{1}$.
— 30. — *atlantica* (?), 8-valved «tridentate» pedicellaria. $^{50}/_{1}$.
— 31. — — (?) («Talisman»), valve of tridentate pedicellaria. $^{50}/_{1}$.
— 32. — — valve of tridentate pedicellaria. $^{50}/_{1}$.
— 33. — — — - — — $^{50}/_{1}$.
— 34. — *lyrifera,* rostrate pedicellaria. $^{37}/_{1}$.



Brissopsis lyrifera (Forb.), capensis n. var., alta n. sp., atlantica n. sp., elongata n. sp.

THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1199	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	136		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 09′	155			64° 37′	54° 24′	109		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34′	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	305	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	136	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	316	5°9
12	64° 38′	32° 37′	1040	0°3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	176	4°4	35	65° 16′	55° 05′	362	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	—0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	—0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°9
17	62° 49′	26° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1566	2°4	40	62° 00′	21° 36′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10′	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19° 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton-Net used		44	61° 42′	9° 36′	545	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr.	Long. W.	Lat. N.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	—0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	—0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′.0	23° 47′.6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′.3	23° 56′.2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					