

# THE DANISH EXPEDITION TO SIAM 1899-1900

D. Kgl. Danske Vidensk. Selsk. Skrifter, 7. Række, naturvidensk. og mathem. Afd. I. 1

---

---

## II. Echinoidea (I)

by

Dr. Th. Mortensen



København

Bianco Lunos Bogtrykkeri

1904

THE DANISH EXPEDITION TO SIAM 1833-1835

II. Echinoides (I)

By Th. Mortensen

København

## Introduction.

The Echinid-Fauna of the Gulf of Siam has not hitherto been especially treated, and only a few species have been stated to occur there. In „Revision of Echini“ only the following regular Echini are mentioned from Siam: *Temnopleurus toreumaticus*, *Salmacis rarispina* and *Heterocentrotus mamillatus*. In the present work 16 species of regular Echini are recorded from the Gulf of Siam, and of these 4 are new to science, viz. *Chætodiadema granulatum*, *Pleurechinus Döderleini*, *Pl. siamensis* and *Gymnechinus pulchellus*, the first named being the type of a new genus. Of the 16 species mentioned two have not been taken by the author; one, *Temnopleurus Reevesii* was found in the Museum of Copenhagen, labelled Salmin, Gulf of Siam; another, *Echinothrix calamaris*, was taken by the „Skeat“-Expedition on the Malacca-Coast of the Gulf. The species are the following:

1. *Stephanocidaris bispinosa* (Lamk).
2. *Diadema saxatile* (L.).
3. *Astropyga radiata* Gray.
4. *Chætodiadema granulatum* Mrtsn.
5. *Echinothrix calamaris* A. Ag.
6. *Temnopleurus toreumaticus* (Klein.)
7. — *Reevesii* (Gray).
8. *Salmacis bicolor*, var. *rarispina* (Agass.).
9. — *virgulata* Agass.
10. — *sphæroides* (L.).
11. — *dussumieri* Agass.
12. *Pleurechinus Döderleini* n. sp.
13. — *siamensis* n. sp.
14. *Gymnechinus pulchellus* n. sp.
15. *Toxopneustes pileolus* (Lamk.).
16. *Parasalenia gratiosa* A. Ag.

There can be no doubt that several more species of regular Echini will be found to occur in the Gulf of Siam. The eastern side of the Gulf, to which my researches were confined, is evidently less rich than the western side; and also the median, deeper part of the Gulf doubtless will prove to be inhabited by several species which are not found at the coasts. Upon the whole the Echinid-Fauna of the Gulf will scarcely differ to any extent from the common Indian littoral Fauna. Scarcely any species peculiar to the Gulf will be found; the new species described here cannot be maintained to be so. *Chaetodiadema granulatum* has been taken by the „Siboga“-Expedition, and I have seen specimens from the sea between New Guinea and Australia and from the Maldive-Islands. *Pleurechinus Döderleini* also occurs at Samoa, and *Pleurech. siamensis* has been taken in considerable numbers by the „Siboga“-Expedition. *Gymnechinus pulchellus* is as yet only known with certainty from the Gulf of Siam and Singapore. It seems very probable that all these species will prove to be widely distributed over the Indo-Pacific Region.

Since the *Diadematidæ* and *Temnopleuridæ* are so well represented in this collection, I have taken the occasion to study these two families more completely, in the same manner as I have done in my work on the „Ingolf“-Echinoidea I. with the families *Cidaridæ*, *Echinothuridæ*, *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*. The present work is then, in some way, a continuation of the „Ingolf“-work. The subjoined attempt at a natural classification of the regular Echini is the result of these very extensive studies.

By these researches I have made all possible efforts to overcome the numerous difficulties caused by the insufficient original descriptions of most of the species and by the consequently unreliable and very often wrong determinations by later authors. As far as possible I have examined the type specimens. I am very much indebted to the Carlsberg-Fond for having granted me assistance, enabling me to visit the large Museums of Europe: the British Museum, the Paris-, Berlin-, Hamburg-, Strassburg-, Génève- and Amsterdam-Museums, where so many types and such rich collections are preserved. Further I have in many cases been favoured by receiving in Copenhagen type-specimens of several species for direct comparison with my own material; I am thus obliged to Prof. DÖDERLEIN, Dr. MEISSNER, Prof. DOUVILLÉ, Prof. JOUBIN, Dr. CH. GRAVIER, Dr. DE MELJERE, Prof. BEDOT, Prof. THÉEL and Prof. ROSA. — Prof. BELL has kindly sent me to Copenhagen several interesting specimens which I had not time to examine sufficiently during my visit to London, and Dr. STEINHAUS has forwarded to me a rich collection of Echinids from the Hamburg Museum for examination. Finally in addition to several other interesting Echini Prof. S. F. HARMER has placed at my disposal the Echinids from the „Skeat“-Expedition, asking me to mention them in my work. All these gentlemen I beg hereby to receive my sincerest thanks.

By the examination of this large material I have found several undescribed species, mostly wrongly referred to other species. Of these new species I have given

short, but I think, sufficient descriptions and figures of the more prominent features. These species are:

*Chætodiadema japonicum.*

*Opechinus spectabilis.*

*Pleurechinus variegatus.*

— *maculatus.*

*Microcyphus elegans.*

— *annulatus.*

*Gymnechinus versicolor.*

— *inconspicuus.*

For the more difficult genera analytical tables of the species are given, which, I hope, will prove useful, so that future faunistic reports can be somewhat more reliable than is the case with several of the previous ones.

Copenhagen, November 1903.

TH. MORTENSEN.

## Fam. Cidaridæ.

### 1. *Stephanocidaris bispinosa* (LAMCK.).

Pl. II. Figs. 3, 17, 18. Pl. IV. Fig. 30. Pl. V. Figs. 20, 25.

- Cidarites bispinosa*. LAMARCK 1816. Hist. nat. des animaux sans vertèbres. T. III p. 57. (1840 T. III. p. 382).
- Stephanocidaris bispinosa*. A. AGASSIZ. 1872. Revision of Echini. p. 160, 393, Pl. I. c. Fig. 43, Pl. I. f. Fig. 1.
- Cidaris Lütkeni*. DE LORIOI. 1873. Descr. de trois espèces d'Echinides. Mém. Soc. Sc. nat. Neuchâtel IV. p. 29. Pl. IV.
- Rhabdocidaris bispinosa*. DE LORIOI. 1873. Ibidem. p. 33. Pl. V.
- Schleinitzia crenularis* (pro parte). STUDER. 1876. Über Echinodermen a. d. antarktischen Meere u. zwei neue Seeigel von den Papua-Inseln, ges. auf d. Reise S. M. S. „Gazelle“ um die Erde. Monatsber. d. Berliner Akad. 1876 p. 463.
- — STUDER. 1880. Übersicht über die während der Reise S. M. Corvette „Gazelle“ um die Erde 1874—76 gesammelten Echinoiden. Ibid. 1880. p. 865 (pro parte, non Fig.).
- Rhabdocidaris recens*. TROSCHEL. 1877. Archiv f. Naturgesch. 43. p. 127. Tab. VIII. Nachträgliche Bemerkung. Ibid. p. 260. — Sitz. ber. d. Niederrhein. Gesellsch. (Phys. Sect.) 1877.
- Phyllacanthus annulifera*. RAMSAY. 1885 (1891). Catalogue of the Echinodermata in the Australian Museum. I. Echini. p. 2, 45.
- Stephanocidaris bispinosa*. KOEHLER. 1895. Catalogue raisonné Echinod. îles de la Sonde. Mém. Soc. Zool. France VIII. p. 409.
- Rhabdocidaris annulifera*. BEDFORD. 1900. On Echinoderms from Singapore and Malakka. Proc. Zool. Soc. p. 274. Pl. XXI. Fig. 1. a—d.
- Leiocidaris bispinosa*. DÖDERLEIN 1902. Bericht über d. v. Herrn Prof. Semon bei Amboina und Thursday Island gesammelten Echinoidea. (Semon. Zool. Forschungsreisen V. — Jen. Denkschr. VIII.) p. 695. Taf. LVIII. Fig. 5—11.
- Stephanocidaris bispinosa*. TH. MORTENSEN. 1903. Echinoidea I. Danish Ingolf Exped. IV. 1. p. 17, 19, 28 and 172. Pl. X. Fig. 17.
- Cidaris* (*Stephanocidaris*) *bispinosa*. DE MEJERE. 1904. Die Echinoidea der Siboga-Expedition. p. 4. Taf. I. 4, Taf. II. 14.

As indicated by the list of Synonyms given here, this species has caused much trouble to Zoologists; now, at length, through the researches of DÖDERLEIN and myself, especially by my examination of LAMARCK'S type-specimen, it has been definitely settled which species is meant by the *Cidarites bispinosa* Lamarck; its systematic position — in the genus *Stephanocidaris* — has likewise been determined with certainty. The *Cid. annulifera* Lamk., which has mostly been confounded with *Steph. bispinosa*, has been definitely shown to be either merely a variety of *Cidaris baculosa* or, at most, a species very closely related to *C. baculosa*, belonging

to the genus *Cidaris* proper. (The type specimen of the *C. annulifera* has also been examined by myself (Ingolf-Echinoidea. p. 172)). That *Cidaris Lütkeni* de Loriol is only a synonym of *Steph. bispinosa* cannot be doubted; the type-specimen I have likewise examined. As for *Schleinitzia crenularis* I must refer to my work on the Ingolf-Echinoidea, p. 20, 173.

For detailed description and figures reference must be made especially to the works cited of DE LORIOI and DÖDERLEIN. A few features only need yet to be mentioned.

The ambulacral and interambulacral areas are figured in Pl. II. Fig. 3, 17. According to AGASSIZ (Op. cit. p. 394) the scrobicular circles are „ill defined, running into one another along the middle of the horizontal lines of contact“. On the specimens before me the scrobicular circles are well defined, with a complete circle of small tubercles. Evidently some variation may occur in this respect (comp. the description of *Cidaris Lütkeni*). In the ambulacral areas there is a series of tubercles inside the primary ones, placed opposite to or a little below the latter. On the inner part of the ambulacral plates a few (mostly two) small miliary tubercles are found.

AGASSIZ (Op. cit. p. 393) describes the abactinal system of the genus *Stephanocidaris* as being „thin, movable, resembling, in fact, far more the flexible anal system of Echinidæ proper than the massive abactinal system of Cidaridæ“, and this is, indeed, the only character given as distinguishing the genus *Stephanocidaris*. I am quite unable to see in the apical area of this species any such difference from that of other Cidarids; as will be seen from the fig. 18 Pl. II it has quite the usual form, and it is not more flexible than the anal system of other Cidarids. In fact it might well be supposed, as suggested by DE MEIJERE, that the specimens of AGASSIZ were not really referable to this species. Be that as it may, the species *bispinosa* must remain the type of the genus *Stephanocidaris*, which is characterized not by the apical system but by the structure of its pedicellariæ, as I have shown in my work on the Ingolf-Echinoidea. It may be pointed out that the tubercles on the outer edge of the genital and ocular plates and partly on the inner edge of the former are somewhat elongate, as remarked by DE LORIOI in his description of *Cid. Lütkeni*, though not so regularly as figured there (Op. cit. Pl. IV. Fig. 3). In the specimen figured here the madreporic plate has two genital pores, an interesting, but not uncommon abnormality.

In his *C. Lütkeni* DE LORIOI finds the upper radioles finely striated longitudinally, while in the rest of them „la surface de la tige est couverte de granules un peu épineux, disposés en séries longitudinales un peu irrégulières dont les intervalles, aussi larges qu'elles mêmes, sont garnis de verrues extrêmement fines“. In his *C. bispinosa* he finds them all finely striated longitudinally. It is true that some of the spines (the upper ones) may be longitudinally striated with very fine striæ. Transverse sections of such spines, however, show that they have no outer layer,

which means that they are not yet full grown, even if they are as long as the other spines (comp. the beautiful researches of PROUHO). On the full grown radioles the outer layer is covered with small, branched, bushshaped thorns, arranged without order between the larger knobs or thorns; they may anastomose with their branches; transverse sections of the spines give figures very much like those of *Dorocidaris papillata* (Ingolf-Ech. Pl. XI. Fig. 14, 31).

The secondary spines have no ampulla; the ambulacral spines are much darker than the interambulacral ones thus forming five dark, radiating lines on the animal. On the actinal side they may be somewhat hollowed in the outer end (especially those around the radioles), while those on the abactinal side are pointed.

The spicules are of the form usual in Cidarids; they lie in two series, which do not join on either side of the tube foot. In the lower part of the foot they are smaller, less spinous and rather scarce. — The globiferous pedicellariæ have been described and figured in the Ingolf-Echinoidea (p. 17. Pl. X. Fig. 17). The tridentate pedicellariæ (Pl. IV. Fig. 30) do not present marked peculiarities; the valves are a little apart below, when the pedicellaria is shut. — The walls of the intestine are closely packed with small, smooth, mostly oval calcareous bodies with a few holes, or with small, irregular, fenestrated plates (Pl. V. Fig. 25). In the mesenteries, genital organs, the organs of Stewart and along the radial vessels irregularly shaped plates are found (Pl. V. Fig. 20).

A young specimen of 5 mm. in diameter shows the features pointed out by DÖDERLEIN (Japanische Seeigel. p. 27 f.) as characteristic of young Cidarids; especially the obliquity of the pores is highly characteristic of the young as compared with grown specimens (Pl. II. Fig. 3.). In one thing this example differs from the common rule, there being already a complete circle of small tubercles around the areoles, which are thus completely separated. Pedicellariæ are found already at this size, the globiferous pedicellariæ are as yet small and not much lengthened, all being of the small form; tridentate ones are numerous and of the typical form. Spicules few and small.

Of this species a good many specimens belonging to the *forma typica* of DÖDERLEIN were taken on different places: at Koh Chuen and Koh Kram, between Koh Rin and Cliff Rock, between Koh Kahdat and Koh Kut, in 10—30 fathoms, on hard bottom. Also at Singapore a few small specimens were taken at 2—3 fathoms.

Two of the specimens were infested with *Stylifer*; one of them especially had many large individuals of this parasitic snail crowded on the apical area.

## Fam. Diadematidæ.

2. *Diadema saxatile* (L.).

Pl. III. Figs. 22, 23, 29. Pl. IV. Figs. 26, 31, 34. Pl. V. Figs. 2, 5, 8, 12, 14, 15.

*Echinus saxatilis*. LINNÉ. 1758. Systema Naturæ. X. Ed. p. 664.*Cidarites diadema*. LAMARCK. 1816. Animaux sans vertèbres. III. p. 58.*Diadema setosa*. GRAY. 1825. Ann. Phil. X. p. 4<sup>1)</sup>.— *Lamarckii*. ROUSSEAU. 1846. In: AGASSIZ & DESOR. Catalogue raisonné des Echinodermes. p. 45. (Ann. d. Sciences nat. 3 Ser. VI. p. 349).— *setosa*. PETERS. 1854. Über die an der Küste von Mossambique beobachteten Seeigel und insbes. über die Gruppe der Diademen. Abhandl. d. Akad. d. Wiss. Berlin. 1854. p. 109.— *Lamarckii*. Ibidem.— *setosa*. BÖLSCHÉ. 1865. Zusammenstellung der bis jetzt bekannten Echiniden aus der Gruppe der Diademen. Arch. f. Naturg. 1865. I. p. 325.— *Lamarckii*. Ibidem.— *Savignyi*. v. MARTENS. Über ostasiatische Echinodermen. Archiv f. Naturgesch. 1866. I. p. 155.— *setosum* (pro parte). A. AGASSIZ. 1872. Rev. of Echini. p. p. 103, 274. Pl. II. b. 6—10. II. c. 6, IV a. 1. VI. a. 5. (The figures cited partly belong to *D. antillarum*.)

— — STUDER. 1880. Übers. über die während d. Reise S. M. Corv. Gazelle ges. Echinoiden. Monatsber. d. Berliner Akad. 1880. p. 868.

— — BELL. 1882. Note on the Echinoderm-Fauna of Ceylon, together with some Observations on Heteractinism. Ann. Nat. Hist. 5. Ser. X. p. 219.

— — (pro parte?). DE LORIOI. 1883. Catalogue raisonné des Echinodermes rec. par. M. V. Robillard à l'île de Maurice. Mém. Soc. de Phys. et d'hist. nat. de Genève. XXVIII. p. 13.

— — DÖDERLEIN. 1885. Seeigel von Japan u. d. Liu-Kiu-Inseln. Arch. f. Naturgesch. 1885. p. 85.

— *saxatile*. LOVÉN. 1887. On the Echinoidea descr. by Linnæus. Bih. K. Sv. Vet. Akad. Handl. XIII. p. 135.— *setosum*. DÖDERLEIN. 1888. Echinodermen von Ceylon. Zool. Jahrb. Abth. f. Syst. III. p. 833.

— — SLUITER. 1889. Die Evertibraten a. d. Sammlung d. kgl. naturwiss. Vereins in Nederl. Indien in Batavia. Natuurk. Tijdschr. Nederl. Indie. 48. p. 288.

— — DE LORIOI. 1893. Echinodermes de la Baie d'Amboine. Rev. Suisse de Zool. 1893. p. 363.

— — SAVILLE KENT. 1893. The Great Barrier Reef of Australia, its Products and Potentialities. p. 42. Pl. 28. Chromopl. XI.

— — KOEHLER. 1895. Catalogue raisonné des Echinodermes rec. par M. Korotnev aux îles de la Sonde. Mém. Soc. Zool. de France. 1895. p. 410.

— — PFEFFER. 1896. Ostafrikanische Echiniden, Asteriden u. Ophiuriden, ges. von Dr. F. Stuhlmann im Jahre 1888 u. 89. Mitth. Mus. Hamburg. XIII. p. 45.

— — LUDWIG. 1899. Echinodermen des Sansibargebietes. Abh. d. Senckenb. naturf. Ges. XXI. p. 552.

— *saxatile*. BEDFORD. 1900. On Echinoderms from Singapore and Malacca. Proc. Zool. Soc. p. 227.

— — DE MEIJERE. 1904. Echinoidea der Siboga-Exped. p. 49. Taf. XIV. Fig. 203.

Non: *Diadema antillarum* Philippi, nec *D. Savignyi* Mich. nec *D. globulosum* Ag.This species, although it has been so very often mentioned in the literature, needs yet a closer examination. AGASSIZ thinks it impossible to distinguish the West-Indian form of *Diadema*, *D. antillarum* Phil., from the Indopacific<sup>1)</sup> Not seen by the author.

form<sup>1)</sup>. Besides *D. saxatile* (*setosum*), he maintains only the West-American form, *D. mexicanum*, as a distinct species, though the differences in test and spines, which are pointed out as distinguishing characters (Rev. of Ech. p. 408), are, indeed, vary slight. But as „the pedicellariæ do not help us in the comparison“, as AGASSIZ states (loc. cit.), there seems to be nothing else left, and all the later authors, indeed, follow AGASSIZ in his view of the species of *Diadema*.

In spite of this universal agreement I am opposed to the representation of the *Diadema*-species given by AGASSIZ. I willingly grant that only very slight differences, scarcely sufficient to distinguish the species thereby, are found in test and spines; but in the positive assertion that the pedicellariæ do not help us in the discrimination of the species lies the fault. The pedicellariæ do indeed give excellent specific characters. A closer examination shows that *D. antillarum* is very well distinguished from *D. saxatile*, and that it is even more loosely related to *D. mexicanum* than to the former species. Further it becomes evident from an examination of the pedicellariæ that *D. Savignyi* Mich. also, which has likewise been made a synonym of *D. saxatile*, is a distinct species, and I should not be surprised, if there eventually proved to be yet more well distinguished species of this genus.

The test of *D. saxatile* does not differ so much from the test of the other species that it can always be recognised with certainty by the characters found in it alone. The following features must be pointed out as more important distinguishing characters. The pore-areas are somewhat widened towards the actinostome, the actinal pores are much smaller than those above the ambitus, though their „peripodia“ are comparatively much larger. They are arranged in close transverse series (arcs) of three, and there is a primary tubercle only to about every three or four arcs of pores. Above this widened part of the pore areas there is a primary tubercle on each compound ambulacral plate — as in all the species of *Diadema* known to me. In a small specimen (35 mm. in diameter) this widening of the pore areas is as yet only slightly developed, in large specimens it is very conspicuous.

The naked part in the interambulacral areas is comparatively larger in this species than in the others; the uppermost one of the large tubercles forming the inner row is found on the fifth or sixth plate from above (beginning with the first complete one), and these tubercles are thus scarcely seen above the ambitus. At the lower end of the naked space there is a conspicuous white, angular spot, covering the inner end of the three last naked plates. Also on the living animal this is seen as a white spot. — The genital plates have mostly a distinct dark impression above the genital pore (evidently corresponding to the blue spot seen there in the living animal) (Fig. 1). This is, however, not an absolutely reliable character, as the

<sup>1)</sup> BÖLSCHKE (Op. cit.) has first maintained the Atlantic form to be the same species as the Indopacific form. v. MARTENS (Op. cit. p. 156) thinks that improbable, but since AGASSIZ in his Revision declared himself to be unable to distinguish the Atlantic from the Indopacific form, nobody has doubted the correctness of this view.

dark impressions may sometimes (though seldom) be indistinct. The number of tubercles on the apical plates is very variable, there may even be none at all. The form of the apical plates is also rather inconstant. In the figure the madreporic plate is seen to spread over the adjoining ocular plates and also over another small plate. The diameter of the apical system is distinctly larger in this species than in the other ones. (Comp. the measures given below).

The pedicellariæ. PERRIER in his well known work on the pedicellariæ has given a good figure (Pl. 4. 1a) of the head of a smaller tridentate pedicellaria, the only one he has found; he names the species *D. savignyi*, but it must certainly be the true *D. saxatile*. (That the *D. turcarum* of PERRIER is synonymous with *D. saxatile* (*setosum*), as stated by AGASSIZ (Rev. of Ech. p. 104) and FOETTINGER<sup>1)</sup>, I must doubt on account of the pedicellaria figured by PERRIER (Pl. IV. 2) being much broader than those of *D. saxatile*). A second form of pedicellariæ has been described and figured by FOETTINGER (Op. cit. p. 485. Pl. 28. 9.); it is named „claviform“ pedicellaria. The same form has been described and figured by DE MELJERE (Op. cit. p. 50. Taf. XIV. Fig. 203). This is, I believe, all that is known of the pedicellariæ of this species, those figured by AGASSIZ (Rev. of Ech. Pl. XXIV. Fig. 38) evidently not belonging to *D. saxatile*, but, probably, to *D. antillarum*; his Fig. 39 is so little characteristic that it may be said to represent a very small tridentate pedicellaria of any of the *Diadema*-species.

Three kinds of pedicellariæ are found, viz. tridentate, triphyllous and ophicephalous (claviform) ones. The tridentate pedicellariæ occur in two forms, a large and a small one, which are, however, not sharply distinguished. In the large form (Pl. III. Fig. 22, 29. Pl. V. Fig. 2) — length of head upto 2 mm. — the valves are narrow, straight and wide apart, joining only at the point. The blade is rather deep, with a well developed smooth meshwork at the bottom reaching about the middle of the blade or even farther out. The edge is coarsely dentate in the whole length, only at the point the serrations are finer; in the lowermost part of the blade the edge with the dentations is mostly bent a little outwards. The neck of this kind of pedicellariæ is very short. In the smaller form of tridentate pedicellariæ (Pl. III. Fig. 23. Pl. V. Fig. 5, 8) — length of head c. 0,1—2 mm. — the valves are a little curved; they are wide apart, joining only at the point. The blade is essentially of the same form as in the large tridentate pedicellariæ, but there is no meshwork at the bottom and the edge is quite smooth or with a few dentations in the lower part. The point is a little widened, forming a distinct angle with the side-edge of the blade. The

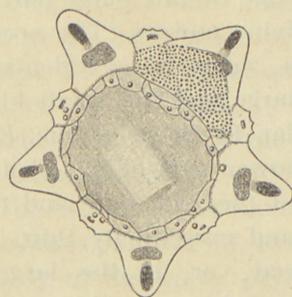


Fig. 1. Apical system of *Diadema saxatile*. (Nat. size).

<sup>1)</sup> Sur la structure des Pédicellaires gemmiformes de *Sphærechinus granularis* et d'autres Echinides. Arch. de Biol. II. 1881. p. 485.

edge of this outer part has extremely fine serrations, visible only under high magnifying powers. The neck of this small form is long. On Pl. V. Fig. 14, 15 is figured a valve of a tridentate pedicellaria intermediate in size and form between the large and the small kinds. — The triphyllous pedicellariæ (Pl. IV. Fig. 26) are similar to those of the *Echinidæ*; the apophysis does not form a coverplate over the lower part of the blade; the edge is quite smooth. The neck is long. — The stalk of the tridentate and triphyllous pedicellariæ is mostly very long, up to c. 10 mm., and exceedingly thin, being formed of only a single, somewhat thorny, calcareous rod, or, in the large tridentate pedicellariæ, of two rods, whose thorns unite and form crossbeams between them. At the upper and lower ends, below the terminal swelling, the stalk is thicker, consisting of some more irregularly connected rods (Pl. IV. Fig. 31, 34.). This structure of the stalk, which has also been observed by DE MEIJERE in this species and in *Chætodiadema granulatum* (Op. cit. p. 56), is very characteristic of the *Diadematidæ*.

The third kind of pedicellariæ, the ophicephalous or claviform ones, have no head, but three enormous glands on the stalk, which is short and thick, consisting of many rods irregularly connected by crossbeams, but not reaching to the point of the pedicellaria. They are about 1 mm. long. (Comp. FOETTINGER and DE MEIJERE). DE MEIJERE first pointed out that these claviform pedicellariæ are probably derived from ophicephalous pedicellariæ (Siboga-Ech. p. 56); that he is right therein, cannot be doubted, I think. The occurrence in *Chætodiadema granulatum* of claviform pedicellariæ with a head of undoubted ophicephalous structure together with the common claviform ones without a head proves it beyond doubt. The name „globiferæ“ used for these pedicellariæ by HAMANN (unfortunately also in „Bronn“) must then, as I have said in the „Ingolf“-Echinoidea (p. 169) be rejected on grounds of morphology as well as of priority, FOETTINGER having before HAMANN named them „ped. claviformes“; if we want a special name for them, which may be expedient we must call them claviform pedicellariæ, as has rightly been done by DE MEIJERE.

The sphæridia do not present any peculiar features; they are placed as figured by LOVÉN (Études sur les Échinoidées. Pl. X. Fig. 89) for *Astropyga*.

With regard to the buccal membrane I must refer to AGASSIZ (Rev. of Ech. p. 275) and LOVÉN (Echinologica. p. 31–32, Pl. XII. Fig. 153). Some pedicellariæ (small tridentate and triphyllous ones) are found on the buccal plates and the other plates of the buccal membrane, but mostly in small numbers. According to LOVÉN part of these plates are „studded with verrucules, spinules and forcipes“; probably these „spinules“ must be stalks of pedicellariæ; true small spines I have only seen on the buccal plates; I have never found spines on all the buccal plates of the same specimen, and generally there are none at all. It must also be added that the „spicules“ in the buccal membrane, mentioned by LOVÉN, are the common fenestrated plates. (Of course there are all transitional forms between the larger fenestrated plates and the small irregular „spicules“ in the *Diadematidæ*). The gills are pro-

vided with irregular fenestrated plates as in the *Echinidæ* etc.; on the side lying towards the test these plates are enormously developed so as to form a strong ridge which in dried specimens mostly adheres to the test, as a continuation of the gillslit, and surpasses it in length; in reality it is part of the gill itself.

Auriculæ and dental apparatus do not seem to give reliable specific characters. Especially do I find the auriculæ very inconsistent in form and size.

The irregular, usually triradiate, branched spicules in the tube feet have been well figured by STEWART<sup>1</sup>), PERRIER (Rech. sur les Pedicellaires p. 135. Pl. 4. 1b) and BELL<sup>2</sup>). They may be very few in number and present only in the upper part of the tube foot, or rather numerous and lying in the whole length of the foot. They are mostly arranged in three distinct series. The buccal tube feet, on the other hand, are very richly provided with spicules in form of large, fenestrated plates, a little curved according to the form of the foot, forming, as it were, a close mail to the foot. In the abactinal tubefeet there is often found in the partition wall a rather complicate calcareous network, formed of beams, which are widened to small fenestrated plates at their outer ends (Pl. V. Fig. 12). Otherwise spicules are not found in the abactinal tubefeet.

The spines have been very carefully studied by MACKINTOSH<sup>3</sup>), to whose descriptions and figures I must refer. He thinks specific differences exist in the structure of the spines of the *Diadema*-species, and he finds *D. antillarum* to be so different from the other species in this respect that he is inclined to regard it as a distinct form, in spite of the assertion of AGASSIZ that it is synonymous with *D. saxatile* (*setosum*). Though I completely agree with MACKINTOSH that *D. antillarum* is a distinct species, I cannot agree with him as to the structure of its spines. I find them quite like those of *D. saxatile*, and upon the whole I cannot discover any reliable difference in the structure of the spines between any of the species of *Diadema*. The figure (Pl. XXXI. 8) given by MACKINTOSH as a transverse section of the median region of the shaft of a primary spine of *D. antillarum* is probably taken from an injured spine. In another treatise<sup>4</sup>) MACKINTOSH mentions having found dimorphic spines in *D. mexicanum* „there being the usual long, tapering, verticillate spines with the normal *Diadema* structure which occur all over the test and a limited number of fusiform ones placed on the actinal surface. These are about half an inch in length, are longitudinally striated, not verticillate, as *Diadema* spines mostly are. . . — It is also interesting that on the same specimen there occur a few

<sup>1</sup>) On the Spicula of the Regular Echinoidea. Transact. Linn. Soc. London. XXV. 1865. p. 368. Pl. 48. Fig 17. a.

<sup>2</sup>) 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. V.

<sup>3</sup>) Researches on the structure of the spines of the Diadematidæ. Trans. R. Irish Acad. XXV. 1875. p. 519—58. Pl. XXXI\*—XXXIII.

<sup>4</sup>) Report on the Acanthology of the Desmosticha III. Further Observations on the Acanthology of the Diadematidæ. Ibid. XXVIII. 1883. p. 259.

spines which present characters intermediate in some ways between the other two<sup>4</sup>. This is quite true, but it may be remarked that the statement holds good for all the species of *Diadema*. In all of them the primary spines of the actinal side are somewhat fusiform or clubshaped, indistinctly verticillate, especially at the point, longitudinally striated; while towards the abactinal side they gradually assume the typical form.

The living animal affords a most beautiful sight, with its well known blue spots, contrasting with the black colour of the test. The anal tube is about 1 cm. long, grey, with a band of yellowish red around the opening. The colouring of the spines (black banded or even quite white) is of no specific importance, as is also asserted by most previous authors. The small secondary spines are in a constant, lively circular motion, the large spines being much more slowly moved. — The habits of this most interesting sea-urchin are well known (SARASIN, DÖDERLEIN, SAV. KENT etc.), and my observations agree with those of these authors. The symbiosis of fishes (*Engraulis?*) with this species (SARASIN<sup>1</sup>), COUTIÈRE<sup>2</sup>) I have not observed.

Numerous specimens were found at Koh Chang and Koh Kahdat; mostly they were seen in large numbers (c. 10—20) together in bare places between the corals, at a depth of 1—5 fathoms. Some specimens were taken at Pulo Redang by the Skeat Expedition.

The distribution of *D. saxatile* has hitherto (since Rev. of Ech.) always been said to be cosmopolitan in the warm region. As now the Atlantic form proves to be a distinct species, the occurrence of the true *D. saxatile* is restricted to the Indo-pacific ocean. Here it seems to be universally distributed in the warm region (together with *D. Savignyi*). I have seen specimens from Zanzibar, Singapore, Siam, Cebu and Tahiti. From the West-American coast it is not known.

I shall now point out the characters by which the other species of *Diadema* are distinguished from *D. saxatile*.

*D. antillarum* Phil. The pore areas are not distinctly widened at the actinostome and the pores here not much smaller than those above the ambitus. As in *D. saxatile* there is not a primary tubercle on each compound ambulacral plate; in small specimens, however, there is a primary tubercle on each plate and such is evidently the case also in *D. saxatile*. It seems then that some of these tubercles — and spines — are absorbed as growth proceeds. The uppermost one of the large interambulacral tubercles of the inner series is found on the 4th or 5th plate from above, the naked space being smaller and the inner series of tubercles reaching higher above the ambitus than in *saxatile*. There are no dark impressions on the genital plates. Apical system small (see measurements given below). The triphyllous

<sup>1</sup>) Über einen Lederigel aus dem Hafen von Trincomalie (Ceylon) und seinem Giftapparat. Zool. Anzeiger. IX. 1886. p. 82.

<sup>2</sup>) Observations sur quelques animaux des recifs madréporiques de Djibouti. Bull. Mus. d'hist. nat. Paris. 1898. p. 238.

pedicellariæ as in *D. saxatile*. Besides the usual claviform pedicellariæ true ophicephalous pedicellariæ also occur; in very young specimens I have found only the latter form; in a specimen of 10 mm. diameter I have found both forms together; in larger specimens only the claviform ones seem to occur. The ophicephalous pedicellariæ are long-stalked without neck and without glands on the stalk. The valves (Pl. III. Fig. 16) are small but of the typical structure, with the usual arc below the articular surface. The tridentate pedicellariæ (Pl. III. Fig. 1, Pl. IV. Fig. 28) are very different from those of *D. saxatile*; the valves are rather short (head c. 1 mm), the blade is broad, spoonshaped, with rather few serrations on the edge, and they are wide apart, joining only at the point. These tridentate pedicellariæ are found as well on the test as on the buccal membrane; on the test some larger tridentate pedicellariæ (head 1,3 mm.) may be found, with narrower, simply leafshaped blades. These latter are more similar to those of *D. saxatile*, though different enough, especially in the edge being much less serrate. The small tridentate pedicellariæ (Pl. III. Fig. 10, Pl. V. Fig. 13) are more like those of *D. saxatile*, only mostly broader. In some small specimens (14—15 mm. in diameter) only small tridentate pedicellariæ were found. The spicules are like those of *D. saxatile*; they are found only in the outer end of the actinal tube feet; in the abactinal ones neither common spicules nor supporting beams in the partition wall are found.

*D. mexicanum* Ag. As an essential character of this species AGASSIZ points out (Revision p. 408) that the abactinal system is larger in proportion than in *D. saxatile*, with a larger anal system and larger genital plates. There is, indeed, some difference in the size of the abactinal system in the species of *Diadema*, but since AGASSIZ's *D. setosum* contains both *D. saxatile* and *D. antillarum*, his statement must be corrected. The diameter of the apical system is, contrary to the statement of AGASSIZ, larger in *D. saxatile* than in the other species; in *D. antillarum* it is of about the same size as in *D. mexicanum*. The single measurement given by AGASSIZ for the abactinal system of *D. setosum* (Revision. p. 275) has probably been taken from a specimen of *D. antillarum*: I shall give some measurements of the three species named, to which *D. Savignyi* may be added.

<i>D. saxatile</i> .		<i>D. antillarum</i> .		<i>D. mexicanum</i> .		<i>D. Savignyi</i> .	
Test	Apical system.	Test	Apical system.	Test	Apical system.	Test	Apical system.
70 mm.	20 mm.	80 mm.	15 mm.	65 mm.	13 mm.	40 mm.	10 mm.
49 —	13 —	67 —	15 —	51 —	10·5 —		
45 —	13 —	56 —	10 —				
		55 —	10·5 —				
		45 —	10 —				

In the form and size of the apical plates and in the size of the periproct and the peristome I do not find any reliable difference. The pore-areas are as in *D. antillarum*; the pores are not much smaller towards the peristome. There are no dark impressions on the genital plates. The naked space in the interambulacral

areas rather small, the uppermost tubercle of the inner row being found on the fourth plate from above. The triphyllous and claviform pedicellariæ are like those of the other species; the large tridentate pedicellariæ (Pl. III. Fig. 20, Pl. V. Fig 1) somewhat resemble those of *D. antillarum*, mostly having a distinct inward folding in the outer end (this feature may also be found sometimes in *antillarum*). The small tridentate pedicellariæ (Pl. III. Fig. 2) have the outer end of the blade a little broader and the corners towards the side-edge a little farther down than in *D. antillarum*. The spicules as in *D. antillarum*. These differences, however, are very slight, and it may be doubtful whether one could say with certainty, if a specimen be *D. antillarum* or *mexicanum*, if it were not known from which side of America it had come. It can scarcely be doubted that they were one species before the formation of the Isthmus. From *D. saxatile* both are easily distinguished, especially by their pedicellariæ.

*D. Savignyi* Mich. The pore areas are not widened at the peristome and the pores are not much smaller below than above the ambitus; there is a primary tubercle to every compound ambulacral plate. Mostly no distinct dark impression on the genital plates. The naked space in the interambulacral areas rather small; the uppermost tubercle of the inner row found on the 5th plate from above. The large tridentate pedicellariæ (Pl. III. Fig. 8. Pl. V. Fig. 7) — head c. 1,5 mm. — with the blade broad and flat, often somewhat irregular. There may be a pair of wingshaped crests on the back of the blade in the larger ones. In the smaller tridentate pedicellariæ (Pl. IV. Fig. 37, Pl. V. Fig. 9) the blade is broad, with the edge strongly serrate. On the buccal membrane some very small tridentate pedicellariæ are found, very similar to those of *D. mexicanum* (Pl. III, Fig. 6, Pl. V. 24). The actinal tubefeet are mostly richly provided with spicules, and often larger irregular fenestrated plates, arranged in three or four longitudinal series, occur in the whole length of the foot; especially at the base of the foot some large plates may be found. In the abactinal tubefeet two longitudinal series of the common triradiate spicules are generally found; they form no supporting beams in the partition wall.

That this is a distinct species I think is evident from the observations here given. That it is really the *D. Savignyi* Mich. I think certain. I have examined in the Museum of Paris a specimen named thus, from Zanzibar, Rousseau 1841. To be sure I found upon it only one large tridentate pedicellaria, which was so crushed that only the basal part was preserved; but in the tubefeet some large fenestrated plates occur, and as I have observed such spicules in no other species, I think we can safely use the name *D. Savignyi* for this species. The differences between *D. Savignyi* and *mexicanum* are evidently very slight. Upon the whole the three species *D. Savignyi*, *mexicanum* and *antillarum* are very nearly related, where as *D. saxatile* stands more distantly, being at once and easily recognized by its narrow tridentate pedicellariæ. *D. Savignyi* probably occurs together with *D. saxatile* in

the whole Indo-pacific region. In the Gulf of Siam and at Singapore, however, it does not seem to occur.

Besides *D. antillarum* and *Savignyi* AGASSIZ further names *D. globulosum* Ag., *paucispinum* Ag. and *nudum* Ag. as synonyms of *D. saxatile* (*setosum*). Of *D. globulosum* there is an authentic specimen in the Museum of Copenhagen, received from AGASSIZ (Society Islands). It is not the same species as *saxatile*. The large tridentate pedicellariæ (head 1 mm.) have broad valves (Pl. III. Fig. 7.). Very slight traces of dark impressions are found on the genital plates. The uppermost tubercle of the inner interambulacral row is found on the fifth plate from above. The specimen in hand is in no way more globular than specimens of *D. saxatile* of a corresponding size, so that the form of the test will not give any reliable difference; and I cannot decide from the single small specimen in hand, if other distinguishing characters exist in the structure of the test. Spicules as in *D. saxatile*. — Possibly this form will prove to be a distinct species, but for the present I must regard it as synonymous with *D. Savignyi*. — Of *D. paucispinum* we have likewise an authentic specimen (from the Sandwich Islands), but unfortunately it has been denuded, so that I have not been able to examine its pedicellariæ and spicules. I think it certain, however, that it is not synonymous with *D. saxatile*, on account of its small apical system, the small naked interambulacral spaces and the absence of dark impressions on the genital plates. Probably it is also synonymous with *D. Savignyi*. — *D. nudum* I do not know, and from the description<sup>1)</sup> nothing at all can be inferred with regard to its true place. — As for *D. Lamarckii* Rouss. I must state, after having examined the type specimen in Paris, that it is really identical with *D. saxatile*.

The SARASINS<sup>2)</sup> mention a form of *Diadema* from Ceylon, which they take to be distinct from *saxatile*. It has a black analtube, and the blue spots are „in Reihen zusammengeschmolzen, so dass die Interambulacra an Stelle der blauen Fleckenreihen mit continuirlichen blauen Bändern geschmückt erscheinen“. Evidently this form is no *Diadema* at all but an *Echinothrix* (*diadema*<sup>3)</sup>), as appears from the numerous small ambulacral tubercles (Op. cit. Taf. III. Fig. 16). Also v. UEXKÜLL<sup>3)</sup> mentions „zwei Arten von *Diadema*“, which he has used for his experiments in Dar-es-Salaam. But he does not give any information as to the differences between these two species. As he likewise mentions a species of *Echinothrix* and one of *Astropyga*, it cannot well be supposed that his second species of *Diadema* belongs to a different genus. Probably v. UEXKÜLL's two species of *Diadema* from Dar-es-Salaam are *D. saxatile* and *Savignyi*, which seems to indicate, that the two species are easily distinguished in the living state.

<sup>1)</sup> Synopsis of the Echinoidea collected by Dr. W. Stimpson on the North Pacific Exploring Expedition. Proc. Acad. Nat. Sc. Philadelphia. 1863. p. 353.

<sup>2)</sup> Ergebnisse naturwiss. Forschungen auf Ceylon. I. Die Augen und das Integument der Diademiten. 1887. p. 5. (Taf. III, 16).

<sup>3)</sup> Die Wirkung von Licht und Schatten auf die Seeigel. Zeitschr. f. Biologie. 40. 1900. p. 448.

3. *Astropyga radiata* (Leske).

Pl. III. Figs. 15, 19. Pl. IV. Figs. 9, 17. Pl. V. Fig. 27.

- Cidaris radiata*. LESKE. 1778. Additamenta ad J. Th. Kleinii Naturalis Dispositio Echinodermatum. p. 52. Pl. 44. 1.
- Astropyga radiata*. AGASSIZ & DESOR. 1846. Catal. raisonné des Echinodermes. p. 41.
- Astropyga mossambica*. PETERS. 1854. Über die an d. Küste v. Mossambique beobacht. Seeigel. p. 112. Fig. 1.
- *radiata*. v. MARTENS. 1866. Über ostasiatische Echinodermen. p. 157.
- — AGASSIZ. 1872. Rev. of Ech. p. 94, 420. Pl. XXIV. Fig. 40.
- *elastica*. STUDER. 1876. Über Echinod. a. d. antarkt. Meere u. zwei neue Seeigel a. d. Papua-Inseln. Monatsber. d. Berl. Akad. 1876. p. 464.
- — STUDER. 1881. Übers. über die während d. Reise S. M. Corv. „Gazelle“ ges. Echinoiden. Ibid. p. 869.
- *radiata*. DE LORIOI. 1883. Catalogue rais. Echinod. à l'île Maurice. p. 18.
- *Freudenbergi*. P. u. F. SARASIN. 1887. Ergebn. naturw. Forsch. auf Ceylon. I. p. 16. Pl. I.
- *radiata*. DÖDERLEIN. 1888. Echinod. von Ceylon. Zool. Jahrb. Syst. III. p. 334.
- — SLUITER. 1889. Die Evertibr. a. d. Samml. naturw. Vereins Batavia. Echinoidea p. 290.
- — KOEHLER. 1895. Catalogue rais. Echinod. îles de la Sonde. p. 412. Pl. IX. Fig. 9.
- — DÖDERLEIN. 1902. Bericht über d. v. Herrn Prof. Semon bei Amboina u. Thursday Isl. ges. Echinoidea. p. 699. Pl. 59. Fig. 67.
- — DE MEIJERE. 1904. Echinoidea der Siboga-Exped. p. 56.
- Other references to the old literature are found in AGASSIZ' „Rev. of Ech.“ p. 94.

After the careful description of this species lately given by DÖDERLEIN (Op. cit.) I need not say anything of the structure of the test; only a single fact I might point out, viz. that in the ambulacra primary tubercles are not found on all the ambulacral plates, but only on every second or third plate<sup>1)</sup>, as is indeed well seen on the figures given by DÖDERLEIN. Only at the peristome (and in young specimens) there is an almost regular series of primary ambulacral tubercles, one to each plate. (For a most careful examination of the composition of the ambulacra in *Astropyga* comp. DUNCAN. On the anatomy of the Ambulacra of recent Diadematidæ. J. Linn. Soc. Zool. XIX. 1885. p. 107. Pl. V. Fig. 9—10).

The primary spines of the abactinal side, especially the ambulacral ones are a little curved at the base; the fine secondary spines, abactinal and actinal are very distinctly curved. This fact also holds good for *A. pulvinata*. The milled ring is oblique, as figured by PETERS (Op. cit. Fig. 1 a.); this is a very prominent feature, especially on the large spines at the ambitus. A few small spines are found on the buccal plates.

The spicules (Pl. IV. Fig. 9) are small, irregular, triradiate bodies, arranged in mostly 5 longitudinal series; below the sucking disk they are rather numerous,

<sup>1)</sup> In the description of *A. pulvinata* in „Rev. of Ech.“ AGASSIZ has noticed this feature (p. 419), and perhaps the sentence „between most of the primaries a small secondary is intercalated“ in the description of *A. radiata* means the same thing (p. 420). *A. denudata* de Meijere has a primary tubercle on each ambulacral plate (De Meijere Op. cit. p. 58).

in the lower part of the foot they are generally very scarce. In the abactinal tubefeet no spicules are found, except at the point, where a few spicules of the common form may be seen. The buccal tubefeet, on the other hand, are provided with large, irregular fenestrated plates, curved in accordance to the form of the foot. (They are arranged transversely to the longitudinal axis of the foot). The gills contain the usual irregular spicules, though there are very few in the finer branches. On the side turning towards the test there is a large, thick plate, as is usual in the Diadematids. According to BELL<sup>1)</sup> the spicules of *Astropyga* are anchorshaped, like those of *Micropyga*. This statement must have been caused by a wrong identification of a species of *Micropyga* as an *Astropyga* (Comp. below: „*Astropyga Freudenbergi*“); in all the species of *Astropyga* the spicules are triradiate.

The pedicellariæ of this species are up to the present time only very incompletely known. AGASSIZ (Rev. of Ech. Pl. XXIV. Fig. 40) has given a not very good figure of a valve of a tridentate pedicellaria, and KOEHLER (Op. cit.) has figured a claviform pedicellaria. Also LOVÉN has figured the claviform pedicellariæ of *Astropyga pulvinata* in his „Etudes sur les Echinoidées“ Pl. X. Fig. 89, without mentioning them, however, in the text. Nothing more is found in the literature on this subject— to my knowledge. — The pedicellariæ of *A. radiata* are as in *Diadema*: tridentate, triphyllous and claviform. The tridentate pedicellariæ occur in two forms; the first form, which is found in very different sizes, from c. 0.5 to more than 2 mm. (length of head), has the blade rather broad and deep, simply leafshaped. (Pl. III. Fig. 15. Pl. V. Fig. 27.) The edge of the blade is coarsely dentate in the lower part; in the outer part, where the valves join, the edge is straight and very finely serrate. In the smaller ones the valves join throughout almost their whole length, in the larger ones they are apart for about  $\frac{2}{3}$  of their length. At the bottom of the blade there is, in the larger ones a well developed meshwork in continuation with the apophysis; in the small ones, there is only an indication of such a meshwork. The neck is quite short in the larger ones, well developed in the smaller ones. The other, small form of tridentate pedicellariæ (Pl. III. Fig. 19) is of the same form as the small ones in *Diadema saxatile*; the blade is narrow, with the outer end marked off at an angle with the lower part of the edge, which may be coarsely serrate in its whole length or with only a pair of indentations at the lower end. The valves are a little curved and join only at the point. The neck is very long. — The claviform pedicellariæ are of the common form and structure; no true ophicephalous pedicellariæ are found. The triphyllous pedicellariæ (Pl. IV. Fig. 17) are very beautiful, the holes in the outer part of the blade being so very elongate as to pass from the outer edge more than half way down. The apophysis forms a little coverplate over the lower part of the blade. The outer edge is smooth. The stalk of the pedicellariæ is as in *Diadema*.

<sup>1)</sup> Note on the spicules found in the ambulacral tubes of the regular Echinoidea. Journ. R. Microsc. Soc. 2 Ser. II. 1882. p. 298.

Two large, beautiful specimens were taken at Koh Kahdat, in 4—5 fathoms.

DÖDERLEIN regards *A. elastica* Studer and *A. Freudenbergi* Sarasin as synonyms of *A. radiata*. I must decidedly follow him therein. I have examined in the Berlin-Museum the type specimen of *A. elastica* and a specimen of *A. Freudenbergi* with regard to pedicellariæ and spicules and find them quite identical with those of *A. radiata*. As *A. pulvinata* Lamk. and *denudata* de Meijere differ markedly from *radiata* in regard to pedicellariæ, one might expect also to find some difference here, if they were really distinct species. The characters pointed out by the authors as distinctive have been shown by DÖDERLEIN to be quite unreliable. Evidently they cannot be maintained as distinct species, not to speak of a distinct genus as suggested by SARASIN. To be sure BELL<sup>1)</sup> maintains *A. elastica* to be distinct from *A. radiata*, and he is even right in some way. I have seen his specimens of *elastica* in the British Museum; they are so far from being identical with *A. radiata* that they are no *Astropyga* at all, but a species of *Micropyga* (*M. violacea* de Meijere, probably). I have not examined the disposition of the pores in these specimens, it is true, but the anchor-shaped spicules in the tubefeet show beyond all doubt that they belong to the genus *Micropyga*. — STUDER says of his *A. elastica*: „die ganze Schale war mit einer dicken gallertigen Epidermis überzogen“ (p. 869). I have not remarked the epidermis in my specimens to be especially jelly-like. — The type specimen of *A. mossambica* Peters I have also examined for pedicellariæ and spicules and found them to be identical with those of *A. radiata*.

The differences between *A. radiata* and *pulvinata* in the structure of the test have been most excellently represented by DÖDERLEIN. I may here point out the difference in the pedicellariæ. The tridentate pedicellariæ occur in one form only, all transitional forms being found between the largest and smallest ones. The largest ones found are about 0,8 mm. (head), with a short neck; the smaller ones have a long neck. The blade in the larger ones is mainly of the same form as in *A. radiata*, but the edge is more irregular (Pl. III. Fig. 3). Below there are a few large indentations, the edge being bent somewhat outwards; between these indentations and the outer, well marked portion, where the valves join, the edge shows a large irregular sinuation. There is very little meshwork in the bottom of the blade. The smaller forms are more like those of *radiata*. The triphyllous pedicellariæ (Pl. IV. Fig. 21) are not very different from those of *radiata*; the holes in the blade are less elongate and the apophysis does not form so distinct a cover-plate. The claviform pedicellariæ and the stalk of the pedicellariæ are as in *radiata*. The spicules are like those of *radiata*, but they are rather numerous in the abactinal tubefeet as well.

<sup>1)</sup> Report on the Echinoderms (other than Holothurians) collected by Dr. Willey. WILLEY. Zoological Results. II. 1899. p. 135.

AGASSIZ in his „Challenger“-Echinoidea p. 70. records *A. pulvinata* from the Arafura Sea (Chall. St. 188 and 190) and from off Honolulu. As this species is a littoral form and has its home on the pacific coast of America, it was a highly remarkable fact to find it on both sides of the Pacific; its eastern and western representatives were thus separated by the immense, deep tracts of the Pacific Ocean which are uninhabitable for littoral forms. It seemed then a little doubtful to me, whether the Challenger specimens really were *A. pulvinata*, the more so, as the description given of a young specimen indicates something rather different from the usual features in *Astropyga*, so that AGASSIZ is led thereby to the conclusion that „it is very evident from the above that in both these species (*A. radiata* and *pulvinata*) we have considerable variation in some of the characters which have thus far been employed to distinguish the two species“. I have examined all the Challenger-specimens and find that none of them are *Astropyga pulvinata*. The specimen of 19 mm. diameter (St. 190) described by AGASSIZ is *Chatodiadema granulatum* (as I had already supposed from the description), and the specimen from St. 188 is the same species. The specimens from Honolulu are either *A. radiata* or perhaps a new species, very nearly related to it. The arrangement of the series of large interambulacral tubercles is as in *A. radiata*, the series being parallel to the outer edge of the area, not to the median line as in *pulvinata*. There is a primary tubercle only to every second ambulacral plate. The pedicellariæ are so very similar to those of *A. radiata* that scarcely a reliable difference can be found therein. The spicules are as in *radiata*. The abactinal spines are beautifully ringed with narrow redbrown and broad white bands; a few are uniformly redbrown with the point a little darker. The actinal spines are almost or quite white. The coloration of the abactinal side reminds one somewhat of *A. pulvinata*; the naked, forked band in the interambulacral area is brown, becoming gradually darker towards the median area and is very sharply marked off from the uniformly white median area by an intensely brown border. This beautiful coloration is very well shown in the two specimens, and the third specimen shows distinct traces of it. Perhaps a closer examination will show this form to be a distinct species or a well marked variety of *radiata*; for the present I must regard it as *A. radiata*. Unfortunately I have not younger specimens of *A. radiata* at my disposal; there is only one medium-sized specimen in the Copenhagen-Museum, and it is white, with ringed spines. Now it seems rather remarkable that the younger specimens should be light coloured with ringed spines and the large ones very dark with uniformly dark spines. If young specimens of a uniform dark colour be found besides the light coloured ones, I can scarcely doubt that they will prove to be two distinct species. (The ringed or uniformly coloured spines do not present a reliable character, as both kinds may occur in the same specimen.) Dr. DE MEIJERE has kindly given me information of the colour of the young specimens from the „Siboga“-Expedition. The specimens from Amboina and Banda have the median

part of the interambulacra light coloured and contrasting with the dark colour of the outer part of the area. The other specimens are uniformly coloured, though in two of the specimens from St. 144 the median part of the interambulacra is somewhat lighter. Dr. MEIJERE does not think them to be two species, and, of course, I dare not assert the contrary without having examined the specimens in question. But I think the matter deserves a close examination based on large material. — SLUITER (Op. cit. p. 290) mentions *A. pulvinata* from Billiton and Krakatau; in „Die Echiniden-Sammlung des Museums zu Amsterdam“<sup>1)</sup> he refers these specimens to *A. radiata* on account of the presumed inconstancy of the distinguishing characters of *A. radiata* and *pulvinata*, which AGASSIZ thought he had proved. According to DE MEIJERE (Op. cit. p. 55) three specimens in the Museum of Amsterdam named *Astropyga radiata* are really *Chaetodiadema granulatum*, and probably the specimens from Billiton and Krakatau will prove to be the same species. That they are not *A. pulvinata* we may take to be certain.

In the „Challenger“-specimens from Honolulu I found a worm-like animal parasitic in the spines; it is found half buried in the point of the spine, which has become a little swollen on that account. Prof. SHIPLEY who has dissected two of these specimens thinks they are a parasitic Mollusc; but the material in hand is not sufficient for giving a description of this curious parasite.

#### 4. *Chaetodiadema granulatum* Mrtsn.

Pl. I. Figs. 1, 3, 21—22. Pl. III. Fig. 11. Pl. IV. Figs. 1, 4, 13—15, 24, 32. Pl. V. Figs. 10, 18, 19, 22, 35.

*Astropyga pulvinata* (pro parte). AGASSIZ. 1881. Report on the scientific Results of the voyage of H. M. S. „Challenger“. III. Echinoidea. p. 70.

— — (?) SLUITER. 1889. Die Evertebr. a. d. Samml. d. naturwiss. Vereins Batavia. Echinoidea. p. 290.

— *radiata* (pro parte). SLUITER. 1895. Die Echiniden Sammlung des Museums zu Amsterdam. Bijdr. tot de Dierkunde. Afl. 17. p. 68.

*Chaetodiadema granulatum*. TH. MORTENSEN. 1903. *Chaetodiadema granulatum* n. g., n. sp., a new Diademid from the Gulf of Siam. Vidensk. Medd. Naturh. Foren. Kjøbenhavn. 1903. p. 1.

— — DE MEIJERE. 1904. Echinoidea d. Siboga-Exped. p. 54. Taf. III. Fig. 28, Taf. XI. Fig. 101, Taf. XIV. Fig. 205—208.

After the publication of my preliminary description of this interesting form DE MEIJERE gave an additional description and some figures of the specimens taken by the „Siboga“-Expedition. As I have yet several things to add, it will be desirable, however, that a complete description should be given here, as promised in the preliminary description.

The test is greatly depressed and very flexible as in the Echinothurids. Seen from the abactinal side the animal looks much like *Astropyga*. The apical area

<sup>1)</sup> Bijdr. tot de Dierk. afl. 17. 1895. p. 68.

(Pl. I. Fig. 1, 21) is large (21 mm. in the specimen of 90 mm. in diameter, on which the description of the test is based), of the usual diadematoïd structure, all the ocular plates being contiguous with the periproct in their whole width; the genital plates are not much elongated. Inside the ocular and genital plates there is a band of small, irregular plates, carrying small spines; the median part of the periproct is naked; there is (according to DE MEJERE) some variation in the relative size of the naked median part of the periproct and the outer ring of plates. There is a large analtube; a small papilla covers each genital opening. (In *Astropyga* I have not been able to find such a papilla). A few small tubercles are found on the genital plates.

The interambulacral areas do not differ in any essential character from those of *Astropyga*, as regards the abactinal side. The uppermost one in the outer series of large tubercles is found on the 9th or 10th plate from above. It is said in the preliminary description that „there is no distinct series of secondary tubercles on either side of this series, only irregularly placed miliary tubercles“. This is not quite correct; there may be a rather distinct series of small tubercles on the almost naked upper interambulacral plates. This series can be traced down to where the large tubercles begin, and here a small tubercle at the upper and inner side of the scrobicular area may be seen to succeed those of the upper plates. There may thus be said to be an inner, longitudinal series of small tubercles along the outer series of large tubercles. The inner series of large interambulacral tubercles commence gradually on the following plates, the second series on the 10th or 11th plate, the third series on the 11th or 12th plate etc. There are 12 longitudinal series of large tubercles in all, arranged (on the actinal side) parallel to the median line of the area, as in *Astropyga pulvinata*. On the abactinal side, however, the series of tubercles are parallel to the outer edge of the area. The naked space with the blue spots, parallel to the outer series of tubercles, disappears suddenly at the ambitus, where a new series of tubercles occupies its place, as in *A. pulvinata*; in one of the specimens, however, the naked space disappears gradually at the ambitus between the two outer series of large tubercles, as in *A. radiata* and as is also the case in DE MEJERE'S specimen. In this specimen the direction of the inner series of large tubercles is a little more convergent towards the median line of the area than is otherwise the case. The large median interambulacral space is set with scattered miliary tubercles.

The ambulacral areas in the large specimens are not raised above the interambulacral areas; in small specimens I find them a little raised, as has been stated by DE MEJERE. There is a primary tubercle on every compound plate, whereas in *Astropyga*, — viz. in *A. radiata* and *pulvinata*, — a primary tubercle is found only on every second or third plate. These tubercles are smaller than the interambulacral ones; the uppermost one is found on about the 10th plate from above. Inside the primary tubercles some small secondary and miliary tubercles

are found, the largest one mostly placed in the inner corner of the plate. Between the pores some small tubercles are found. The uppermost plates are quite naked.

In the character of the actinal side this form differs very much from *Astropyga* and, indeed, from all other Diadematids. The large tubercles only reach just below the ambitus; then they suddenly diminish very much in size, and from here the whole actinal side is covered by a very close and fine, uniform granulation, through which the limits of the plates cannot be traced. The tubercles forming this granulation are, however, not of the same size; some are a little larger, with distinct scrobicular area; the others are quite small miliary tubercles filling up all the spaces between the larger ones. In the outer part of the granulated portion there are, in both areas, indications of an arrangement of the tubercles in longitudinal series, in continuation of the series of large tubercles at the ambitus, but this arrangement is soon lost in the uniform granulation. At the edge of the peristome the test is bent strongly inwards, the ambulacral areas being somewhat sunken below the interambulacral areas. In the granulated part of the ambulacral areas the pores are very small, scarcely half as large as those at the ambitus and on the abactinal side; towards the apical system they are much larger; in smaller specimens the size of the pores is almost the same on both sides. In the outer part of the granulated portion in large specimens they are closely and irregularly arranged; in the inner part, from about half way to the peristome, they are arranged in a single, almost straight row, the pores being wide apart from each other, an arrangement the more curious as otherwise the pores are usually very crowded at the edge of the peristome. Where the arrangement of the pores in a single series commences the ambulacral area is a little widened and from here again it becomes gradually narrower towards the peristome.

An examination of the interior of the test gives a clear view of the structure of the abactinal ambulacral plates; they are constructed after the diadematoid type and they are not arranged in compound plates of two triplets as in *Astropyga*<sup>1)</sup>. On the actinal side the structure cannot be seen distinctly in large specimens, partly on account of the plates overlapping each other irregularly, and not adorally alone. As the pores are so wide apart from each other, one might suppose it to be the case here as in *Kamptosoma* that some of the primary components of the plates had disappeared. That such is not the case, however, is sufficiently shown by the radial watercanal which has no rudimentary branches on it; all the branches and their ampullæ and tubefeet are well developed; but in the proximal part they are wide apart; whereas farther out they are very crowded. The plates are thus composed of the usual primary components, but these are excessively large.

<sup>1)</sup> Comp. DUNCAN: On the Anatomy of the Ambulacra of the recent Diadematidæ. (J. Linn. Soc. Zoology. XIX. 1885.)

In young specimens the structure of the ambulacra is more easily seen to be typically diadematoid. The structure of the interambulacral areas is well seen from the inside, also on the actinal side. In accordance with the large size of the ambulacral plates the interambulacral ones are very large (high) at the peristome, very short and crowded in the outer part of the granulated portion, and here they seem to split up into several small, irregular pieces at the median end, a feature which is evidently something secondary<sup>1</sup>). In the other part of the test there is no indication of any division of the interambulacral plates; they are rather distinctly overlapping, the adoral edge being covered (as seen from without).

The peristome is small, about  $\frac{1}{4}$  of the diameter of the test (22 mm. in a specimen of c. 90 mm. diameter of test); DE MEIJERE finds it even smaller, 11 mm. in a specimen of 60 mm. diameter. The buccal membrane contains numerous irregular, fenestrated plates; the buccal plates do not carry pedicellariæ or spines. The mouthslits are very small and indistinct; the gills are very small, containing the usual irregular spicules. The compact plate in the part of the gills turning towards the test is small and short.

The spines on the abactinal side and at the ambitus are slender and straight,  $\frac{1}{3}$ — $\frac{1}{2}$  times as long as the diameter of the test; those just below the ambitus are flattened and a little widened at the point. The actinal spines are short, c. 8 mm. (in DE MEIJERE'S specimen only 5 mm.), curved, very close set, giving the animal a curious, almost bearded appearance. Those at the peristome are a little longer. The milled ring is oblique as in *Astropyga*, even to an extreme degree in the spines at the ambitus (Pl. V. Fig. 10). The spines are verticillate as usual in the *Diadematidæ*; in the small spines the thorns may be bent outwards. In the small abactinal spines the whorls of thorns continue to the very point, in the small actinal ones the end

<sup>1</sup>) AGASSIZ has observed a similar splitting up of the interambulacral plates in *Astropyga* (Chall. Echinoidea. Pl. X. a. fig. 9.) „into irregularly shaped independent plates, thus producing interambulacral areas which, as in the Palæechinidæ proper are composed of more than two vertical rows of plates . . . In *Astropyga* we find that the large interambulacral plates from the edge of the ambitus nearly to the abactinal system, as far as the external line of primary tubercles extends, are made up of two very distinct plates, so that in *Astropyga* as well as in *Phormosoma* (viz. *Echinoma tenue*, — Chall. Ech. p. 95) we have an interambulacral area, in which the vertical zones are not composed simply of two rows of plates but of four“. (Chall. Ech. p. 72). Later on (p. 78) this splitting up of the plates in *Astropyga* is said to be „limited to a few plates on the actinal side(s) of the test“, and on p. 95 it is likewise said to be on the actinal side. DUNCAN (Op. cit. p. 110) has not been able to see this splitting up of the plates in *Astropyga*; but whether it usually exists or not, and, if it exists, whether it be on the abactinal or actinal side, it is certainly wrong to see a remnant of the palæechinoid structure therein. If it were really a palæechinoid remnant, it must evidently be found in the young specimens; but it has not been shown to exist in the young specimens, and it is rather probable that the splitting up of the plates in large specimens may be due simply to the breaking of the delicate plates by the handling of the specimens — both in *Astropyga*, *Chætodidema* and *Echinoma*, and, without doubt, all large forms with such delicate plates. — Unfortunately I have not had sufficient material of *Astropyga* for examining the question myself.

is without thorns (Pl. IV. Fig. 14). In transverse sections the spines look essentially like those of *Astropyga* (Comp. MACKINTOSH. Researches on the structure of the spines of the Diadematidæ. Trans. R. Irish. Acad. XXV. 1875. p. 544. Pl. XXXIII. figs. 31—35). The central cavity is filled with a very open reticular network; the solid radii may be connected by a few transverse bars. In the flattened end of the spines at the ambitus the cavity is quite filled by a close meshwork. (Pl. V. Fig. 18—19).

The pedicellariæ are tridentate, triphyllous and claviform as in *Astropyga*. The tridentate pedicellariæ (Pl. IV. Fig. 1. Pl. V. Fig. 22, 35) have narrow, elongated valves, a little widened towards the end; the edge is strongly serrate; they are wide apart, joining only at the end. A little meshwork may be found at the lower end of the larger ones. Only one form of tridentate pedicellariæ is found, but they are very different in size, from c. 0,3 mm. to c. 1,5 mm. (length of head). In the larger ones the neck is short, in the small ones rather long. Sometimes also the stalk may be very short. The valves of the triphyllous pedicellariæ (Pl. IV. Fig. 24) have only some of the inner holes a little elongated, thus not presenting the beautiful aspect of those of *Astropyga*. The claviform pedicellariæ (Pl. IV. Fig. 4, 32) are especially large and numerous between the large spines just below the ambitus; on the abactinal side much smaller ones occur. As DE MEIJERE has pointed out there may be found claviform pedicellariæ with the head developed, the valves being simple, with almost straight, finely serrate edges (Pl. III. Fig. 11), but undoubtedly of the ophicephalous type; these pedicellariæ alone would prove sufficiently that the claviform pedicellariæ of *Diadematidæ* are developed from ophicephalous ones. The stalk of the pedicellariæ is as in *Diadema* and *Astropyga*.

The sphæridiæ are globular, quite smooth; they are placed outside the granulated portion, almost at the ambitus, 3—4 to each pore-area; otherwise they are placed at the tubefeet as in other Diadematids, not in the median line of the ambulacral area. In a young specimen of 19 mm. (Challenger, see below) they proceed to the edge of the peristome. In another young specimen of 22 mm. diameter one of the sphæridiæ in each series is placed in the granulated portion, the other outside between the large spines. It thus seems that the sphæridiæ disappear from the granulated part as it becomes more densely covered with spines — as if they could not perform their functions in that dense forest of spines.

The spicules (Pl. IV. Fig. 13, 15) are triradiate, very slender, and are more or less distinctly arranged in longitudinal series; in the buccal feet they are more irregular. The sucking disk is small, the rosette slightly developed. In the abactinal tubefeet the spicules are exceedingly fine, more or less irregularly branched; they are found especially at the point of the foot. (In the preliminary description it is wrongly stated that spicules are wanting in the abactinal tubefeet). No spicules are found in the walls of the intestine and the genital organs.

The dental apparatus is very low, but otherwise typically diadematoid, the teeth being unkeeled. The auriculæ and their connecting ridges are bent very strongly inwards; the connecting ridge is very high, the auriculæ themselves forming only little projecting corners; the opening is rather small, triangular.

The colour of the abactinal side of the test is well shown by the beautiful figure given in DE MELJERE'S work (Pl. XI. Fig. 101), except that the white tubercles, seen on account of the spines being torn off, make the figure look a little different from the living, undamaged animal, in which the uniformly brownish spines do not contrast with the colour of the test. The blue spots do not extend below the ambitus; there is a series of large, mostly triangular spots down each side of the interambulacra along the inner side of the outer series of large tubercles, one to each plate, a large spot on each genital plate and some smaller spots irregularly scattered over the whole abactinal side. The actinal side, test and spines, are whitish.

Of this species a large, beautifully preserved specimen was taken 15 miles W. of Koh Kut, at 30 fathoms, and 4 large, but rather badly preserved specimens were taken 7 miles NW. of Koh si Chang, at 10 fathoms. In both localities the bottom was soft mud. Further a specimen was found in the Copenhagen Museum, labelled: Gulf of Siam, Salmin 1877. It was determined by LÜTKEN as *Astropyga* n. sp., but he never gave a description of it. — On the specimen from Koh Kut a small crab was discovered on the spines of the abactinal side and some small Cirripeds were found fixed to the point of some of the actinal spines.

It is very curious that this large and beautiful Echinid should not have been known previously, though being a littoral form, whose distribution, it might be supposed beforehand, could not be limited to the Gulf of Siam; from the localities recorded by the Siboga-Expedition it may be safely inferred that it is distributed over the whole Malay Archipelago. In fact it has been recorded several times, already, only under other names. DE MELJERE has shown that the specimens from the Bay of Batavia mentioned by SLUITER (Die Echiniden-Sammlung d. Museums zu Amsterdam p. 68) under the name of *Astropyga radiata* are really *Chaetodiadema granulatum*, and I am able to add two other instances. In the Challenger-Echinoidea p. 70 AGASSIZ describes under the name of *Astropyga pulvinata* a young specimen of 19 mm. diameter (from St. 190), which from the description appears to be a *Chaetodiadema*; after having examined the specimen in the British Museum I must positively assert it to be a young *Chaetodiadema*, and further I find the specimen from St. 188 (42 mm. in diameter) to be the same species. — Through the kindness of Prof. S. F. HARMER in Cambridge I have been able to examine some Echinids from the Maldive Islands (Collection J. S. Gardiner); I find among them a small specimen of *Chaetodiadema granulatum* from N. Malé, labelled *Astropyga* sp. juv., evidently one of the specimens mentioned by BELL<sup>1)</sup> as immature forms of *Astropyga* in his Report on

<sup>1)</sup> The Fauna and Geography of the Maldive and Laccadive Archipelagos. I. Part. 3. p. 231.

the actinogonidiate Echinoderms of the Maldive and Laccadive Islands. As it is of importance to know the structure of the young stages of the species, I shall make some remarks on this specimen.

Diameter 22 mm., height 8 mm., apical area 7,5 mm., peristome 5 mm. The naked part of the interambulacra is somewhat sunken, the ambulacra and the adjacent part of the interambulacra correspondingly raised. The uppermost one of the large interambulacral tubercles in the outer series is found on the 3rd or 4th plate from above (the small incomplete plates at the upper end not included); the next series begins on the following plate. Only two series of large tubercles are found on each side of the area. A series of secondary tubercles along the inner side of the large tubercles of the outer series continues until the apical system. A primary ambulacral tubercle is found on all the plates until the apex, except, of course, on the uppermost young plates. The apical system does not differ from that of the larger specimens; the genital papilla is well developed. The actinal side presents the features typical for the species. The pores are arranged in a quite regular single series, not crowded at the ambitus, and not so distant in the granulated part as in the large specimens; on the abactinal side they form rather distinct arcs; they are almost equally large over the whole test. Pedicellariæ and spicules as in the large specimens, only the spicules more numerous. The colour of test and spines is whitish; there is a small violet spot at the base of the spines, on the side turning towards the top. Blue spots as in large specimens.

The distribution of this species is thus shown to be from the Maldive Islands to New Guinea.

Among some Echinids from Japan (Sagami-See, 30 fathoms, coll. OWSTEN), sent to me for examination from the Hamburg-Museum, I find two *Astropyga*-like specimens (of 71 and 76 mm. diameter), which through the arrangement of the pores on the actinal side in a single series prove to belong to the genus *Chætodidema*. They are, as regards their habitus, very similar to *C. granulatum*, from which species, however, they differ so much in several characters that they must form a separate species, for which I propose the name *Chætodidema japonicum* n. sp.

The form of the test (Pl. II. Figs. 16, 19) is like that of *Ch. granulatum*. The abactinal side agrees with that species as regards the tuberculation; however, it looks rather different owing to the blue spots along the outer edge of the interambulacra being united so as to form a continuous line from the ambitus to the apical system; at the upper end the two lines of each area diverge, bending towards the ambulacra, making thus a very characteristic design (Pl. II. Fig. 16.). In the specimen figured from the abactinal side the thick skin of these lines is rubbed off, the white plating below thus making the lines much more prominent than when the dark skin is preserved. No blue spots are seen on the apical system.

The actinal side presents more considerable differences from *granulatum*. The tubercles diminish more gradually in size from the ambitus towards the

peristome, the series of primary tubercles not ending so abruptly close below the ambitus. There are eight longitudinal series of larger tubercles in each interambulacrum at the ambitus in both specimens; in *granulatum* specimens of a corresponding size have ten series at the ambitus. The tubercles are somewhat smaller than in *granulatum*, the tuberculation being upon the whole much scarcer than in that species. The longitudinal series are parallel to the median line of the area. The granulation of the inner part is much less close than in *granulatum*, and the limits of the plates are distinct (especially in the specimen figured from the abactinal side; unfortunately, the actinal side was so badly preserved in this specimen that it could not be figured).

The pores are very distinct along the whole actinal side, and are nearer together and much larger than in *granulatum*; they are not crowded at the ambitus. The spines are like those of *granulatum*, with oblique basis; those of the actinal side are rather coarse and not so close set, the bearded appearance being not very noticeable. The colour as in *granulatum*, excepting the arrangement of the blue spots. — The pedicellariæ are mainly like those of *granulatum*; the tridentate pedicellariæ, however, differ somewhat in form. They are shorter (c. 1 mm., head), often four-valved; the valves (Fig. 2) are not widened at the point, the edge of the lower part is bent outwards, and coarsely serrate; the smaller forms are like those of *granulatum*. The claviform pedicellariæ may have the head developed, the valves being similar to those of *granulatum* only more slender (Figure can not be given, as I have no good preparation of them). — The spicules are arranged more or less distinctly in four longitudinal series; they are tri-radiate, slender, but more irregular than in *granulatum*. In the abactinal tubefeet similar spicules may be found at the tip.

Through this new species of *Chaetodiadema* it becomes evident, that the very close granulation of the actinal side is not the essential character of this genus, this feature being much less developed in *Ch. japonicum* than in *granulatum*. The main character of *Chaetodiadema* is: the arrangement of the pores in a single series on the actinal side, by which feature it is at once distinguished from *Astropyga*; to which genus it has otherwise a great resemblance. Quite small specimens of *Astropyga* certainly will show the same character; this cannot, however, alter the value of the genus *Chaetodiadema*. The occurrence of a primary tubercle on all the ambulacral plates is no exclusive character of the genus, being found also in *A. denudata*, which species upon the whole seems to stand rather near *Chaetodiadema*.

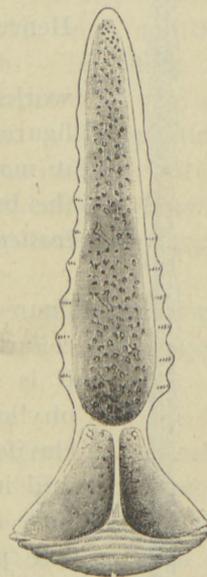


Fig. 2. Valve of tridentate pedicellaria of *Chaetodiadema japonicum*. (Seib. Obj. II. Oc. III.)

5. *Echinothrix calamaris* (Pallas).

Pl. III. Figs. 5, 13, 17, 21, 30. Pl. IV. Fig. 7. Pl. V. Figs. 3, 11.

*Echinothrix calamaris*. AGASSIZ. 1872. Revision of Echini. p. 119, 413. Pl. III a. Fig. 1—2. Pl. XXXV. Fig. 10—15.— *desorii*. AGASSIZ. Ibidem. p. 120, 415.*Echinothrix Desori*. LORIOI. 1883. Catalogue rais. des Echinodermes de Maurice. p. 14.

— — — 1893. Echinodermes de la Baie d'Amboine. p. 362.

— — — KOEHLER. 1895. Echinodermes des îles de la Sonde. p. 411.

— *calamaris*. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. p. 698. Taf. LIX, 9, LXIII, 6.

— — — DE MEIJERE. 1904. Echinoidea d. Siboga-Exped. p. 51.

For the numerous references to the old literature I must refer to AGASSIZ and for other less important references to the later literature to DE MEIJERE (Op. cit.).



Fig. 3.  
The point of  
an ambula-  
cral spine of  
*Echinothrix*  
*calamaris*.  
(Zeiss. A. A.  
Oc. 1.)

This species was not taken by the author in the Gulf of Siam, but the „Skeat“-Expedition took a specimen at the East Coast of Redang. Hence it may be mentioned here.

The structure of the test and the spines is well known from the works cited, so I need not say anything thereof. I shall only give a figure of the curious serrate point of the ambulacral spines (Fig. 3.); it may also be remarked that in large specimens there are spines on the buccal plates, this feature thus not being exclusive for the genus *Centrostephanus* among Diadematids, as said by AGASSIZ.

The pedicellariæ are quite insufficiently known. PERRIER<sup>1)</sup> has figured a valve of a small tridentate pedicellaria and a triphyllous pedicellaria, the figure of the latter (Pl. 4. Fig. 3a) being rather coarse, so that it is somewhat difficult to recognize in it the slender and elegant triphyllous pedicellariæ. DE MEIJERE (Op. cit. p. 53) has described the claviform pedicellariæ. The figures 33—36, Pl. XXIV in „Rev. of Ech.“ said in the explanation of the plate to be of *Ech. calamaris* are really *Ech. diadema*, under which species they are rightly mentioned in the text (p. 416).

The tridentate pedicellariæ occur in two forms. In the one, larger form (1.5 mm., head) (Pl. III. Fig. 5, 13, 30) the valves are wide apart, joining only at the end, which is somewhat widened, making a distinct angle with the lower part of the edge. The blade is a little curved, narrow, flat and filled with a coarse meshwork. The edge of the outer part is closely, but irregularly serrate; the lower part may be quite smooth or with more or fewer small teeth. The neck is rather short. This form, however, varies very much both in size and in shape. The part, where the valves join, may be larger (Pl. III. Fig. 30), equalling half the part of the blade, or they may even join throughout

<sup>1)</sup> Rech. sur les pédicellaires. p. 136, Pl. 4. Fig. 3 a—c.

almost the whole length; the blade is then simply leaf-shaped, rather deep with only a little meshwork in the bottom of the blade, and the whole edge closely serrate. This variety leads to the second form of tridentate pedicellariæ (Pl. III. Fig. 21. Pl. IV. Fig. 7), which may be as long as the first one but much more slender. The valves join in their whole length; the blade is narrow, deep, without meshwork; the edge is rather thick, the teeth are placed irregularly, not in a single series, along its whole length. (Also in the first form the teeth are placed irregularly). The quite small tridentate pedicellariæ (Pl. V. Fig. 3) are very like those of *Diadema saxatile*.

The ophicephalous pedicellariæ occur both in the form of claviform and of true ophicephalous ones. The latter are few in number and found only on the test, not on the buccal plates. The valves (Pl. V. Fig. 11) are small, without meshwork, the edge sinuate and serrate as usual. The stalk is long and thick; there is no neck. In the claviform pedicellariæ I have never found the head developed. The triphyllous pedicellariæ are essentially like those of *Diadema*, the shape only being a little different (Comp. Pl. IV. Fig. 23 of *Ech. diadema*); the edge is smooth. — The stalk of the tridentate and triphyllous pedicellariæ is, as in *Diadema*, constructed of one or two simple rods; in the latter case they are connected by crossbeams. — The spicules (Pl. III. Fig. 17) are triradiate, arranged mostly in two (in the abactinal) or three (the actinal tubefeet) distinct longitudinal series; in the abactinal tubefeet they are mostly larger than in the actinal ones. The buccal tubefeet are provided with large fenestrated plates as in *Diadema*.

With regard to *Ech. desori* I quite agree with DÖDERLEIN and DE MEIJERE that it cannot be maintained as a distinct species; in its pedicellariæ and spicules it is quite like *Ech. calamaris*.

*Echinothrix diadema* differs markedly from *calamaris* in regard to pedicellariæ and spicules. The tridentate pedicellariæ occur in two forms. The one is large (2.5 mm. head), without a neck (Pl. III. Fig. 9, 14); [the valves join throughout half the length of the blade or more, the blade is simply leaf-shaped, rather deep, with a dense meshwork in the bottom; even in the basal part there is such meshwork on either side of the apophysis. The edge is rather thick, serrate in the whole length, the fine teeth being placed irregularly; also the edge of the basal part is serrate. (This form has been rather well figured by AGASSIZ, Rev. of Ech. Pl. XXIV 33—36). The second form (Pl. IV. Fig. 25, 36) is much smaller, c. 0.8 mm. (head), with a long neck. The valves are wide apart, joining only at the end. The blade is somewhat curved, narrow, almost flat, a little widened at the end, with a little meshwork in the lower part. The edge is smooth, and only in the outer part very finely serrate. The triphyllous pedicellariæ (Pl. IV. Fig. 23) are like those of *Ech. calamaris*. True ophicephalous pedicellariæ I have not found; the claviform ones have been figured by DE MEIJERE (Siboga-Ech. Pl. XIV. Fig. 204). The spicules (Pl. III. Fig. 24, 27)

are irregular, elongated, fenestrated plates, arranged (in the abactinal) in two or (in the actinal tubefeet) three or more longitudinal series, the spicules with their axis parallel to the axis of the foot. Sometimes, however, they are of the common, triradiate shape. Some few bihamate spicules may also be found. The buccal tubefeet are as usual, provided with large fenestrated plates.

I may now take the occasion to give some additional remarks on the other *Diadematidæ* not mentioned above, viz. the genera *Centrostephanus*, *Cænopedina*, *Aspidodiadema* and *Dermatodiadema*. As regards the genus *Lissodiadema* I must refer to my description of it in Rev. Suisse de Zool. 1903. Vol. XI. p. 393, and for *Micropyga* to DE MELJERE (Siboga-Ech. p. 59). To the description of *Micropyga* I have only to add a few remarks on the pedicellariæ. The tridentate ones have a well developed meshwork in the bottom of the elongate, rather narrow blade. The edge is coarsely serrate in the lower part, finely serrate with some larger teeth placed in rather regular distances, in the outer part, where the valves join. The small tridentate pedicellariæ are finely serrate along the whole edge of the blade (Pl. V. Fig. 33, 37). The triphyllous pedicellariæ have a distinct coverplate, and the outer edge is extremely finely serrate (visible only under high magnifying powers). (Pl. IV. Fig. 27.) The stalk of the pedicellariæ consists of several very loosely connected rods, being thus very different from those of the other Diadematids.

*Centrostephanus longispinus*. The spicules are triradiate or H-shaped, arranged more or less distinctly in mostly four longitudinal series in the lower part of the tubefeet, irregularly in the upper part. In the abactinal tubefeet the spicules are rather numerous, especially towards the point of the foot. In the buccal tubefeet the spicules are large, compact, fenestrated plates. — The pedicellariæ are of four kinds: tridentate, ophicephalous, globiferous and triphyllous. The tridentate pedicellariæ (comp. KOEHLER: Notes Echinologiques. p. 27. Pl. IX. Fig. 10) are very elongate, up to almost 3 mm. (head); the neck is rather short. The valves (Pl. V. Fig. 29) join in about the outer third part of their length; the blade is narrow, leaf-shaped, with one or a few crossbeams at the lower end, otherwise without meshwork. The edge is slightly and irregularly serrate in the whole length. HAMANN says<sup>1)</sup> that there are two kinds of tridentate pedicellariæ in this species, the one having smaller valves and being „schmächtiger“ than the other. I have been unable to find more than one form; perhaps it is the otherwise not mentioned triphyllous pedicellariæ, which HAMANN has taken to be the second form of tridentate pedicellariæ; he has given no figures of them<sup>2)</sup>. The ophicephalous pedicellariæ have a rather long neck and the valves are of the typical structure (Pl. IV.

<sup>1)</sup> Histologie der Echinodermen. H. 3. p. 15.

<sup>2)</sup> Having received from me a preparation of the triphyllous pedicellariæ of *Centrostephanus longispinus*, Prof. HAMANN kindly informs me that he thinks he has confounded the triphyllous pedicellariæ with the tridentate ones.

Fig. 2); they are found on the buccal plates and on the actinal side of the test, the latter ones generally a little larger, as observed by KOEHLER, but otherwise not differing in structure.

The globiferous pedicellariæ (*Globiferæ* HAMANN) are found only on the test; there are glands on the stalk; the head is very small, and may even be totally wanting (torn off?). No neck; the upper end of the stalk is widened, but not cupshaped. The blade (Pl. IV. Fig. 11) is narrow, provided with 4–6 large teeth in the outer end; often one of the teeth has a median position, but it is not larger than the other ones, and there is no canal on its upper side, in accordance with the fact that no poison gland is found on the valve. — It may be disputable whether these pedicellariæ are true globiferous pedicellariæ or only somewhat transformed ophicephalous ones. They remind one very much of the ophicephalous (claviform) pedicellariæ with large stalk glands in *Aspidodiadema*, but in these the valves are of a true ophicephalous structure. On the other hand they must certainly be taken to be homologous to the undoubted globiferous pedicellariæ of *Cænopedina* and *Stomopneustes*. Evidently we must conclude, that they are a sort of globiferous pedicellariæ, developed from the ophicephalous ones. It may be disputed whether the globiferous pedicellariæ of *Echinidæ* etc. are really homologous to these forms; but it seems not unreasonable. Of course they cannot be derived from such specialized forms as those of *Cænopedina*, but between the globiferous pedicellariæ of *Centrostephanus*, especially the forms with a median tooth, and those of *Hypsiechinus* and *Parechinus* the difference is not so very great. In *Centr. Rodgersii* there seem to be glands on the valves of the globiferous pedicellariæ; if that be really so (my material is not sufficient for stating it definitely), there can scarcely be any doubt that this suggestion of the origin of the globiferous pedicellariæ in *Echinidæ*, *Toxopneustidæ* and *Echinometridæ* is correct.

The triphyllous pedicellariæ are rather different from those of the other Diadematids. The blade is elongated and flat, the edge is quite smooth (comp. Pl. IV. Fig. 22 — of *C. Rodgersii*). They remind one very much of those in *Stomopneustes*. The stalk of the pedicellariæ is irregularly perforate. The sphæridiæ are elongate, pearshaped and smooth.

*Centrostephanus coronatus* I have not seen; from the description given by VERRILL it appears to be very nearly related to *C. longispinus*, but this cannot be affirmed definitely, before its pedicellariæ and spicules have been examined.

*Centrostephanus Rodgersii*. The spicules are as in *C. longispinus*, only more scarce in number. The pedicellariæ are of the same four kinds as in that species. The tridentate pedicellariæ are rather short, only c. 1 mm. (head); the neck is well developed. The valves (Pl. V. Fig. 34) are curved, wide apart, joining only at the point. The blade is narrow, almost flat, filled with meshwork; the edge is straight, with some few thorns, at the outer end sinuate, a little (irregularly) serrate. (A not very good figure of a valve of a tridentate (large-headed, long-stemmed) pedicellaria is given

by AGASSIZ in „Rev. of Ech.“ Pl. XXIV fig. 37). The ophicephalous pedicellariæ (Pl. III. Fig. 4) are essentially as in *C. longispinus*. AGASSIZ (Rev. of Ech. Pl. XXIV. 37') figures a valve of an ophicephalous pedicellaria without the usual arc below the basal part, and from this fact he concludes (Op. cit. p. 664) that „the buccal pedicellariæ of the Diadematidæ differ from those of the Echinidæ in having a solid base“. This cannot be held as a general rule; the base of the valves is only partly solid. In each ophicephalous pedicellaria two of the valves have the usual arc, only the third may have a solid base, but this even does not seem to be always the case. — The globiferous pedicellariæ (Pl. IV. Fig. 19) are like those of *C. longispinus*, only with more elongated blade and larger teeth at the point; there are not always glands on the stalk, those without glands being larger than the other ones. There seem to be glands on the outside of the valves. — Though *C. Rodgersii* looks very different from *C. longispinus*, there can be no doubt that they are nearly related, and they are rightly referred to one genus.

Through the kindness of Prof. DÖDERLEIN I have had occasion to examine the pedicellariæ and spicules of *Cænopedina (Hemipedina) mirabilis*. Meantime DE MEIJERE has given an excellent description with figures of his *C. (H.) indica* (Siboga-Echinoidea. p. 65), and as the two species agree rather closely as regards pedicellariæ and spicules, I need only say a little of this very interesting form. — The spicules are like those of *C. indica*, and are arranged in two series as in that species. I have seen a single bihamate spicule in the gills. The globiferous and ophicephalous pedicellariæ (Pl. IV. Fig. 3, 5—6) present some small differences, as will be seen by comparing the figures given here with DE MEIJERE'S figures from *C. (H.) indica* (Pl. XVI. Fig. 237—40). The triphyllous pedicellariæ are quite like those of *indica*. Tridentate pedicellariæ are not mentioned by DE MEIJERE for *C. indica*; in *C. mirabilis* I have found a few ones. They are small, simply leafshaped (Pl. III. Fig. 12) without meshwork in the bottom; the edge is a little sinuate, slightly and irregularly serrate. The valves apparently join in a little more than half their length; the neck is short. Possibly also a second form of tridentate pedicellariæ is found, with narrow, elongated blades, strongly serrate in the edge; but I dare not assert this positively. The stalk of the pedicellariæ is irregularly fenestrated.

The genera *Aspidodiadema* and *Dermatodiadema* have likewise been carefully treated by DE MEIJERE; I may, however, give some additional remarks, especially on the Atlantic species, which are as yet insufficiently known.

*Aspidodiadema tonsum*. (This species is the first named in the Preliminary Report on the „Challenger“-Echinoidea, and is thus the type species of the genus). The spicules are arranged in two longitudinal series; they have been figured by DE MEIJERE (Pl. XIII. 182). The tridentate pedicellariæ (Pl. V. Fig. 6) are elongate (c. 1 mm. — head) and slender; the valves join in almost their whole length; figures are given of them by DE MEIJERE (Pl. XIII. 178—80). The neck is well developed, the stalk a single, thick, smooth rod. Also AGASSIZ has given a tolerable figure of a valve

of this form of pedicellariæ, under the name of „slender long-headed pedicellaria“ (Chall. Ech. Pl. XLIV. 15); but that the fig. 5. Pl. XLII represents a whole pedicellaria of the same kind requires a great deal of fancy to understand. DE MELJERE has found a second form of tridentate pedicellariæ with short blade and the upper edge of the apophysis serrate (Fig. 280); this form I have not observed. The triphylous pedicellariæ remind one rather much of those of the Echinothuridæ (*Asthenosoma* f. i.); the blade is quite closed in the lower part, the edges meeting and forming a coverplate, the outer end spoonshaped widened; only this widened part of the valves is joining, when the pedicellaria is closed (Pl. V. Fig. 31). The outer edge is finely serrate; DE MELJERE finds „hin und wieder kurze Zähnelung“ thereupon; I have always found the edge regularly serrate. The stalk is a single smooth rod, widened and irregularly fenestrated at the ends. The ophicephalous pedicellariæ occur in two very different forms: a small form, with small head, with or without large glands on the stalk, and another form with large head, without stalkglands; in both of them the head is supported directly on the end of the stalk, there is no neck. The valves of the small form are simple, without meshwork in the blade; the edge is finely serrate, as are the continuations of the apophysis. (Comp. the quite similar form in *A. microtuberculatum*, Pl. IV. Fig. 12). There is no structural difference between those without and those with stalkglands; the latter may be termed claviform pedicellariæ, being, of course, homologous with the claviform pedicellariæ of *Diadema* etc. The valves of the second form are large, almost triangular with the blade quite filled by a coarse meshwork (Pl. III. Fig. 26); the edge is somewhat sinuate, but otherwise thick and smooth; the point of the blade is bent inwards as a broad hook. The stalk of the ophicephalous pedicellariæ is not a single rod but is rather complicate, irregularly fenestrated, so that it is not distinctly seen to be formed of parallel rods<sup>1)</sup>. The upper end of the stalk in the small form is beautifully cupshaped, that of the large form only thickened and rounded. — DE MELJERE regards the large ophicephalous form, which he has not found in this species, as a tridentate pedicellaria; I prefer to regard it is as an ophicephalous pedicellaria, though its shape is rather different from the typical ophicephalous form. — It may be mentioned that there is a distinct genital papilla developed.

This species is recorded in the „Challenger“-Ech. from Cebu and the Kermadec-Islands, 100—630 fathoms, and from the Atlantic, off Macio, 1700 fathoms. I was at first doubtful whether the Atlantic specimens would really prove identical with the Pacific ones, both on account of the great distance and of the great difference in the depth of those localities. I have not, however, been able to find

<sup>1)</sup> AGASSIZ (Blake-Echini p. 25.) says that the „shaft“ of the „sheathed pedicellariæ“ (in *A. Jacobyi* and *antillarum*) consists of „a long, slender radiole, distinctly articulated“. This is wrong; it is not articulated only irregularly fenestrated.

any reliable difference between the Atlantic and the Pacific specimens, so it seems really to be true that this species has so wide a distribution.

*Aspidodiadema Jacobyi*. The spicules are as in *A. tonsum*; in the upper part of the tubefeet, however, they take the form of larger, irregular, fenestrated plates; they are arranged in two longitudinal series. Of the pedicellariæ only one form, the „sheathed“ ophicephalous („claviform“) ones have been mentioned and figured by AGASSIZ; as in *A. tonsum* tridentate, triphyllous and ophicephalous pedicellariæ are found. The tridentate pedicellariæ (Pl. V. Fig. 28) are rather small, c. 1 mm. (head); the valves are simply leafshaped, without meshwork in the bottom; they join in almost their whole length. The neck is short. The ophicephalous pedicellariæ occur in two forms, a large form without glands on the stalk and a small-headed form with large glands on the stalk (claviform), both with the head placed directly on the stalk, as in all the *Aspidodiadematidæ*. The valves in the large form (head c. 1.5 mm.) are elongated, with a coarse meshwork filling the blade (Pl. III. Fig. 25); the edge is thick, smooth and sinuate, the point forming a more or less distinct hook. The second form is provided with very large stalkglands (I have not found this form without glands), as is well seen in the figures given by AGASSIZ („Blake“-Echin. Pl. IX. a. fig. 9); the head is very small, with slightly developed valves, which present, however, an undoubted ophicephalous structure (Pl. IV. Fig. 10). The triphyllous pedicellariæ (Pl. IV. Fig. 20) essentially as in *A. tonsum*; the upper edge of the coverplate is a little produced over the blade, which may, however, also be the case in *A. tonsum*. The stalk of the pedicellariæ is irregularly fenestrate, but not articulate, as said by AGASSIZ (for the claviform pedicellariæ); in the claviform pedicellariæ the upper end of the stalk is cupshaped. — There are distinct genital papillæ.

*Aspidodiadema nicobaricum* Döderl. has been treated by DE MEIJERE (Op. cit. p. 46), to whose work I may refer. I may only add that I have found two sorts of tridentate pedicellariæ on a specimen, which Prof. DÖDERLEIN very liberally allowed me to examine; the one form is like that of *A. tonsum*, the other, much larger form, like that figured in Pl. III. Fig. 28 and Pl. V. Fig. 30 of *A. microtuberculatum*. The ophicephalous pedicellariæ (only claviform ones observed) seem to be constantly four-valved.

*Aspidodiadema microtuberculatum* Ag. Under this name AGASSIZ has confounded two species; since I have examined the „Challenger“-specimens in the British Museum, I can state this with certainty. The specimen from St. 134, off Tristan d'Acunha, accords well with the description and may thus be taken as the type of the species *microtuberculatum*. It has as yet retained the dark violet colour. There are spines on the buccal plates, a feature not mentioned by AGASSIZ; the figures, however, show several tubercles on the buccal plates, and the expression „when denuded“ used of them in the text may indicate the same thing. It must further be emphasized that the ambulacral plates have not all an equally large tubercle in

the inner part, but on every third plate there is a primary tubercle, larger than those of the other plates — in fact the usual arrangement among *Diadematidae* prevails here also, the only difference being, that the primary tubercle remains small. — Genital papillæ are found. The spicules as in *A. tonsum*. The tridentate pedicellariæ (Pl. III. Fig. 28, Pl. V. Fig. 30) are very characteristic; the valves join only for a very short space at the point, the blade is narrow and there is mostly a coarse meshwork filling the bottom almost to the point. There is a well developed neck; length of head c. 1—1.5 mm. The triphyllous pedicellariæ are somewhat variable in form, some of them being like those of *A. tonsum*, others having the outer part of the blade strongly bent inwards in the middle (Pl. IV. Fig. 18). The stalk of the tridentate and triphyllous pedicellariæ is irregularly fenestrated. Of the ophicephalous pedicellariæ I have only seen the claviform ones; but as there is evidently great variation in the occurrence of the large ophicephalous pedicellariæ in other species (e. g. *A. tonsum*), it can scarcely be doubted that they will be found in this species too. The valves of the claviform pedicellariæ are small and very simple (Pl. IV. Fig. 12). — The specimen from St. 299 is also a true *A. microtuberculatum*.

Of the other specimens from the „Challenger“ referred to this species those from off Macio and from St. 122 are certainly not *A. microtuberculatum*. There are no spines on the buccal plates; only in one of the specimens from off Macio I have found a single spine on four of the buccal plates, and of these two were partly transformed into sphæridiæ, looking very much like the figure I have given in my paper on Echinoderms from East Greenland<sup>1)</sup> of transformed buccal spines of *Echinus esculentus*. The pedicellariæ are like those of *A. antillarum*; in fact I think the specimens must be referred to that species. The absence of spines on the buccal plates distinguishes them from *A. tonsum*, as does also the size of the ambulacral tubercles. — The specimens from St. 298 I have not seen.

*Aspidodiadema antillarum* Ag. The ambulacral tubercles are not equally sized, those on every third plate being a little larger than the others, thus indicating the primary tubercle of the compound ambulacral plates in other Diadematids. This feature is well shown on Pl. IX. fig. 6 of the „Blake“-Echini. (Comp. *A. microtuberculatum*); it is no quite regular feature, however, sometimes the tubercles of several plates in succession being equally large. The buccal plates are naked, as are also the anal plates in young specimens; in larger specimens the latter are covered with spines. Genital papillæ are developed. Of the pedicellariæ AGASSIZ has given some rather bad figures, and the text, stating that „they are either long narrow-headed and long-stemmed, or short-headed and stout-stemmed, or short-stemmed and pyramidally headed“ („Blake“-Echini. p. 26), is in no way better. The three usual kinds of pedicellariæ occur. The tridentate and triphyllous pedicellariæ (Pl. IV. Fig. 16, 29, 35)

<sup>1)</sup> Meddelelser om Grønland. XXIX. 1903. p. 78. Fig. 1—3.

are very similar to those of *A. lonsum*. The ophicephalous pedicellariæ occur in a large and a small form. The large form (Pl. IV. Fig. 8, Pl. V. Fig. 4) has the valves rather elongate, as those of *A. Jacobyi*, but they are not so large as in that species; they are filled with an irregular meshwork, and the outer end of the valves forms a hook, especially large on one of the valves (see Pl. V. Fig. 4). The small form occurs both with glands on the stalk (Pl. IV. Fig. 33) and without such glands (Pl. V. Fig. 32); in both of them the upper end of the stalk is cupshaped. The valves (Pl. III. Fig. 18) are simple, without meshwork; the outer edge is somewhat sinuate, the whole form somewhat different from those of the preceding species.

*Dermatodiadema indicum* Döderl. and *amphigymnum* de Meijere have been carefully treated by DE MEIJERE (Siboga-Echinoidea p. 46 seq.); they prove to be essentially like the above mentioned species as regards pedicellariæ and spicules; the tridentate pedicellariæ of *D. indicum* are like those of *D. microtuberculatum*, those of *D. amphigymnum* are unknown, the tridentate pedicellariæ mentioned under this species by DE MEIJERE being the large ophicephalous pedicellariæ. *D. molle* Döderl. has tridentate pedicellariæ like those of *microtuberculatum* (Prof. DÖDERLEIN has kindly allowed me to examine the pedicellariæ of this species during my visit in Strassburg); otherwise it does not present important characters in its pedicellariæ. — The species *D. globulosum* Ag. and *horridum* Ag. I have not seen.

The genus *Dermatodiadema* has been established by AGASSIZ („Albatross“-Echini 1898. p. 76) for the species „having only small secondary tubercles in the ambulacral areas“; accordingly the species *microtuberculatum* and *antillarum* must be transferred to that genus; DE MEIJERE also rightly names these species *Dermatodiadema*. This difference in the ambulacral tubercles is indeed the only character distinguishing the two genera, and as there may be found an indication of larger primary ambulacral tubercles in species with small ambulacral tubercles, this character is evidently of little value. The pedicellariæ do not afford generic characters; only the tridentate pedicellariæ present two distinct types, but as both these types occur in both the genera, no generic character can be taken from them. — POMEL<sup>1)</sup> has established in 1883 the genus *Plesiodiadema* for *Aspid. microtuberculatum*; this name has then to be used instead of *Dermatodiadema*. DUNCAN<sup>2)</sup> has later on, 1885, used the name *Plesiodiadema* for a fossil form, but of course it must be maintained in the sense of POMEL.

The claviform pedicellariæ of *Aspidodiadema* and *Plesiodiadema* are held by AGASSIZ to be of great value for comparative morphology. „These pedicellariæ“, he says in the „Blake“-Echini p. 25, „recall at once the remarkable sheathed spines... in *Asthenosoma Grubei*, they form an additional link in the chain proving that pedicellariæ are only modified spines. The diminutive heads of these pedicellariæ,

<sup>1)</sup> Classification méthodique et genera des Echinides vivants et fossiles. 1883. (Doct. Thesis)

<sup>2)</sup> Quart. Journ. Geol. Soc. 41. 1885.

if completely resorbed, would leave us a sheathed spine identical with the sheathed spine of the Echinothuriæ; the existence in that family of club-shaped primary spines as in *Phormosoma bursaria* (um), the tip of which is still sheathed to a certain extent, shows how close is the relation of the sheathed spines to true pedicellariæ“. — I am decidedly opposed to this reasoning. The sheathed spines in *Asthenosoma* are spines of the structure typical in Echinothurids: beautifully fenestrated tubes ending in a fine point. In the „sheathed“ pedicellariæ of *Aspidodiadema* (and of all *Diadematidæ*) the stalk is of an irregular structure quite different from that of the spines of the Echinothurids (or of any other Echinids), and even when the head of these pedicellariæ disappears, they do not get more accordance in structure with the spines, and they never can be homologized with the sheathed spines of *Asthenosoma*. The clubshaped spines of *Phormosoma bursarium* etc. are also true spines and can not present any proof whatever of the close „relation of the sheathed spines to true pedicellariæ“. Upon the whole I must confess that I cannot see any evidence of the pedicellariæ of Echinids being only transformed spines. In the Asterids, to be sure, there can be no doubt that some forms of pedicellariæ are transformed spines; but that that is true for all of them, I am not convinced (e. g. those of *Asterias*). The figures given of their development by AGASSIZ (Embryology of the Starfish. Pl. VIII. figs. 2—4) are much too undetailed to show them to be transformed spines, nothing definitely being seen there of the formation of the calcareous valves. But especially with regard to the pedicellariæ of Echinids no proof at all has been produced, showing them to be transformed spines. In fact the only argument produced by AGASSIZ in favour of this supposition is „the case of tripartite, pedunculated, Echini pedicellariæ attached as common spines are, upon a tubercle, surrounded by the peculiar smooth area called the scrobicular circle“ as is found in *Podocidaris*<sup>1)</sup>. I cannot find any proof of the homology herein. As is well known, the scrobicular circle is only the impression of the muscular coat at the base of the spines; in large spines it is very distinct, in small ones indistinct or not to be seen at all. All pedicellariæ are attached to small tubercles and surrounded by a muscular coat at the base, just as in the articulation of the spines, only much more delicate. A scrobicular circle may certainly be found in many Echini around the tubercles of the larger pedicellariæ. But from this fact it only follows that pedicellariæ and spines are articulated in the same manner to the test, not at all that they are homologous. Neither can I see the least proof of their homology in the fact that the spines of Echinidæ present differences „fully as great as those observed in the pedicellariæ“ (Rev. of Ech. p. 669). It must be emphasized that no transitional forms are found between pedicellariæ and spines in Echinids; likewise the development of the pedicellariæ in Echinids is quite different from that of the

<sup>1)</sup> Rev. of Echini. p. 669.

<sup>2)</sup> Comp. the Ingolf-Echinoidea I. p. 6. Pl. XII. 30 etc.

spines; from the first beginning it is easy to see, if we have a young pedicellaria or a spine before us, the pedicellariæ always commencing with a separate calcareous plate for each valve and one for the stalk, the latter developing from the upper end downwards<sup>1)</sup>, whereas the spines always commence with a single calcareous plate, developing from the base towards the tip. I must decidedly maintain that the pedicellariæ of Echinids are not transformed spines, they are organs sui generis. The fact that some forms of pedicellariæ in Asterids are only transformed spines does not alter the fact of the Echinid-pedicellariæ being organs sui generis, as it may well be supposed that these organs have appeared independently in the two classes, being thus, strictly speaking, not homologous but only analogous structures. (Comp. CUÉNOT. Études morphol. sur les Echinodermes. p. 368).

### Classification of the Diadematids.

The family *Diadematidæ* was established by PETERS<sup>2)</sup> for the genera *Diadema*, *Astropyga*, *Echinothrix* and *Centrostephanus*, the two former genera, *Diadema* and *Astropyga* having previously been referred to the *Cidaridæ* (GRAY) or to the *Echinidæ* (by AGASSIZ & DESOR); the two latter genera, *Echinothrix* and *Centrostephanus* were established by PETERS in the work quoted. AGASSIZ in his „Revision of Echini“ assumed the family *Diadematidæ* in accordance with PETERS, adding only the genus *Asthenosoma*. Later on he has added to that family the genera *Aspidodiadema*, *Dermatodiadema* and *Micropyga*, whereas *Asthenosoma* is transferred to the family *Echinothuridæ*. The genus *Cænopedina* (*Hemipedina*) AGASSIZ refers, as well known, to the „*Triplechinidæ*“, though he otherwise regards it as being a subgenus of *Pseudodiadema*. POMEL (Op. cit.) adopts the same arrangement, only *Cænopedina* is referred to the *Pedinidæ*. An essentially different classification is given by DUNCAN in his important „Revision of the Genera and great Groups of the Echinoidea“<sup>3)</sup>. The genus *Aspidodiadema* is made the type of a distinct family *Aspidodiadematidæ*, and the family *Diadematidæ* is divided into four subfamilies, viz. I. Subfam. *Diadematinaæ*, with the genus *Diadema*, under which *Centrostephanus*, *Hemipedina* and the fossil *Microdiadema*, *Diademopsis* and *Echinodiadema* are placed as subgenera, and the fossil genera *Placodiadema*, *Heterodiadema*, *Codiopsis*, *Pleurodiadema*, *Magnosia* and *Cottaldia*. II. Subfam. *Diplopodiinaæ*, with the genus *Micropyga* and the fossil genera *Diplopodia*, *Pedinopsis*, *Acanthechinus*, *Phymechinus*, *Asteropsis*, *Diplogtagma* and *Plistophyma*. III. Subfam. *Pedininaæ*, with the genera *Echinothrix* and *Astropyga* and the fossil genera *Pedina* (with the subgenus *Pseudopedina*), *Echino-*

<sup>1)</sup> Ingolf-Echinoidea. I. p. 6. Pl. XII. fig. 30 etc.

<sup>2)</sup> Über die an der Küste von Mossambique beobachteten Seeigel und insbesondere über die Gruppe der Diademen. Abh. d. Berl. Akad. 1853.

<sup>3)</sup> Journ. Linn. Soc. Zoology. XXIII. 1891.

*pedina*, *Stomechinus*, *Micropedina*, *Heterocidaris*, *Polycyphus* and *Codechinus*. IV. Subfam. *Orthopsinae*, comprising no recent form, but the fossil genera *Orthopsis*, *Eodiadema*, *Peronia*, *Echinopsis* and *Gymnodiadema*. — This classification has been adopted with a little modification by GREGORY in the „Treatise on Zoology“, ed. by RAY LANKESTER (Part III. Echinoderma. 1900). Lastly LAMBERT<sup>1)</sup> arranges the recent and fossil genera of Diadematids in the subfam. *Diademinæ*, with the Tribus: *Astropyginae* and *Aspidodiademinæ*; subfam. *Tiarinae*, with the Tribus: *Hemicidarinae*, *Eodiademinæ*, *Pseudosaleninae*, *Pseudodiademinæ*, *Diplopodinae* and *Glyphocyphinae*; subfam. *Pedininae*, with the Tribus: *Orthopsinae* and *Climapedinae*. LAMBERT'S classification is „évidemment encore artificielle et elle conserve l'inconvénient de separer d'une facon trop absolue des genres que rapprochent une partie de leurs caractères“ (Note sur quelques Éch. éoc. de l'Aude p. 512) and as he names only a few of the genera of his different tribus it is rather difficult to get a quite clear understanding thereof. DUNCAN'S attempt at giving a natural arrangement of the recent and fossil genera seems to me the more important; in any case it is very radical and consistent. However, I cannot adopt his classification. To be sure my knowledge of the fossil Echinids is rather small and exclusively based on literary studies; but trusting to my researches on the recent forms I think it not too bold to draw some conclusions also as regards the fossil forms. Now there cannot be the least doubt that DUNCAN'S classification is quite unnatural as regards the recent Diadematids, and so it is probably not better for the fossil ones. Thus LAMBERT, whose knowledge of the fossil forms is so very profound and extensive, says of this classification that it presents „une inégalité et une confusion regrettables, car les genres successivement énumérés n'ont souvent entre eux que des rapports très éloignés. Ainsi on y voit figurer comme sous-genre d'*Acrocidaris* polypore, à tubercules crénelés et perforés, un Arbacien, *Acropeltis*, oligopore, à tubercules lisses et imperforés. *Diplopodia* à tubercules crénelés, *Pedinopsis* à tubercules lisses, *Acanthechinus* pourvu de fossettes et *Phimechinus* polypore, à tubercules imperforés, s'y succèdent“ (Éch. éoc. de l'Aude. p. 513).

DUNCAN considers the structure of the ambulacra as being of primary taxonomic importance, whereas the „very popular and useful“ arrangement of the genera by the existence or not of crenulation and perforation of the primary tubercles is too artificial, „for the physiological importance of the superficial structures is exceedingly small“. — „It may be stated as a general truth, that if these genera be classified by the ornamentation of the tubercles, groups possessing very diverse ambulacra will be associated“. — I have already in the Ingolf-Echinoidea I. (p. 12—13) on treating the classification of the Cidaridæ criticized DUNCAN'S opinion, that structures „of no physiological importance“ cannot be used as systematic characters.

<sup>1)</sup> Note sur quelques Échinides Éocènes de l'Aude (Bull. Soc. Géol. d. Fr. 3. Sér. XXV. 1897) and: Étude sur quelques Échinides de l'Infra-Lias et du Lias (Bull. Soc. de l'Yonne. 1899).

D. K. D. Vidensk. Selsk. Skr., 7. Række, naturvidensk. og mathem. Afd. I. 1.

I must here again affirm that characters of primary importance for classification are often found in structures of evidently very little physiological importance (spicules f. i.); I even think that we must especially look out for systematic characters among the features likely to be of little or no physiological importance, such structures being little liable to be altered for any special use. For the rest it is rather rash to declare without reservation — and without proofs by physiological experiments — that the physiological importance for instance of the superficial structure of the tubercles is exceedingly small, and on the other hand that the number of interradial coronal plates in Cidarids for instance is of physiological importance.

The structure of the ambulacra, on which DUNCAN lays so great stress, is certainly of the highest systematic importance, and it is DUNCAN'S great merit to have shown by his careful studies on the anatomy of the ambulacra of the Echinids that different types of compound plates exist<sup>1)</sup>. He establishes six types, viz. the cidaroid, the diadematoïd, the arbacioid, the cyphosomatoid, the diplopodous and the echinoid types. Of these the arbacioid, diplopodous and cyphosomatoid structures are only modifications of the diadematoïd; I can only admit three different types, viz. the cidaroid type, with simple primaries which do not combine to form compound plates, the diadematoïd type in which the adoral primary plate is a small plate, the following one being the largest, and the echinoid type, in which the adoral component is the largest, and never a demi-plate, the following being smaller. But these features do not present generic or family-characters; they are of higher value. All the families of Ectobranchiata may be arranged in three groups: namely with simple<sup>2)</sup>, or diadematoïd or echinoid ambulacra; these are then characters of orders. The minor variations in the ambulacral structure may present generic characters, but scarcely any of higher value. Thus DUNCAN, when using exclusively the minor variations in the ambulacral structure for subdividing the family *Diadematidæ*, gets such surprising results as to make *Centrostephanus* and *Hemipedina* subgenera of *Diadema* and to place *Echinothrix* and *Astropyga* (to which *Chaetodiadema* and *Lissodiadema* should probably have been added) in another subfamily. After the diagnoses given by DUNCAN of the two subfamilies *Diadematinæ* and *Pedininæ*, one might as well transfer all the genera of the *Diadematinæ* to the *Pedininæ* and vice versa.

We must then seek other characters for grouping the genera, and there we meet at once the „very popular and useful“ structures, the crenulation and perforation of the tubercles. In fact DUNCAN has not given any reason for neglecting the characters from these structures, except the assertion that „it may be stated, as a general truth, that if these genera (viz. the group of the fossil genera which is characterized by having numerous small tubercles placed actinally and at the

<sup>1)</sup> On the Anatomy of the Ambulacra of the recent Diadematidæ. J. Linn. Soc. Zool. XIX. 1885.

On the Structure of the Ambulacra of some Fossil Genera and species of Regular Echinoidea. Quart. Journ. Geol. Soc. XLI. 1885.

<sup>2)</sup> The simple ambulacra do not make a very distinct type, all ambulacra being originally simple.

ambitus, but then ceasing more or less, as for instance *Codiopsis*, *Gymnodiadema*, *Plistophyma* and *Polycyphus*; and also *Orthopsis* and its allies) be classified by the ornamentation of the tubercles, groups possessing very diverse ambulacra will be associated\*. This may perhaps be possible; but it is certain that by leaving this feature out of consideration DUNCAN has been induced to make e. g. *Hemipedina* a subgenus of *Diadema*, two forms so different that they must certainly be referred to two different families. And nobody will deny, I am sure, that the recent forms must afford the test of the value of characters used in the classification of the fossil forms. — By using the perforation of the tubercles as a systematic character among the recent Ectobranchiata no forms are grouped together, which by their other characters are shown to stand apart from each other. This is then a character of great value. Among the Diadematids no instance is known, of allied genera having the one perforated, the other imperforated tubercles. Among the Cidarids there is one instance: the genus *Tylocidaris* Pomel having imperforate tubercles, whereas in all the other recent and fossil Cidarids the primary tubercles are perforate. The crenulation of the tubercles is a less reliable character, as there are instances among the recent forms where undoubtedly allied genera, such as *Echinothrix* and *Lissodiadema*, *Temnopleurus* and *Pleurechinus*, have the one crenulated, the other noncrenulated tubercles. It is, however, in many instances a very useful character, which ought not to be neglected. Further the structure of the spines is of some importance; by neglecting the characters afforded thereby DUNCAN is induced for instance to make the important fossil genus *Pseudodiadema*, characterized by its smooth, solid spines, synonymous with *Diadema*, whose spines are hollow and verticillate. As with the crenulation of the tubercles, however, the characters afforded by the structure of the spines must be used very cautiously. — Finally the pedicellariæ and spicules afford some characters of importance, though not so many as in the other regular Echinids. That the characters afforded by the structure of test ought not to be neglected either, needs scarcely be mentioned. — Having thus made clear which characters can be used in the classification we may proceed to discuss the relations of the different genera.

The genera *Plesiadiadema* and *Aspidodiadema* are undoubtedly the most primitive of recent Diadematids. DUNCAN establishes for them a special family, *Aspidodiadematidæ*, distinguished from the *Diadematidæ* by the large, narrow, ringed apical system, formed by broad basals and broad intervening radial plates, by having few interradial plates, each with a large primary perforate and crenulate tubercle, and by the straight ambulacra with numerous low primary plates, with or without primary tubercles. Though I find none of these characters very important or exclusive, I quite agree with DUNCAN that these genera ought to form a separate family. A few characters are to be added from the spicules and pedicellariæ. The spicules are elongate, mesially widened and fenestrated plates, whereas in the *Diadematidæ* proper the spicules are triradiate or larger irregular plates. With regard

to the pedicellariæ the most distinct character is found in the triphyllous ones; they remind one very much of those of the Echinothurids, the blade being closed by a large coverplate in the lower part and the outer edge being serrate. The ophi-cephalous pedicellariæ occur in two different forms, a small form with or without glands on the stalk, and a large form without glands on the stalk. (To be sure the large form has not been found in all the species, but as its occurrence in the species, where it is known, is rather variable, it is allowable to suppose, that it will be found on further examination of more material in all the species). The characters here pointed out are certainly very slight, but added to the characters found in the test they can only strengthen the view that these two genera form a separate family of Diadematids. GREGORY unites *Aspidodiadema* with the genera placed by DUNCAN in the subfam. *Orthopsinæ* and makes thereof a family *Orthopsidæ*. I cannot agree with GREGORY herein. *Aspidodiadema* and *Plesiodiadema* have perforate and crenulate tubercles, but among the genera of „*Orthopsinæ*“ this is the case only in *Eodiadema*. This genus (according to the description) must certainly be very nearly related to *Aspidodiadema*; but none of the other genera placed here by GREGORY have perforate and crenulate tubercles, and I can accordingly see no proof that they are nearly related to *Aspidodiadema*. We must then retain the name *Aspidodiadematidæ* for this family, as well because of its priority as because it is very doubtful, if the genus *Orthopsis* does really belong to this family.

The separation of the genus *Micropyga* from the fam. *Diadematidæ* is certainly correct. In addition to the characteristic arrangement of the pores in sets of two it differs from all other Diadematids by its peculiar anchorshaped spicules. (BELL in his Note on the Spicules of the Regular Echinids<sup>1)</sup> has already expressed some doubt, if *Micropyga* has been rightly united with the Diadematids, on account of these spicules). On the other hand I must doubt the correctness of referring it to the subfamily *Diplopodinæ*, nay even the correctness of making a family or subfam. *Diplopodinæ* at all. It is a very obvious character, to be sure, the arrangement of the pores in sets of two; but it is also certain, I think, that all the forms with the pores arranged in this way are not really nearly related. It may well be supposed that the biserial arrangement has originated independently in different families, as is certainly the case with the polyporous arrangement. If we look to the ornamentation of the tubercles in the genera referred to the *Diplopodidæ*, we find that *Diplopodia* and *Pedinopsis* have perforate and crenulate tubercles, *Acanthechinus* and *Asteropsis* imperforate, crenulate, and *Phymechinus*, *Diplogamma* and *Plistophyma* imperforate, noncrenulate tubercles. Finally *Micropyga* alone has perforate noncrenulate tubercles. This „family“ accordingly seems very unnatural. It ought also to be remembered that in *Phymosoma* the pores are biserial on the abactinal side; but even DUNCAN has not ventured to be consistent and transfer this genus to the

<sup>1)</sup> Journ. R. microsc. Soc. 2. Ser. II. 1882. p. 298.

„*Diploporidæ*“. The biserial arrangement of the pores is then evidently of no more systematic value than the trigeminate and multigeminate arrangement. It seems to me most correct to make a separate family *Micropygidæ*, n. fam., for the genus *Micropyga* and leave it undecided, whether any of the known fossil genera may be referable to the same family. This family is characterized above all by its anchorshaped spicules, further by wanting ophicephalous pedicellariæ either in the form of true ophicephalous or of claviform ones; the triphyllous pedicellariæ are finely serrate in the outer edge, and the stalk of the pedicellariæ consists of several slender rods, almost not united except at the ends. The tubercles are perforate, non-crenulate. The biserial arrangement of the pores and the deep actinal cuts may probably not be family characters; that the extraordinary development of the abactinal tubefect in *M. tuberculata* is no character of high order is proved by the fact that in *M. violacea* these tubefects are simple.

The arrangement given by DUNCAN and GREGORY of the families (or subfamilies) *Diadematidæ* and *Pedinidæ* looks most extraordinary. *Cænopedina* (*Hæmipedina*) is placed with *Centrostephanus* and *Diadema* (by DUNCAN the two former are even regarded as subgenera of *Diadema*) in the fam. *Diadematidæ*, *Echinothrix* and *Astropyga* (to which *Chætodiadema* and *Lissodiadema* should probably have been added) in the fam. *Pedinidæ*. The diagnoses of these two families are: Fam. *Diadematidæ*. Ambulacral plates compound near the ambitus, the pairs of pores in simple vertical series or in arcs of three (or more). Fam. *Pedinidæ*. Ambulacral plates compound and the pore-pairs triserial. — I wonder if anybody can find in these diagnoses a single feature, which really differentiates these two families! When reviewing the characters found in the recent genera, *Diadema*, *Astropyga*, *Chætodiadema*, *Echinothrix*, *Lissodiadema*, *Centrostephanus* and *Cænopedina*, we find that *Lissodiadema* and *Cænopedina* have perforate, noncrenulate tubercles and smooth spines (solid in *Cænopedina*), whereas the other genera have perforate, crenulate tubercles and verticillate (hollow) spines. The spicules are simple, tri-radiate bodies, or larger, irregular, fenestrated plates (*Diadema Savignyi*, *Echinothrix diadema* and *Cænopedina*). In the two latter a few bihamate spicules may be found, but, though of great interest, this feature can certainly not be of any classificatory value. With regard to the pedicellariæ there are some facts of importance to note. The tridentate pedicellariæ do not present any features of more than specific importance; in the triphyllous pedicellariæ it is to be noticed that the edge is smooth and the blade open, without coverplate. The ophicephalous pedicellariæ occur in *Astropyga* and *Chætodiadema* only in the form of claviform pedicellariæ, seldom (*Chætodiadema*) with the head developed. In *Diadema (antillarum)* and *Echinothrix* they occur both as claviform and as true ophicephalous pedicellariæ, with the head placed directly, without neck, on the stalk. In *Centrostephanus* they also occur in both forms, but there is a well developed neck on the true ophicephalous ones, and in the claviform ones the head is especially developed with teeth on the valves,

so that this form is probably to be regarded as a primitive globiferous pedicellaria. Finally in *Cænopedina* the latter form has been developed into a curious form of globiferous pedicellariæ, with no glands on the stalk; there are true ophicephalous pedicellariæ. The stalk of the pedicellariæ is a single rod, or two rods connected by crossbeams in the triphyllous and tridentate pedicellariæ, irregular, complicated in the ophicephalous ones. In *Cænopedina* it is irregular and complicated, also in the triphyllous and globiferous pedicellariæ. (*Lissodiadema* is imperfectly known as regards the pedicellariæ.) There are thus several differences found in the pedicellariæ, but scarcely any of higher classificatory value. We are thus referred to the structure of the test and spines for characters from which to group the genera, and there we note as the most important fact that in *Cænopedina* the tubercles are smooth, whereas in all the other genera (except *Lissodiadema*) they are crenulate. The apical system of *Cænopedina* is small, with all the ocular plates excluded from the anal system, very different from the large apical system of other Diadematids, in which the ocular plates are more or less directly in contact with the anal system. Finally the stout solid spines are very different from the hollow spines of *Diadema* etc. There are no blue spots on the test. — There can certainly be no doubt that *Cænopedina* must be referred to a different family from the rest of the Diadematids, viz. to the fam. *Pedinidæ*; and to this family I would also refer such fossil genera as *Pedina* Ag., *Pseudopedina* Cotteau, *Mesodiadema* Neumayr, *Micropedina* Cotteau, *Leiopedina* Cotteau, *Echinopedina* Cotteau, *Hemipedina* Wright, *Echinopsis* Ag., *Diademopsis* Desor, *Phymopedina* Pomel, *Hecistocyphus* Pomel, *Orthopsis* Cotteau, *Miorthopsis* Pomel, *Gymnodiadema* Loriol, *Palæopedina* Lambert. — Among the genera referred by DUNCAN to the *Pedinidæ* the genera *Stomechinus*, *Polycyphus* and *Codechinus* have imperforate, noncrenulate tubercles, and *Heterocidaris* perforate, crenulate tubercles; these evidently cannot belong to this family. I thus quite agree with POMEL in his view of the family *Pedinidæ*.

The other recent genera of Diadematids must certainly be referred to one family, the *Diadematidæ*. To be sure, they are not all very nearly related; thus *Astropyga* and *Chætodiadema* form one group, *Diadema* and *Echinothrix* another group, and *Centrostephanus* again stands apart from the other genera. But to refer these groups to different families would certainly not be correct, the characters distinguishing the groups being only of secondary importance (form of the test, the blue spots, the pedicellariæ). The genus *Lissodiadema*, I think, must be referred to the same family, in spite of its smooth tubercles and spines; as I have pointed out in the description of this form it suggests *Echinothrix* in several important characters, and it must probably be regarded as an aberrant form of that type. — Among the fossil genera *Placodiadema* Duncan and *Helikodiadema* Gregory must probably be referred to this family.

A number of fossil genera have been united by POMEL in a family *Pseudodiadematidæ*, differing from the true *Diadematidæ* in having solid, smooth spines.

I dare not assert, if it be correct to make a separate family of these forms, though I think it probable. At any rate DUNCAN is wrong in making *Pseudodiadema* a synonym of *Diadema*. As no recent form of Pseudodiadematids is known, it is impossible to have a full knowledge of their characters. The genus *Lissodiadema*, to be sure, has only smooth spines, but it can scarcely have any close affinity to the *Pseudodiadematidæ*, all its characters pointing more towards *Echinothrix*.

I must here once more draw attention to the genus *Stomopneustes*. I have already (Ingolf-Ech.) shown it to be very different from the *Echinometridæ*, with which family it was hitherto associated. On the contrary it reminds one in several respects of the *Diadematidæ*. The spicules are irregular like those of the Diadematids, though more complicated. The globiferous pedicellariæ recall those of *Centrostephanus* and its triphyllous pedicellariæ are quite like those of the latter genus. It is very difficult to say, if these similarities are only characters of convergence. The difference in the ambulacra (echinoid in *Stomopneustes*) and the teeth (keeled in *Stomopneustes*) is evidently of more importance than the characters furnished by spicules and pedicellariæ. It is very unfortunate that no living representatives of forms like *Stomechinus* are found. It might well be supposed that *Stomopneustes* is a highly specialized descendant of such forms. At any rate the family *Stomopneustidæ* must be upheld, representing the lowest stage of the Echinoidea with echinoid ambulacra.

*Glyptocidaris crenularis* has been referred to the *Phymosomatidæ*<sup>1)</sup> by POMEL and DUNCAN; AGASSIZ, though referring it to the „Triplechinidæ“, even thinks it to belong to the genus *Phymosoma*. I think, POMEL and DUNCAN are right in placing it in the family *Phymosomatidæ*. The ambulacra are diadematoid (see Rev. of Ech. Pl. VI. 2)<sup>2)</sup>; the spicules are large fenestrated plates (Rev. of Ech. Pl. XXXVIII. 19). Globiferous pedicellariæ are found, but their structure unfortunately cannot be seen from the figure given by AGASSIZ (Rev. Pl. XXV. 4).

Having now discussed the relations of the genera of Diadematids, I may give my opinion of the interrelations of the families of the regular Echinoidea. Since I have made a special study of the recent forms of all these families<sup>3)</sup>, except the small and well characterized groups of the *Salenidæ* and *Arbaciidæ*, my views on their affinities may not prove unfounded, although they differ considerably from those of previous authors.

AGASSIZ (Rev. of Ech.) does not give a more elaborate system, he only names all the families of regular Echinids one after another, all being united into

<sup>1)</sup> As pointed out by LAMBERT (Ét. sur quelques Échinides de l'Infra-Lias et du Lias. p. 54) the name *Cyphosoma* cannot be used, as it rightly belongs to one of the Coleoptera.

<sup>2)</sup> In this figure the plate above the adoral one is a small demiplate, the following being the largest.

<sup>3)</sup> The family Temnopleuridæ is treated below.

## POMEL.

- Les Globiformes.
- Palechinida.
- Nearechinida.
  - Holostomata.
    - Cidaridæ.
    - Echinothuridæ.
  - Glyphostomata.
    - Diadematidæ.
      - Diadematinæ.
      - Pseudodiadematinæ.
      - Pedininæ.
      - Hemicidarinæ.
    - Phymosomidæ.
      - Saleninæ.
      - Phymosominæ.
      - Arbacinæ.
      - Temnechininæ.
      - Psammechininæ.
      - Stomechininæ.
      - Schizechininæ.
      - Heliocidarinæ.
      - Echinometrînæ.

## DUNCAN.

- Subclass I. Palæechinoidea.
- II. Euechinoidea.
- Order. Cidaroida.
  - Fam. Cidaridæ.
- Order. Diadematoida.
  - Suborder. Streptosomata.
    - Fam. Echinothuridæ.
  - Suborder. Stereosomata.
    - Fam. Saleniidæ.
      - Hemicidaridæ.
      - Aspidodiadematidæ.
      - Diadematidæ.
        - Subfam. Diadematinæ.
          - Diplopodiinæ.
          - Pedininæ.
          - Orthopsinæ.
    - Fam. Cyphosomatidæ.
      - Arbaciidæ.
      - Temnopleuridæ.
        - Subfam. Glyphocyphinæ.
          - Temnopleurinæ.
  - Fam. Echinometridæ.
    - Subfam. Echinometrînæ.
      - Polyporinæ.
  - Fam. Echinidæ.
- (Order III. Holecypoida.
  - IV. Clypeastroida.
  - V. Spatangida.)

- | GREGORY.                               | LAMBERT.                    |
|--|-----------------------------|
| Subclass I. Regularia endobranchiata.  | Subclass. Gnathostomata.    |
| Order 1. Bothriocidaroida.             | Order. Plagiocysta.         |
| — 2. Cysticidaroida.                   | Suborder. Cysticidaroida.   |
| Fam. Palæodiscidæ.                     | Order. Holostomata.         |
| — Echinocystidæ.                       | Suborder. Bothriocidaroida. |
| Order 3. Cidaroida.                    | — Perischoechinoida.        |
| Fam. Lepidocentridæ.                   | — Plesiocidaroida.          |
| — Archæocidaridæ.                      | — Cidaroida.                |
| — Cidaridæ.                            | Fam. Cidaridæ.              |
| — Diplocidaridæ.                       | Order. Glyphostomata.       |
| Order 4. Melonitoida.                  | Suborder. Streptosomata.    |
| Fam. Palæechinidæ.                     | Fam. Echinothuridæ.         |
| — Melonitidæ.                          | Suborder. Stereodermata.    |
| — Lepidesthidæ.                        | Fam. Diadematidæ.           |
| Order 5. Plesiocidaroida.              | Subfam. Diademinæ.          |
| Fam. Tiarechinidæ.                     | Tribus. Astropyginæ.        |
| — Lysechinidæ.                         | — Aspidodiademinæ.          |
| Subclass II. Regularia ectobranchiata. | Subfam. Tiarinæ.            |
| Order 1. Diademoida.                   | Tribus. Hemicidarinæ.       |
| Suborder 1. Calycina.                  | — Eodiademinæ.              |
| Fam. Saleniidæ.                        | — Pseudosaleninæ.           |
| — Acrosaleniidæ.                       | — Pseudodiademinæ.          |
| Suborder 2. Arbacina.                  | — Diplopodinæ.              |
| Fam. Hemicidaridæ.                     | — Glyphocyphinæ.            |
| — Arbaciidæ.                           | Subfam. Pedininæ.           |
| Suborder 3. Diadema.                   | Tribus. Orthopsinæ.         |
| Fam. Orthopsidæ.                       | — Climapedinæ.              |
| — Diadematidæ.                         | Fam. Echinometridæ.         |
| — Diplopodiidæ.                        | Subfam. Phymosominæ.        |
| — Pedinidæ.                            | Tribus. Saleninæ.           |
| — Cyphosomatidæ.                       | — Coptosominæ.              |
| — Echinothuridæ.                       | — Salmacinæ.                |
| Subfam. Pelanechininæ.                 | Subfam. Arbaciadinæ.        |
| — Echinothurinæ.                       | — Echininæ.                 |
| Suborder 4. Echinina.                  | Tribus. Orthoporinæ         |
| Fam. Temnopleuridæ.                    | — Oligoporinæ               |
| Subfam. Glyphocyphinæ.                 | — Polyporinæ                |
| — Ortholophinæ.                        | Prototiarinæ.               |
| — Temnopleurinæ.                       | Cotteaudinæ.                |
| Fam. Triplechinidæ.                    | Temnechinæ.                 |
| — Strongylocentrotidæ.                 | Pleurechinæ.                |
| — Echinometridæ.                       | Triplechinæ.                |
|  | Schizechinæ.                |
|  | Sphærechinæ.                |
|  | Trochalosominæ.             |
|  | Heliocidarinæ.              |
|  | Acrocladinæ.                |

one suborder; *Desmosticha* Haeckel. In the „Challenger“-Echini the same course is followed, and it is here (p. 18) even attempted in a mathematical way „to show once for all how futile it must be to carry on the attempts of tracing the genealogy of this or that group of animals“, in case the Echinoidea. There are about twenty variable terms in Echini, „which may be, of course, combined in all possible ways one with the other, and which are capable in their most restricted limits of at least  $2^{19}$  combinations; and when we remember that in the 225 genera which we have thus far recognised, we may imagine any one or all the twenty variables affecting the relationship of each of the genera, it seems somewhat hazardous, to say the least, to attempt anything beyond the broadest indications of the outlines of the relationship“. This may be theoretically true, but in practice there remain only some few characters to be taken into consideration when trying to trace the relationship of the forms, and the matter is not so difficult as it looks from the mathematical problem as put up by AGASSIZ.

More elaborate classifications have been given especially by POMEL, DUNCAN, LAMBERT and GREGORY<sup>1)</sup>; they are represented above in a tabular view.

Also the system of BELL<sup>2)</sup> ought to be mentioned, viz.

Entobranchiata.

Fam. 1. Cidaridæ.

Ectobranchiata.

Ser.  $\alpha$ . (Palæoproctous.)

Fam. 2. Salenidæ.

Ser.  $\beta$ . (Neoproctous.)

Subser. I. (polylepid.)

Fam. 3. Echinothuridæ.

Subser. II. (decalepid.)

Fam. 4. Arbaciadæ.

— 5. Diadematidæ.

— 6. Echinidæ.

As seen by these tabular views there is very little accordance among authors on the classification of the regular Echini. Leaving aside here the question, as to the propriety of subdividing the whole class into Regularia and Irregularia, or into Gnathostomata and Atelostomata, I shall here deal only with the Regularia.

The *Palæechinoidea* have hitherto been regarded as a separate subclass, differing from all the other Echinids (*Euechinoidea*) in having more than two series or (*Bothriocidaris*) only one series of interambulacral plates and two or more ambu-

<sup>1)</sup> A review of the different classifications of the Echinoidea has been given by MEISSNER in Bronn's Classen u. Ordn. Echinodermen. p. 1321.

<sup>2)</sup> The Echinometridæ, their affinities and systematic position. Proc. Zool Soc. 1881. p. 410.

lacrals plates. In Lankester's „Treatise on Zoology“ III (1900) GREGORY has made a most interesting attempt at a more natural classification. The Palæechinoids are no more regarded as a separate subclass equivalent to all other Echinids, but they are united with the regular Echinids and, together with the *Cidaridæ*, classed as *Regularia Endobranchiata*. I think this a very important step towards a natural classification, though I do not quite agree with GREGORY in the arrangement of the families. It seems to me rather bold to place the *Cidaridæ* and *Lepidocentridæ* in one order. But that the *Archæocidaridæ* are closely related to the *Cidaridæ* seems, indeed, very probable, the only important difference, as far as we know, being the pluriseriate arrangement of the interambulacral plates in the *Archæocidaridæ* — and this character even is not quite exclusive, there being four series of interambulacral plates in *Tetracidaris*, which can by no means be classed with the *Archæocidaridæ*. I think it right then to follow GREGORY in uniting the *Archæocidaridæ* and the *Cidaridæ* into one order, *Entobranchiata*<sup>1)</sup>, against another order: *Ectobranchiata*, comprising the other regular Echinoidea, except, perhaps, some of the *Palæechinoidea*. GREGORY is scarcely right in assuming that none of the *Palæechinoidea* had outer gills; but as I have no very extensive knowledge (and only literary) of the Palæechinids I shall not enter into a more detailed discussion of this problem.

The family *Echinothuridæ* Wyv. Thomson is adopted by AGASSIZ in the „Challenger“-Echini, though it is pointed out that its difference from the *Diadematidæ* is very slight, „some of the species of *Echinothuridæ* here described show(ing) that some of the important characters upon which this family is distinguished from the *Diadematidæ* may become gradually obliterated“. In some *Echinothurids* „the lapping of the plates is reduced to a minimum, if it exists at all“, while on the other hand in *Astropyga* the lapping of the plates is very distinct, which genus therefore must be considered „a genus either belonging to the *Echinothuridæ* or at any rate possessing some of the most characteristic features of both the *Diadematidæ* and *Echinothuridæ*“. (Op. cit. p. 72.) These facts pointed out by AGASSIZ certainly show that the lapping of the plates is no exclusive character of the *Echinothuridæ*, but they do not at all show the family to be untenable. The structure of the ambulacra and the continuation of the ambulacral plates on the buccal membrane are characters so distinct that there can be no doubt at all of the *Echinothuridæ* forming a very distinct family. Also the structure of the actinal spines which end in a distinct hoof or a thick bag of skin seems to be a very exclusive character; it is to be remembered, however, that we do not know, how the actinal spines of *Kamptosoma* terminate. With regard to pedicellariæ and spicules no characters of importance can be pointed out as distinguishing the *Echinothuridæ* from the *Diadematidæ*. DUNCAN and LAMBERT (and recently MEISSNER) place the

<sup>1)</sup> The name *Holostomata* cannot be used, as also the *Echinothurids* are holostomatous.

*Echinothuridæ* as a suborder *Streptosomata* of the *Diadematoidea* against all the other families as another suborder *Stereosomata* (*Stereodermata*)<sup>1)</sup>. POMEL goes even further, as he unites the *Echinothuridæ* with the *Cidaridæ* as *Holostomata* against all other regular Echinoids (the Palechinoids excepted) as *Glyphostomata*. But it is to be remembered that he did not know the occurrence of gills in the Echinothurids. If he had known that (and he might have known it, as LUDWIG's paper on *Asthenosoma varium* was published in 1880, POMEL's work in 1883), he would certainly have altered his classification. GREGORY goes the other way, making the Echinothurids only a family of his suborder *Diademina*. He finds the characters given for the suborder *Streptosomata* indistinctive. „In the Pedinid *Astropyga* and the Diademid *Helikodiadema* the test is more or less flexible. Both external and internal branchiæ are as well developed in *Diadema* as they are in *Phormosoma*. In those of the *Stereosomata* which have plates on the peristomal membrane these are always ambulacral“<sup>2)</sup>. It is very curious that GREGORY has been induced to make the latter assertion, which is as much erroneous as it is fundamental. In all the regular Echinids, except the Cidarids and Echinothurids, there are only five pairs of buccal ambulacral plates, provided with tube feet, which are mostly larger and a little different from the other tube feet (in a single instance, *Pleurechinus Döderleini* there are constantly only five unpaired buccal plates and tubefeet; see the description of this species below). Besides these buccal plates there may be more or less numerous plates in the buccal membrane, but these are always irregularly placed, and have nothing at all to do with either the ambulacral or interambulacral coronal plates; they are formed in the buccal membrane itself, the youngest ones being found nearest to the edge of the peristome, not detached from the test, and there are never found tubefeet on these plates. In the Echinothurids the plates covering the peristome are true ambulacral plates, all bearing tubefeet, and the first pair of tubefeet are not larger than or different from the following ones. In the Cidarids the same fact holds good, only here also the interambulacral plates continue over the peristome. — These fundamental facts have already been clearly pointed out by LUDWIG<sup>3)</sup>, who has, indeed, first placed the Echinothurids as a separate group against all the other regular Echinids above the Cidarids. — GREGORY further thinks he has found in the genus *Pedinothuria* a form intermediate between the Pedinids and the Echinothurids, showing the latter family to be „an offshoot from the Pedinidæ“ (Treatise on Zool. p. 310). This genus has perforate, crenulate tubercles, the pores are arranged biserially at the

<sup>1)</sup> W. KEEPING. Notes on the Palæozoic Echini. Quart. J. Geol. Soc. XXXII. 1876. p. 40. Under the section *Stereodermata* KEEPING includes both regular and irregular Echini (*Endocyclica* and *Exocyclica* Wright). The name can then scarcely be used in the meaning of DUNCAN and LAMBERT.

<sup>2)</sup> On the affinities of the Echinothuridæ; and on *Pedinothuria* and *Helikodiadema*, two new genera of Echinoidea. Quart. Journ. Geol. Soc. LIII. 1897.

<sup>3)</sup> Über *Asthenosoma varium* Grube und über ein neues Organ bei den Cidariden. Morph. Studien. II. p. 17. (1880.)

ambitus, triserially on the actinal side, and the buccal membrane is as in other Diadematids. The apical system is unknown, but as it was very large (its diameter about half that of the test) there can scarcely be any doubt that its structure was diadematoid. It is then difficult to see how *Pedinothuria* can prove the Echinothurids to be an offshoot from the Pedinids, as it has evidently nothing to do with either of these families but must be referred to the *Pseudodiadematidæ* (or *Diadematidæ*). GREGORY has thus not produced any fact extinguishing the fundamental difference between the Echinothurids and the other regular Echinids, viz. the continuation on the peristome of the ambulacral plates.

Also NEUMAYER<sup>1)</sup> is inclined to think the Echinothurids have been derived from the Pedinids. It must be taken for granted, he argues, that the complicate structures of ambulacra are developed on account of the compression of the plates, „wenn die überzähligen Ambulacraltäfelchen nicht oder nur in ungenügender Zahl auf das Peristom übertreten können. Demgemäss kann auch die Herausbildung von complicierten Ambulacralbildungen nur bei Formen mit starrem Gehäuse stattfinden“. Accordingly the ancestors of the Echinothurids must have had a hard test. Among the Palæechinids the genus *Palæechinus* has a hard test and a beginning of the complicate ambulacral structures. It is, however, difficult to understand how the Echinothurids could have developed from a form as *Palæechinus*, and no intermediate forms are known. It seems then necessary to derive them from the Diadematids, and here *Pelanechinus* is thought to be intermediate between *Hemipedina* and the Echinothurids. — *Pelanechinus*, however, has now been proved by GROOM to be a true Echinothurid, even a very specialized form, and thus it can prove nothing of the ancestry of the Echinothurids any more than *Pedinothuria* can.

On a priori grounds it seems, indeed, rather absurd to derive the Echinothurids from the most specialized group of Diadematids, the *Pedinidæ*. It is the most natural thing to look out for the ancestors of the Echinothurids among the Palæechinids, and perhaps we may find them among the *Lepidocentridæ*. The genus *Lepidechinus* has been shown by JACKSON<sup>2)</sup> to have the ambulacra, but not the interambulacra, continuing over the peristome, and the same probably will hold good for the other genera. The ambulacra are simple, consisting of two series of plates, whereas the interambulacra consist of several rows of imbricating plates. There is thus, in fact, only this one essential difference between *Lepidechinus* and the Echinothurids, viz. the structure of the interambulacra, which also obtains between *Archæocidaridæ* and *Cidaridæ*. I think then, it will be natural to unite the *Lepidocentridæ* and the *Echinothuridæ* into one suborder: *Streptosomata*.

The character of the multiple series of plates in the interambulacra (and ambulacra) seems thus to be less important than has been hitherto commonly thought.

<sup>1)</sup> Stämme des Thierreichs I. 1889. — Über *Palæechinus*, *Typhlechinus* und die Echinothuriden. N. Jahrb. f. Mineral. Geol. u. Pal. 1890. I. p. 84.

<sup>2)</sup> Studies of Palæechinoidea. Bull. Geol. Soc. America. VII. 1896.

Forms like *Tetracidaris* and *Sperosoma* also show this character to be less exclusive. — It is interesting to note that in both Cidarids and Echinothurids we thus know a form with pluriseriate plates.

JACKSON finds an important stage of development in the condition with only one interambulacral plate and two ambulacral plates, as in *Bothriocidaris*; he names it the „Protechinus“-stage. It is found, indeed in all Echini. For the Echinothurids it has not hitherto been indicated to exist. I can, however, assert that it is really found; it is seen very distinctly in young *Phormosoma placenta*. I give here a figure of this stage (Fig. 4).

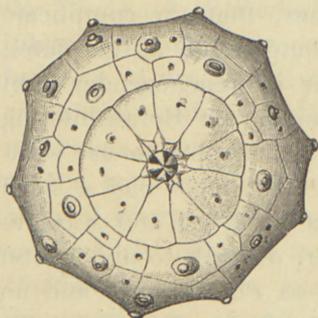


Fig. 4. Actinal side of a young *Phormosoma placenta* (3 mm. diameter) in the „Protechinus“-stage.

It now remains to group the families of the *Stereosomata*. The characters upon which such an arrangement must be undertaken are: the structure of the ambulacra — diadematoid or echinoid — and the structure of the tubercles — perforate or imperforate — (the crenulation is evidently of much less value). Finally the structure of the teeth — keeled or unkeeled — is evidently a very important character, though it has hitherto received very little attention. Other more important characters I do not find; but when we group the families according to these three characters an arrangement results which seems to answer fairly well to the natural relations of the different families. — Unfortunately the structure of the ambulacra and, especially, of the teeth is unknown in a great number of the fossil forms.

But it is likely that these structures will be known by and by, the teeth being not so very seldom preserved in the fossil Echini. For the present we must mainly make our conclusions from the recent forms.

An examination of the different families with regard to these features then gives the following result. Diadematoid ambulacra, perforate tubercles and unkeeled teeth are found in the fam. *Diadematidæ*, *Micropygidæ* and *Pedinidæ*<sup>1)</sup>; the *Aspidodiadematidæ* certainly belong to the same group, their simple ambulacra evidently representing only a primary stage of the diadematoid ambulacra (in *Aspidodiadema* the ambulacral plates with the large tubercles are indeed compound after the diadematoid type). That the *Pseudodiadematidæ* belong to the same group I think nobody will doubt, even though the teeth are unknown. Further the *Hemi-*

<sup>1)</sup> When seeking information in „Rev. of Ech.“ of the structure of the teeth in *Cænopedina*, I found the following information: p. 292 „the teeth resemble those of *Arbacia*“; of the *Arbaciidæ* it is said p. 263: „teeth like those of *Diadematidæ* and *Cidaridæ*“ (unkeeled); p. 399: „the teeth are shaped as in the *Diadematidæ* and *Echinidæ* proper“ (keeled and unkeeled); p. 688 the teeth are said to be „keeled in the middle“. — It is rather difficult to find from these indications the real fact that in *Arbaciidæ* the teeth are keeled, in *Cænopedina* they are unkeeled.

*cidaridæ* certainly have to be referred to this group also, since they likewise have unkeeled teeth, diadematoid ambulacra and perforate tubercles.

The *Saleniidæ*, *Arbaciidæ* and *Phymosomatidæ* agree in having imperforate tubercles and keeled teeth. The *Saleniidæ* have simple ambulacra; in the two other families the structure is diadematoid. These three families are evidently related, especially the *Arbaciidæ* and *Phymosomatidæ*. The *Saleniidæ* on account of their other peculiarities (apical system, spines of cidaroid structure) form a special group, but it is perhaps not unreasonable to see their nearest allies in the *Arbaciidæ*. If the fam. *Stomechinidæ* Pomel be rightly maintained, it will probably have its place near the *Arbaciidæ*.

The rest of the families of regular Echinids all agree in having echinoid ambulacra, imperforate tubercles and keeled teeth. These families then evidently form one group, as has, indeed, been commonly accepted.

The result of the grouping of the families after the structure of ambulacra, tubercles and teeth is thus seen in no way to violate evident natural relations. All the diadematoid genera remain in one group and all echinoid genera likewise remain together. It can thus scarcely be said to be an unnatural classification. But then the uniting of *Arbaciidæ* and *Phymosomatidæ* (and *Stomechinidæ*) must in all probability also be the natural grouping of these families, which have been so differently placed in the previous systems; likewise the referring of the *Hemicidaridæ* to the group of the Diadematids must certainly be correct. My system of the regular Echinids then looks as follows, the Palæechinids being partly left out of consideration:

Order 1. Entobranchiata.

Suborder. Cidaroida. Both ambulacral and interambulacral plates continuing over the peristome.

Fam. 1. Archæocidaridæ.

— 2. Cidaridæ.

Order 2. Ectobranchiata.

Suborder 1. Streptosomata. Ambulacral plates covering the peristome; no large „buccal“ plates, the first pair of tubefeet not developed as larger „buccal“ tubefeet.

Fam. 1. Lepidocentridæ.

— 2. Echinothuridæ.

Suborder 2. Stereosomata. Only 5 pairs of ambulacral plates, the „buccal“ plates, on the peristome, provided with tubefeet mostly larger than those of the test.

Tribus 1. Diademina. Ambulacra diadematoid; tubercles perforate; teeth unkeeled.

- Fam. 1. Aspidodiadematidæ.  
 — 2. Diadematidæ.  
 — 3. (?) Pseudodiadematidæ.  
 — 4. Micropygidæ.  
 — 5. Pedinidæ.  
 — 6. Hemicidaridæ.
- Tribus 2. Salenina. Ambulacra simple; tubercles imperforate; teeth keeled.  
 Fam. 1. Saleniidæ.
- Tribus 3. Phymosomina. Ambulacra diadematoid; tubercles imperforate; teeth keeled.  
 Fam. 1. Arbaciidæ.  
 — 2. Phymosomatidæ.  
 — 3. (?) Stomechinidæ.
- Tribus 4. Echinina. Ambulacra echinoid; tubercles imperforate; teeth keeled.  
 Fam. 1. Stomopneustidæ.  
 — 2. Temnopleuridæ.  
 Subfam. Temnechininæ.  
 — Temnopleurinæ.
- Fam. 3. Echinidæ.  
 Subfam. Parechininæ.  
 — Echininæ.
- Fam. 4. Toxopneustidæ.  
 Subfam. Schizechininæ.  
 — Strongylocentrotinæ.  
 — Parasaleninæ.
- Fam. 5. Echinometridæ.

## Fam. Temnopleuridæ.

It is a very surprising fact that the pedicellariæ of the Temnopleurids prove to be only of subordinate value for classification. In the allied families *Echinidæ*, *Toxopneustidæ* and *Echinometridæ* they afford excellent characters for both species, genera and families, and also in the *Cidaridæ*, *Echinothuridæ* and *Diadematidæ* they afford very important systematic characters. In the Temnopleurids they mostly give only specific characters. In the larger genera, e. g. *Salmacis*, *Temnopleurus*, the globiferous pedicellariæ assume the forms occurring both in the *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*; in some species, e. g. *Salmacis bicolor*, they even occur in the same specimen in both the two forms which distinguish the families *Toxopneustidæ* and *Echinometridæ*. This very curious fact, of

course, does not alter the classificatory value of the pedicellariæ in the other regular Echinids; but we are forced to seek the generic characters of the Temnopleurids in the structure of the test. (The spicules do not yield such characters either; they are, with the single exception of *Temnopleurus Reevesii*, simply bihamate). Now, fortunately, the Temnopleurids afford many very characteristic features in the test, and as these have been very well studied by the previous authors on this subject, the classification of these forms is very well founded, and I have almost nothing to alter with regard to the genera. As for the species the pedicellariæ often afford excellent characters, and thus, naturally, a close examination of these structures makes some rearrangement of the species necessary.

All the usual four kinds of pedicellariæ occur in the Temnopleurids<sup>1)</sup>. The tridentate ones have not been found in all the species, thus f. i. in several of the *Pleurechinus*-species. They do not vary much in form, but afford, however, good specific characters in a few instances (the *Salmacis*-species). The globiferous pedicellariæ are always without neck, and they have always (? *Amblypneustes grossularia*) two quite separate glands on each valve; the stalk is composed of long fibres as in the *Echinidæ*. As is said above, they occur in all the forms found in the *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*. The primitive form known from *Par-echinus* and *Loxechinus* is found among the Temnopleurids only in *Hypsiechinus*, which is evidently the most primitive of all the *Temnopleuridæ*, as indicated also by its triradiate spicules. The globiferous pedicellariæ of *Mespilia* (Pl. VII. Fig. 16, 22) remind one somewhat of this form, but they are evidently rather modified. — The form characteristic of *Echinus* is found in some species of *Salmacis* and *Temnopleurus*, (*Salm. sphaeroides*, *dussumieri*, *Temnopl. toreumaticus*); the form without lateral teeth characteristic of the *Toxopneustidæ*, is found in *Salm. virgulata* and *bicolor*, *Pleurechinus variegatus* etc. The most common form, however, is that with one unpaired lateral tooth, the Echinometrid-form; it occurs in *Salm. bicolor* and *belli* (together with the form without lateral teeth), *Pleurechinus Döderleini*, *Amblypneustes* etc. The ophicephalous and triphyllous pedicellariæ do not present any marked peculiarities; the latter are never serrate in the outer edge, except in *Prionechinus* and *Trigonocidaris*. The sphæridiæ do not present any peculiar features. — The spicules are bihamate, with the exception only of *Hypsiechinus* and *Temnopleurus Reevesii*, in which latter species they are bowshaped, the ends not being bent inwards. They are mostly very scarce and very delicate.

Specific characters of importance are also found in the spines, especially in the form of the point. It may be knoblike, smooth, or it may form a long central

<sup>1)</sup> DUNCAN in his paper „On some Points in the Anatomy of the Temnopleuridæ“ (Ann. N. Hist. 6. Ser. I. 1888) gives a description of the pedicellariæ of *Temnopleurus* (p. 128) which is very confused. His „common tridactyle pedicellariæ“ are the globiferous ones, and they have not „often“ long, soft necks. „The globiferæ“ are ophicephalous and the figure given of a „triphylta or ophicephalous“ pedicellaria looks more like a small ophicephalous one.

thorn surrounded by smaller ones etc. They are especially of importance in the genera *Pleurechinus* and *Amblypneustes*.

The buccal membrane is mostly quite naked, with the exception, of course, of the buccal plates; only in *Trigonocidaris*, *Prionechinus* and *Hypsiechinus* it is covered with large plates. There are some small irregular plates just round the mouth, otherwise no plates or only a few, but mostly numerous bihamate spicules; where such plates are found outside the buccal plates, they are mostly placed opposite to the gills, carrying some pedicellariæ. Otherwise pedicellariæ are very scarce or quite wanting on the buccal plates; neither do spines occur thereon. A very curious feature is found in the new species of *Pleurechinus*, *Pl. Döderleini*, described below, there being only five buccal plates and five buccal tube-feet. It reminds one of *Prionechinus* and *Hypsiechinus*, which have likewise only five buccal tube-feet (but ten buccal plates) in the young stages; but in *Pl. Döderleini* this condition is permanent.

In the collections brought home by the Siam-Expedition the *Temnopleurids* are very well represented, viz. by the species: *Temnopleurus toreumaticus*, *Salmacis sphaeroides*, f. *typica*, *S. bicolor*, var. *rarisipina*, *S. virgulata*, *S. dussumieri*, *Pleurechinus Döderleini* n. sp. and *Pl. siamensis* n. sp. Further specimens of *Temnopleurus Reevesii* are found in the Museum of Copenhagen, from the Gulf of Siam (SALMIN).

## 6. *Temnopleurus toreumaticus* (Klein).

Pl. VI. Figs. 8, 14, 22, 49. Pl. VII. Figs. 3, 28.

- Cidaris toreumatica*. KLEIN. 1734. Naturalis dispositio Echinodermatum. p. 17. Pl. X. fig. E.  
*Temnopleurus toreumaticus*. L. AGASSIZ & DESOR. 1846. Catalogue rais. des Éch. p. 360 (56).  
 — *Reynaudi* — — — — —  
*Toreumatica granulosa* GRAY. 1855. An arrangement of the Families of Echinidæ, with descriptions of some new Genera and Species. Proc. Zool. Soc. 1855. p. 39.  
*Temnopleurus toreumaticus*. A. AGASSIZ. 1872. Rev. of Echini. p. 166, 463. Pl. VIII. a. fig. 4—5.  
 — *granulosus*. BELL. 1880. On some genera and species of the Temnopleuridæ. Proc. Zool. Soc. 1880. p. 424—25.  
 — *toreumaticus*. DUNCAN. 1881. On some points in the Morphology of the test of the Temnopleuridæ. J. Linn. Soc. XVI. p. 350. Pl. VIII. figs. 10—14.  
 — — DÖDERLEIN. 1885. Seeigel v. Japan u. den Liu-Kiu-Inseln. p. 15.  
 — — IVES. 1891. Echinoderms and Arthropods from Japan. Proc. Acad. Nat. Sc. Philadelphia. 1891. p. 214.  
 — — BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 280.  
 Non: *Temnopleurus Reynaudi*, A. AGASSIZ. Rev. of Echini (= *Reevesii* Gray).  
 — — *toreumaticus* SLADEN. 1878. On the Asteroidea and Echinoidea of the Korean Seas. J. Linn. Soc. XIV. p. 438. (= *Pleurechinus variegatus* Mrtsn.).  
 — — — BELL. 1884. Echinodermata „Alert“-Exped. p. 119.  
 — — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 80.

This very well known species has been excellently described by AGASSIZ and DÖDERLEIN. Only the pedicellariæ and spicules need yet be mentioned, the description of the pedicellariæ given by DUNCAN being far too inaccurate, as pointed out above. The globiferous pedicellariæ (Pl. VI. Fig. 8, 14) have one little, but distinct lateral tooth on each side of the rather elongate blade, which is closed, with the exception of a small elongate opening just below the lateral teeth; sometimes, however, one of the lateral teeth may be wanting, or the one may be placed farther down than the other. The outer corners of the basal part are somewhat produced. The tridentate pedicellariæ (Pl. VI. Fig. 49, Pl. VII, Fig. 3) have long and narrow valves, a little curved, wide apart, joining only at the point. The edge is a little serrate or sometimes quite smooth, except at the point, which has a few larger serrations. No meshwork in the blade; the apophysis has some coarse serrations in the edge. They are mostly small, but may reach a size of 1 mm. (head). In the ophicephalous pedicellariæ (Pl. VI. Fig. 22) the valves are rather elongate, otherwise they do not present marked features, and the same holds good for the triphyllous ones. (Pl. VII. Fig. 28). — The spicules are bihamate and very few in number. In the buccal membrane there are some irregular plates inside the buccal plates; outside these the membrane is almost bare, only with a few plates opposite to the gills; very few bihamate spicules occur in the buccal membrane. In the walls of the intestine and genital organs there are some few bihamate spicules, only now and then a spot may be found, where the spicules are more crowded.

Several specimens were taken in the fishing-nets of the natives at Koh Kong, (4—5 fathoms); also some small specimens were taken at Koh Kahdat, 10 faths., between Koh Rin and Cliff Rock, 15 faths., and N.W. of Koh si Chang, c. 10 faths. By the Skeat-Expedition it was taken at Pulo Bidang (1 specimen).

Quite small specimens (c. 5—6 mm. in diameter) are not easily distinguished from equally sized specimens of *Salmacis sphaeroides*, the pits of the test being as yet rather alike in size. However, the spines are proportionally much longer in *T. toreumaticus* (almost as long as the diameter of the test in *toreumaticus*, scarcely half that length in *S. sphaeroides*). The colour of the spines is a little different, more greenish in *toreumaticus*, reddish or whitish in *sphaeroides* (both are ringed); the pedicellariæ present only quite insignificant differences.

*Temnopleurus Reynaudi* L. Agass. is, as might already be supposed from the original diagnosis (Cat. rais. p. 56), synonymous with *T. toreumaticus*. Dr. GRAVIER has most kindly sent me the type-specimens for examination, so that I am able to say this with full certainty. What AGASSIZ describes under the name of *T. Reynaudi* in „Rev. of Ech.“ is not this species but *Temnopl. Reevesii* (Gray). (See below.)

*Temnopleurus granulatus* (Gray) is made synonymous with *T. Reevesii* („*T. Reynaudi*“) by AGASSIZ (Rev. of Ech. p. 166). BELL (Op. cit.) maintains it as a distinct species. After having examined the type-specimens of GRAY in the British

Museum I must quite agree with BELL that they have nothing to do with *T. Reevesii*, but on the other hand I do not find a single character by which to distinguish *granulosus* with certainty from *toreumaticus*. BELL does not point out any character distinguishing it from *toreumaticus*, he only remarks that the sutural furrows are not so deep nor so wide as in that species; but this is a feature much too variable to be relied upon for sole specific character. Accordingly I must regard *T. granulosus* as a synonym of *T. toreumaticus*. — The specimens of „*T. granulosus*“ mentioned by BELL<sup>1)</sup> from Port Denison, Queensland, are partly *Salmacis Alexandri*, partly another *Salmacis* (probably *S. sphaeroides*, var. *pyramidata*); only a single small specimen is probably *T. toreumaticus*.

In the „Alert“-Echinodermata (p. 119) BELL mentions a specimen of *Temnopl. toreumaticus* from Port Denison, which „has all the spines which are preserved on it perfectly white, without any bands whatever“. I have examined this specimen in the British Museum and can thus assert that it is not *T. toreumaticus*; its globiferous pedicellariæ have no lateral teeth. To which species and genus it belongs I cannot say, having not examined it sufficiently for that purpose.

The specimen described by SLADEN in his paper on the Asteroidea and Echinoidea of the Korean Seas<sup>2)</sup> as a young *Temnopl. toreumaticus* is a *Pleurechinus* of the species described below as *Pleurech. variegatus*. (The specimen was examined in the British Museum). Finally the specimen referred by DE MEIJERE to *Temnopl. toreumaticus* (Op. cit.) is not that species either. The globiferous pedicellariæ have no lateral teeth, and the spines are yellowish-green with red base; from these two characters it might be supposed to be *Salmacis Alexandri*<sup>3)</sup>. „Nach anderen Autoren (DÖDERLEIN, BEDFORD) kommen auch Exemplare mit mehr oder weniger geringelten Stacheln vor“ says DE MEIJERE (Op. cit. p. 81). All the specimens I have seen of *T. toreumaticus* have ringed spines, though sometimes rather indistinctly, when the spines are very dark coloured, and I am not aware that specimens with not-ringed spines have been recorded, except those wrongly referred to *toreumaticus* by BELL and DE MEIJERE. On the contrary ringed spines do not occur in the other species of *Temnopleurus*; accordingly the ringed spines form one of the specific characters of *toreumaticus*, and the assertion that ringed spines do „also“ occur in this species thus sounds rather curious.

IVES (Op. cit.) regards *Temnopl. Hardwickii* (Gray) as synonymous with *toreumaticus*, having found specimens intermediate between these two species as defined by AGASSIZ. „One specimen having rather deep pits, has the ocular and genital plates covered with prominent tubercles, and other specimens show the

<sup>1)</sup> Echinodermata. „Alert“-Exped. p. 119.

<sup>2)</sup> Journ. Linn. Soc. Zoology XIV. 1878. p. 438.

<sup>3)</sup> After the manuscript was finished, DE MEIJERE has kindly lent me the specimen for examination. It is *S. virgulata* var. *Alexandri* or perhaps a new variety. The test is white; no tridentate pedicellariæ are found on the specimen.

passage from the deep rectangular pits to the bevelled grooves of the ambulacral and interambulacral regions". It is quite true that forms intermediate in the structure of the test between *toreumaticus* and *Hardwickii* may be found (I have seen such forms only among Japanese specimens); however, *T. Hardwickii* must be maintained as a distinct species<sup>1</sup>). An examination of the pedicellariæ shows some additional good specific characters. The globiferous pedicellariæ (Pl. VI, Fig. 34, Pl. VII, Fig. 21) have no distinct lateral teeth, only a rounded knob on each side below the endtooth. The outer corners of the basal part are very sharp. (The figure of a „prong of open-headed, long-stemmed interambulacral pedicellaria“ given by AGASSIZ in „Rev. of Ech.“ Pl. XXV. 2, represents a valve of a globiferous pedicellaria, where the endtooth has been broken off, seen from the outer side). Tridentate pedicellariæ I have not been able to find on any of the specimens examined by me, among which are two large, beautifully preserved specimens from the Berlin-Museum. The ophicephalous pedicellariæ (Pl. VI, Fig. 32) are shorter and broader than in *toreumaticus*, and the sinuations of the edge are small and indistinct. The triphyllous pedicellariæ are alike in the two species, neither is there any difference as regards the spicules and their occurrence in the tubefeet, buccal membrane and internal organs.

The characters thus found in the pedicellariæ added to those previously known, viz. the raised apical system, the bevelling of the pits (in larger specimens) and the colour of the spines (dark at the base, not ringed<sup>2</sup>), certainly prove *T. Hardwickii* to be a distinct species. — POMEL (Op. cit. p. 87) goes to the opposite extreme of what has been maintained by IVES, holding *T. Hardwickii* to be a distinct genus, for which the old name *Temnotrema* Ag. is used. If that were right the older name *Toreumatica* Gray (under which *T. Hardwickii* is named as first species) would have to be used. But there is evidently no reason at all for making a separate genus of this species; it is merely a distinct, easily recognizable species of the genus *Temnopleurus*.

The (supposed) original specimens of *T. Hardwickii* (in the British Museum) are two naked tests which are, indeed, more like *toreumaticus* than *Hardwickii* as now understood. The pits are not much bevelled, the apical area not much elevated; the few primary spines remaining are greenish, not dark at the base; they are all broken, so it cannot be seen if they were ringed. It is thus rather doubtful if they are really the species now named *Hardwickii*, but as they are not suffi-

<sup>1</sup>) MEISSNER (Die von Herrn Marine-Stabsarzt Dr. Sander heimgebrachten Seeigel. Sitz. ber. Ges. Naturf. Fr. Berlin. 1892. p. 183) also maintains *T. Hardwickii* as a distinct species against IVES, without giving his reasons for it, however.

<sup>2</sup>) *Temnotrema sculpta* A. Ag., which is referred to *T. Hardwickii* as synonym by AGASSIZ (Rev. of Ech.) is described as having „spines ringed with white and violet“; thus it certainly cannot be synonymous with that species. It needs a renewed examination.

ciently well preserved for stating beyond doubt to which species they belong, it would be unreasonable to alter the familiar name of *Temnopl. Hardwickii*.

The specimens mentioned by AGASSIZ in the Challenger-Echini p. 107 under *T. Hardwickii* are only partly that species. I have examined them in the British Museum and find them to be as follows:

Kobi, Japan. — 5 beautiful specimens of *T. toreumaticus*, recalling, however, in the development of their pits *T. Hardwickii*.

Arafura Sea. — A very young specimen, probably of *T. toreumaticus*; the spines are ringed, not dark at the base.

St. 192. — One specimen, representing a new species of the genus *Opechinus* (described below as *O. spectabilis*).

Off Yokohama. — 5 beautiful specimens of *T. Hardwickii*.

I may further remark that the two small specimens from lat. 32° 49' N., long. 128° 54' E. mentioned by SLADEN in the above cited paper on the Asteroids and Echinoids from the Korean Seas as young *T. Hardwickii* (p. 436) are *Pleurechinus variegatus* (see below) or a very nearly related species.

## 7. *Temnopleurus Reevesii* (Gray).

Pl. VI. Figs. 3, 10, 12. Pl. VII. Fig. 37.

*Toreumatica Reevesii*. GRAY. 1855. An arrangement of the Families of Echinidæ etc. Proc. Zool. Soc. 1855. p. 39.

*Temnopleurus Reynaudi*. AGASSIZ. 1872. Revision of Echini. p. 166, 461. Pl. VIII, 22—24, VIII. a. 6—7.

— — SLADEN. 1878. On the Asteroidea and Echinoidea of the Korean Seas. J. Linn. Soc. XIV. p. 437.

— — BELL. 1880. On some genera and species of the Temnopleuridæ. Proc. Zool. Soc. 1880. p. 424.

— — DÖDERLEIN. 1885. Seeigel von Japan u. den Liu-Kiu-Inseln. p. 19.

— — DE MEIJERE. 1904. Siboga-Echinoidea. p. 81. Pl. XVI. Fig. 270, Pl. XVII. Fig. 271.

NON: *Temnopleurus Reynaudi*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Éch. p. 56.

— — — BELL. 1894. Echinoderms of Macclesfield Bank. Proc. Zool. Soc. p. 410.

— — — (?) BEDFORD. 1900. Echinoderms from Singapore and Malacca; p. 281.

The description of this easily recognizable species given by AGASSIZ is very good, so I need only add a few remarks, mainly on the pedicellariæ and spicules. — The globiferous pedicellariæ, as described and figured by DE MEIJERE, have a long, fine lateral tooth on either side or sometimes only on the one side below the long and slender endtooth; they are generally placed at an unequal distance from the end-

tooth, that on the straight side farther down than that on the side with the terminal widening. The outer corners of the basal part are broadly rounded (Pl. VI. Figs. 3, 10). Tridentate pedicellariæ I have not found; the ophicephalous pedicellariæ are like those of *toreumaticus*, only less elongate and with less developed meshwork; the sinuations of the edge are rather deep (Pl. VI. Fig. 12). The triphyllous pedicellariæ do not present any peculiarities. The spicules (Pl. VII. Fig. 37) are very characteristic and unique among the Temnopleurids; they are biacerate, bowshaped, without branches. They occur in the head of the globiferous pedicellariæ, in the tubefeet, buccal membrane and gills. Common bihamate spicules may occur more or less numerous among the biacerate ones. Very few, bihamate, spicules are found in the walls of the intestine and genital organs.

The buccal membrane has rather few plates inside and none outside the buccal plates; the latter are placed one a little outside the other (in *toreumaticus* and *Hardwickii* they are placed at the same distance from the mouth). The spines are a little more coarsely spinous than in the two other species; this, however, is a very unimportant difference. Upon the whole the spines of the *Temnopleurus*-species are very smooth. It may also be remarked that the actinal primary spines are curved, in all three species.

This species was not taken by myself or by the „Skeat“-Expedition, but two specimens from the Gulf of Siam (SALMIN) are preserved in the Museum of Copenhagen.

AGASSIZ makes *T. Reevesii* Gray synonymous with *T. Reynaudi* L. Agass., and all the later authors follow him therein. As stated above (p. 59) this is wrong. As I had not remarked all the essential characters of the type-specimens of *T. Reynaudi* during my visit last summer in Paris, having not yet at that time studied the Temnopleurids more profoundly, I asked Dr. GRAVIER to send me, if possible, the specimens for a more close examination. With the greatest liberality, for which I beg him to take my best thanks, Dr. GRAVIER sent me the specimens (those from Ceylon (Reynaud); those from Malacca (Eydoux et Souleyet) cited in the „Catalogue raisonné“ p. 56 are no longer in the Paris Museum). I could thus directly compare them with the other species of *Temnopleurus*, and the result is that they prove to be identical with *toreumaticus*, as might, indeed, have been supposed from the diagnosis given in „Cat. rais.“ — The species described by A. AGASSIZ (Rev. of Ech.) is therefore not *T. Reynaudi*, but it completely agrees with *T. Reevesii* Gray, the type-specimens of which (two naked tests) present the characters pointed out by AGASSIZ as distinctive of „*T. Reynaudi*“: one ocular plate reaching the periproct, the pores placed at some distance from the edge of the ambulacral area etc. — The name *T. Reevesii* must then be revived for this species, and the name *T. Reynaudi* must be dropped as a synonym of *T. toreumaticus*.

In his paper „On the Echinoderms of Macclesfield Bank“ Prof. BELL mentions two specimens of „*T. Reynaudi*“ with rather long, creamy white spines, with

bands of red or with the free end red. Already from this colour of the spines it might be supposed not to be *T. Reevesii*, and the examination of the specimens shows them to be something quite different from that species; they belong to the genus *Gymnechinus* and must form a new species, which is described below as *Gymnechinus versicolor*. Otherwise *T. Reevesii* is really found on Macclesfield Bank. I have seen in the British Museum several specimens from that locality named *T. toreumaticus* (not mentioned in BELL's Report), which are really *T. Reevesii*.

The specimen mentioned by BEDFORD (Op. cit. p. 281) as *Temnopleurus Reynaudi*? I have also examined in the British Museum; it is *Salmacis dussumieri*. Of the specimens mentioned in the Challenger-Echini p. 107 as *Temnopl. Reynaudi* scarcely one is really *T. Reevesii*. The specimen from St. 166 is very small (4.5 mm. in diameter), without genital pores. There is a small red spot on the outer end of each genital plate; a large anal plate covers the whole anal area. This may perhaps be *T. Reevesii*, but it is not possible to say so without a very careful examination and comparison with undoubted young specimens of *Reevesii*. To which species the other specimens, from St. 192 and 219, belong I dare not say from the short examination of them I made during my visit in the British Museum last summer. I may only remark that they have large pits, distinct down to the peristome; no ocular plate reaches the periproct; the spicules are bihamate. These characters prove that the specimens are not *T. Reevesii*.

Only the three species of *Temnopleurus* mentioned here are known as yet. *T. japonicus* v. Martens is stated by AGASSIZ (Rev. of Ech. p. 166) to be synonymous with *T. Hardwickii*. — Dr. MEISSNER has kindly sent me the type-specimens (naked tests), and, indeed, the whole material of *Temnopleurus* preserved in the Berlin-Museum, for examination, so I have been able to compare them with the other species. As far as can be seen from the naked tests alone they are really identical with *T. Hardwickii*. Two other specimens from Japan, determined by v. MARTENS (1881) and DÖDERLEIN as *T. japonicus*, are *toreumaticus*.

*Temnopleurus cavernosa* Woods<sup>1)</sup> is seen from the figures and the description to be a *Pleurechinus*, and it can even scarcely be doubted that it is *Pl. bothryoides*, the only species known to grow to such a size as shown in these figures.

The three species of *Temnopleurus* may be distinguished thus:

1. Spicules biacerate (and bihamate); one ocular plate in contact with the periproct. A distinct anal plate is found, even in larger specimens. The pores are distant from the edge of the ambulacral area. Pits very small on the abactinal side, almost as in *Salmacis*. Spines not ringed. *T. Reevesii* (Gray).  
Spicules bihamate only; no ocular plate in contact

<sup>1)</sup> I. E. TENISON-WOODS. On a young specimen of a *Temnopleurus*. Proc. Linn. Soc. N. S. Wales. V. 1880. p. 493—94. Pl. XV. Figs. 3—4.

- with the periproct. No distinct anal plate in larger specimens. The pores are close to the edge of the area. Pits large on the abactinal side (sharp or bevelled)..... 2.
2. Globiferous pedicellariæ without distinct lateral teeth; ophicephalous pedicellariæ with the edge very little sinuated. Apical area raised; pits bevelled in larger specimens. Spines dark at the base, not ringed .... *T. Hardwickii* (Gray).
- Globiferous pedicellariæ with 1—1 small, but distinct lateral teeth; ophicephalous pedicellariæ distinctly sinuate at the edge. Apical area not raised; pits (mostly) sharp, also in larger specimens. Spines ringed ..... *T. toreumaticus* (Klein).

### 8. *Salmacis bicolor* Ag., var. *rarisipina* (Ag.).

Pl. VI. Figs. 2, 4, 23, 26, 39, 40. Pl. VII. Fig. 1.

- Salmacis bicolor*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Échinides. p. 55.  
 — *rarisipinus*. — Ibidem. —  
 — *bicolor*. AGASSIZ. 1872. Rev. of Ech. p. 156, 471. Pl. VIII. a. Figs. 11—12.  
 — *rarisipina*. — Ibidem. p. 156, 475. Pl. VIII. b. Figs. 4—6.  
 — *bicolor*. BELL. 1880. On some genera and species of Temnopleuridæ. p. 428.  
 — *rarisipina*. — Ibid. p. 429.  
 — *bicolor*. BELL. 1882. Note on the Echinoderm Fauna of the Island of Ceylon, together with some observations on Heteractinism. Ann. Nat. Hist. 5. Ser. X. p. 219.  
 — — DE LORIOI. 1883. Catalogue rais. des Éch. de Maurice. p. 20.  
 (?) — *globatrix*. LOVÉN. 1887. Echinoidea descr. by Linnæus. p. 72.  
 — *bicolor*. DUNCAN & SLADEN. 1888. Echinoderms of the Mergui Archipel. Journ. Linn. Soc. XXI. p. 318.  
 — *rarisipina*. BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 283.  
 — *bicolor*. DÖDERLEIN. 1902. Bericht über die von Herrn Prof. Semon bei Amboina u. Thursday Isl. gesammelten Echinoidea. p. 714. Taf. LXI. Fig. 6—10.  
 — *rarisipina*. DÖDERLEIN. 1902. Ibidem. p. 719. Taf. LXIV. Fig. 3—3 c.  
 — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 83. Taf. V. Fig. 40.
- Non: *Salmacis rarispina*. DE LORIOI. 1893. Échinodermes de la baie d'Amboine. p. 370 (= *S. sphæroides* (L.)).  
 — — — A. AGASSIZ. 1881. Challenger-Echinoidea. p. 113.

After the most excellent description of the structure of the test in the different *Salmacis*-species given by DÖDERLEIN it is unnecessary to discuss the subject here again. Only the pedicellariæ and a few other features need yet to be mentioned.

All the four common kinds of pedicellariæ are found — as in all the *Salmacis*-species. The globiferous pedicellariæ are of two different kinds, a large form without lateral teeth (Pl. VI. Fig. 26) and a small, delicate form with one, unpaired

lateral tooth (Pl. VI. Fig. 2). The large form, which has also been observed by DE MELJERE, is almost exclusively found on the upper part of the test, where it is very conspicuous; the small form is also very numerous at the top of the test, but occurs more spread over the whole test. The tridentate pedicellariæ are rather small (ca. 0.8 mm. head); the blade is short and broad, the edge irregularly sinuate and finely serrate (Pl. VI. Figs. 39, 40. Pl. VII. Fig. 1). In the larger forms the valves join only in the outer part, in the smaller ones in almost their whole length, and in these the edge is almost quite straight; the larger ones have a well developed meshwork in the bottom of the blade. The ophicephalous (Pl. VI. Fig. 4) and the triphyllous pedicellariæ (Pl. VI. Fig. 23) do not present any marked peculiarities. — The spicules of the tube feet are bihamate and usually very few in number.

The buccal membrane contains numerous small, irregular, fenestrated plates inside the buccal plates; outside these there are some few thick plates opposite to the gills; sometimes there are numerous small plates over almost the whole membrane opposite to the interambulacra, whereas there are almost none opposite to the ambulacra. According to DE LORIO (Op. cit. p. 21) these plates „portent de soies d'une grande finesse“; these are certainly stalks of pedicellariæ, which occur (in spite of DE LORIO'S assertion that he does not find pedicellariæ on the buccal membrane) on the large plates at the gills and on the buccal plates, but not on the other small plates, when such are developed. Bihamate spicules are not numerous in the buccal membrane; sometimes, however, small patches are found quite studded with spicules. The gills contain the usual irregular plates, but mostly in the lower part only; in the finer branches only bihamate spicules are found. — The walls of the intestine are provided with rather few bihamate spicules, whereas the stone-canal is quite studded with such spicules, interwoven with each other. The genital organs consist of a great many long, unbranched tubes, arranged round a long main stem; the latter and the lower part of the tubes are quite full of bihamate spicules, whereas the tubes are quite destitute of spicules.

Many specimens of different sizes of this most beautiful sea-urchin were taken at Koh Kram, 20—30 fathoms; also some specimens at Koh Chuen, 30 faths., and between Koh Kahdat and Koh Kut, 8—10 fathoms, all on hard bottom (sand, shells, stones). A specimen of only 2.5 mm. in diameter is already quite typical, with both kinds of globiferous pedicellariæ developed. One specimen is abnormal and deformed, one of the ambulacra reaching only halfway to the apical system.

Several of the specimens are infested with a small parasitic Gastropod, probably an Eulimid. Further I observed on several of them a little crab, which devours the spines (probably the muscles only), pedicellariæ and tube feet, quite cleaning the test; it mostly follows one area from the top downwards. Where it has been, one may find young stages of pedicellariæ in enormous numbers, quite covering the test; also young spines may be found in such places. If the tube feet are regenerated, I cannot ascertain beyond doubt, but it seems so.

It has not hitherto been doubted that *Salm. bicolor* and *rarispina* were two good species. Especially in DÖDERLEIN's most excellent work a full description is given of both of them, and the distinctive features are pointed out. *S. rarispina* is distinguished from *S. bicolor* „durch die kleinen, sehr weit von einander entfernten Hauptwarzen der Apicalseite, durch die auffallend flache Unterseite und das kleine Buccalfeld, durch die sehr spärliche Warzenbildung, welche die Oberfläche auffallend nackt erscheinen lässt, sowie durch die rautenförmigen Zeichnungen auf der Schale“. (Op. cit. p. 721.) According to the description of the species given by DÖDERLEIN there is, however, a great variation in all these features; only in the character of the flat actinal side in *S. rarispina* no variation is mentioned, but as DÖDERLEIN had only two specimens of *rarispina* for examination, much stress can-

Locality.	Salmacis bicolor, typica.			Locality.	Salmacis bicolor, var. rarispina.		
	Diameter.	Number of Ambulacral plates.	Number of I-ambulacral plates.		Diameter.	Number of Ambulacral plates.	Number of I-ambulacral plates.
Mauritius.	37 mm.	31	24	Siam.	36 mm.	30	26
Ceylon.	40 —	40	32	—	40 —	32	28
				—	42 —	31	26
				—	43 —	34	29
				—	44 —	36	30
Mauritius.	45 —	35	28	—	46 —	36	28
—	46 —	34	26	Zanzibar.	46 —	36	27
—	50 —	41	29	Siam.	50 —	36	30
				—	51 —	36	31
				—	51 —	35	28
				—	53 —	37	30
				—	55 —	41	32
?	56.5 —	48	35	—	55 —	38	33
Ceylon.	62 —	49	37	—	56 —	36	29

not be laid on this fact — and from my rich material it is seen that no reliable distinction can be found herein either. Also the height of the test is rather variable. In a letter to me DÖDERLEIN has further pointed out that the number of coronal plates is distinctly smaller in *rarispina* than in *bicolor*. This will not always hold good either. When comparing the measurements of *S. bicolor* cited above from DÖDERLEIN (p. 720) with the measurements of my Siamese specimens, it will be seen that the specimens from Mauritius agree with the siamese form in the number of the coronal plates. There are then only left the two specimens from Ceylon and the one of unknown locality. Among the Siamese specimens there are none of 62 mm. diameter, so that only the specimens of 40 and of 56.5 mm. can be directly compared with specimens of *rarispina*. We have then in a specimen of 40 mm.: 40 ambulacral and

32 interambulacral plates in *bicolor*, 32 ambulacral and 28 interambulacral plates in *rarispina*; in a specimen of 56 mm.: 48 ambulacral and 35 interambulacral plates in *bicolor*, 36 ambulacral and 29 interambulacral plates in *rarispina*, a very conspicuous difference. Now the material of *bicolor* examined is very small, and it may safely be supposed that a rather large amount of variation will occur also here. But the examinations made tend to show that the Ceylon-form of *bicolor* has on an average more coronal plates than those from Mauritius and the Siamese specimens of *rarispina*. Other distinctive characters do not seem to occur. Pedicellariæ, spicules and structure of spines are quite alike; as regards the colour of the spines it may be said that the light rings are generally broader in *rarispina* than in *bicolor*, but it is no constant feature. Neither can any character be taken from the angular pores; they vary very much, may be very distinct or almost quite obliterated in specimens of the same size. Thus I think it an inevitable conclusion that *Salmacis bicolor* and *rarispina* are indeed only one species, of which may be distinguished a forma *typica*, with numerous coronal plates, as yet known only from Ceylon, and a var. *rarispina*, with less numerous coronal plates, known from Siam, Mauritius and Zanzibar.

It may be especially remarked that I have examined the type specimens of both *bicolor* and *rarispina* in the Paris-Museum, also with regard to pedicellariæ. Furthermore Dr. GRAVIER has been so very kind as to send me the type specimen of *rarispina* for direct comparison with my Siamese specimens. I can thus say with absolute certainty that they are really *S. rarispina*. The question of these two „species“ I hope thus to have definitely settled.

The *Salmacis rarispina* of DE LORIOI from Amboina is, indeed, *Salm. sphaeroides*, as supposed by DÖDERLEIN. Through the kindness of Prof. BEDOT I have had the specimen sent for examination. The specimens mentioned by KOEHLER (Cat. rais. Éch. de la Sonde. p. 413) will then probably also be *sphaeroides*, as they are said to be identical with DE LORIOI's specimen. The *S. globatrix* of LOVÉN can scarcely be anything but *S. bicolor*. The expression „spinæ basi rubræ“ does not agree with any other *Salmacis*-species. — The *Salm. bicolor* named by BELL in the „Alert“-Echinodermata (p. 118) is *S. belli* Döderl. — Of the specimens named in the „Challenger“-Ech. (p. 113) the *S. rarispina* from St. 188 is *S. belli*, those from St. 186 (2 small specimens) are, the one *S. dussumieri*, the other perhaps *S. belli* (no globiferous pedicellariæ found), at any case not *rarispina*. The specimens from St. 203 I have not seen. The *S. bicolor* from Zamboangan is really that species.

### 9. *Salmacis virgulata* Agass. forma *typica*.

Pl. VI. Figs. 7, 18, 46, 47. Pl. VII. Fig. 40.

*Salmacis virgulatus*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Échinides p. 359 (55).

— *conica*. v. MARTENS. 1866. Ostasiatische Echinodermen. Archiv f. Naturgesch. 1866. p. 159.

- Salmacis Alexandri*. DÖDERLEIN. 1888. Echinod. von Ceylon. Zool. Jahrb. Syst. III. p. 836. Tab. 32.7. 33.10.  
 — *sulcata*. DUNCAN & SLADEN. 1888. On the Echinoidea of the Mergui Archipelago. Journ. Linn. Soc. Zool. XXI. p. 317.  
 — — SLUITER. 1889. Evertebraten Sammlung Batavia. Natuurk. Tijdschr. Nederl. Indie. 48. p. 292.  
 — — BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 281. Pl. XXII. Fig. 3.  
 — *virgulata, typica*. DÖDERLEIN. 1902. Echinoidea v. Amboina u. Thursday Isl. (Semon). p. 712. Taf. LXII. Fig. 2.  
 — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 83. Taf. XVII. Fig. 273.

The type specimen of this species I have also examined in the Paris-Museum, and as I have found both pedicellariæ and spines on it, I can positively assert that DÖDERLEIN's interpretation of this species is the right one. The characters of the test have been so well made out by DÖDERLEIN that nothing need be added. Only the pedicellariæ are insufficiently known.

The globiferous pedicellariæ (Pl. VI. Fig. 18) occur only in one, large form with rather elongated blade without lateral teeth; DE MEIJERE has first mentioned and figured this form of pedicellariæ in this species. He mentions one „welche merkwürdiger Weise am Ende aller Klappen abgestutzt erschien, ohne dass von einem einfachen Abbrechen der Spitze die Rede war“. That must certainly be a not yet fully developed pedicellaria; the endtooth is formed at last, as I have seen beyond doubt in the different stages of development, which may rather easily be found. The tridentate pedicellariæ (Pl. VI. Fig. 7, 46, 47) are rather small (ca. 0.6 mm., head), the valves short, joining only at the point, the blade is narrow, with a few serrations in the edge; the outer edge, where the valves join, forms an obtuse angle with the side edge. The basal part of the valve is very large in proportion to the blade; sometimes there are four valves. The ophicephalous and triphyllous pedicellariæ without remarkable features, the meshwork in the blade of the former being, however, less developed than in *S. bicolor*, and the form a little more elongate (Pl. VII. Fig. 40).

The spicules of the tubefeet are very variable in number, sometimes almost none at all, sometimes a great number occurring, especially close under the sucking disk. Also in the globiferous pedicellariæ spicules may occur, as seen by DE MEIJERE. In the buccal membrane there are numerous small plates inside the buccal plates; outside these a few rounded plates may be found in larger specimens. Bihamate spicules are not numerous in the buccal membrane. The gills as in *bicolor*. The intestine and genital organs, even the stone canal, almost without a single spicule. The genital organs of the common structure, a close aggregation of very irregular, branched tubes.

Numerous small specimens from between Koh Rin and Cliff Rock, 15 faths.; 1 large specimen from Koh Kram, 30 faths. (with ripe eggs; taken the 2. March), and some small specimens from the same locality. Some few small specimens were taken at Koh Chuen, 30 faths., Koh Mesan, 5—9 faths., 20 miles South of Koh Samit,

20 faths. and S. of Koh Kahdat, 8—10 faths. Further two medium-sized specimens were found in the Museum from the Gulf of Siam (SALMIN). The „Skeat“-Expedition took one large specimen off the East coast of Redang.

Even the smallest of the specimens (5 mm.) are perfectly recognizable by their pedicellariæ and the colour of the spines; in regard to the colour they are very similar to *dussumieri*, from which species they may, however, easily be distinguished by the globiferous pedicellariæ. (The alternation of the primary ambulacral tubercles in *S. dussumieri* is not seen in quite small specimens.) — In these small specimens there are, of course, only the two series of primary tubercles in each area; at a size of about 10 mm. a second, inner row of tubercles appears at the ambitus in the interambulacra; the pits are very distinct in the smallest specimens. The genital openings appear at a size of c. 9 mm. diameter.

*Salmacis conica* v. Martens is a synonym of this species. Dr. MEISSNER has kindly sent me the specimen (a naked test) from the Berlin-Museum, so that I can say with full certainty that it is identical with the typical form of *S. virgulata*.

The var. *Alexandri* (Bell) agrees completely, as regards pedicellariæ and spicules, with the typical form of *virgulata*.

## 10. *Salmacis sphæroides* (L.).

Pl. V. Fig. 23. Pl. VI. Figs. 1, 11, 41.

- Echinus sphæroides* LINNÉ. 1758. Systema naturæ. Ed. X. p. 664.  
 — — — 1764. Museum Ludovicæ Ulricæ. p. 706.  
*Salmacis sulcatus*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné d. Éch. p. 359 (55).  
 — *festivus*. GRUBE. 1868. 45. Jahresber. Schles. Gesellsch. vaterl. Cultur. p. 43.  
 — *sulcata*. AGASSIZ. 1872. Rev. of Ech. p. 476.  
 — — — 1881. Challenger Ech. p. 114.  
 — — STUDER. 1881. Echinoidea ges. von „Gazelle“. p. 873.  
 — *sphæroides*. LOVÉN. 1887. Echinoidea descr. by Linnæus. p. 69. Pl. II.  
 — *rarispinga*. DE LORIOL. 1893. Échinod. de la Baie d'Amboine. p. 370.  
 — — KOEHLER. 1895. Échinod. îles de la Sonde. p. 413.  
 — *globator*. BEDFORD. 1900. Echinod. from Singapore and Malacca p. 282. Pl. XXII. 4. a. b.  
 — *sphæroides*. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. (Semon) p. 716. Taf. LXIII. 1—4.  
 — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 82. Taf. XVII. 272.

This species has been definitely settled by the researches of LOVÉN and DÖDERLEIN. That it is the same as *S. sulcata* Ag. can scarcely be doubted. In the Muséum d'histoire naturelle in Paris no type-specimen is preserved, but in the collection of l'École des mines there is a specimen from the Philippine Islands (without further indications) named *Salm. sulcata*; this is then probably a type-specimen. It is certainly *S. sphæroides*; with regard to pedicellariæ and spines it also completely agrees with that species.

In a specimen of 16 mm. diameter there are as yet only the two primary series of tubercles in both areas, the secondary tubercles all being quite small. The miliary tubercles at the distal side of the primary tubercles are elongated, thus looking as if they radiate from the primary tubercle. No genital openings have yet been formed; in a specimen of 18 mm. diameter they have appeared. Otherwise I have nothing to add to the description of the test given by DÖDERLEIN; only the pedicellariæ, spicules and the buccal membrane need to be mentioned.

The globiferous pedicellariæ (described and figured by DE MEIJERE) are of one kind only, with 1—1 lateral teeth. The outer corners are produced, but not always so sharply as in the figured one (Pl. VI. Fig. 11). The tridentate pedicellariæ (Pl. VI. Fig. 1, 41) are rather small, ca. 1 mm. (head). The valves are very wide apart, joining only at the point; the blade is long, narrow, deep in the lower part, a little widened in the outer part. The edge is quite smooth or finely serrate below, coarsely sinuate at the point, where the valves join; this part of the edge is at an obtuse angle with the rest of it. There may be rather much meshwork in the blade. The ophicephalous and triphyllous pedicellariæ do not present obvious characters; the former are like those of *bicolor* or a little more elongate, the latter have the blade a little widened. — The spicules of the tube feet are mostly very scarce, except just below the sucking disk, where they may be found in great numbers.

The buccal membrane has, as usual, numerous small plates round the mouth, inside the buccal plates; outside these some spread plates may be found besides the usual thick plates, covered with pedicellariæ, placed opposite the gills. Numerous small bihamate spicules are found in the buccal membrane. The buccal plates may be covered with small tridentate or triphyllous pedicellariæ. — The walls of the intestine are provided with rather few small bihamate spicules; in the stone canal and ovoid gland they are more numerous and may be a little irregular. The genital organs are treeshaped; the stem and the main branches have the walls studded with very curious calcareous bodies, namely bihamate spicules, which have become closed to a ring and with a more or less complicate network on the outside of the ring. All transitional forms between the typical bihamate and the most complicated form are found (Pl. V. Fig. 23). In the finer branches of the genital organs only bihamate spicules are found, often in great numbers together on small spots, the rest of the branch being almost destitute of spicules; they are distinctly smaller than those in the stem. — Ripe eggs are found in specimens taken in February in the Gulf of Siam and in August in the Johore-Strait (Singapore).

A rich material of this species, small and large specimens, was taken at Koh Kram, 20—30 fathoms, Koh Mesan, 10—15 faths. and Koh Kahdat, 4—5 faths. Further a number of large specimens were taken by MARIUS JENSEN in Johore-Strait (Singapore) in August 1901. One of the latter specimens has the spines on the abactinal side almost quite white.

The var. *pyramidata* (Troschel) completely agrees with the typical form of *sphaeroides* in regard to pedicellariæ and spicules, and to the spicules of the genital organs. (I have examined the type-specimen in the Berlin-Museum.)

The var. *belli* Döderlein, on the other hand, is something quite different. The pedicellariæ agree exactly with those of *S. bicolor*, even in the tridentate pedicellariæ a reliable difference can scarcely be pointed out; there can be no doubt that it is very nearly related to that species, whereas it has nothing to do with *sphaeroides*. According to DÖDERLEIN (in a letter to me) it must be maintained as a distinct species; the most easily seen character of it is the green base of the spines; other characters of little importance may be found in the test (comp. DÖDERLEIN'S description, p. 718). The buccal membrane contains very numerous bihamate spicules; the plates opposite the gills are covered with pedicellariæ, as are the buccal plates.

## 11. *Salmacis dussumieri* Ag.

Pl. VII. Fig. 15.

- Salmacis dussumieri*. AGASSIZ & DESOR. 1846. Catalogue rais. des Échinides. p. 359 (55).  
*Toreumatica concava*. GRAY. 1855. An arrangement of the fam. of Echinidæ. Proc. Zool. Soc. p. 39.  
*Salmacis dussumieri*. AGASSIZ. 1872. Rev. of Ech. p. 473. Pl. VIII. b. Figs. 7—8.  
 — — BELL. 1880. On some Genera and Species of Temnopleuridæ, p. 429.  
 — — RAMSAY. 1885. Catalog. Echin. Austral. Mus. I. p. 16, 49.  
 — *lactea*. DÖDERLEIN. 1885. Seeigel von Japan u. d. Liu-Kiu-Inseln. p. 22.  
 — *dussumieri*. LOVÉN. 1887. Echinoidea descr. by Linnæus p. 73.  
 — — DUNCAN & SLADEN. 1888. Echinoidea of the Mergui Archipelago. p. 317.  
*Temnopleurus Reynaudi*? BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 281.  
*Salmacis dussumieri*. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. (Semon's Reisen). p. 715. Taf. LXIII. Fig. 5—5. c.  
 — *sulcata*. BELL. 1903. Report on a Collection of Echinoderms from the Neighbourhood of Zanzibar. Part. I. Ann. Nat. Hist. 7. Ser. XII. p. 247.  
 — *dussumieri*. DE MEIJERE. 1904. Siboga-Echinoidea. p. 85.

This species differs so much from the other *Salmacis*-species, through the low form of the test, the deeply sunken peristome, and especially by having a primary tubercle only on every second ambulacral plate (which character has first been distinctly pointed out by LOVÉN, loc. cit., though BELL'S expression: „when there are vertical rows of tubercles on each half of the ambulacral plates, the tubercles do not form transverse rows, but are set alternately“ (loc. cit.) may mean the same) that very little uncertainty has prevailed as regards it. To the descriptions in the works cited I may only add that the colour of the large spines at the ambitus varies rather much, from almost white with a few red rings at the outer end to intensely red in the whole length, with the rings at the outer end almost obscured. In such dark specimens also the small primary spines of the abactinal side are red, whereas in the light coloured specimens these spines are quite white. (A

very dark coloured form of this species I have seen in the British Museum, from Tuticorin (Thurston); the spines are greenish with brown rings. There does not seem to be any other difference from the typical form, so that it can only be regarded as a colour-variety. The *Salm. sulcata* named by BELL in his paper On Echinoderms from the Neighbourhood of Zanzibar (loc. cit.) is identical with this form of *S. dussumieri*.

The alternation of the primary ambulacral tubercles has already appeared in specimens of 6—7 mm. diameter; in younger specimens (and, of course, in the proximal part of the ambulacra of larger specimens) there is a primary tubercle on every ambulacral plate. The genital openings appear very early, being found already in specimens of ca. 5 mm., a curious difference from *S. sphaeroides*, where they do not appear till the animal has reached a much larger size, c. 17—18 mm. in diameter.

The pedicellariæ are so very like those of *S. sphaeroides* that scarcely a single characteristic feature can be pointed out; reference may simply be made to the figures given of the pedicellariæ of *sphaeroides*. The spicules of the tube feet are rather numerous and of the usual bihamate form. The buccal membrane, as in the other species, contains a number of small, irregular plates inside the buccal plates, forming a ring around the mouth; some few small, rounded plates may occur outside the buccal plates but not especially opposite to the gills. Bihamate spicules do not occur in great numbers in the buccal membrane; a few small, bow-shaped spicules may be found among them. The walls of the intestine are full of very small, bowshaped spicules. In the stone-canal the spicules are larger, elongate, more or less irregularly branched. The genital organs are bushshaped, with close, irregular branches. They are full of two kinds of spicules: the small, bow-shaped ones, which, however, mostly develop to larger, branched spicules (mainly in the stem), and very large, bihamate spicules (Pl. VII. Fig. 15).

A number of specimens of different sizes were taken at the following localities: Koh Kram, 30 fathoms, Koh Lan, 30 faths., between Koh Rin and Cliff Rock, 15 faths. (only small specimens), Koh Kam, 5 faths., Gulf of Rayong, 7—10 faths., 20 miles S. of Koh Samit, 20 faths., off Tung Kaben, 6 faths., S. of Koh Kahdat, 8—10 faths. Also from Singapore I have specimens, taken by Mr. GAD, 1903. — The species is found both on hard and on muddy bottom.

A number of species of *Salmacis* have been described besides those mentioned above, viz:

*Salmacis varius* Agass. (Catalogue raisonné des Échinides. p. 55.)

— *globator* Agass. (Ibidem.)

— *rubrotinctus* Grube. (45. Jahresber. Schles. Ges. vaterl. Cultur. 1868. p. 42.)

— *rufa* Bell. (Echinoderms from Macclesfield Bank. Proc. Zool. Soc. 1894. p. 411. Pl. XXVI. 2—3.)

- Salmacis* (?) *elegans* Bell. (Report on the Echinoderms collected by Dr. Willey. — A. Willey. Zoological Results. II. 1899. p. 135. Pl. XVII. 1.)
- *Woodsi* Ramsay. (Catalogue of the Echinodermata in the Australian Museum. I. Echini. 1885. p. 18, 48. Pl. II. 1—3.)

(„*S. Desmoulinsii* Agass.“ in DUJARDIN & HUPÉ: Histoire naturelle des Zoophytes Échinodermes. 1862. p. 516 is no doubt a printing error for *S. dussumieri*, which is not named there).

The type specimen of *S. varius* is no longer in the Paris-Museum, so we must be content with the assertion given by A. AGASSIZ (Rev. of Ech. p. 156) that it is synonymous with *rarispinga*.

The type-specimen of *S. globator* is to be found neither in the Museum of Paris nor in the collection of l'École des mines. What AGASSIZ describes under this name in „Rev. of Ech.“ is no doubt *S. virgulata*, var. *Alexandri*. The *S. globator* of BELL (On some genera and species of the Temnopleuridæ p. 431) is partly ( $\alpha$ ) *S. virgulata*, var. *Alexandri*, partly ( $\beta$ ) *S. sphaeroides*, var. *pyramidata*. A specimen from Dauma Island named *S. globator* is *S. belli*. The *S. globator* of „Challenger“ St. 146 is *S. Alexandri*. The *S. globator* of BEDFORD is *S. sphaeroides*. (All these specimens I have examined in the British Museum.) The *S. globatrix* of LOVÉN probably is *bicolor* var. *rarispinga*.

*S. rubrotinctus* Grube is probably *S. bicolor*, but as the type-specimen cannot be found (DÖDERLEIN. p. 715), the question must remain a little uncertain.

*S. Woodsi* Ramsay cannot from the description be referred with certainty to any of the well known species. I have seen, however, in the British Museum a specimen from Holothurian-Bank (1892) which has exactly the same form as *S. Woodsi*, whereas it otherwise agrees completely with *S. belli* (only the large globiferous pedicellariæ I have not found); but it is certainly a monstrosity. On the narrow part of the test some small irregular bodies occur, probably of parasitic nature. There can thus scarcely be any doubt that *S. Woodsi* is only a monstrosity of *S. belli* (or perhaps the same monstrosity may occur also in other species).

*S. rufa* Bell is a *Psammechinus*; some notes on this species are given below. *S. elegans* Bell is a young *Coelopleurus Maillardi* (Mich.). (The specimens were examined in the British Museum.)

Finally I may give some further notes of „*Salm. sulcata*“. What SLADEN names thus in his paper „On the Asteroidea and Echinoidea of the Korean seas“ p. 439, is probably *Salmacopsis olivacea*; the tubercles are noncrenulate. Unfortunately I could not find any globiferous pedicellariæ on these specimens. — The *S. sulcata* of BELL from Port Denison (Echinoderms. „Alert“. p. 118) are partly *S. sphaeroides*, partly *S. dussumieri*. What is meant by *S. sulcata* in BELL's paper „On some genera and species of the Temnopleuridæ“ I cannot say, as, unfortunately, I forgot to make any note of it during my visit to London last summer.

The genus *Melebosis* Girard is maintained by POMEL (Op. cit. p. 87) as separate from *Salmacis*. According to AGASSIZ (Rev. of Ech. p. 156) *Melebosis mirabilis* Gir. is synonymous with *S. sphaeroides (sulcata)*; but there is not the least reason to maintain this species as a distinct genus. Neither can the name *Diploporus* Troschel (for the var. *pyramidata* of *sphaeroides*) be made use of.

The *Salmacis*-species have for a long time had a very bad reputation as being most difficult to distinguish. Mainly through the researches of DÖDERLEIN combined with the investigations here recorded it has now been shown that only five easily distinguished species with some varieties are known; the difficulties are not due to the animals but to the insufficient or bad descriptions of previous authors. It may be desirable to give here an analytical table of the *Salmacis*-species<sup>1)</sup>.

1. Globiferous pedicellariæ of two kinds, large ones without lateral teeth and small ones with an unpaired lateral tooth; tridentate pedicellariæ with short and broad valves. Spines ringed. The pores mostly not reaching the edge of the area; tubercles occur outside the pores ..... 2.
  - Globiferous pedicellariæ of one kind, without or with 1—1 lateral teeth; tridentate pedicellariæ with narrow blade. Spines ringed or not ..... 3.
2. Spines with red base ..... *S. bicolor* Ag. (with the var. *rarisпина*).  
 — — green base ..... *S. Belli* Döderl.
3. Globiferous pedicellariæ without lateral teeth; spines not ringed. The pores reach to the edge of the ambulacral area; no tubercles outside the pores ..... *S. virgulata* Ag. (with the var. *Alexandri*).
  - Globiferous pedicellariæ with 1—1 lateral teeth. Pores on the buccal side and at the ambitus not reaching the edge of the area; with tubercles outside the pores ..... 4.
4. A primary tubercle is found on all the ambulacral plates; test rather high, peristome not much sunken ..... *S. sphaeroides* Ag. (with the var. *pyramidata*).  
 A primary tubercle is found only on every second ambulacral plate; test very low, peristome much sunken ..... *S. dussumieri* Ag.

<sup>1)</sup> DÖDERLEIN and DE MEJERE have already given analytical tables of the species of *Salmacis*; as, however, I have made here several corrections of their views of these species, it seems not superfluous to give a new analytical table thereof.

The genera *Temnopleurus* and *Salmacis* are very nearly related, so nearly indeed that it seems impossible to find any character distinguishing between them with full certainty. To be sure DUNCAN<sup>1)</sup> has found in *Temnopleurus* only 4 parts in the „rosette“ of the sucking disk, in *Salmacis* 6—7 parts. This would give an easily accessible character distinguishing these two genera, but unfortunately it does not hold good. In all the *Temnopleurus*- and *Salmacis*-species I find the number of these plates to be 4—5, rarely 3 or 6. In *T. Reevesii* I have found only four, in *S. dussumieri* only five, but I do not doubt that in these species also the other numbers may occur. — The pedicellariæ and spicules do not afford generic characters here and so cannot be used for distinguishing the genera. Thus only the well known characters in the structure of the test are left for the distinction of the two genera, but none of these characters are exclusive. *Temnopleurus* has large grooves in the test, *Salmacis* only small pits: but *S. Alexandri* is almost like *Temnopleurus* and *T. Reevesii* almost like *Salmacis* in this respect. *Temnopleurus* has few series of tubercles, *Salmacis* has several series, both vertical and horizontal; but large specimens of *Temnopleurus* have also more (6) series of interambulacral tubercles, arranged likewise in horizontal series, and young specimens of *Salmacis* have few series of tubercles as *Temnopleurus*. The form of the test is generally high in *Salmacis*, low in *Temnopleurus*, but *S. dussumieri* is as low as any *Temnopleurus*. Both ringed and uniformly coloured spines occur in both genera; also the buccal membrane is alike in both of them. There is thus not a single character which distinguishes sharply between the two genera. It will, however, be practical to maintain both the genera; it will scarcely ever be difficult to decide to which of them any species has to be referred. It is the two species *T. Reevesii* and *S. dussumieri* (together with the var. *S. Alexandri*) which cause the difficulties; if these two species were removed from the genera there would be excellent characters distinguishing *Temnopleurus* and *Salmacis*; only the var. *Alexandri*, which cannot be excluded from the genus *Salmacis* on account of its evident near relation to *S. virgulata*, will remain as a form intermediate in characters between the two genera. The two above named species would then have to be made the types each of a separate genus, as it would be impossible to unite them into one genus. This might not be unreasonable. The name *Toreumatica* Gray should then be used for *Reevesii*, whereas the name *Diploporus* Troschel might be used for *dussumieri*. I do not feel sure, however, which is the better arrangement, and for the present I leave these species in the genera, where they have been placed for so long a time, and with which they are evidently most nearly related.

<sup>1)</sup> On the Anatomy of the Temnopleuridæ. Ann. Nat. Hist. 6. Ser. I. 1888. p. 127.

12. *Pleurechinus Döderleini* n. sp.

Pl. I. Figs. 12, 13. Pl. II. Figs. 1, 7, 8. Pl. VI. Figs. 35, 43. Pl. VII. Figs. 10, 48.

The form of the test is rather variable. The largest specimens (12 mm. in diameter) are rather high (10 mm.) and conical, the smaller ones are generally more flat (7 mm. high to 10 mm. in diameter for instance). The lower side is rather flat and a little incurved at the peristome.

The ambulacra (Pl. II. Fig. 8) are only a little narrower than the interambulacra. The pores are rather large, disposed in an almost straight series, the middle pair in each compound plate being placed scarcely so much as half the width of a single pore outside the two other pairs; they are not placed close to the edge of the area, in the largest specimens there are even some small tubercles outside the pores. The interporiferous zone is twice as broad as the poriferous. The primary tubercles — one to each compound plate — form a distinct series close to the poriferous zone; above each primary tubercle there is a smaller secondary one, placed in the same line as the primary ones. On the inner part of the plate there may be (in the larger specimens) a pair of secondary tubercles, or this part of the plate may be covered by miliary tubercles. The ambulacral plates are as high as the interambulacral ones, the number of plates being almost exactly the same in both areas (12–13 in specimens of 10–12 mm.). The pits are large and deep, rectangular, reaching to the base of the primary tubercles; they are indistinct on the 2–3 lowermost plates. The pits along the outer edge of the ambulacral plates are distinct, those in the sutures between the compound plates being distinctly larger than those at the sutures of the primary components of the ambulacral plates; they sometimes unite with the outer interambulacral pits, which are of the same size as the ambulacral ones.

In the interambulacral areas (Pl. II. Fig. 7) the primary tubercles likewise form a very distinct series. The secondary tubercles are not arranged in a horizontal row on each plate; there may be 2–3 larger ones outside and inside the primary tubercle and one above the primary tubercle at the upper side of the plate. The secondary tubercles of each plate thus form an oblique series on each side of the primary tubercle, meeting at a right angle in the tubercle placed above the primary one. The miliary tubercles may be rather scarce or they may occur in great numbers, covering the whole plate; in the latter case the secondary tubercles are very inconspicuous, and hardly larger than the miliary ones. The pits are very large and deep, leaving only a narrow band free in the middle of the horizontal suture, as broad only as the base of the primary tubercle. Both the inner and outer pits are a little widened towards this part. A distinct covering membrane may be seen along the edge of the pits (comp. *Pl. siamensis*).

The apical area (Pl. II. Fig. 1) is small, 2.5 mm. in diameter in a specimen of 10 mm. diameter of test. At the inner end of the ocular plates there is a distinct

depression; no ocular plate reaches the periproct. Along the inner edge of the genital plates there is a close ring of tubercles; one tubercle on each ocular plate. The periproct is covered by very small, rounded plates, all of the same size; the anal opening is central.

The buccal membrane shows the quite unique feature that there are only five buccal plates and tentacles; the plates are small, round, green. In the inner border of the buccal membrane, close around the mouth, there is a narrow ring of small, rather thick, greenish plates; all the rest of the buccal membrane is naked, with a few bihamate spicules. The gills are small, with the usual, irregular fenestrated plates. The mouthslits are very small and indistinct. The auriculæ are connected and very variable in shape. The diameter of the peristome is rather large: 4.5 mm. in a specimen of 12 mm. diameter, 4.2 mm. in a specimen of 10 mm. diameter — c. 37 — 42% of the diameter of test.

Pedicellariæ. The globiferous pedicellariæ (Pl. VI. Fig. 35. Pl. VII. Fig. 10) have an unpaired lateral tooth almost as large as the endtooth; the blade may be

quite open or with a more or less broad crossbeam over the inner side. The outer corners are rather sharp but not produced. The glands are double — as usual among the Temnopleurids. The ophicephalous pedicellariæ have a short neck; the blade is rather short, without meshwork, only with a median keel; the edge is a little sinuous and distinctly serrate (Pl. VII. Fig. 48). Tridentate pedicellariæ I have not found. The triphyllous pedicellariæ (Pl. VI. Fig. 43) are very small, a little elongate, with smooth outer edge. The sphaeridiæ are placed at the pits of the 5—6 inferior plates. The spicules are extremely scarce; in the tube feet and the internal organs I have found none, only in the buccal membrane a few bihamate ones have been found.

The spines (Fig. 6) are short and slender, c.  $\frac{1}{3}$  of the diameter of the test (in larger specimens); they are a little thorny in the outer part, the point not swollen, ending in a central thorn with a circle of points around, all small and rather indistinct. The actinal spines are not curved or widened at the end.

The colour of the test is green with some irregular white spots, and sometimes a reddish tint in the median part of the interambulacral areas. The edge

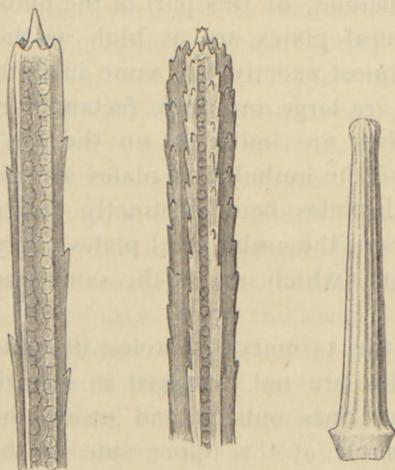


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. The point of a secondary spine of *Pleurechinus scillæ* (Seibert. Obj. II. Oc. III).

Fig. 6. The point of a primary spine of *Pleurechinus Döderleini*. (Seibert. Obj. 0. Oc. 0.)

Fig. 7. A primary spine of *Pleurechinus siamensis*. (Seibert. Obj. II. Oc. III.)

of the ambulacra, outside the pores, is reddish. The spines are green, often reddish brown in the middle, whitish in the outer part; they are not ringed.

Off Tung Kaben, 6 fathoms; sandy mud (6 specimens). Koh Mesan, 5—9 fathoms (10 specimens). A specimen was taken at Singapore by Mr. GAD. Prof. DÖDERLEIN kindly tells me he has a specimen of this species from Samoa.

This beautiful and very interesting species is very distinct from all the other species of *Pleurechinus* (comp. those described below). It is above all distinguished by the very remarkable feature of having unpaired buccal plates and buccal tube feet. (Also in young specimens of *Hypsiechinus* and *Prionechinus* may be found only 5 buccal tube feet, but there are always 10 buccal plates. I have also seen a specimen of *Pl. bothryoides* in which one of the buccal plates, in one pair only, was rudimentary and without tubefoot, the other plate bearing two feet; the other pairs were normally developed. Likewise in a specimen of *Pl. variegatus* I have found the one tubefoot wanting in one of the pairs of buccal plates.) Possibly it ought to be made the type of a separate genus; but as it is otherwise a typical *Pleurechinus*, I think it best to retain it in this genus. If in the future more species with this disposition of the buccal plates and tube feet should be made known, there might be more reason to make a separate genus for their reception.

### 13. *Pleurechinus siamensis* n. sp.

Pl. I. Figs. 2, 7, 11, 20. Pl. II. Figs. 2, 9, 14, 15, 22. Pl. VI. Figs. 16, 36. Pl. VII. Figs. 14, 44, 53.

The test is low, 5 mm. high in a specimen of 7.5 mm. in diameter. The actinal side is flat, not distinctly incurved at the peristome; mouthslits quite indistinct. Peristome 3.2 mm. to a diameter of test of 7.5 mm., c. 40% of the diameter of test.

The ambulacra (Pl. II. Fig. 2) are  $\frac{2}{3}$  as broad as the interambulacra. The pores are very small, disposed in a single straight series and close to the edge of the area. The poriferous zone is very narrow, without any tubercles, scarcely  $\frac{1}{3}$  so broad as the interporiferous zone. The ambulacral plates are as high as the interambulacral ones, their number being the same, 9—10 in a specimen of 7.5 mm. diameter. The primary tubercles, one to each compound plate, form a distinct series close to the poriferous zone; they are of the same size as the interambulacral primary tubercles. The base of the primary tubercles of both areas is a little stellate reminding one of *Genocidaris maculata*. (Also in *Pl. Döderleini* there may be a very faint indication of a stellate condition.) Secondary tubercles rather few and small, only at the ambitus they may be distinct, forming a small inner series on a few (3—4) plates. The pits are large, deep, rectangular, with the ends a little rounded. Also on the lower side they are distinct, except on the first 1—2 plates. The pores along the edge of the ambulacra very indistinct.

In the interambulacral areas (Pl. II. Fig. 9) the primary tubercles are, as in the ambulacra, a little stellate, disposed in a distinct longitudinal series. The

secondary tubercles are rather numerous, small, not disposed in distinct series. Miliary tubercles not very numerous. The median part of the interambulacra is naked on the upper 3—4 plates. The pits are large, rectangular, deep, leaving only a narrow band free in the middle of the horizontal suture, as broad only as the base of the primary tubercle; they are distinct also on the lower side.

Along the edge of the pits in both areas there is a rather broad membranous brim, leaving only a small oval hole in the middle (Fig. 8).

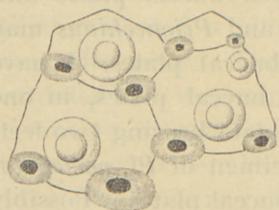


Fig. 8. Part of interambulacral area of *Pleurechinus siamensis*; showing the membrane covering the pits. (Seib. Obj. 0. Oc. 0.)

DUNCAN (On the genus *Pleurechinus*, its classificatory position and alliances. Journ. Linn. Soc. Zoology. XVI. 1882. p. 453) has evidently seen the same structure in *Pleurech. bothryoides*. It seems probable that these large pits may have some special function. I have made sections of the test in order to see if there be any special histological structures indicating sensory organs or the like, but failed to see anything of that kind. The preservation of my specimens, however, is not good enough for settling the question. There is nothing to support the suggestion that they may have something to do with the hatching of the eggs and young ones (DUNCAN. p. 453). It might seem reasonable to ascribe to

these structures a respiratory function; but observations on the living specimens and histological researches on specimens preserved for that purpose are needed for settling the question.

The apical area (Pl. II. Figs. 14—15) is rather large, 2.8 mm. to a diameter of test of 7.5 mm. The depression at the inner end of the rather large ocular plates may be large and almost tripartite or quite indistinct. There is a distinct secondary tubercle on each ocular plate; none of the plates reaches the periproct. The form of the ocular plates is peculiar, the part outside the pore looking like a small, separate, white plate. The ocular pore cannot be seen from above, as is generally the case in the *Pleurechinus*-species. The genital plates have 1—3 tubercles at the inner edge; the outer part is mostly dark coloured. Genital openings rather large. The periproct is covered by one large anal plate and a few smaller plates; the anal opening is excentric.

The buccal membrane is naked, with rather numerous, very slender, but rather large bihamate spicules (Pl. VI. Fig. 16). Along the inner edge around the mouth there is a single series of small irregular plates. The buccal plates are small, round, colourless (not green as in *Döderleini*); they are paired, and all 10 buccal tube feet are developed as is normally the case in Echinids. The gills contain the usual irregular plates. The auriculæ are rather large and connected.

The globiferous pedicellariæ (Pl. VI. Fig. 36. Pl. VII. Fig. 14) have no distinct lateral teeth, only a rounded knob on the one side; the blade is of medium length, the basal part evenly rounded. The ophicephalous pedicellariæ (Pl. VII. Fig. 44)

have a rather well developed meshwork in the outer part of the blade. Tridentate pedicellariæ have not been observed. The triphyllous pedicellariæ (Pl. VII. Fig. 53) are small and simple. — Sphæridiæ are found on the 4–5 lower plates. Spicules have been met with only in the buccal membrane, and a few of the same shape as those in the buccal membrane, in the walls of the genital organs.

The spines (Fig. 7) are short, the longest about  $\frac{1}{3}$ – $\frac{1}{4}$  of the diameter of the test; they are rather robust, smooth, a little swollen at the point. Those around the peristome are flattened at the end and curved. The smaller ones end in a distinct central point with a circle of smaller points around; in the larger ones the point is rounded (Pl. II. Fig. 22). They are white with one or two narrow greenish bands. Sometimes the base is reddish, and then the primary tubercles likewise are reddish.

The colour of the test is greenish with some irregular white spots. The median naked part of the interambulacra on the abactinal side is mostly darker coloured; there is thus formed a star-shaped figure on the abactinal side. A small specimen of 3.5 mm. diameter has the interambulacra beautifully red, and in a larger naked test (10 mm.) the interambulacra are a little red at the ambitus. These specimens otherwise agree completely with the rest.

Koh Mesan, 3–15 fathoms (9 specimens); Koh Chuen, 15–38 faths. (7 specimens); Koh Kram, 20–30 faths. (2 specimens); Koh Kahdat, 10 faths. (1 specimen).

This small species proves to be very widely distributed in the Indo-Pacific Ocean. In the collections of the British Museum I have found some specimens from the Seychelles, 12 fathoms (named *Salmacis bicolor*? young), from Holothurian Bank, North Australia, 15 fathoms (named *Temnopleurus* young) and from the Amirante Islands, 17 fathoms (named *Salmacis bicolor*, young?), which I must refer to *Pl. siamensis*, in spite of some minor differences. A specimen from Torres Strait (HADDON) found among some Echinids sent me for examination by Prof. S. F. HARMER in Cambridge, must likewise be referred to this species. It is 12 mm. in diameter, 8 mm. high, and is the largest specimen of this species that I have seen. (Pl. I. Figs. 7, 11. Pl. II. Figs. 2, 9, 14.) Also the „Siboga“-Expedition has dredged several specimens of this species. — Seeing from DE MEJERE's remarks on *Pleurech. bothryoides* („Siboga“-Ech. p. 77) that probably more than one species had been included under this name, I asked Dr. DE MEJERE to let me see the specimens, and he most kindly sent me all of them. As supposed, I found them to belong to several species, viz. *Pl. maculatus* (described below), *siamensis* and *scillæ*, besides the true *bothryoides*. The species *siamensis* was found to occur in many of the stations (enumerated on p. 202 of the „Siboga“-Echinoidea), being thus very common in the Malay Archipelago.

All these specimens show the species to be very variable. Several of the specimens from „Siboga“ are quite like those from the Gulf of Siam; others are much darker, brownish with white spots or quite brown. The specimens from the

Seychelles and from Holothurian Bank are almost white; the spines are less thickened at the point than in the typical form; the pits between the ocular and the genital plates are very distinct, and the genital plates bear several tubercles along their inner edge, forming a circle round the periproct. Perhaps the secondary tubercles are also a little more numerous than in the typical form. In the specimen from Torres Strait the secondary tubercles are distinctly more numerous. These are, however, very trifling and unreliable differences, so that I find it necessary to regard them all as belonging to one species. Only one form I must regard as a distinct variety. It is beautifully red coloured, both on the test and spines, and thus looks very different from the typical *siamensis*. I am, however, unable to find other characters than the colour by which it can be distinguished from that species, and the colour sometimes is little intense. The anal opening may be subcentral. This variety, which I may name var. *pulchellus*, n. var., I have seen from the Amiranthe-Islands and from the Maldive-Islands; further it was found in the „Siboga“-collection, from the Stations: 43, 104 and 240.

The genus *Pleurechinus* proves to be represented by a considerable number of species in the Indo-pacific Ocean. Until recently only the one species *Pl. bothryoides* was known, and it was considered a great rarity. In 1885 DÖDERLEIN (in his paper „Seeigel von Japan und den Liu-Kiu-Inseln“) described two new species, *Pl. ruber* and *variabilis*. BELL (Echinoderms of Macclesfield Bank. 1894. p. 410) points out that *Pl. bothryoides* now has been shown to be „by no means a rare species“ — but as to the species described by DÖDERLEIN he has „a pretty strong conviction that the progress of research will result in showing that *Pleurechinus variabilis* and *P. ruber* of Dr. DÖDERLEIN are synonyms of this variable species“. In his recent work on the Echinoidea from Amboina and Thursday Island (Semons Reisen) (p. 705) DÖDERLEIN maintains his species against BELL, and with full right. I have examined the type specimens of all the three species hitherto described, as well as the specimens from Macclesfield Bank determined by BELL as *Pl. bothryoides*, and I find *Pl. ruber* to be a very distinct species, whereas *Pl. variabilis* is so far from being synonymous with *Pl. bothryoides* that it cannot even be retained in the same genus; it belongs to the genus *Opechinus* Desor, hitherto known only as fossil. The specimens from Macclesfield Bank are not *Pl. bothryoides* either but a distinct species, described below as *Pl. maculatus* n. sp. In the collections of the British Museum I have further found a number of small specimens of *Pleurechinus*, identified as young *Temnopleurus* or even as *Temnopleurus toreumaticus*. As I could not examine all these specimens sufficiently during my visit at the British Museum, Prof. BELL kindly sent me the whole material to Copenhagen. By the close examination of these specimens they were found to belong to three different species of *Pleurechinus*, viz. the above named *Pl. maculatus*, *siamensis*, and one species more which has proved to be identical with the „*Temnopleurus*“ *scillæ*, described by MAZZETTI. Further the Copenhagen-Museum possesses

a number of specimens of a *Pleurechinus* from East Asia, which likewise prove to be a new species; it is described below as *Pl. variegatus* n. sp. — The description of these new species may be preceded by a few notes on the two previously known species, *Pl. bothryoides* and *ruber*.

*Pleurechinus bothryoides* Agass. differs from all the other *Pleurechinus*-species in having a distinct, though small, lateral tooth on either side below the endtooth in its globiferous pedicellariæ (Pl. VI. Fig. 5—6). The basal part is narrow, without produced outer corners, but otherwise rather variable in form, as shown by DE MEIJERE, who first described and figured these pedicellariæ („Siboga“-Echinoidea. p. 77. Pl. XVI. Fig. 267—68). In this species also tridentate pedicellariæ occur. They are small (ca. 0.2 mm. head), with the valves joining only at the point. The blade is narrow, simple, widened at the point; the edge is straight, except in the widened outer part, where it is coarsely sinuate and extremely finely serrate (Pl. VI. Fig. 38. Pl. VII. Fig. 9). The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 5, 51) do not present any peculiar features. The buccal membrane contains rather numerous bihamate spicules, and there is a border of small irregular plates round the mouth. In the tube feet I have found no spicules. The spines are smooth, not swollen at the point, ending in a more or less distinct central thorn. They have two or three beautiful red bands in the outer part. There is a transverse line on the genital plates.

In the description of this species (Rev. of Ech. p. 465) AGASSIZ says: „There are four deep disconnected pits of about equal size along the sutures of the plates above the ambitus“. Later on, in the „Challenger“-Echinoidea (p. 108) it is said: „in the interambulacral area there are two disconnected elliptical pits at the two extremities of the horizontal sutures“, and the same is shown by the beautiful figure (Pl. X. a. fig. 2). These two statements are evidently contradictory and might seem to indicate that the examples described in the „Challenger“-Echinoidea (and by DÖDERLEIN) were not the same species as the type of *Pl. bothryoides* described in „Rev. of Ech.“. As it was rather important to get this question settled, I asked Prof. DOUVILLÉ if he would lend me the type specimen (from the collection of L'école des mines in Paris) for examination. Prof. DOUVILLÉ most kindly sent me the precious specimen, for which service I beg him here to take my best thanks. The type specimen (labelled „Coll. Michelin, Iles Gallopagos“) proved to be an uncommonly large (40 mm. in diameter, 31 mm. high), beautiful, naked test of the species figured in the Chall. Ech. and by DÖDERLEIN, having thus only two large, deep, disconnected pits along each horizontal interambulacral suture and one in each ambulacral horizontal suture. The „four deep disconnected pits“ AGASSIZ must either have found by reckoning the whole width of the Interambulacra, or perhaps he really saw such a form (such recent forms really existing — comp. „*Pleurech. variabilis* and the new species of *Opechinus* described below) and then confounded his notes of the two forms. The note that the type specimen of *bothryoides* is „in

such a condition that no description of any value can be made" also seems to indicate a confounding of notes on different forms; the type specimen of *bothryoides* is in excellent condition, and as AGASSIZ does not otherwise give much more than descriptions of the tests, it seems difficult to understand, why this most characteristic form could not be described from the test alone. — The colour of the test in the type specimen is (now) grey, with a faint violet tint; it is not dark violet as stated by AGASSIZ; perhaps it was so, when he examined it.

The specimens recorded in the literature under the name of *Pleurechinus bothryoides* are not all really that species. The specimens from Kobi, Japan (Chall. Ech. p. 109) probably belong to the species *Pl. variegatus*, described below; in any case they are not *bothryoides*. The specimens from Chall. St. 186 are actually *bothryoides*. Of the specimens mentioned under this name by DE MEIJERE (Siboga-Ech. p. 77) only three large specimens from Jedan (St. 273) are really *bothryoides*; the rest are *Pl. maculatus*, *siamensis* and *scillæ* (see above p. 81; „Siboga“-Ech. p. 202). The specimens from Thursday Island, Torres Strait, mentioned by BELL (Echinodermata — „Alert“ p. 119) are really *bothryoides*, whereas the specimens from Macclesfield Bank mentioned by BELL as *Temnopleurus bothryoides* (Echinoderms of Macclesf. Bank. p. 410) are *Pl. maculatus*. (The „Challenger“-specimens, as well as those from Thursday Island and Macclesfield Bank I have examined in the British Museum.) The *Temnopleurus cavernosus* of WOODS is probably this species.

*Pleurechinus ruber* Döderlein. To the description of the test given by DÖDERLEIN<sup>1)</sup> may only be added that the anal opening is central and that no distinct anal plate is found. The spines are smooth, not swollen at the point; the actinal spines are not widened at the point and not curved. The globiferous pedicellariæ have no lateral teeth, only a rounded knob on one side below the endtooth; the blade is very short, the basal part with sharp, but not produced, outer corners (Pl. VI. Fig. 28, Pl. VII. Fig. 6). The opificephalous pedicellariæ are like those of *bothryoides*; triphyllous (and tridentate) pedicellariæ I have not seen; the triphyllous ones will probably be like those of *bothryoides*, as is the case in *Pl. variegatus*, with which species it otherwise completely agrees as to pedicellariæ; tridentate pedicellariæ probably do not occur at all.

*Pleurechinus variegatus* n. sp. (Pl. I. Figs. 5—6, 8, 19). The test is low (7 mm. to 11.5 mm. in diameter, 11 mm. high to 17 mm. in diameter), beautifully rounded above, a little curved inwardly at the peristome. The pits (in both areas) are small, not reaching to the base of the primary tubercles, leaving thus a rather large part of the horizontal suture not deepened; no covering membrane is seen round the edge of the pits. The primary tubercles (of both areas) form distinct longitudinal series, diminishing very little in size towards the apex and the peristome; they are almost equally large in both areas. In larger specimens the tubercles are rather

<sup>1)</sup> Seeigel von Japan und den Liu-Kiu-Inseln. p. 20.

distinctly crenulate, and there may be indications of a stellate structure at their base. The secondary tubercles are rather numerous, in larger specimens very crowded, forming more or less distinct vertical and horizontal series; especially inside the primary series there is a vertical series of secondary tubercles, which may be almost as large as the primary ones; they may be more distinct in the ambulacra than in the interambulacra. The pores are very small, disposed in a very nearly straight series, close to the edge of the area (only at the ambitus a little distant from the edge in the largest specimen), no tubercles being found outside the pores. The poriferous zone is very narrow, only ca.  $\frac{1}{7}$ — $\frac{1}{8}$  as broad as the interporiferous zone. The ambulacral plates are as high as the interambulacral ones, their number being the same. The small pits at the outer edge of the area are very indistinct or quite wanting.

Apical system (Pl. II. Fig. 6). The genital plates show the peculiar feature of the outer part with the genital opening being separated from the inner part by a distinct, mostly curved line, so that it seems as if the plate were divided in two parts, which is, however, not really the case. Sometimes the transverse line is obscured by tubercles, but never, so far as my experience goes, on all the plates; on the madreporite it is never distinct. The outer part of the genital plates is mostly darker coloured than the inner part. There is a circle of tubercles along the inner edge. The genital opening is placed near the outer edge. The ocular pore is placed on the outer edge of the rather thick ocular plate and cannot be seen from above; the part of the plate outside the pore is white and looks like a small distinct plate. The depression between ocular and genital plates is small and indistinct. The anal opening is not central; there is a distinct anal plate.

The buccal membrane contains rather many bihamate spicules; the plates along the oral edge may be rather numerous (a fact which depends on the size of the animal, in all probability). The buccal tubefeet may sometimes be placed one outside the other; in one specimen I have found the one tubefoot wanting in one of the pairs, a fact which is not without interest, considering the curious instance of *Pl. Döderleini* having all the buccal tubefeet constantly unpaired. — The spines are short ( $\frac{1}{8}$ — $\frac{1}{4}$  of the diameter of test), smooth, not thickened at the point; the actinal spines are not widened or curved. — The globiferous pedicellariæ are quite similar to those of *Pl. ruber*, and reference may simply be made to the figures given thereof for that species. The triphyllous pedicellariæ are quite similar to those of *bothryoides*. The ophicephalous pedicellariæ do not present peculiar features. Bihamate spicules may be rather numerous in the walls of the intestine. — The colour of the test is gray or grayish-yellow, with some white spots; the pore areas are white. The spines are faintly greenish or whitish with a faint red tint at the base and a darker band in the outer part.

Specimens of this species have come from the following localities: Formosa-Channel, 35 fathoms (Suenson); Lat.  $32^{\circ} 22' N.$ , long.  $128^{\circ} 42' E.$ , 170 faths. (Suenson);

Lat. 33° N., long. 129° 24' E., 30 faths. (Schönau); Lat. 23° 57' N., long. 118° 33' E., 28 faths. (Schönau); Lat. 35° 5' N., long. 128° 22' E., 25 faths. (Schönau); Lat. 25° 28' N., long. 120° 29' E., 36 faths. (Schönau). Further Prof. DÖDERLEIN has taken the species in Sagami-Bay, at Yogashima and Kadsiyama, Japan (he has kindly lent me the specimens for examination); it is this species which is figured in Pl. LXI. Fig. 5, 5a of DÖDERLEIN'S „Echinoidea von Thursday Island und Amboina“ under the name of *Pleurech. variabilis* juv.

Perhaps there will prove to be one more species of *Pleurechinus*, allied to *ruber* and *variegatus*, in the Japanese seas. Among the specimens sent me from Prof. DÖDERLEIN there is a specimen with larger pits and fewer tubercles than *variegatus*; the anal opening is central. Otherwise it agrees with *variegatus*. Whether or not it be really a distinct species, I shall not try to decide from the scanty material before me.

The two species, *ruber* and *variegatus*, are evidently nearly related, both agreeing in having much smaller pits than the other species of *Pleurechinus*. They are easily distinguished from each other. The pores are much larger in *ruber* than in *variegatus*; the tuberculation is also rather different. Finally the different colour instantly conveys the impression of their being two very distinct species. — *Pl. variegatus* has also some resemblance to *siamensis* as to habitus; it is, however, very easily distinguished from that species by the small pits, the numerous tubercles, the not thickened spines, the impression on the genital plates, besides by the form of the globiferous and triphyllous pedicellariæ.

*Pleurechinus scillæ* (Mazzetti) (Pl. I. Figs. 9—10, 17—18). — The description and figures of „*Temnechinus*“ *scillæ* given by MAZZETTI<sup>1)</sup> are very insufficient, being made from a naked test, in which even the apical system was wanting. It is only possible to see with certainty that it is no *Temnechinus* but a *Pleurechinus*, as pointed out by DE MEJERE (though not *Pleurech. bothryoides* as he supposes). (Siboga-Ech. p. 79.) Finding that some of the specimens of *Pleurechinus* before me were probably identical with this species, I asked Prof. ROSA in Modena to lend me the type-specimen for comparison; he very kindly sent it to me, for which service I beg him to take my best thanks. The comparison did not leave any doubt that my specimens were really identical with the „*Temnech.*“ *scillæ*, and I am thus able to give a more detailed description of this hitherto very insufficiently known species and to assign to it its true place in the system.

The specimens from the British Museum which led me to suppose the identity with *Pl. scillæ* were taken at Muscat, in the Persian Gulf, thus very near to the place from which the type-specimen had come. Together with these specimens there was a pair of specimens from New Britain (Collection WILLEY)<sup>2)</sup>, differing

<sup>1)</sup> Gli Echinidi del Mar Rosso. Mem. della R. Acad. di Sci. di Modena. 2 Ser. X. 1894. p. 213.

<sup>2)</sup> Mentioned by BELL in his paper on the Echinoderms collected by Dr. WILLEY as *Temnopleurus* young. WILLEY. Zoological Results. II. 1899. p. 135.

so much (especially by their large anal plate) from those from Muscat that I could not doubt that they belonged to a distinct species. The rich material of *Pleurechinus* from the „Siboga“-Expedition, however, yielded so many forms intermediate between the specimens from New Britain and Muscat that I must regard these as the two extreme forms of one very variable and widely distributed species. In the „Siboga“-Ech. p. 202 this species is mentioned under the name of *Pleurech. reticulatus*, as I could not at that time say with certainty whether it was identical with *Pl. scillæ* or not, having not yet seen the type specimen.

The test is low (6 mm. high to a diameter of 9 mm.), beautifully rounded above, almost flat below. The pits (in both areas) are large, reaching to the base of the primary tubercles, leaving only a small part of the horizontal suture not deepened (Pl. II. Figs. 4, 13); they are generally narrowed in the middle, rounded at both ends, the end looking towards the primary tubercle being the wider; the ambulacral pits are more regular in outline. There is a distinct covering membrane round the edge of the pits. The surface of the plates looks very different in the extreme forms of the species; but intermediate conditions are found. In those from New Britain the primary tubercles (in both areas) are little conspicuous, some few of those at the ambitus being a little larger than the others; their base is very distinctly stellate, undermined, as it were, by a circle of deep, round pits. Along the middle of the plate there is a depression in continuation with the pit in the opposite suture. The plates thus get a very reticulated surface (Pl. II. Fig. 13). The secondary tubercles, which are of about the same size as the primary ones, are arranged in a more or less distinct zigzag manner, forming oblique transverse series between the primary tubercles of the two series. Outside the primary interambulacral tubercles there are a few secondary tubercles. No vertical series are formed by the secondary tubercles. — In the specimens from Muscat the primary tubercles are more distinct, with only faint traces of a stellate condition of their base. There is no distinct median depression on the plates, and the secondary tubercles are not arranged in oblique series. — The pores are small, disposed in a straight line, close to the edge. The poriferous zone is very narrow, only c.  $\frac{1}{7}$  as broad as the interporiferous zone. The plates of both areas are equally high, their number being the same (9 in a specimen of 8 mm. diameter). No pits are seen along the edge of the ambulacral areas.

The apical system (Pl. II. Figs. 10, 12) in the specimens from New Britain shows the peculiar feature of the periproct being completely covered by one large anal plate, no small plates being found besides it. In other specimens some few small plates are found on one side, and in the specimens from Muscat several small plates are found, the anal plate being, however, very large. The pits at the inner angle of the ocular plates is large, generally divided in two or three almost or quite separate pits. The ocular pore is directed outwardly, generally not seen from above. The genital plates have some more or less distinct depressions, the outline

being rather sinuate; there is sometimes a distinct transverse line over the outer part of the genital plates. The genital opening is placed almost in the middle of the plate. One or two small tubercles are found at the inner edge of the genital plates and one in the middle of the ocular plate.

The buccal plates may be placed one outside the other in each pair or equally distant from the edge. The plates along the inner edge of the buccal membrane are very faintly developed or even totally wanting, and the same holds good for the bihamate spicules. — The spines are short, the longest being about half as long as the diameter of the test; they are slender, not widened at the point, except those at the peristome, which are flattened and a little widened, and also a little curved. The primary spines are more or less thorny, sometimes, however, quite smooth, though — so far as my experience goes — never all of them in the same specimen; the secondary spines (Fig. 5) are generally more thorny, ending in a large central thorn, surrounded by small ones at its base.

The globiferous pedicellariæ (Pl. VI. Fig. 13, Pl. VII. Fig. 25) have no lateral teeth, only a rounded knob on each side below the endtooth. The outer corners of the basal part are sharp and generally a little produced. The ophicephalous and triphyllous pedicellariæ do not differ from those of *siamensis*. — Spicules I have not seen in the tubefeet, but at the base of the spines some few may be found.

The colour is rather variable: whitish with faint brownish spots, which are often most prominent between the primary tubercles in each series, or brown with a white spot in each area near the ambitus; the interambulacra may be darker coloured, forming thus a starshaped figure on the upper side of the test, as may also be the case in *siamensis*. The genital plates are mostly white in the middle, the edge being brown; in lighter coloured specimens there is only a brown spot at the two inner corners and one at the outer end of the plate. The primary spines are whitish with one or two faintly reddish bands.

This very small species (the largest specimen, I have seen, is 9 mm. in diameter) is evidently very widely distributed in the Indo-Pacific Ocean, being known from the Red Sea, the Persian Gulf, the Malay Archipelago and New Britain. For the localities where it has been dredged by the „Siboga“ reference must be made to DE MEIJERE's work (p. 202). — It is evidently most nearly related to *siamensis*, from which species it is, however, easily distinguished, mainly by its thorny spines which are not thickened at the point. Specimens like those from Muscat otherwise may look very like *siamensis*. The large anal plate is a very interesting feature, and the reticulate condition of the plates and tubercles reminds one of *Genocidaris*, showing thus that the reticulate or grooved condition of the plates is no exclusive character of such genera as *Trigonocidaris* and *Genocidaris*. (Comp. below: the classification of the Temnopleurids.)

*Pleurechinus maculatus* n. sp. (Pl. I. Figs. 4, 14). This species very closely resembles *Pl. bothryoides* in the form and structure of the test. The pits are somewhat variable in size, sometimes not reaching to the base of the primary tubercle; those at the outer edge of the ambulacral areas are generally less distinct than in *bothryoides*. There is a well developed covering membrane along the edge of the pits, which will probably be found to be the case also in *bothryoides*. (Comp. DUNCAN. On the genus *Pleurechinus*.) The pits at the inner edge of the ocular plates likewise are somewhat variable in size. The genital plates (Pl. II. Fig. 5) have the outer part, with the genital opening, depressed and marked off from the inner part by a sinuate transverse line, as is the case also in *bothryoides* and *variegatus*. It is especially distinct in smaller specimens. The anal opening is central or subcentral; the plates of the periproct are rather large, and the anal plate is distinct. The spines are smooth, generally distinctly knobshaped at the tip; the actinal ones are widened and curved. — The globiferous pedicellariæ (Pl. VI. Fig. 20, Pl. VII. Fig. 17) have no lateral teeth, only a small rounded knob on either side; only in one instance have I found the lateral teeth distinctly developed; the outer corners of the basal part are marked but not produced. Upon the whole the form of these pedicellariæ, however, is not very constant. Tridentate pedicellariæ are found; they are like those of *bothryoides*, and the same holds good for the ophicephalous ones; the triphyllous pedicellariæ (Pl. VI. Fig. 44) have the blade more widened than in *bothryoides*.

The colour is very variable; the test may be uniformly gray, with some indistinct white spots, or white with reddish spots or even quite white; sometimes it is violet or red. The spines are uniformly whitish, reddish or violet or with a pair of faint reddish bands.

This species is the „*Temnopleurus bothryoides*“ of BELL<sup>1)</sup> from Macclesfield Bank. I have also seen specimens from Hongkong (Hamburg Museum), Torres Strait (Haddon) and from the „Siboga“-Stations 43, 99, 164, 258 and 315 (?). It is evidently closely related to *Pl. bothryoides* and perhaps ought to be regarded only as a variety of that species. But in any case it must be kept as a distinct form; whether it then be regarded as a separate species or only as a variety, is of very little importance. — From *siamensis*, to which it may also have considerable resemblance, it is distinguished by the transverse line of the genital plates and by the tubercles forming horizontal rows; the latter feature, however, is of course not seen in very small specimens. — It is a rather large species, though, probably, it does not reach the size of *bothryoides*.

The number of species of the genus *Pleurechinus* having thus been increased from 2 (*Pl. bothryoides* and *ruber*, the species *variabilis* Döderl. not really belonging to this genus) to 7, it will be very useful to give an analytical table of the species.

<sup>1)</sup> Echinoderms of Macclesfield Bank. p. 410.

Table of the species of *Pleurechinus*.

1. Only five buccal plates and tube feet; anal opening central, no anal plate. Spines thorny. Globiferous pedicellariæ with a large unpaired lateral tooth..... *Pl. Döderleini* Mrtsn.  
 Ten buccal plates and tentacles. A more or less distinct anal plate. Spines smooth or thorny. Globiferous pedicellariæ with 1—1 lateral teeth or with only a rounded knob on one or either side below the endtooth..... 2.
2. Pits small; spines smooth. Globiferous pedicellariæ without lateral teeth, the blade very short..... 3.  
 Pits large, reaching to the base of the primary tubercles. Globiferous pedicellariæ without teeth or with 1—1 lateral teeth; the blade not very short..... 4.
3. Pores rather large; ambulacral plates lower than the interambulacral ones, their number being somewhat larger. Colour of test red; the spines red with white bands. Genital plates without transverse line..... *Pl. ruber* Döderl.  
 Pores very small; ambulacral plates as high as the interambulacral ones, their number being the same. Colour of test gray; the spines reddish at the base, mostly with a small dark band in the outer part. The outer part of the genital plates separated from the inner part by a sinuous line..... *Pl. variegatus* Mrtsn.
4. Globiferous pedicellariæ with 1—1 distinct lateral teeth; spines smooth, with intensely red bands. Test uniformly dark coloured..... *Pl. bothryoides* Agass.  
 Globiferous pedicellariæ without lateral teeth, only a rounded knob on one or both sides below the endtooth. 5.
5. Spines thorny, at least the secondary ones, not swollen at the point..... *Pl. scillæ* (Maz.).  
 Spines smooth, the primary ones swollen at the point. 6.
6. The genital plates divided by a transverse line into an outer and inner part; the secondary tubercles arranged in a horizontal row..... *Pl. maculatus* Mrtsn.  
 The genital plates not divided into two parts by a transverse line; the secondary tubercles not forming horizontal series..... *Pl. siamensis* Mrtsn.

The validity of the genus *Pleurechinus* has been somewhat disputed. AGASSIZ (Rev. of Ech.) regards it as a subgenus of *Temnopleurus*, and this is also the position accorded to it by DUNCAN<sup>1)</sup> in his „Revision of the Genera and great Groups of the Echinoidea“ (p. 107). BELL (Echinodermata. „Alert“ p. 119) makes it synonymous with *Temnopleurus*, whereas DÖDERLEIN (Echinoidea von Amboina — Semon's Reisen) recognizes the validity of a genus or, at least, subgenus *Pleurechinus*, distinguished „durch ihre auffallend kugelig gerundete, meist hohe Schale, durch die fehlende Crenulierung ihrer Hauptwarzen, besonders aber dadurch, dass auf der Buccal- wie Apicalseite die Ambulacral- und Interambulacralplatten regelmässige Horizontalreihen kleiner Hauptwarzen tragen, endlich durch ihre sehr kurzen und überall etwa gleich langen Stacheln“. — „Die Apicalseite ist ferner bei *Pleurechinus* der Buccalseite sehr ähnlich, bei *Temnopleurus* sind beide Seiten sehr verschieden“. Through the comparatively large number of species made known in this paper, the characters pointed out by DÖDERLEIN as distinctive of the genus are modified to some extent. The form of the test is low in *siamensis* and *scillæ*, being very different from such species as *bothryoides* and *maculatus*; no generic character is then found in the form of the test. The primary and secondary tubercles do not form transverse series in *Döderleini*, *siamensis* and *scillæ*. This feature must accordingly also be left out of consideration as a generic character. The absence of crenulation is a more general feature, but not quite exclusive, the tubercles being rather distinctly crenulate in larger specimens of *variegatus*; this is, however, evidently a very important character uniting this group of species. The large pits would be another excellent character, were it not for the two species *ruber* and *variegatus*, where they are rather small. It is also to be remarked that there is a covering membrane round the edge of the pits, leaving only a smaller opening in the middle — but this is not found in *variegatus* (and, probably, not in *ruber*). The uniform character of the spines and of the two sides of the test holds good. No generic character is found in the pedicellariæ. It is thus rather difficult to give a good definition of the genus *Pleurechinus*. If the species *ruber* and *variegatus* were removed from the genus, the large pits bordered by a membrane would give an excellent character for the other species; and if *Döderleini* were removed also, the rest of the species would form a somewhat more close group, though not even then a uniform group, the species *bothryoides* and *maculatus* on the one hand, *siamensis* and *scillæ* on the other hand forming special groups. It seems, however, unnecessary to make these groups each a separate genus. I prefer to leave them all in the genus *Pleurechinus*, which is, I think, sufficiently distinguished from *Temnopleurus* by its noncrenulate tubercles (in spite of the large specimens of *variegatus*) the uniform size of the spines and the uniform aspect of both sides of the test. To regard it as a mere subgenus of *Temnopleurus* (or even synonymous with that

<sup>1)</sup> Comp. also DUNCAN's paper: On the genus *Pleurechinus*, L. Agass., its classificatory position and alliances. J. Linn. Soc. XVI. 1882. p. 447.

genus) I find no reason, especially now that it has been shown to contain a much larger number of species than the genus *Temnopleurus* itself.

„*Pleurechinus*“ *variabilis* Döderlein differs very markedly from all the *Pleurechinus*-species mentioned or described above in having in the interambulacra two large shallow depressions along each horizontal suture besides the usual ones at the inner and outer end of the suture, which are, however, only low depressions, not deep pits as in the other *Pleurechinus*-species; in the ambulacra there is one such intermediate groove. (Comp. the description given by DÖDERLEIN: Seeigel von Japan u. den Liu-Kiu-Inseln. p. 18.) This species in fact completely agrees with the genus *Opechinus* Desor<sup>1)</sup>, and there can certainly be no doubt that it must be referred to that genus. *Opechinus* is most nearly related to the genus *Temnechinus* Forbes, both being distinguished by having only low depressions in the sutures, but no true, deep pits, undermining the plates, as are found in *Pleurechinus*, *Temnopleurus*, *Salmacis* etc. To DUNCAN is due the merit of having pointed out this important difference<sup>2)</sup>. The „*Pl.*“ *variabilis* is thus really very different from *Pleurechinus*. To be sure it is said in DÖDERLEIN's description of this species that the grooves at the end of the sutures „gewöhnlich sehr seicht, manchmal auch scharf und tief erscheinen“ (p. 19), an assertion which is in direct opposition to the primary importance of the difference between true and false pits. But DÖDERLEIN is wrong here, having confounded specimens of *Pleurechinus variegatus* with the true *variabilis* (which has evidently also caused the name *variabilis*), as I can state, Prof. DÖDERLEIN having most kindly placed his material at my disposal. The specimen figured by Döderlein (Taf. LXI. Fig. 5 a—b) as *Pleurech. variabilis* juv. is really *Pleurech. variegatus*.

DUNCAN (On the genus *Pleurechinus*. p. 449) makes *Opechinus* a synonym of *Temnechinus* Forb., „as its essential character, never generic, is due to chances of growth of ornamentation“. For this assertion there is no reliable evidence. In DUNCAN & SLADEN's Monograph of the Tertiary Echinoidea of Kachh and Kattywar (Palæontologia Indica. Ser. XIV. 1883) it is stated for *Temnechinus (Opechinus) Rousseaui* that „the fossettes are not seen in the very young form; and in some large specimens there is so little trace of them that they resemble species of *Salmacis*, and the plates are then not bevelled“ (p. 55). But there is no proof at all that these specimens are really the same species as those with the fossettes well developed; this cannot be made out with certainty in fossil specimens, where the characters found in pedicellariæ and spines etc. have been lost. I quite agree with GREGORY (British Fossil cænozoic Echinoidea. Proc. Geologists Assoc. XII. 1891. p. 29) that *Opechinus* must be maintained as a distinct genus besides *Temnechinus*, the Crag-

<sup>1)</sup> In Rev. of Ech. p. 465 AGASSIZ says the same of *Pleurechinus bothryoides*, which would have been true if his description of that species had been correct. But *Pl. bothryoides* has really only two pits in each horizontal suture, and it does not correspond to *Opechinus*.

<sup>2)</sup> On some Points in the Morphology of the test of the Temnopleuridæ. J. Linn. Soc. XVI. 1881.

species and the Oriental species forming two very well defined groups, the one without, the other with intermediate depressions. „The differences between the two groups of species may be only due to the disposition of the raised epistromal ribs, but these affect so materially the whole aspect of the tests, and the epistroma plays so prominent a part in the classification of the Glyphocyphinae that it is convenient to express the differences in this way“. „*Pl.*“ *variabilis* is then a recent representative of the genus *Opechinus*, so well represented in the Tertiary of India by the species: *Rousseaui* d'Arch., *Hookeri* d'Arch., *costatus* d'Arch., *tuberculosis* d'Arch., *Valenciennesi* d'Arch. (this is the first named but, unfortunately, the least typical species, the intermediate grooves not being distinctly separated from the angular ones), *percultus* Desor, *affinis* Dunc. & Slad. (but not *Temnech. stellulatus* Dunc. & Slad. nor *Gajensis* Dunc. & Slad., which have no sutural depressions, but a strongly reticulated surface; they are probably nearly related to *Genocidaris* and *Trigonocidaris*).

POMEL (Op. cit. p. 85) makes the species *costatus* d'Arch. the type of the genus *Opechinus*, referring the species *Valenciennesi*, *Rousseaui*, *Hookeri*, *tuberculosis* and *percultus* to the genus *Pleurechinus*. — This wrong representation of the two genera evidently is caused by the fault in the description of *Pl. bothryoides* of AGASSIZ pointed out above. To separate the species *costatus* from the other species with intermediate fossettes on account only of its having a depression in the middle of the interambulacral plate in succession to the series of depressions along the opposite suture seems rather absurd, the more so as in other species the median sutural depression may proceed on the median point of the opposite interambulacral plate (in *O. spectabilis* f. i.).

It is interesting to note the assertion of DESOR with regard to this genus (Synopsis des Échinides fossiles. p. 107) that „il en existe des espèces vivantes“; it thus seems that he has seen specimens of some recent form of *Opechinus*; likewise the description of *Pl. bothryoides* in „Rev. of Ech.“ might seem to indicate, that AGASSIZ has seen such a specimen (comp. above p. 83). In the „Challenger“-Echinoidea (p. 108) AGASSIZ further says of some small specimens of *Pleurechinus bothryoides* (those specimens, I suppose, which are not *bothryoides* but, probably, *variegatus*): „they show clearly that we may expect to find in the China Seas a species of *Temnopleurus* still retaining the principal features so characteristic of some of the nummulitic species of India, figured by d'Archiac and Haime“ (*Temnopleurus Valenciennesi*). I am unable to understand how these specimens can show this, since all the „Challenger“-specimens of *Pl. bothryoides* are, in any case, true *Pleurechinus*-species with only two pits in each suture. But it is a very curious thing too that among the „Challenger“-Echinids AGASSIZ really had a species of that interesting group, and even a large, beautiful and well preserved specimen; but he cannot have examined it very exactly, having determined it as *Temnopleurus Hardwickii* (St. 192). Through the kindness of Prof. BELL I have been

allowed to examine this most interesting form, which is described below as *Opechinus spectabilis* n. sp. Thus we know now two living representatives of this very remarkable group.

*Opechinus variabilis* (Döderl.). To the description of this species may be added some few remarks. The spines are smooth, not swollen at the point, ending in a central thorn with a circle of small thorns at its base. The globiferous pedicellariæ (Pl. VI. Fig. 27. Pl. VII. Fig. 2) have no lateral teeth; the outer corners of the basal part are marked and more or less produced; the blade is quite open or with a single transverse beam. The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 7, 49) do not present any remarkable characters. Slender bihamate spicules are found in the tubefeet and in the head of the globiferous pedicellariæ. De MEIJERE („Siboga“-Echinoidea. p. 79) mentions some specimens of „*Pleurechinus*“ *variabilis*. Since he has sent me these specimens together with all his specimens of „*Pleurechinus bothryoides*“, I can state that those (two) from St. 98 are quite different from *O. variabilis*. They evidently belong to an undescribed species of the genus *Genocidaris*. The specimen from St. 105 is a true *Opechinus* and probably *O. variabilis*, though it has comparatively fewer tubercles than the type-specimen.

*Opechinus spectabilis* n. sp. (Pl. I. Fig. 15). The test is low, the abactinal side somewhat conical, the actinal side flat. (Diameter 30 mm., height 16 mm.) The primary tubercles are noncrenulate, of about equal size in both areas, diminishing a little in size towards the apical system. In the ambulacra the secondary tubercles form a distinct vertical series inside the primary series. Numerous small tubercles are scattered irregularly on the plates inside and above the primary tubercle, which is placed close to the pores. Along the median line there is a smooth space. Besides the depression at the median end of the suture there is, at the ambitus, another smaller, intermediate depression opposite to the space between the primary and the large secondary tubercle. This intermediate depression appears at about the 6<sup>th</sup> plate from above; below the ambitus both depressions soon disappear. The pores are disposed in an almost straight series close to the edge of the area; the interporiferous zone is much broader than the poriferous. The ambulacral plates are a little lower than the interambulacral ones, their number being 19 against 16—17 interambulacral plates.

In the interambulacra the secondary tubercles form at the ambitus two vertical series inside and one outside the primary tubercles, almost as large as the primary ones. Below the ambitus the innermost series first disappears, the two other series being distinct almost to the peristome. Both these series likewise are distinct almost to the apical system, whereas the innermost series only appears at the 6<sup>th</sup>—7<sup>th</sup> plate from above. All these tubercles likewise form a distinct horizontal series on each plate. Small tubercles cover the rest of the plates, forming a close circle around each larger tubercle. The median line is naked. At the ambitus there are no less than 6 depressions in each horizontal suture, the two angular

and 4 intermediate ones. The largest are those at each side of the primary tubercle; from there the depressions decrease in size towards the angles. Outside the large grooves there is only one, the angular groove, inside the large ones there are two intermediate grooves and the angular one. Towards the apical system the grooves nearest the angular ones by and by disappear, uniting with the angular ones. On the 4—5 uppermost plates there are only two grooves in each horizontal suture; from the 5<sup>th</sup>—6<sup>th</sup> the two large grooves at the primary tubercle become separated off from the angular ones. Below the ambitus all the intermediate grooves disappear very soon, whereas the angular ones may be traced almost to the peristome. The inner angular groove is continued over the suture upon the median corner of the opposite plate.

The apical area, 8.5 mm. in diameter, is regular, no ocular plate reaching the periproct. The genital opening is at the outer edge of the plate, and there is a small genital papilla. A circle of tubercles is found at the inner edge of the genital plates. The ocular plates are covered by numerous small tubercles. The anal area (4.5 mm.) is covered by numerous small, irregular plates without tubercles. No distinct anal plate. The anal opening is central.

The buccal membrane has only some few small plates in the inner edge besides the buccal plates, which are equally distant from the edge. Otherwise the buccal membrane contains numerous slender, bihamate spicules, which are often arranged in thick bundles, mostly forming rings (Pl. V. Fig. 21). — The spines are very short, the longest being scarcely 5 mm.,  $\frac{1}{6}$  of the diameter of test. They are greenish, dark at the base and faintly ringed; they are smooth, ending in a rather large central thorn with a circle of small thorns at its base; the point is not swollen. The actinal ones are a little widened, flat and curved.

The globiferous pedicellariæ (Pl. VII. Figs. 18, 19) have no lateral teeth, but a rather large rounded knob on each side below the endtooth; the blade is rather elongate, the outer corners of the basal part rounded, not produced. Tridentate pedicellariæ occur in this species (Pl. VI. Fig. 42. Pl. VII. Fig. 45); they are rather small (c. 0.5 mm. head). The valves are broad, with a little meshwork at the bottom of the blade. The edge has some coarse sinuations in the outer part and is otherwise finely serrate in the whole length. The valves join in their whole length. Below the basal part there is a well developed semicircular arc, as in the ophicephalous pedicellariæ, a very interesting, though not unique, feature. The ophicephalous pedicellariæ are like those of *O. variabilis*; the triphyllous ones (Pl. VII. Fig. 27) have the blade somewhat widened. — Bihamate spicules are found in the tube feet, though not very numerous, and at the base of the spines. — The colour of the test is greenish-gray, with large, irregular spots at the ambitus; the actinal surface is white.

The only specimen known of this most interesting species was taken by the „Challenger“ at the Kei-Islands (New Guinea), Lat. 5° 42' S., long. 132° 25' E.

129 fathoms, mud. (St. 192.) As mentioned above it is named *Temnopleurus Hardwickii* in the „Chall.“ Echinoidea p. 107.

The relation between the two recent species of *Opechinus* thus far made known and the fossil species is not to be made out with certainty, as the latter are known from the tests alone; but it seems that *O. variabilis* is most nearly allied to *O. Rousseaui*, whereas *O. spectabilis* differs from all the fossil species known (to me) in the number of grooves, being thus the most specialized form of the genus. Otherwise it has most likeness to *O. Rousseaui*, which species may then perhaps be the ancestor of the recent species.

I may here take the occasion to give some notes on the other *Temnopleurids*, not mentioned above.

*Salmacopsis olivacea* Döderlein. The globiferous pedicellariæ (Pl. VI. Figs. 25, 30) have no lateral teeth, only a rounded knob on one side below the endtooth; the outer corners of the basal part are rounded, a little produced. The ophicephalous pedicellariæ are like those of *Opech. variabilis*; the triphyllous ones (Pl. VII. Fig. 23) have a few serrations in the edge of the lower part of the blade (always?). The spicules are bihamate, very scarce in the tube feet; in the stalk of the globiferous pedicellariæ some spicules may occur. The buccal membrane is quite naked except the buccal plates and some bihamate spicules. The genital plates show the same peculiar feature as *Pleurech. variegatus*, the outer part of the genital plates being apparently separated off from the inner part by a transverse (straight) line. The primary spines are smooth, ending in a mostly rather long central thorn, surrounded at its base by a circle of smaller thorns. The secondary spines are faintly thorny, a little swollen at the point; the central thorn is not prominent above those of the outer circle. — *Salmacopsis pulchellinus* Yoshiwara I have not seen. — The genus *Salmacopsis* evidently has the same relation to *Salmacis* as *Pleurechinus* has to *Temnopleurus*.

*Mespilia globulus* (L.). The globiferous pedicellariæ (Pl. VII. Figs. 16, 22) are exceedingly characteristic; there are 2—5 lateral teeth on either side of the blade, the upper ones, which are directed outwards, being almost as long as the endtooth; the lower ones are mostly smaller and are gradually turned inwards. The blade is open; the basal corners not produced. These (small) pedicellariæ occur in immense numbers on the naked parts of the test together with a few triphyllous ones. Tridentate pedicellariæ I have only found in the type specimen of *M. Whitmæi* (comp. below); they are exceedingly small and simple, leafshaped (Pl. VII. Fig. 47); the ophicephalous pedicellariæ (Pl. VII. Fig. 33) have the valves narrowed in the middle. The triphyllous pedicellariæ (Pl. VI. Fig. 17) are very small, with the apophysis incompletely developed; generally some of the holes are elongate. In „Rev. of Ech.“ Pl. XXXVIII. Fig. 22 AGASSIZ figures an „interambulacral abactinal pedicellaria“ of *M. globulus*, which looks quite problematic. I have never seen anything like it; if it represents a globiferous pedicellaria of this species, the figure is, as will be seen

by comparing it with the figures given here, very bad. — The buccal membrane contains the usual ring of plates in the oral edge; otherwise no plates, but some bihamate spicules are found. In the tubefeet spicules (bihamate) are very scarce. The spines have no central thorn in the point; they are not swollen. In larger specimens the pores are rather distant from the edge of the area.

In his most severe (but not too severe) criticism of PERRIER's work on the pedicellariæ (Rev. of Ech. p. 661) AGASSIZ says: „no mention even is made of GRUBE's suggestions as to the pedicellariæ of these interesting genera“ (*Temnopleurus*, *Salmacis* etc.). The only thing I can find in the writings of GRUBE concerning the pedicellariæ of Temnopleurids is the following notice: „Bei der Gattung *Mespilia* sind auf der Rückenseite die Mittelpartien der Ambulacral- und Interambulacralfelder stachelfrei und erscheinen bei trocknen Schalen wie fein chagriniert; bei wohl-erhaltenen Weingeistexemplaren sehen die Stellen so aus, als wären sie mit Filz oder Schimmel bekleidet, und die mikroskopische Untersuchung dieses Überzuges zeigt, dass derselbe aus lauter Pedicellarien von der Form der *gemmatae* besteht, während Pedicellarien mit schlanken Armen spärlicher zwischen den Stacheln vorkommen“<sup>1)</sup>. According to the manner in which AGASSIZ expresses the fact of the omission it can scarcely be this little notice which is meant. I am sorry to be ignorant of something of importance regarding the pedicellariæ; but it is very unfortunate that AGASSIZ so very often refers to his own and other authors writings without citing the place or even the work in which the observations are found. It causes his fellow workers very much unnecessary and, unfortunately, often lost labour to find out the references.

*Mespilia Whitmæi* Bell<sup>2)</sup> does not differ from *globulus* as regards pedicellariæ and spines (I have examined the type-specimen). As distinguishing characters are pointed out by BELL the well-marked gill-cuts, the narrow median ambulacral space and more numerous tubercles, and the more spatulate character of the free end of the radius. None of these characters are reliable. Two specimens (from „the South-Sea“, 20—25 mm. in diameter) preserved in the Museum of Copenhagen, which are quite similar to the type-specimen of *M. Whitmæi*, have a very narrow median bare space in the ambulacra and more tubercles than usual, but the actinal cuts are small. The character in the radius (rotula) is scarcely of any value either; in one specimen I find two of the rotulæ spatulate, the three others distinctly bifid. Upon the whole I do not find the form of these inner structures (auriculæ, dental apparatus) so constant as to be relied upon for specific characters. When BELL says that the number of pores of the outer row „seems to be about

<sup>1)</sup> Über diejenigen Gattungen der regelmässigen Seeigel, welche an den Grenzen der Täfelchen sowohl auf den Ambulacral- als Interambulacralfeldern Eindrücke zeigen. Jahresber. Schles. Gesellsch. Vaterl. Cultur. XLIII. 1865. p. 62.

<sup>2)</sup> Description of a new species of the genus *Mespilia*. Proc. Zool. Soc. 1881. p. 433.

double those in the inner row“ it must be a lapsus calami; the inverted order prevails.

While *M. Whitmæi* thus certainly must be withdrawn as a synonym only of *M. globulus*, some specimens in the British Museum from Macclesfield Bank, named *M. globulus*, will perhaps prove to be another species. They present the curious feature of the calcareous substance in the pedicellariæ being of a beautiful red colour (especially the ophicephalous ones); but otherwise the pedicellariæ do not present differences from those of *M. globulus*. Only the naked interambulacral spaces are dark, the rest of the test is beautifully red coloured; the spines are distinctly red ringed. — Possibly they belong to *M. levituberculata* Yoshiwara<sup>1)</sup>, for which species it is pointed out that the pedicellariæ are brown; however they do not accord very well with the (insufficient) description of that species, so that I shall not try to decide whether they really belong to it having seen no authentic specimen of *M. levituberculata*. YOSHIWARA points out as the most important character of *M. levituberculata* that its primary and secondary tubercles are very small, not perforated or crenulated „thus differing from any other species of *Mespilia*“. It need scarcely be remarked that no Temnopleurid at all, nor, indeed, any Echinid of the Tribus *Echinina* has perforate tubercles; and crenulate tubercles do not occur in the only other known species of *Mespilia*, *M. globulus*.

*Microcyphus maculatus* Agass. The globiferous pedicellariæ (Pl. VI. Fig. 19. Pl. VII. Fig. 20) are rather large and have no lateral teeth; the outer corners of the basal part are rounded, and may be a little produced. The valves of the ophicephalous pedicellariæ (Pl. VII. Fig. 31) are narrowed in the middle; the triphyllous pedicellariæ are very similar to those of *Salmacopsis olivacea* (Pl. VII. Fig. 23), but the edge is quite smooth. Tridentate pedicellariæ I have not found. The spicules of the tubefeet (bihamate) are very few in number. The buccal membrane has a ring of small plates in the oral edge, otherwise it is naked, with a few bihamate spicules. Ophicephalous and triphyllous pedicellariæ may occur on the buccal plates. The spines, primary and secondary, end in a large central thorn without small thorns at its base (Pl. II. Figs. 23, 28).

It may well be regarded as doubtful, whether *M. Rousseaui* Agass. (the form figured in „Rev. of Ech.“ Pl. VIII. a. Fig. 8) is really synonymous with *M. maculatus*, as maintained by AGASSIZ. In any case the spines and pedicellariæ of this form must be examined, before we can say with certainty, if they be identical or not. (The type-specimen is a naked test.) A priori it seems not very probable that such changes as seen by comparing the figures 8 and 9 in Pl. VIII. a. of „Rev. of Ech.“ do really occur in the same species. Also the type of *Anthechinus roseus* A. Ag. might well deserve a renewed examination. The perfectly smooth genital plates, the spines on the anal plates and the „exceedingly slender“ spines do not agree very well with *M. maculatus* to which species AGASSIZ refers it as a synonym.

<sup>1)</sup> Preliminary notice of new Japanese Echinoids. Annot. Zool. Japon. II. 1898. p. 58.

In the collection of Echini from the Hamburg Museum I found a small specimen of a *Microcyphus* (from Tor, on the coast of Sinai; Dr. Hartmeyer, 1901) which is distinguished from the typical *M. maculatus* by its redbrown, ringed spines (with 2—4 narrow light bands) and its redbrown test. Also the ophicephalous pedicellariæ are reddish. Otherwise it agrees with *maculatus*. Probably this form will prove to be a distinct variety of *maculatus* or perhaps a separate species. As, however, it may possibly prove identical with *M. Rousseaui*, I shall not propose any name for it, but be content with drawing attention to this form.

*Microcyphus zigzag* Agass. The globiferous pedicellariæ are very small and have mostly a large lateral tooth; rather often, however, this lateral tooth is not developed or quite rudimentary. The blade is flat, not in the usual form of a closed tube; upon the whole they are like those figured of the new species *M. annulatus*, to which figures reference may be made (Pl. VI. Figs. 29, 31). The valves of the ophicephalous pedicellariæ are short and broad, not narrowed in the middle; they are like those of *M. annulatus* (Pl. VI. Fig. 15). Triphyllous pedicellariæ like those of *M. maculatus*; tridentate pedicellariæ not found. Rather numerous small bihamate spicules in the tubefeet and sometimes in the globiferous pedicellariæ. The buccal membrane contains no plates besides the usual ring of small plates in the oral edge. A few bihamate spicules may also be found in the buccal membrane; no pedicellariæ on the buccal plates. The spines (Pl. II. Figs. 20, 25, 26) end abruptly in a not very long central thorn, mostly without a distinct circle of small thorns at its base. The secondary spines are a little widened at the point, the central thorn being little conspicuous. The primary spines are of a dark red colour, the secondary ones faintly reddish.

Of this species I found three specimens in the British Museum from Port Philip, named *Amblypneustes ovum* (see below); they agree exactly with the figures in „Rev. of Ech.“ Pl. VIII. c. 11—13; the largest specimen (25 mm. diameter, 23 mm. high) in particular is very like the large specimen figured by AGASSIZ. Of the two other specimens one is 12 mm. in diameter, 10 mm. high, the other 11 mm. in diameter, 9.5 mm. high. — Unfortunately the type-specimen in the Paris-Museum has only some ophicephalous pedicellariæ left; they agree with those of *M. annulatus*. In his „Notes on the Echinoderms collected at Port Philip by Mr. J. B. Wilson“<sup>1)</sup>. BELL mentions a small specimen of *Microcyphus zigzag* „of a most beautiful rosy colour“. This specimen I have examined; it differs from *M. zigzag* in several respects. The form of the test is alike, but the tuberculation is a little poorer than in *M. zigzag* of a corresponding size; thus in *M. zigzag* there are two rather large secondary tubercles inside the primary one in the interambulacra, these three tubercles together forming a horizontal series. In this specimen there is only one such tubercle inside the primary one. The naked spaces are somewhat

<sup>1)</sup> Ann. Nat. Hist. 6. Ser. II. 1888. p. 405.

larger than in specimens of *M. zigzag* of a corresponding size. The globiferous pedicellariæ (Pl. VI. Fig. 24. Pl. VII. Fig. 38) have no lateral teeth, but as they occur in *M. zigzag* both with and without an unpaired lateral tooth, it may perhaps be the case here also. The other pedicellariæ are like those of *M. zigzag*. The secondary spines are much widened at the point and without a distinct central thorn; the primary spines are like those of *M. zigzag*, but they are very faintly red coloured. No plates in the buccal membrane except the ring at the inner edge and the buccal plates. — The characters pointed out here are certainly not very marked, but the different coloration of the test and spines makes this form look so different from *M. zigzag* with its dark coloured naked spaces that it must certainly be separated from that species. Perhaps it ought only to be regarded as a variety of *M. zigzag*; but from the material at hand I must regard it as a distinct species, for which I propose the name *Microcyphus elegans* n. sp. I have seen one more specimen of this species in the British Museum, from the same locality; it was named *Amblypneustes ovum* (comp. below). The two specimens measure 12·5 mm. in diameter, one 11·5, the other 10·5 mm. in height.

At least one more species of *Microcyphus* exists. A specimen named *Microcyphus zigzag*, from „Challenger“ St. 162 (Bass Strait, 40 fathoms) proves to be quite different from both *M. zigzag* and *elegans* and must certainly be made the type of a new species. (As regards the specimens from St. 161, Port Philip, the red banded spines in one of them show it to belong to the same species as the example from St. 162. My notes upon the rest of them are, however, insufficient to settle their position). The test is high as in the two other species, but it presents the very interesting feature of being elongate, the longitudinal axis passing through the ocular plate to the right of the madreporic plate, as seen from above. The short diameter is 12·8 mm., the long diameter 14·8 mm. (height 12 mm.), the elongation being thus very distinct. Now, of course, this cannot be concluded with certainty from the one specimen examined to be a constant character of this species; it may possibly be an abnormality. But the specimen otherwise looks quite normal, and it seems probable that this is really a specific character, and one of great interest as the only known example of obliquity of test among the *Temnopleuridæ*. The naked median spaces are very large, especially the interambulacral ones, comprising almost the inner half of the plates. The tuberculation is much more sparse than in *M. zigzag* (specimens of equal size being compared); the interambulacral plates bear inside the primary tubercle (at the ambitus) only one secondary tubercle and two or three miliary ones, whereas in *M. zigzag* there are two (in large specimens three) large secondary tubercles inside the primary one, all together forming a distinct horizontal series. Close above the primary tubercle, a little to the outside of it, there is another large tubercle, almost as large as the primary one; otherwise only quite small tubercles are found outside the primary one. In *M. zigzag* a corresponding tubercle can be

pointed out, but it is much less conspicuous; in the latter species also some larger tubercles are found outside the primary one in larger specimens, but this will perhaps also be the case in larger specimens of the new species. In the ambulacra there is a larger secondary tubercle, half as large as the primary one, midway between the inner edge and the primary tubercle; in *M. zigzag* there is a large tubercle, almost as large as the primary one, rather close to the inner corner of the plate. No pits are visible; neither in *M. elegans* nor in the specimens examined of *M. zigzag* were pits to be seen. The apical area is comparatively large (5 mm.), prominent and almost naked; only 2--3 small tubercles are found on the middle of each genital plate (in *M. zigzag* they are almost wholly covered by tubercles). Anal opening central. The buccal membrane contains, besides the usual ring of plates in the oral edge, some small, more or less thorny plates (Pl. V. Fig. 17) between and outside the buccal plates; also the edge of the buccal plates may be somewhat thorny; rather numerous bihamate spicules are also found in the buccal membrane. The spines end in a not very long, central thorn, with a circle of small thorns at its base; the secondary spines are a little widened in the point, the central thorn being little conspicuous. The globiferous pedicellariæ (Pl. VI. Figs. 29, 31) are very small and have a rather large lateral tooth; the blade is flat, not in the usual form of a tube. The valves of the ophicephalous pedicellariæ (Pl. VI. Fig. 15) are short and broad, not narrowed in the middle, though not always so short as the figured one. The triphyllous pedicellariæ are like those of *M. maculatus*; tridentate pedicellariæ are not found. — The colour of the test is pale brownish, the naked spaces being white. The primary spines are white, with a broad red band in the lower part. — For this very distinct species I propose the name *Microcyphus annulatus* n. sp.

Among some specimens in the British Museum from Port Philip, named *Amblypneustes ovum* (see below) there is a small specimen, which probably belongs to this species. The short axis is 7.5 mm., the long 8 mm. (height 6 mm.), the obliquity thus being already rather distinct in this very small specimen — an additional fact tending to show the elongation to be a normal feature of this species. The colour of the test is darker, the naked spaces not white, though paler in colour than the tuberculated part. The red band on the spines is very intense in colour. Otherwise it agrees with the specimen described above.

AGASSIZ says (Rev. of Ech. p. 470) with regard to *Microcyphus zigzag* „this species is interesting as forming a link between *Microcyphus* and *Amblypneustes*. It has the structural features of the former and the facies of the latter“. This is quite true. These two genera are indeed so very closely related that the only real distinguishing character, which seems to be found, is the naked median space in *Microcyphus*. Now this feature is very slightly developed in *M. zigzag* (which species also in form and size is so very like a typical *Amblypneustes*), and in *Amblypneustes* there may also be an indication of a bare median space. It will, however, certainly be right to maintain the two genera, which both contain a number of

species, whose extreme forms: *Microcyphus maculatus* and *Amblypneustes pallidus* (or any other *Amblypneustes*-species) differ so much that it would be impossible to unite them in the same genus.

The genera *Amblypneustes* and *Holopneustes* are notorious for their difficulty. A rich material will be needed for definitely working out the rather numerous species; such is, however, not yet found in the collections of the different Museums. By far the largest number of the preserved specimens are naked tests, which do not afford sufficient characters for the distinction of the species. Especially it is an unfortunate circumstance that the type-specimens are naked tests, if they are found at all, which is not the case with all of them. As I have examined the specimens preserved in the British Museum and the Paris-Museum, and as the Copenhagen-Museum is comparatively rich in these forms, I am able, in spite of the unfortunate circumstances pointed out above, to make some remarks on this subject, which, I think, will not prove valueless.

First an important character may be pointed out, by which the genera *Amblypneustes* and *Holopneustes* are easily distinguished, viz. that in all the *Amblypneustes*-species (except *A. pentagonus* — see below) there is a primary tubercle on all the ambulacral plates; in the *Holopneustes*-species a primary tubercle is found only on every second or third ambulacral plate, or even more irregularly. By this character even quite small specimens, in which the pores are placed in regular arcs of three as in *Amblypneustes*, may be safely distinguished as belonging to *Holopneustes*; in a specimen of 10 mm. diameter I find the alternation of the primary tubercles quite distinct. — It may be remarked that in large specimens of *Holopneustes* several of the ambulacral plates do not reach the median line of the ambulacral area, thus looking like small primaries. In reality they are compound plates; the number of tube feet has been so exaggerated that the plates have become very low and almost rudimentary to make room for all the feet (Comp. „Ingolf“-Echinoidea. I. p. 132–3). GREGORY<sup>1)</sup> has pointed out the same feature in *Tripneustes*, remarking that, in fact, here are more than two series of ambulacral plates, as in the *Palæechinoidea*. This feature is much more distinct in *Holopneustes*. Of course it is really something very different from the pluriseriate ambulacra of the *Palæechinids*, as in the latter all the ambulacral plates are primaries, whereas in *Tripneustes* and *Holopneustes* they are very modified compound plates.

Among the species referred to *Amblypneustes* one has already been removed from that genus by DUNCAN (Revision p. 113) and made the type of a separate genus, *Goniopneustes*. (AGASSIZ himself supposes („Rev. of Ech.“ p. 483) that it will eventually form a separate genus between *Salmacis* and *Amblypneustes*.) To the characters pointed out by AGASSIZ and DUNCAN I may add one, which is seen in the figures (photographs) of the species given by AGASSIZ (Rev. of Ech.“ Pl. VIII. c. 7–8) viz. that only every second or third ambulacral plate has a primary tubercle. Pedicellariae

<sup>1)</sup> In RAY LANKESTERS Treatise on Zoology. III. 1900, p. 299.

(and spicules) unfortunately are unknown. The validity of this genus can scarcely be doubted; but it seems certain, in any case, that it is very nearly related to *Holopneustes*, with which genus it agrees in the character of the ambulacra, as opposed to all other Temnopleurids (except *Salmacis dussumieri*).

*Amblypneustes formosus* Val. To the description in „Rev. of Ech.“ p. 479 the following remarks may be added. The globiferous pedicellariæ (Pl. VI. Fig. 37. Pl. VII. Fig. 4) are small, with an unpaired lateral tooth (which may, however, be more or less rudimentary); the basal corners not produced. The ophicephalous pedicellariæ (Pl. VI. Fig. 9) have short and broad valves; the triphyllous pedicellariæ (Pl. VII. Fig. 13) have the blade rather elongate and narrow. Tridentate pedicellariæ I have not seen. — The spicules (bihamate) are rather numerous in the tube feet. The buccal membrane contains the usual ring of plates in the oral edge, otherwise it is naked — excepting the buccal plates, of course — but with numerous bihamate spicules. The gills contain some few of the common irregular plates and numerous bihamate spicules. The primary spines (Fig. 9) are almost equally thick in their whole length, ending quite abruptly in a little central peak surrounded by small thorns at its base; sometimes the central thorn is not seen. The point is not swollen (Pl. II. Fig. 27). The secondary spines are more or less swollen at the point; they may have a distinct central thorn like the primary ones, or the point may be covered by very small thorns, without a larger central one.

*Amblypneustes ovum* (Lamk.) is most nearly related to *A. formosus*, with which it agrees in having slender primary spines, not thickened at the point. The secondary spines are thickened at the point, without a central thorn. The globiferous pedicellariæ are like those of *A. formosus*. The ophicephalous pedicellariæ are very variable in shape, the valves being short and broad like that figured for *A. formosus* or very elongate (Pl. VII. Fig. 50), and between these extremes all transitional forms are found. Tridentate pedicellariæ occur in this species; they are rather small (c. 0.8 mm., head); the valves are simply leafshaped with rather much meshwork in the bottom (Pl. VII. Fig. 11), the edge is very finely serrate, the outer part sinuate; they join in their whole length. They have an arc below the basal part like the ophicephalous ones and can, indeed, hardly be distinguished from the larger ophicephalous pedicellariæ. The triphyllous pedicellariæ are like those of *A. formosus*. Spicules are scarce in the tubefeet, numerous in the buccal membrane and at the base of the spines.

This species, when preserved with the spines, can only be confounded with *A. formosus*, from which species, however, it seems very well distinguished, especially by its large ophicephalous pedicellariæ. The base of the spines is dark green in *A. ovum*, pink in *A. formosus*; but this is no constant feature, as they may



Fig. 9. Primary spine of *Amblypneustes formosus* (Obj. 0. Oc. 0).

be white in both species. From the other species, *A. griseus* and *pallidus*, it is at once distinguished by its slender primary spines, which are not swollen in the point.

The literary references to this species are very unreliable. The *Amblypneustes ovum* named by BELL in his „Notes on the Echinoderms collected at Port Philip by Mr. J. Br. Wilson“<sup>1)</sup> are not that species. The glass which has that name on the label contains: 3 specimens of *Microcyphus zigzag* (among which there is one large one, agreeing exactly with that figured in „Rev. of Ech.“. Pl. VIII. c. 11—12), 1 *Micr. elegans*, 1 *Micr. annulatus*, 1 *Holopneustes purpurascens*, 3 *H. inflatus* and 2 *H. porosissimus*, but no *Amblypneustes*. In Strassburg I have seen a specimen of *Holopneustes* (*purpurascens*?) determined by RAMSAY as *A. ovum*, which proves that RAMSAY has not known the true *A. ovum*, and his remarks<sup>2)</sup> on the variation in colour and form of this species are thus valueless. — Of 10 naked tests lying in one box under the name of *A. ovum* in the British Museum I found 8 specimens to be *Holopneustes*, 2 only *Amblypneustes*. This shows that no reliance can be put on the remarks of BELL<sup>3)</sup> on this species either. — The statement of the occurrence at Cape of Good Hope of *A. ovum* (BELL. Op. cit.) is based on two specimens (naked tests) from Dr. BOWERBANK, 1860. That the locality is wrong, can scarcely be doubted.

*Amblypneustes pallidus* (Lamk.). In the Museum of Copenhagen is preserved a beautiful specimen of an *Amblypneustes*, which is certainly the same species as that described in „Rev. of Ech.“ as *A. pallidus*. It is like *A. formosus* in the form of the test. The globiferous pedicellariæ are perhaps a little more slender than those of *formosus*, but otherwise they agree with them. The ophicephalous pedicellariæ (Pl. VII. Fig. 42) are somewhat more elongate. Tridentate pedicellariæ are found, though exceedingly scarce; they are small, c. 0.5 mm. (head). The valves (Pl. VI. Fig. 48) are simply leafshaped, without meshwork in the bottom; they join in their whole length. The edge is a little sinuate in the outer part, otherwise smooth. The triphyllous pedicellariæ (Pl. VII. Fig. 12) are a little widened in the outer part of the blade. The buccal membrane contains a ring of rather large, rounded plates in the oral edge, otherwise only bihamate spicules in rather great number. In the tubefeet these spicules are very scarce. The spines are rather slender, swollen at the point, without central thorn (Pl. II. Fig. 21). The primary spines are green, the secondary ones white, faintly tipped with violet.

The specimen here described cannot belong to any of the other species of *Amblypneustes*, since it differs from *griseus* in the high shape of the test, from *formosus* and *ovum* in its clubshaped spines. Thus I cannot agree with AGASSIZ, who is convinced that *A. pallidus* will prove identical with *formosus* (Rev. of Ech. p. 482),

<sup>1)</sup> Ann. Nat. Hist. 6. Ser. II. 1888. p. 402.

<sup>2)</sup> Catalogue Ech. in the Australian Museum. I. Echini. 1891. p. 52.

<sup>3)</sup> On some genera and species of the Temnopleuridæ. Proc. Zool. Soc. 1880.

neither with T. Woods, who suggests that *A. griseus* and *pallidus* may be only varieties of *A. ovum*<sup>1)</sup>. However, I am not sure that it is really *A. pallidus*. In „Voyage de la Frégate Venus.“ Atlas de Zoologie. Zoophytes. Pl. II. Fig. 1 is figured the test of an *A. pallidus*, which is rather low, like an *Echinus*, not egg-shaped as in the above mentioned specimen. Also a spine is figured; it is not clubshaped, but tapering. If this form be the true *A. pallidus*, the specimen described above must be a new species. I cannot settle this question for the present, and thus, of course, shall not add to the confusion of the *Amblypneustes*-species by giving a new name to this form. Till the contrary be proved I must regard it as *A. pallidus*.

*Amblypneustes griseus* (Blv.). This species is easily distinguished by the somewhat depressed test. The pedicellariæ are like those of *formosus*; the spines are clubshaped, both primary and secondary ones. In large specimens of this species there may be a little irregularity in the occurrence of the primary ambulacral tubercles; no confusion with *Holopneustes* should, however, take place, the regular trigeminate arcs of pores showing sufficient difference from the irregular arrangement of the pores in that genus. — The notes on this species given by BELL (On the genera and species of Temnopleuridæ. p. 436) are not reliable. Of the eleven specimens mentioned there I find 7 to be *Holopneustes*, 3 probably *A. ovum* and only one *A. griseus*. A similar result I found concerning *A. ovum* (comp. above, p. 104), and what is named *A. pallidus* in that paper is likewise not that species alone. Upon the whole it is scarcely possible for the present to distinguish these species by the naked tests alone; that it will prove a possible thing to do so with certainty, when once examinations have been made on sufficient fresh material, seems not improbable.

*Amblypneustes grossularia* Studer. (The type-specimen examined in the Berlin-Museum). The globiferous pedicellariæ are larger than those of the other species of this genus; also the form of the valves is somewhat different (Pl. VI. Fig. 33), but as usual there is one unpaired lateral tooth. The ophicephalous pedicellariæ (Pl. VII. Fig. 52) are narrowed in the middle, differing thus rather markedly from those of the other species. The triphyllous pedicellariæ (Pl. VI. Fig. 21) have the blade much widened, whereas in all the other species of *Amblypneustes* (and *Holopneustes*) the blade is narrow (comp. the figure given for *A. formosus*, Pl. VII. Fig. 13). Spicules as in the other species. The secondary spines are a little swollen at the point and without central thorn; how the primary spines end I cannot say, having seen only broken ones. — STUDER says in his description of this species<sup>2)</sup>: „die Spinen sind klein und spitz, ähnlich wie bei *Salenia*“; this must be a lapsus calami for *Salmacis*; they are not in the least similar to those of *Salenia*. The statement of STUDER that there are 4 pairs of pores to each compound ambulacral plate is wrong; there are really only three. — That this species is not the young

<sup>1)</sup> On the habits of some Australian Echini. Proc. Linn. Soc. N. S. Wales. V. 1881. p. 193.

<sup>2)</sup> Übersicht über die während der Reise S. M. S. Gazelle ges. Echinoidea. Monatsber. Akad. Berlin. 1880. p. 873.

of some one of the other known species of *Amblypneustes*, as STUDER thinks possible (Op. cit. p. 874) is quite certain; it is, on the contrary, rather remote from all the other species, and perhaps ought not to be retained in that genus.

*Amblypneustes vegæ* LOVÉN (mentioned by DÖDERLEIN in his paper „Seeigel von Japan und den Liu-Kiu-Inseln, p. 38, but not published by LOVÉN himself) is only *Mespilia globulus*; Prof. THÉEL has kindly sent me a specimen from the Stockholm-Museum.

*Holopneustes purpurascens* Ltk.<sup>1)</sup>. The type specimen is a naked test, but the spines and some pedicellariæ have been preserved. The spines (Fig. 10, Pl. II. Fig. 24) are distinctly clubshaped and red coloured. The ophicephalous pedicellariæ (Pl. VII. Fig. 32) have rather elongate valves, not narrowed in the middle. The



Fig. 10. Primary spine of *Holopneustes purpurascens*. (Obj. A\*. Oc. 3.)

triphylous pedicellariæ are like those of *A. formosus* etc. Globiferous pedicellariæ I have not been able to find among the remnants preserved of the type-specimen; but in the specimen from Port Philip mentioned above (p. 104) I find them to be like those of *A. formosus*. — In his description of this species in „Rev. of Ech.“ p. 485 AGASSIZ says: „actinal and abactinal diameter equal“. If that means diameter and height, the statement is correct (53—52 mm. in the type-specimen). Further AGASSIZ says: „poriferous zone equal in width to the corresponding tuberculiferous ambulacral space“ — this is wrong; the poriferous zone is not equal in width to the whole interporiferous area (as is the case in *H. porosissimus*), only a little more than half as wide as the whole interporiferous zone (comp. measurements given below). The outer row of pores is said to be „characterized by the greater size of the inner pore, and the distance separating the pores of a pair“. I do not find this feature distinct in the type specimen, nor in the other specimen examined. „In large specimens the middle row of pores is very irregular“ — in the type-specimen, which may well be said to be a large specimen, the median row is almost quite regular. „The tubercles of both areas form most regular horizontal rows“. This does not suit very well with the type-specimen. In the interambulacra there are at the ambitus inside the primary tubercle about 5 tubercles, much smaller

than the primary one, forming a rather regular horizontal row in the middle of the plate; some few small secondary tubercles are more or less regularly disposed at the upper and lower edge of the plate. Outside the primary tubercle there are more secondary tubercles, among which one is larger than the rest, but not quite so large as the primary one; these larger tubercles form a rather regular vertical series besides that formed by the primary tubercles. In the ambulacra there is a row of three tubercles, almost equally sized, in a few plates; these rows, however, are not horizontal but markedly oblique, rising towards the median line of the area.

<sup>1)</sup> Not *purpurescens*, as spelled in „Rev. of Ech.“

AGASSIZ thinks it possible that this species will prove to be „nothing but *H. porosissimus* with a rather narrow poriferous zone“. It is a priori very improbable that so large specimens as the type (53 mm.) should not yet have attained the definitive arrangement of the pores, and the fact that in specimens of *porosissimus* of much smaller size the characters in the ambulacra are already very distinct (comp. measurements below), definitely proves that it must be two distinct species.

*Holopneustes inflatus* Ltk. The type-specimen is a naked test, only some spines being preserved; they are clubshaped, of a faint reddish tint. In the British Museum I have found some small specimens of this species from Port Philip (named *Ambl. ovum*); they show that in pedicellariæ and spicules there is no difference from *H. purpurascens*. In the description of this species given by AGASSIZ (Rev. of Ech. p. 483) it is said: „poriferous zone more than equalling in width the median ambulacral region“; as in *H. purpurascens* this means not the whole interporiferous zone, but only half of it, the poriferous zone being only a little more than half as wide as the median, non-poriferous part of the ambulacral area. A feature worth mentioning for this species is this that the interambulacral plates make a distinct curve downwards below the primary tubercle, most distinctly on the abactinal side; in *H. purpurascens* this feature is very indistinct in the type-specimen, but in the small specimen from Port Philip it is rather distinct, as is also generally the case in *H. porosissimus*. It may also be noted that the ambulacra are only as wide as the interambulacra, whereas in *H. porosissimus* they are distinctly wider than the interambulacra even in quite small specimens. By this feature *H. inflatus* is easily distinguished from *porosissimus*, whereas it is difficult to distinguish it from *purpurascens*. The test is higher in *purpurascens* and the whole form is different; in *purpurascens* the test is eggshaped, narrowing evenly towards the mouth, whereas in *inflatus* the actinal side is rather broad and flat. Also the colour is different, dark purplish red in *purpurascens*, faint reddish or brownish in *inflatus* (both test and spines). Perhaps it will not be possible to maintain *inflatus* as a distinct species; there is in the Copenhagen Museum a large specimen from Victoria (42 mm.) which seems to hold an intermediate position between *purpurascens* and *inflatus*. But from the scanty material at my disposal I dare not say with certainty whether *inflatus* has to be made synonymous with *purpurascens* or maintained as a distinct species. The suggestion of RAMSAY<sup>1)</sup> respecting the three *Holopneustes*-species that „it is quite likely that they all belong to one species“ is undoubtedly wrong and caused by his having confounded not only the species but also the genera *Amblypneustes* and *Holopneustes* (see above, sub. *A. ovum*); in any case the two species *purpurascens* and *porosissimus* must be maintained.

*Holopneustes porosissimus* Agass. The pedicellariæ are like those of *H. purpurascens*; the spines are strongly clubshaped and of a conspicuous red colour. I have examined two young specimens from Port Philip; they agree with the larger spe-

<sup>1)</sup> Catalogue Ech. in the Australian Museum. I. Echini. 1891. p. 52.

cimens in having the ambulacra distinctly wider than the interambulacra, so they must be referred to this species, according to our present knowledge. I should not, however, be very surprised, if there should prove to exist more than one species of *Holopneustes* with such wide ambulacra.

I give here some measurements of the specimens before me of the three *Holopneustes*-species. These give very good distinguishing characters, which are the more needed as no specific characters are found in pedicellariæ, spicules or structure of spines.

	Diameter.	Height.	Width of				
			Inter-ambulacra.	Ambulacra.	Poriferous zone.	Interporiferous zone.	
<i>Holopn. purpurascens</i>	53	52	16.5	16	4.5	7	(Type-specimen.)
— — (?)	42	38.5	14	12	3.5	6	(The measurements of interporiferous and poriferous zones together give 13 mm; the measurement 12 mm. for the whole ambulacral area is due partly to the rounding of the test, partly to inevitable small errors in the measuring.)
— —	16	13.5	4.5	4.5	1	3	
— <i>inflatus</i> . . . . .	36	30	11.5	11	3	5	(Type-specimen.)
— — . . . . .	40	33	12.5	13	4	6	
— — . . . . .	40	32.5	12	12	3.5	6	
— — . . . . .	22.5	17.5	7	7.5	2	3.8	
— — . . . . .	17.5	13	5.5	5.8	1.5	3	
— — . . . . .	16	12	4.8	5	1	2.5	
— — . . . . .	11.5	9.5	3.2	3.2	0.8	2	
— <i>porosissimus</i>	70	58	18	24	8	8	
— —	36	30	10.2	13	4.2	4.6	
— —	35	27	10	13	4	5	
— —	17	12	4	5.5	1.5	2	
— —	11	8.5	3	4	1	1.8	

These researches on the *Amblypneustes*- and *Holopneustes*-species seem to show that they are not so difficult to distinguish as commonly believed, when only the specimens are preserved with their spines etc., whereas naked tests cannot always be distinguished with full certainty, at any rate in the present state of our knowledge. The analytical table of these species given below will, I hope, prove to be useful. (Due allowance, however, must be made for the uncertainty, whether the species named *A. pallidus*, is really that species; comp. above p. 105.) In this table I also include the species of *Microcyphus*, so much like *Amblypneustes* (except *M. maculatus*), and *Goniopneustes*. Upon the whole these species differ very little in appearance and will certainly be confounded without a close examination, as I have shown to have been the case in several instances.

LÜTKEN<sup>1)</sup> places the genera *Amblypneustes* and *Holopneustes* in a separate group, *Amblypneustidæ*. They are certainly nearly related, but there is no reason to separate them from the family of the *Temnopleuridæ*, whose most specialized members they are.

Analytical table of the species of *Microcyphus*, *Amblypneustes*,  
*Holopneustes* and *Goniopneustes*.

1. A primary tubercle found on all the ambulacral plates; the pores arranged in regular arcs of three ..... 2.  
     A primary tubercle found only on every second or third ambulacral plate, or even more irregularly..... 9.
2. The median space of both areas bare and smooth (*Microcyphus*)..... 3.  
     No distinct bare median space, the tubercles reaching to the median line of the areas (*Amblypneustes*)..... 6.
3. The test low; the median naked spaces very large. The spines rather stout, green. Globiferous pedicellariæ without lateral teeth ... *Microcyphus maculatus* Agass.  
     The test high. Globiferous pedicellariæ with or without an unpaired lateral tooth; spines not green..... 4.
4. Spines red-banded; the test elongate (always?) *Microcyphus annulatus* Mrtsn.  
     Spines not banded; the test eggshaped.. 5.
5. The naked spaces narrow, dark brown coloured, standing very prominently against the faint red colour of the other part of the test. Spines intensely red..... *Microcyphus zigzag* Agass.  
     The whole test of a uniform beautiful red colour; spines faintly reddish..... *Microcyphus elegans* Mrtsn.
6. Test high, eggshaped..... 7.  
     Test somewhat depressed, spheroidal; spines clubshaped..... *Amblypneustes griseus* (Blv.).
7. Primary spines clubshaped, green, faint lozenge-shaped figures on the test. Ophicephalous pedicellariæ not very elongate..... *Amblypneustes pallidus* (Lmk.).  
     Primary spines not clubshaped..... 8.

<sup>1)</sup> Bidrag til Kundskab om Echiniderne. p. 84.

8. Spines red at the base; ophicephalous pedicellariæ not elongate; distinct lozenge-shaped figures on the test ..... *Amblypneustes formosus* Val.  
 Spines dark green at the base; ophicephalous pedicellariæ partly very elongate. No lozenge-shaped figures on the test ..... *Amblypneustes ovum* (Lmk.).
9. Two ocular plates reaching the periproct; primary spines very prominent, not clubshaped ..... *Goniopneustes pentagonus* (A. Ag.).  
 No ocular plates reaching the periproct; primary spines not prominent, clubshaped. (*Holopneustes*.) ..... 10.
10. Ambulacra distinctly wider than interambulacra ..... *Holopneustes porosissimus* Agass.  
 Ambulacra not distinctly wider than interambulacra ..... 11.
11. Test high, eggshaped, narrowed towards the mouth; spines and test dark red ..... *Holopneustes purpurascens* Ltk.  
 Test rather low, sphaeroidal; the actinal side somewhat flattened; spines and test faint reddish ..... *Holopneustes inflatus* Ltk.

The genera united by AGASSIZ in „Rev. of Ech.“ under the name *Temnopleuridæ* have been universally acknowledged as forming a natural group. Only LAMBERT<sup>1)</sup> has a different view of their relations; he places the „*Salmacina*“ under the *Phymosomina*, and the „*Temnechina*“ and „*Pleurechina*“ under the *Echinina*; the *Phymosomina*, *Arbaciadina* and *Echinina* being again placed as subfamilies of the family *Echinometridæ*. This classification gains no support at all from the researches on the regular Echinids, represented here and in the „Ingolf“-Echinoidea, nor from those of any other recent author on that subject, and LAMBERT does not give more detailed reasons for assuming this classification; it can then be dropped, I think, without further discussion. DUNCAN has shown, through his excellent researches on the structure of the test of the *Temnopleuridæ*<sup>2)</sup> that the genera form two separate groups, the one having true pits undermining the test and the plates being united by knobs and sockets, the other having only sutural depressions or a raised ornamentation on the plates, the plates not being united by knobs and sockets. In his „Revision“ these groups are made subfamilies of the fam. *Temnopleuridæ*, the one, *Temnopleurina*, including the genera *Temnopleurus*, *Pleurechinus* (regarded as a subgenus only of the former), *Temnechinus*

<sup>1)</sup> Étude sur quelque Échinides de l'Infra Lias et du Lias. Bull. Soc. Sc. de l'Yonne. 1899.

<sup>2)</sup> On some Points in the Morphology of the test of the *Temnopleuridæ*. On the genus *Pleurechinus*. (J. Linn. Soc. XVI. 1881.)

(including *Opechinus* and *Genocidaris*), *Salmacis* (with *Salmacopsis* as a subgenus), *Mespilia*, *Microcyphus*, *Amblypneustes*, *Goniopneustes* and *Holopneustes*, the other, *Glyphocyphinae*, including *Trigonocidaris* and the fossil genera: *Glyphocyphus*, *Dictyopleurus*, *Arachniopleurus*, *Ortholophus*, *Paradoxechinus*, *Echinocyphus*, *Zeuglopleurus*, *Lepidopleurus*, *Leiocyphus* and *Coptophyma*. In his „Revision of the British fossil Cænozoic Echinoidea“<sup>1)</sup> GREGORY suggests that *Temnechinus*, as having no true pits, ought to be transferred to the *Glyphocyphinae*. In the „Treatise on Zoology“, however, he retains this genus among the *Temnopleurinae*; further the subfam. *Glyphocyphinae* is restricted so as to comprise those genera „in which the compound ambulacral plates are composed of three primaries“, the genera „in which the compound ambulacral plates are composed of two primaries and an intermediate demi-plate“ being made another subfamily, *Ortholophinae*; to the latter subfamily *Trigonocidaris* is also referred, though with a mark of interrogation (Op. cit. p. 312).

According to AGASSIZ („Blake“-Echini. p. 38) „the presence of pits and sutures is a feature only developed with age, and the transition is insensible between the types in which the pits and sutures are formed by the modification of a flat surface due on one side to the thickening or elevation of nearly the whole plate, or, on the other, of only a portion of it“. I cannot agree with AGASSIZ herein; I find the pits very distinct in very small specimens, as small as, upon the whole, it is possible to determine with certainty. — The distinction between true and false pits is thus certainly of great importance, and I quite agree with DUNCAN and GREGORY that the genera of the *Temnopleuridae* must be classified upon this structure. The forms with true pits have also the plates united by „dowelling“, and they further agree in having, generally, smooth plates without superficial ornamentation (in this respect, however, *Pleurechinus scillæ* is a very conspicuous exception). These genera: *Temnopleurus*, *Pleurechinus*, *Salmacis*, *Salmacopsis*, *Mespilia*, *Microcyphus*, *Amblypneustes*, *Goniopneustes* and *Holopneustes* evidently form a natural group and must form a subfamily *Temnopleurinae*. The other genera: *Hypsiechinus*, *Prionechinus*<sup>2)</sup>, *Genocidaris*, *Trigonocidaris*, *Temnechinus* and *Opechinus* differ from the *Temnopleurinae* in having no true pits and the plates not united by dowelling. DUNCAN evidently contradicts his own results when saying in his diagnosis of the whole family *Temnopleuridae* that the plates are united by dowelling. In his paper „On the genus *Pleurechinus*“ (p. 454) he emphasizes that in *Temnechinus* „none of the remarkable minute structures of the test of *Temnopleurus* are present“ (which, I can state, is correct, after examining an excellently preserved fragment of *Temnechinus Woodi* (Agass.) in the British Museum), and in another paper „On some Points in the Anatomy of the *Temnopleuridae*“<sup>3)</sup> he says with regard to the recent

<sup>1)</sup> Proc. Geologists Assoc. XII. 1891. p. 30.

<sup>2)</sup> *Arbacina* (*Cottaldia*) *forbesiana* has been shown by DE MELJERE to be a *Prionechinus* („Siboga“-Ech. p. 71).

<sup>3)</sup> Ann. Nat. Hist. 6. Ser. I. 1888. p. 110.

„*Temnechinus*“ (*Genocidaris*) *maculatus*: „should the knob-and-socket arrangement of the union of the plates be discovered, *Temnechinus* will enter the *Temnopleurinae*“. This contradiction by DUNCAN unfortunately has been more accentuated by GREGORY, who expressly says in the diagnosis of the *Glyphocyphinae* and *Ortholophinae* „the plates are united by dowelling“, whereas this sentence is omitted in the diagnosis of the *Temnopleurinae*. The fact is just the opposite, as originally shown by DUNCAN. To be sure all the genera without true pits have not been examined with respect to this structure, but it may be justifiable to conclude from those examined that in none of these genera such a dowelling exists. Of *Temnechinus* the fact is stated above; *Trigonocidaris albida* and *Genocidaris maculata* have been examined by AGASSIZ („Blake“-Echini. p. 37) with the result that no dowelling exists, and the same I can state for *Hypsiechinus*.

The genera *Hypsiechinus*, *Prionechinus*, *Genocidaris*, *Trigonocidaris*, *Temnechinus* and *Opechinus* must then form a second subfamily: *Temnechininae*. (In DELAGE & HÉROUARD's „Traité de Zoologie concrète“ for which work I have written the classification of the regular Echinoidea, this subfamily is named *Trigonocidarinae*. It will be more convenient to name it *Temnechininae*, the more so, as this name has already been used by LAMBERT (comp. above p. 110), though perhaps not exactly in the sense in which it is used here). — The genera *Hypsiechinus* and *Prionechinus*, to be sure, differ considerably from the other genera, the former by its triradiate spicules and its globiferous pedicellariæ (comp. „Ingolf“-Echinoidea. p. 86), the latter by its smooth test. It would, in fact, be very difficult to say by which characters *Prionechinus* is distinguished from the Echinometrids. There can, however, be scarcely any doubt that they are both most nearly related to *Trigonocidaris* and *Genocidaris*. — The name *Glyphocyphinae* cannot be used for this subfamily. The genus *Glyphocyphus* Haime has perforate and crenulate tubercles, and the same holds good for the genera *Dictyopleurus* Dunc. & Sladen and *Arachniopleurus* Dunc. & Sladen; these genera thus cannot belong to the *Temnopleuridae*, but, probably, form a special group of the Diadematids, distinguished by the ornamentation of the test. The name *Glyphocyphinae* may be retained for this group. The ambulacral structure of *Arachniopleurus* is not sufficiently known, but from the perforate tubercles it may be concluded that it will prove to be diadematoid; in *Glyphocyphus* the ambulacral plates are composed of low, broad primaries, with straight transverse sutures, and in *Dictyopleurus* they are of true diadematoid structure. The genus *Ortholophus* Dunc. seems really to be related to *Trigonocidaris*, but I should prefer not to name the subfamily after a little known fossil form, whose relation to the recent genera is not beyond doubt. The name „*Ortholophinae*“ then ought not to be used. — Among the other fossil genera referred by DUNCAN to the Temnopleurids *Zeuglopleurus* Greg. has diadematoid ambulacra, and the same may be the case with *Echinocyphus* Cott. and *Leiocyphus* Cott., which thus cannot remain here, whereas

*Paradoxechinus* Laube, *Coptophyma* Per. & Gauth. and *Lepidopleurus* Dunc. & Sladen may really belong to this subfamily.

The natural arrangement of the genera of Temnopleurids then seems to be as follows:

Fam. *Temnopleuridæ*.

Subfam. *Temnechininæ*. No pits; mostly raised ornamentation on the plates or low sutural depressions. Plates not united by dowelling:

Genera: *Hypsiechinus* Mrtsn., *Prionechinus* A. Ag., *Genocidaris* A. Ag., *Trigonocidaris* A. Ag., *Temnechinus* Forb., *Opechinus* Desor, *Ortholophus* Dunc., *Paradoxechinus* Laube, *Coptophyma* Per. & Gauth., *Lepidopleurus* Dunc. & Sladen.

Subfam. *Temnopleurinae*. True pits; the plates united by dowelling, mostly with smooth surface.

Genera: *Temnopleurus* Agass., *Pleurechinus* Agass., *Salmacis* Agass., *Salmacopsis* Döderl., *Mespilia* Agass., *Microcyphus* Agass., *Amblypneustes* Agass., *Goniopneustes* Dunc., *Holopneustes* Agass.

## Fam. *Toxopneustidæ*.

### Subfam. *Schizechininæ*.

#### 14. *Gymnechinus pulchellus* n. sp.

Pl. I. Figs. 16, 23. Pl. II. Fig. 11. Pl. VII. Figs. 8, 29, 36, 41, 46.

The test is very low, both sides flat, or (in the larger specimens) the abactinal side gently rising towards the apical system; it is a little pentagonal, the ambulacra raising somewhat above the interambulacra at the ambitus. The mouth edge is a little inwardly curved. A few measurements may be given here.

Diameter.	Height.	Peristome.	Apical system.	Width of		Number of plates.		Longest spines.
				Ambulacra.	I-ambulacra.	Ambulacra.	I-ambulacra.	
19 <sup>1)</sup> mm.	9 mm.	7 mm.	6 mm.	4.5	7	17-18	13	4
15 —	7 —	6 —	4.5 —	4	5	14-15	12	4
11 —	5 —	5 —	3.8 —	3	4	13-14	11	3

<sup>1)</sup> The largest specimen.

Ambulacra rather broad, though distinctly narrower than the interambulacra; also at the peristome they are distinctly narrower than the latter. The pores

are disposed in rather inclined arcs, the outer pair being placed close to the edge of the area. At the peristome the pores are smaller, the pore-area narrower than at and above the ambitus. The plates are rather high, not much exceeding the interambulacral plates in number. The sutures are rather indistinct, somewhat inclining outwards. The primary tubercles (one to each ambulacral plate as in the other species of this genus) form a very distinct and regular vertical series, diminishing a little in size towards the apical system and very little so towards the peristome. Inside the primary tubercle there is a smaller secondary one at the upper edge of the plate, forming likewise a more or less regular vertical series; in larger specimens a secondary tubercle may be found also at the inner edge of the plates at the ambitus. Between the primary tubercle and the pores there is a small tubercle on each plate, forming likewise a regular vertical series.

The interambulacral plates have a primary tubercle situated about in the middle of the plate, not much larger than the ambulacral ones; they form a beautiful vertical series, not distinctly diminishing in size towards the mouth or apex. Inside the primary tubercle there is, as in the ambulacra, a secondary tubercle at the upper edge of the plate and one at the inner edge; the latter is mostly the larger and may form a rather prominent vertical series. A few more small tubercles may be found, irregularly placed. Outside the primary tubercle some secondary tubercles are found, partly disposed, in larger specimens, in two more or less distinct vertical series, and forming also together with the primary tubercle and the median inner tubercle a more or less distinct horizontal row of four tubercles. Miliary tubercles very few and indistinct.

The apical area is like that of *G. Robillardii* (de Loriol.) (Pl. II Fig. 11). The periproct is pushed out towards the right posterior Interradius, the corresponding genital plate being quite low. The genital plates of the opposite side are on the contrary very high and large; sometimes one or two of them are divided by a transverse line into an inner and outer part, and sometimes one of the genital plates, mostly the left anterior, may be excluded from the periproct. The genital openings are formed already in specimens of 5 mm. diameter. The two ocular plates are broadly in contact with the periproct, the others widely separated therefrom. A single rather large tubercle is found in the middle of each genital and ocular plate, except the posterior, low genital plate. The periproct is covered by several small, irregular, smooth plates, among which no distinct central plate can be made out (in larger specimens). The anal opening is situated nearest to the posterior edge of the periproct.

The buccal membrane is naked; in the oral edge a single irregular rod may be found, but mostly there is none. Outside the buccal plates some very few small fenestrated plates may occur in larger specimens. Bihamate spicules are almost quite wanting in the buccal membrane; in the gills there are mostly a few; here and there, however, larger numbers are found, but the usual irregular, fenestrated plates are not

met with. The buccal plates are placed one a little outside the other. A few pedicellariæ are found on the buccal plates in larger specimens. The mouthslits are small but rather sharp.

The spines are smooth, short, those at the ambitus and just below being the longest (about  $\frac{1}{4}$  of the diameter of the test); towards the apical system they become gradually shorter. Those round the actinostome are a little curved, not widened at the point; they are beautifully red coloured and tipped with white.

The globiferous pedicellariæ (Pl. VII. Fig. 8) do not present marked characters by which they may be distinguished from those of the other *Gymnechinus*-species. There are glands on the stalk. „Claviform“ pedicellariæ are also found. The tridentate pedicellariæ (Pl. VII. Fig. 29) are very characteristic. The blade is narrow in the lower part, with a more or less developed meshwork high up from the bottom uniting the sides; the outer part is widened, the edges irregularly sinuate and finely serrate; the edge of the lower part is smooth or with a few irregularly placed serrations. The valves join only with the outer, widened part. Length of the head c. 0.5 mm. The ophicephalous pedicellariæ (Pl. VII. Fig. 41) do not present peculiar features; the triphyllous ones (Pl. VII. Fig. 36) have the blade rather widened, otherwise they are of the common form. — The sphaeridiæ are smooth, of the usual form. — The spicules of the globiferous pedicellariæ (Pl. VII. Fig. 46) are bowshaped, with the ends thickened. In the tubefect a few bihamate spicules are found. The walls of the intestine may contain some very few small bihamate spicules; in the genital organs I have seen none.

The auricles are formed of two high, narrow processes, which do not unite above, even in the largest specimens. The dental apparatus is low and strongly rounded below.

The colour of the test is white, with a faint reddish tint, the red colour of the spines looking most delicate against the white ground colour.

A considerable number of this beautiful little species was taken at several localities in the Gulf of Siam: Koh Kam, 5—10 fathoms, Koh Kram, 30 faths., Koh Mesan, 5—15 faths., Koh Kahdat, 1—10 faths., Koh Mak, 5—6 faths., all on hard bottom, sand, gravel or stone. Further a few specimens have been taken at Singapore by Mr. GAD, 1903. A great number of them carried an empty bivalve shell on them, held rather firmly by the abactinal suckers, the whole animal being thereby quite covered, when seen from above. From the Maldivé Islands I have seen 3 small specimens (in the collection sent me for examination from Prof. S. F. Harmer), which appear to belong to this species, but as tridentate pedicellariæ could not be found, I dare not affirm that they belong to this species. The colour of the spines is faint violet. (They were named *Temno-pleurus?*)

In the „Ingolf“-Echinoidea (p. 110) I have written of *Gymnech. darnleyensis* that the ocular plates are not excluded from the periproct, according to infor-

mation received from Prof. BELL in a letter to me. Trusting to this statement DE MEIJERE has concluded that *G. darnleyensis* has the apical system „sehr schief ausgebildet“, and on this account he has referred some specimens from the „Siboga“-Expedition to that species. Now I must state, after having reexamined the specimens of *G. darnleyensis* in the British Museum during my visit there last summer, that all the ocular plates are, indeed, excluded from the periproct, the apical system being regular and very different from the oblique apical system in *G. Robillardi* and *pulchellus*. Seeing thus that the „Siboga“-specimens could not belong to *darnleyensis*, I asked Dr. DE MEIJERE to send me some specimens for examination. He most kindly sent me two specimens; they prove to be nearly related to *G. pulchellus*. They are somewhat larger than the largest Siamese specimens (23 mm. diam., 11 mm. height and 18.5 mm. diam., 10.5 mm. height) and the form of the test is somewhat different being higher at the ambitus and more flat on the abactinal side than in the larger specimens of *pulchellus*; the smaller specimen agrees with the Siamese specimens in colour, the spines only being of a more violet tint: the larger specimen has the abactinal spines faintly greenish, indistinctly banded, the actinal ones are a little violet, and there is a faint greenish tint on the test towards the apical system. The tridentate pedicellariæ do not quite agree with those of the Siamese specimens. In the smaller specimen the lower part of the blade is not so narrow, and the holes in the outer part are conspicuously lengthened; in the larger specimen they are, again, of another form, more leafshaped, broadest in the middle, and the edge of the lower part strongly serrate; the holes are small and round. It thus seems doubtful, whether they can be referred to *G. pulchellus*; they even seem to be two different species. But a larger material is needed for establishing the constancy of these features before the specimens can be made separate species.

Some specimens from Macclesfield Bank, mentioned by BELL<sup>1)</sup> as *Temnopleurus Reynaudi* (and some more specimens from the same locality found in the British Museum, only named „*Echinus*“) prove to be a new species of *Gymnechinus*, allied to *G. pulchellus*, which I may describe here as *Gymnechinus versicolor* n. sp.

The test is very low, faintly conical on the abactinal side, with the mouth-edge rather strongly incurved. The tuberculation is rather rich. In both areas there is a larger secondary tubercle in the inner edge of the plate, forming a somewhat irregular longitudinal series. In the interambulacra the secondary tubercles form a rather distinct

Diameter.	Height.	Peri- stome.	Width of		Number of plates.		Longest spines.
			Ambulacra.	I-ambulacra.	Ambulacra.	I-ambulacra.	
26 mm.	12	8	6	9.5	c. 22	17	8

<sup>1)</sup> Echinoderms of Macclesfield Bank. p. 410.

circle around the primary one. Between each two adjoining primary interambulacral tubercles there is (on the abactinal side) a narrow, slightly elevated ridge with a small tubercle on the middle, connecting the primary tubercles. In the ambulacra such a ridge may be faintly indicated. The median space, in both areas, is bare and a little sunken; it is rather large in the interambulacra. The apical system is like that of *G. pulchellus*. The spines are slender, those at the ambitus the longest, c.  $\frac{1}{3}$  of the diameter of the test; the primary ones smooth, the secondary thorny; the actinal spines are not widened or curved. The auricles are low processes, which do not meet above to form an arc. The mouthslits are small but sharp. The buccal membrane has no plates in the mouth edge, but rather numerous small bihamate spicules (Pl. VII. Fig. 24. a) are found spread in the whole membrane; in the gills such spicules occur in great numbers together with the usual irregular plates. The tubefeet contain rather numerous small, very little curved, bihamate spicules (Pl. VII. Fig. 24 c.). The globiferous pedicellariæ present the shape usual in this genus; they have small glands on the stalk. Numerous small bowshaped spicules (Pl. VII. Fig. 24 d.) are found in them. The tridentate pedicellariæ are very characteristic (Pl. VII. Fig. 30); the blade is almost flat, narrow, widened in the outer part; the edge is smooth and in the outer part exceedingly finely serrate. The valves are a little curved and join only with the outer part. The neck is rather short. The ophicephalous pedicellariæ do not present any special characters; the triphyllous ones (Pl. VII. Fig. 26) differ somewhat in shape from those of *G. pulchellus*, the blade being less widened. The stalk and neck of these pedicellariæ contain numerous very small bihamate spicules (Pl. VII. Fig. 24. b.). — The colour of the test is wholly white, or with a faint brownish tint on the bare spaces. The spines are banded with 1—3 bands of red; in the lower part they are green or white, both types of colorations occurring in the same specimen. The base of the spines is red.

This beautiful species belongs to the group of *G. Robillardi*, distinguished by its remarkable oblique apical area; to the same group the species *G. pumilio* de Meijere<sup>1)</sup> seemed to belong. Through the kindness of Dr. DE MEIJERE, however, I have had a specimen for examination, and I must state that it is no *Gymnechinus*, but a *Psammechinus*, and that it is the species described by BELL (Echinoderms of Macclesfield Bank) as „*Salmacis*“ *rufa* (see below p. 122).

*Gymnechinus darnleyensis* (Woods) differs very markedly from all the species mentioned above in having a regular apical system with no ocular plates reaching the periproct (comp. above p. 116). In the „Ingolf“-Echinoidea (p. 110) I have stated that the auriculæ are of the usual form (according to a communication from Prof. BELL in a letter to me), as opposed to the statement of Woods<sup>2)</sup> that they are slight thin processes, which do not meet. Having reexamined the specimens in the British Museum

<sup>1)</sup> „Siboga“-Echinoidea. p. 90.

<sup>2)</sup> The Echini of Australia. Proc. Linn. Soc. N. S. Wales. II. 1878. p. 165.

I find them to be, as BELL states, connected above. (Also in a specimen received from Prof. DÖDERLEIN the auriculæ unite.) As these specimens otherwise agree well with the description, the statement of WOODS probably may be due to his having confounded more than one species in his „*Echinus*“ *darnleyensis*. He describes the spines as being „rose pink, dull green or reddish, and sometimes banded or tipped with yellow“. Such a wide range of colours in a single species appears to me rather improbable. My experiences tend to show that colours in Echinids are generally much more constant than is commonly supposed, and I find colour in many cases a very good additional specific character. Thus all my numerous specimens of *G. pulchellus*, without exception, show a similar coloration, and the same is the case with the different *Salmacis*-species, *Pleurechinus* etc.

In the Museum of Copenhagen are preserved two specimens of a small Echinid from Funafuti, which agree in several respects with *G. darnleyensis*, but differ in other characters so much from that species that they must certainly form a distinct species, which I may describe here as *Gymnechinus inconspicuus* n. sp.

The form of the test is beautifully rounded, the height being more than half as large as the diameter of the test (6 mm. to a diameter of 10 mm.); it is regularly arched on the abactinal side. The primary tubercles of both areas form a regular vertical series, the ambulacral almost as large as the interambulacral ones. The ambulacral plates carry a secondary tubercle at the upper edge of the plate inside the primary one, at the ambitus there may also be a tubercle at the median edge. On the interambulacral plates there are two secondary tubercles at the upper edge, one to each side of the primary tubercle, further one inside and two outside the primary tubercle, all these secondary tubercles together forming an almost regular circle round the primary one. The apical system is like that of *darnleyensis*, with the periproct in the normal position and the anal opening central and surrounded by a circle of rather large plates. In the larger specimen (10 mm.) one ocular plate reaches the periproct, in the smaller one (8 mm.) they are all excluded. There is a rather large tubercle on all the ocular plates, none on the genital plates. The latter have a little area in the middle composed of more open, reticular tissue, looking like the madreporic plate, whereby the curious aspect is produced, as if all the genital plates were madreporic plates. The mouthslits are very small and indistinct; the auriculæ unite in the larger specimen, and one pair of them does so in the smaller specimen. The buccal membrane is quite bare, with only a few bihamate spicules; the buccal plates, which are placed at the same distance from the mouth-edge, carry some pedicellariæ. The gills contain numerous bihamate spicules, but no, or — in the small specimen — only a few fenestrated plates. The globiferous pedicellariæ have no glands on the stalk; the glands of the valves are small; no spicules found. The valves are like those of *darnleyensis*. The tridentate pedicellariæ are very different from those of *darnleyensis* (Pl. VI.

Fig. 45, Pl. VII. Fig. 39); the blade is very narrow, compressed in the lower part, widened in the outer part; the edge is irregularly sinuate, in the widened outer part finely serrate. The ophicephalous pedicellariæ are rather elongate, narrow, like those of *Psammechinus rufus* (Pl. VII. Fig. 43); the triphyllous ones widened in the outer part (Pl. VII. Fig. 54) and differing in form from those of *darnleyensis* (which are like those figured of *G. pulchellus*). No spicules have been found in pedicellariæ or tubefeet. The spines are short, about  $\frac{1}{3}$  of the diameter of test, almost equally long over the whole test; the primary ones are smooth, the secondary faintly thorny, as is the case in all the *Gymnechinus*-species, and a little swollen at the point<sup>1)</sup>; the actinal spines are not curved. — The colour of the test is brownish, with a darker median band in each area, in which the sutures may appear as white lines. The spines are of a bluish or reddish tint, lighter towards the point; in the smaller specimen those on the actinal side are indistinctly banded. — In both specimens the genital openings are distinct.

The 5 species of *Gymnechinus* thus far known form two distinct groups: the *Robillardi*-group, with excentric anal area, and the *darnleyensis*-group, with the anal area central. Perhaps these two groups ought to be made two subgenera; this, however, is of very little importance. To facilitate the determination of the species of *Gymnechinus*, which, together with *Psammechinus*, will doubtless prove to contain yet several species, I give here an analytical table of the species.

#### Table of the *Gymnechinus*-species.

1. Anal area central .....	2.
— — excentric .....	3.
2. Elongate calcareous bodies in the inner edge of the buccal membrane; numerous dumbbell-shaped spicules in the globiferous pedicellariæ. Valves of tridentate pedicellariæ wide, not compressed in the lower part of the blade. Spines not swollen at the point.....	<i>G. darnleyensis</i> (Woods).
No elongate bodies in the inner edge of the buccal membrane; no spicules in the pedicellariæ. Tridentate pedicellariæ compressed in the lower part of the blade. Spines a little swollen at the point.....	<i>G. inconspicuus</i> Mrtsn.
3. Spines white.....	<i>G. Robillardi</i> (de Loriol).
— red, white tipped, not banded.....	<i>G. pulchellus</i> Mrtsn.
— banded with red, the lower part mostly green..	<i>G. versicolor</i> Mrtsn.

<sup>1)</sup> In *darnleyensis* they are more evenly rounded or tapering.

15. *Toxopneustes pileolus* (Lamk.).

- Echinus pileolus*. LAMARCK. 1816. Animaux sans vertèbres. III. p. 45.  
*Boletia pileolus*. AGASSIZ. & DESOR. 1846. Catalogue raisonné des Échinides. p. 362.  
*Toxopneustes pileolus*. AGASSIZ. 1872. Revision of Echini. p. 167, 497. Pl. VIII. b. 1—2, XXV. 20, 21, XXXVIII. 16—17.  
*Boletia pileolus*. DE LORIOI. 1883. Catalogue rais. Échinod. île Maurice. p. 27.  
*Toxopneustes pileolus*. DÖDERLEIN. 1885. Seeigel v. Japan u. d. Liu-Kiu-Inseln. p. 26.  
 — — WALTER. 1885. Ceylons Echinodermen. Jen. Zeitschr. f. Naturw. XVIII. p. 375.  
 — — KOEHLER. 1895. Catalogue rais. Échinod. îles de la Sonde. p. 414.  
 — — MORTENSEN. 1903. Ingolf-Echinoidea. I. p. 111. Pl. XXI. 13, 21, 41.  
 — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 92. Taf. XVII. 280—85.
- Non: *Boletia rosea* A. Ag. (Comp. Ingolf-Echinoidea. I. p. 111).  
 — : — *bizonata* Desor.  
 — : *Echinus trizonalis* Blv.

Five specimens were taken at Koh Mesan, 10—15 fathoms, on hard bottom. On one of them a beautiful Ophiurid was found on the actinal side; also the small crab, mentioned under *Salmacis bicolor*, was found on this species, denuding also here the part of the test, where it had taken its place.

The well known transverse bands are rather differently developed, in one specimen almost quite wanting, in another very distinct; but the white zones are very narrow, the test looking thus rather different from the Polynesian specimens, where the white and violet or green bands are generally equally large. According to DE LORIOI the specimens from Mauritius have no transverse bands; I must, however, remark that in a specimen from Mauritius in the Copenhagen-Museum the white transverse bands are found, though very narrow. Possibly the Indian specimens may be distinguished from the Polynesian ones as a distinct variety; but so far as I can judge from the material at my disposal no other differences can be pointed out than the colour of the test. In the pedicellariæ no difference is found.

In the „Ingolf“-Echinoidea (loc. cit.) I have said that no spines are found on the buccal plates in *T. pileolus*. This is not quite correct; there may be found a few small spines thereon, which holds good also for *T. roseus*. — The genital glands are of a curious reticulate structure; they are long and narrow, passing along the median line of the Interambulacra down to the actinal side. Some bihamate spicules are found in their walls; the walls of the intestine contain almost no spicules (bihamate).

*Echinus trizonalis* Blv. and *Boletia bizonata* Desor are stated by AGASSIZ and later authors to be synonymous with *T. pileolus*; as I have examined the type-specimens of these „species“ in Paris, I can positively affirm that this is not the case. To be sure, the type-specimens are only naked tests, but the fact that they have a primary tubercle on all ambulacral plates sufficiently shows that they cannot be the young of *T. pileolus*. There can scarcely be any doubt that they are either *Psamm-*

*echinus variegatus* or *Ps. verruculatus*; to which of these two species they belong can scarcely be decided, especially as the locality, from where they have come, is unknown.

### Subfam. Parasaleninæ.

#### 16. *Parasalenia gratiosa* A. Ag.

Pl. V. Fig. 36.

- Parasalenia gratiosa*. A. AGASSIZ. 1863. List of Echinoderms etc. Bull. Mus. Comp. Zool. I. p. 22.  
*Echinometra Arbacia*. LÜTKEN. 1864. Bidrag til Kundskab om Echiniderne. p. 92 (160).  
*Parasalenia gratiosa*. AGASSIZ. 1872. Revision of Echini. p. 148, 435.  
 — — STEWART. 1880. On some structural features of *Echinostrephus molaris*, *Parasalenia gratiosa* and *Stomopneustes variolaris*. Journ. R. Microsc. Soc. III. p. 909. Pl. XX.  
 — — PFEFFER. 1887. Über *Parasalenia gratiosa* (A. Ag.) u. *P. Pöhlii* n. sp. Verhandl. d. Vereins f. naturw. Unterhaltung. Hamburg. VI. p. 107.  
 — *Pöhlii*. PFEFFER. Ibidem.  
 — *gratiosa*. MEISSNER. 1892. Über *Parasalenia gratiosa* von Madagascar. Sitz. ber. Ges. naturf. Fr. Berlin. 1892.  
 — — SLUITER. 1895. Die Echiniden Sammlung des Museums z. Amsterdam. p. 69.  
 — — MORTENSEN. 1903. „Ingolf“-Echinoidea. I. p. 127. Pl. XXI. Fig. 32.  
 — — DE MEIJERE. 1904. „Siboga“-Echinoidea. p. 97. Taf. XVII. Fig. 290.

Non: *Parasalenia gratiosa*. BELL. 1903. Report on a Collection of Echinoderms from the Neighbourhood of Zanzibar. I. Ann. Nat. Hist. 7. Ser. XII. p. 247. (*Stomopneustes variolaris*.)

A few additional remarks may be given on this otherwise well known species. — The globiferous pedicellariæ contain numerous bihamate spicules; the skin on the upper end of the stalk is swollen, forming a gradual passage from the thin lower part to the head. This swelling might seem to be due to mucous glands, but according to DE MEIJERE there are no glands on the stalk. (The valves have been figured by STEWART.) It is a curious fact that the globiferous pedicellariæ are often totally wanting. In none of my specimens have I found them. The tridentate pedicellariæ (Pl. V. Fig. 36) are very slender and elongate, the head attaining sometimes even a length of more than 2 mm.; the valves join in the outer half of their length. Also quite small tridentate pedicellariæ are found, with simply leafshaped blades. The sphæridiæ are of usual form and smooth. — No spicules are found in the walls of the intestine or genital organs.

4 specimens of this beautiful little Echinid were taken in old Coral blocks in about 1 fathoms depth at Koh Chang and the little Island Koh Sarlak in the Sound between Koh Chang and the mainland.

DE MEIJERE has shown that *Parasalenia Pöhlii* cannot be distinguished from *P. gratiosa* by the characters pointed out as distinctive in the original diagnosis by

PFEFFER. I quite agree with DE MEIJERE herein and can add that neither in the pedicellariæ is any distinguishing character to be found. *P. Pöhlü* must then be withdrawn as a synonym of *P. gratiosa*.

AGASSIZ finds young specimens so unlike the larger ones that „they would at first glance readily pass for young of *Heterocentrotus trigonarius*“. I must confirm DE MEIJERE's statement that this is not the case; my smallest specimen (9 mm.) is so exactly like the larger specimens that I am quite unable to understand how even smaller specimens (AGASSIZ names 6 mm.) could look so different. AGASSIZ must probably have mistaken some young *Heterocentrotus* for *Parasalenia*..

This species evidently occurs in the whole Indo-Pacific region. As yet it was only known from Zanzibar and Madagascar in the Indian Ocean; I can add, besides the Gulf of Siam, the Red Sea, having seen a specimen therefrom in the British Museum. On the other hand having examined the specimen in the British Museum I must state that the *P. gratiosa* from Zanzibar, named by BELL (Op. cit.), is a lapsus for *Stomopneustes variolaris*.

I may here add a few remarks on *Psammechinus rufus*, *verruculatus* and *Echinometra oblonga*.

*Psammechinus rufus* (Bell). This species was described by BELL in his paper „On the Echinoderms of Macclesfield Bank“. p. 411 as *Salmacis rufa*. I have examined the type-specimens in the British Museum and find the species to be no *Salmacis* at all, but a Toxopneustid of the genus *Psammechinus*. Further I must state that the *Gymnechinus pumilio* described by DE MEIJERE („Siboga“-Echinoidea. p. 90) is the same species, DE MEIJERE having kindly lent me his largest specimen for examination. Perhaps the smaller specimens from the „Siboga“ are another species, as DE MEIJERE states that two ocular plates reach the periproct. In the larger specimen the apical system is like that figured by BELL, no ocular plate reaching the periproct and all the genital plates being low, thus differing very much from the genital plates in the *Gymnechinus*-species with excentric periproct. — To the descriptions given by the two authors I may add a few remarks. — The buccal membrane contains a great number of small irregular plates (Pl. V. Fig. 16), both inside and outside the buccal plates, which, as pointed out by DE MEIJERE, are placed very far from the mouth, almost at the edge of the peristome. Several bihamate spicules are also found in the buccal membrane. — DE MEIJERE says that the ophicephalous pedicellariæ do not present characteristic features; I cannot agree with him in this respect. They are of a very characteristic elongate form, narrow in the middle (Pl. VII. Fig. 43). The tridentate pedicellariæ (which were not found in the „Siboga“-specimen) are rather small (c. 0.8 mm., head); the valves are simple, widened in the outer part, with no meshwork in the bottom. The edge is finely serrate in the outer part, irregularly so in the lower part (Pl. VII. Fig. 34). The valves are widely separated, joining only with the outer part. — On the figure given

by BELL (Op. cit. Pl. XXVI. Fig. 3) the poriferous zone looks very peculiar, the pores being arranged in sets of two, and the porebearing plates being separated from the inner part of the ambulacral plate. This is wrongly drawn; the ambulacra are quite typically echinoid, with the pores arranged in distinct arcs of three.

„It is a somewhat difficult matter to suggest what are the nearest allies of this species“, says BELL. I think there can be no doubt that it is nearest allied to *verruculatus* among the *Psammechinus*-species, which species has likewise only small plates in the buccal membrane, though larger than in *Ps. rufus*, both differing in this respect very much from *Ps. variegatus*, where the buccal membrane is quite covered by thick plates. But on the other hand *Ps. rufus* reminds one of the *Gymnechinus*-species, especially of *G. pulchellus*, in which species a few small fenestrated plates may occur in the buccal membrane outside the buccal plates. Also the rather excentric periproct of *Ps. rufus* reminds one of the *Gymnechinus*-species of the *Robillardi*-group. It seems thus that *Ps. rufus* forms the transition from *Psammechinus* to *Gymnechinus*, and it might almost as well be referred to the latter genus; but it is most practical to refer it to *Psammechinus*, as otherwise the limits of these two genera would become indistinct — and these two genera must be maintained, as it would be rather absurd to unite the extreme forms, *Ps. variegatus* and *G. Robillardi* or *versicolor* into one genus.

In the collection of Echinids sent me from Prof. HARMER there are several specimens (naked tests) of *Psammechinus verruculatus* from the Sandwich Islands, which are peculiar by having the pore-areas and the adjoining part of the interambulacra (outside the primary tubercles) beautifully red coloured; also the usual greenish spots are found. On a specimen from Samoa (Hamburg Museum) preserved in alcohol, it is seen that the spines are white, with 1—4 narrow, red bands. In spite of this characteristic coloration this beautiful form can scarcely be regarded as distinct from *verruculatus*, no other differences being found. And among the specimens from the Sandwich-Islands there are some with the red colour faintly indicated and others without any indication of it. In one specimen with a few spines preserved these are violet at the base. — According to DE LORIOLE (Echinod. Maurice. p. 23) two ocular plates reach the periproct; this is the case in some of the specimens before me, in others, however, only one ocular plate reaches the periproct.

DE MEIJERE („Siboga“-Echinoidea p. 101) expresses his doubt of *Echinometra oblonga* being a distinct species, as he finds all transitional forms between *E. Matthæi* and *oblonga*. In the „Ingolf“-Echinoidea (p. 129) I have stated that *E. oblonga* agrees with the other species (*lucunter* etc.) as regards spicules and pedicellariæ, mentioning only that it has a joint on the stalk of the globiferous pedicellariæ. In a letter to me Prof. DÖDERLEIN has called my attention to the fact that the *Echinometra oblonga* has, indeed, triradiate, not bihamate spicules in its tubefeet. My statement, that it has bihamate spicules, was occasioned by my having relied upon a determination of LÜTKEN. It was not my intention to work out more closely the

*Echinometra*-species, as they did not seem to present differences of greater interest, so I did not revise the determination of this species. What I took for *oblonga*, now proves to be *E. Matthæi* and thus my statements for *oblonga* are wrong. *E. oblonga* differs, indeed, very markedly from the other *Echinometra*-species in having triradiate spicules in the tubefeet (Pl. V. Fig. 26); bihamate spicules, however, may also occur together with the triradiate ones, and transitional forms between bihamate and triradiate may be found; also the tridentate pedicellariæ are characteristic (Pl. VII. Fig. 35), whereas the globiferous pedicellariæ are like those of the other species (*lucunter* etc.). (I have not examined the type-specimen.) This species thus is quite unique among the Echinometrids, which have otherwise bihamate spicules (only in *Selenechinus* de Meijere they are thorny), and must perhaps form a separate genus. I shall, however, not propose a name for it. The triradiate spicules can evidently not be regarded as a primitive feature; the transitional forms from the bihamate spicules seem to indicate that they are a further development from the bihamate ones. That would also agree with the fact of this species being the most elongate of all Echinometrids.

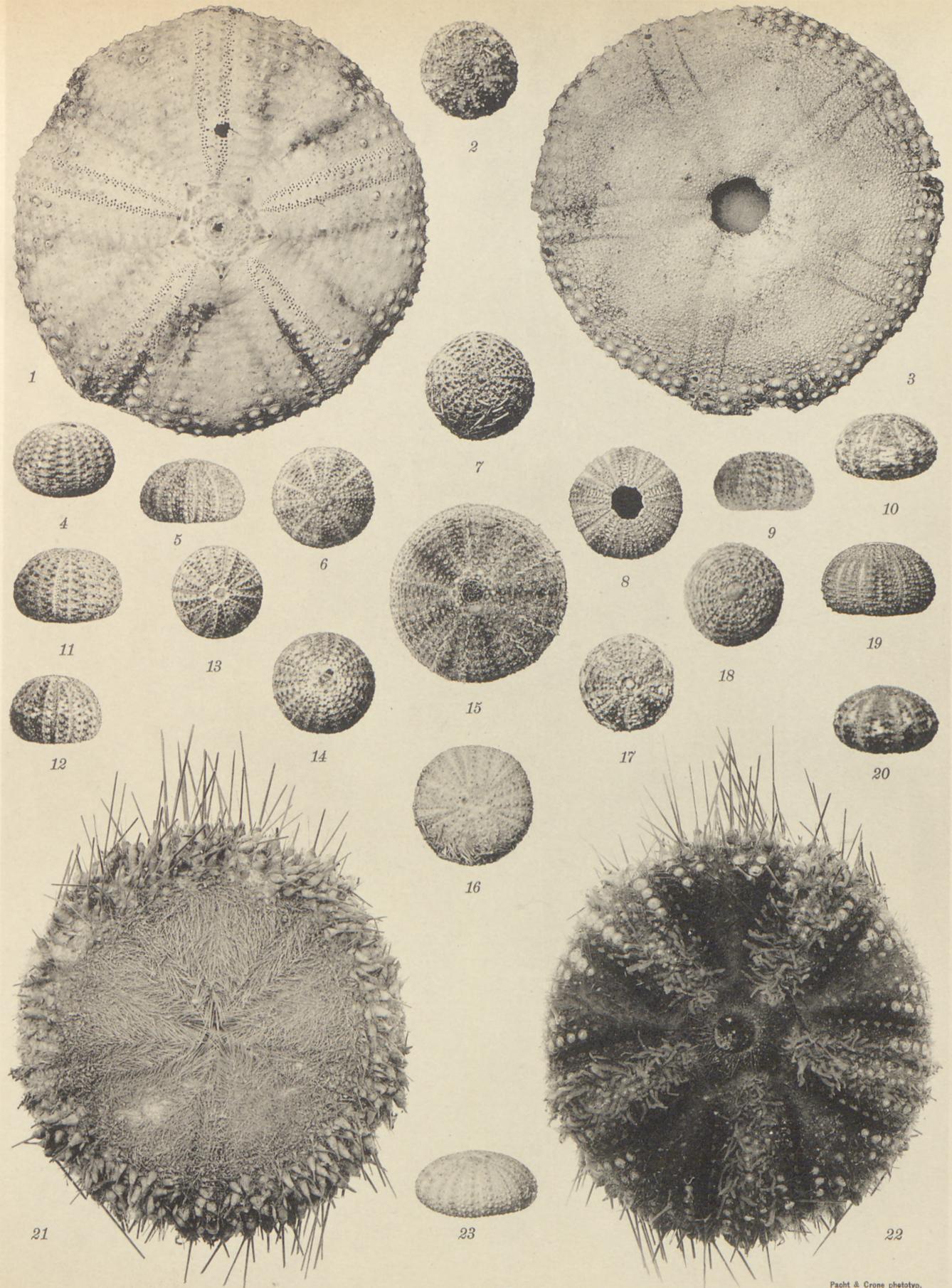
In his paper „Echinoderms from Puget Sound“ (Proc. Boston Soc. Nat. Hist. XXIX. 1901. p. 331) CLARK mentions *Echinometra oblonga* from that locality. This seems very improbable. The statement that *Astropyga pulvinata* and *Toxopneustes pileolus* occur on both sides of the Pacific has been proved to be erroneous, and it seems very doubtful if any littoral species does so. In any case a very close examination must be made of such species, before so wide a distribution can be accepted as a certain fact.

Mrs. R. I. Pocock has kindly undertaken the revision of the language in the present work. I beg her to accept my best thanks for this service.



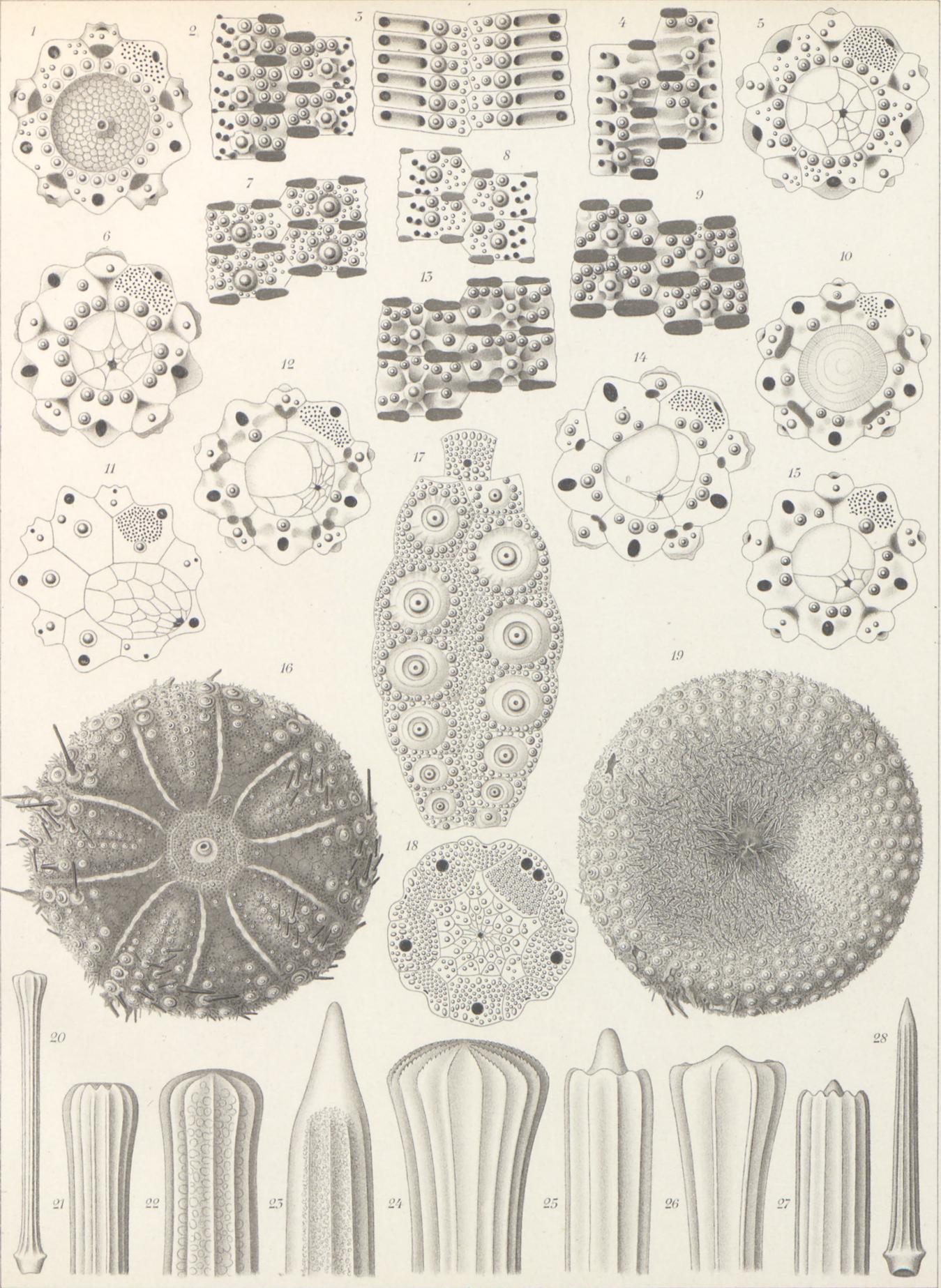
## Plate I.

- Fig. 1. *Chætodiadema granulatum*; abactinal side; a little diminished.  
 — 2. *Pleurechinus siamensis*; abactinal side. From a specimen 8 mm. in diameter.  
 — 3. *Chætodiadema granulatum*; actinal side. Same specimen as Fig. 1.  
 — 4. *Pleurechinus maculatus*; side view. Nat. size.  
 — 5. — *variegatus*; — — From a specimen 12 mm. in diameter.  
 — 6. — — abactinal side. Same specimen as Fig. 5.  
 — 7. — *siamensis*; — — From a specimen 12 mm. in diameter (from Torres Strait).  
 — 8. — *variegatus*; — — Nat. size.  
 — 9. — *scillæ*; side view. From a specimen 8.5 mm. in diameter (from New Britain).  
 — 10. — — — — — — — — (from Muscat).  
 — 11. — *siamensis*; side view. Same specimen as Fig. 7.  
 — 12. — *Döderleini*; — — From a specimen 11 mm. in diameter.  
 — 13. — — abactinal side. Same specimen as Fig. 12.  
 — 14. — *maculatus* — — — — — — — — 4.  
 — 15. *Opechinus spectabilis*; — — Nat. size.  
 — 16. *Gymnechinus pulchellus*; — — — —  
 — 17. *Pleurechinus scillæ*; — — Same specimen as Fig. 10.  
 — 18. — — — — — — — — 9.  
 — 19. — *variegatus*; side view. Same specimen as Fig. 8.  
 — 20. — *siamensis*; — — — — — — — — 2.  
 — 21. *Chætodiadema granulatum*; actinal side. A little diminished.  
 — 22. — — abactinal side. Same specimen as Fig. 21.  
 — 23. *Gymnechinus pulchellus*; side view. Same specimen as Fig. 16.
-



## Plate II.

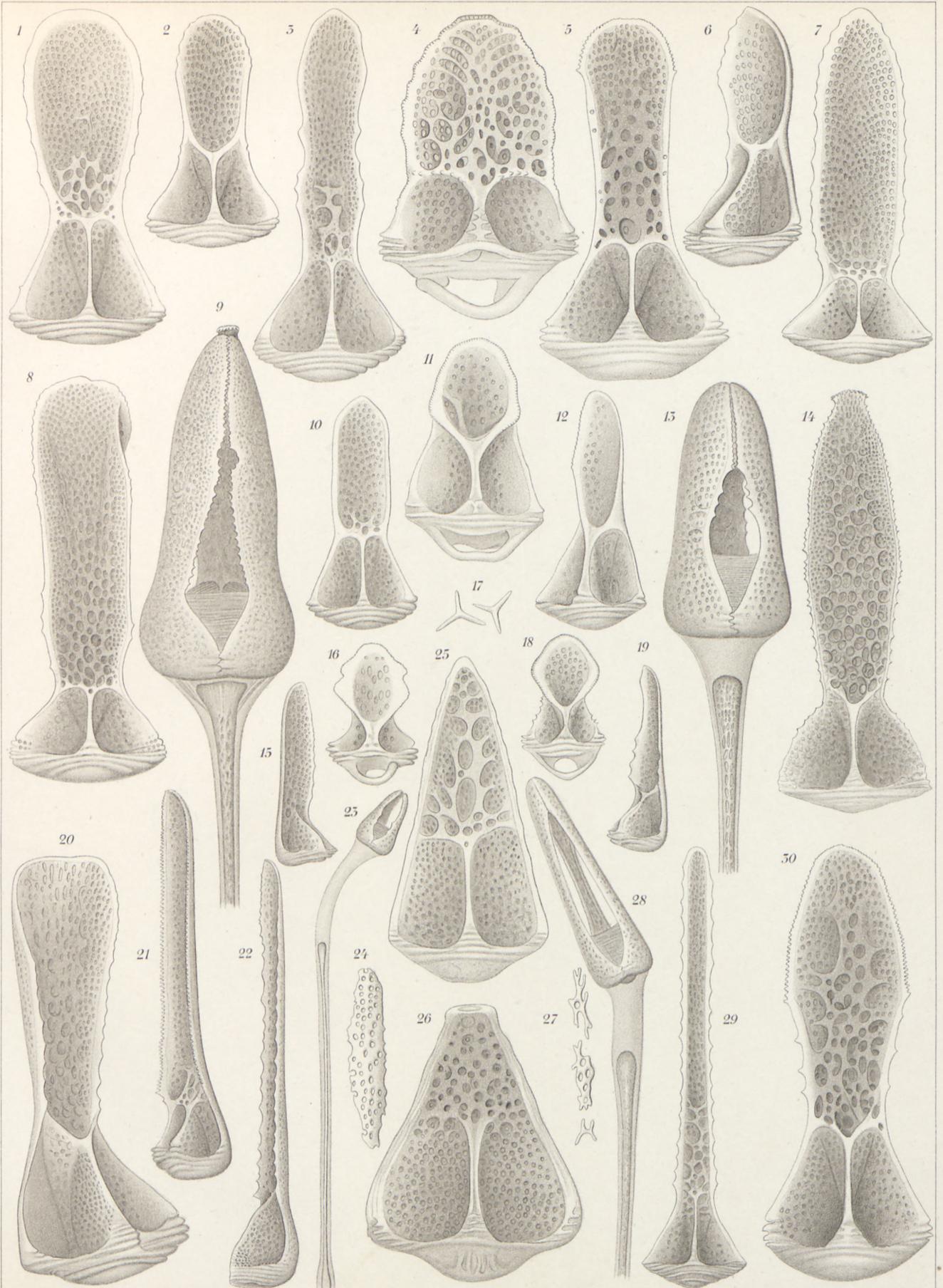
- Fig. 1. Apical area of *Pleurechinus Döderleini*. Zeiss. a\*. Oc. 2.  
 — 2. Part of ambulacral area of *Pleurechinus siamensis* (Torres Strait). Zeiss. a\*. Oc. 3.  
 — 3. — - — - *Stephanocidaris bispinosa*. Zeiss. a\*. Oc. 1.  
 — 4. — - — - *Pleurechinus scillæ*. Zeiss. a\*. Oc. 2.  
 — 5. Apical area of *Pleurechinus maculatus*. Zeiss. a\*. Oc. 2.  
 — 6. — - - - *variiegatus*. Zeiss. - -  
 — 7. Part of interambulacral area of *Pleurechinus Döderleini*. Zeiss. a\*. Oc. 3.  
 — 8. — - ambulacral — - — Zeiss. - -  
 — 9. — - interambulacral — - — *siamensis* (Torres Strait). Zeiss. a\*. Oc. 3.  
 — 10. Apical area of *Pleurechinus scillæ*. Zeiss. a\*. Oc. 2.  
 — 11. — - - *Gymnechinus pulchellus*. Zeiss. a\*. Oc. 1.  
 — 12. — - - *Pleurechinus scillæ* (Muscat). Zeiss. a\*. Oc. 2.  
 — 13. Part of interambulacral area of *Pleurechinus scillæ*. Zeiss. a\*. Oc. 2.  
 — 14. Apical area of *Pleurechinus siamensis* (Torres Strait). Zeiss. a\*. Oc. 3.  
 — 15. — - - — (Gulf of Siam). Seib. Obj. 00. Oc. 00.  
 — 16. *Chatodiadema japonicum*, abactinal side (from a photograph).  
 — 17. Interambulacral area of *Stephanocidaris bispinosa*. <sup>2</sup>/<sub>1</sub>.  
 — 18. Apical area of *Stephanocidaris bispinosa*. <sup>2</sup>/<sub>1</sub>.  
 — 19. *Chatodiadema japonicum*, actinal side (from a photograph).  
 — 20. Secondary spine of *Microcyphus zigzag*. Seib. Obj. 0. Oc. I.  
 — 21. The point of a primary spine of *Amblypneustes pallidus*. Seib. Obj. II. Oc. I.  
 — 22. — - — - *Pleurechinus siamensis*. Seib. Obj. II. Oc. III.  
 — 23. — - — - *Microcyphus maculatus*. — — —  
 — 24. — - — - *Holopneustes purpurascens*. Obj. AA. Oc. 3.  
 — 25. — - — - *Microcyphus zigzag*. Seib. Obj. II. Oc. I.  
 — 26. — - secondary — - — — — III.  
 — 27. — - primary — - *Amblypneustes formosus*. Seib. Obj. 0. Oc. III.  
 — 28. Primary spine of *Microcyphus maculatus*. Seib. Obj. 0. Oc. 0.
-



## Plate III.

Diadema antillarum 1, 10, 16. D. mexicanum 2, 20. D. Savignyi 6, 8. D. globulosum 7. D. saxatile 22, 23, 29. Centrostephanus Rodgersii 4. Astropyga radiata 15, 19. A. pulvinata 3. Chaetodiadema granulatum 11. Echinothrix diadema 9, 14, 24, 27. E. calmaris 5, 13, 17, 21, 30. Aspidodiadema Jacobyi 25. A. tonsum 26. Plesiodiadema antillarum 18. Pl. microtuberculatum 28. Cænopedina mirabilis 12.

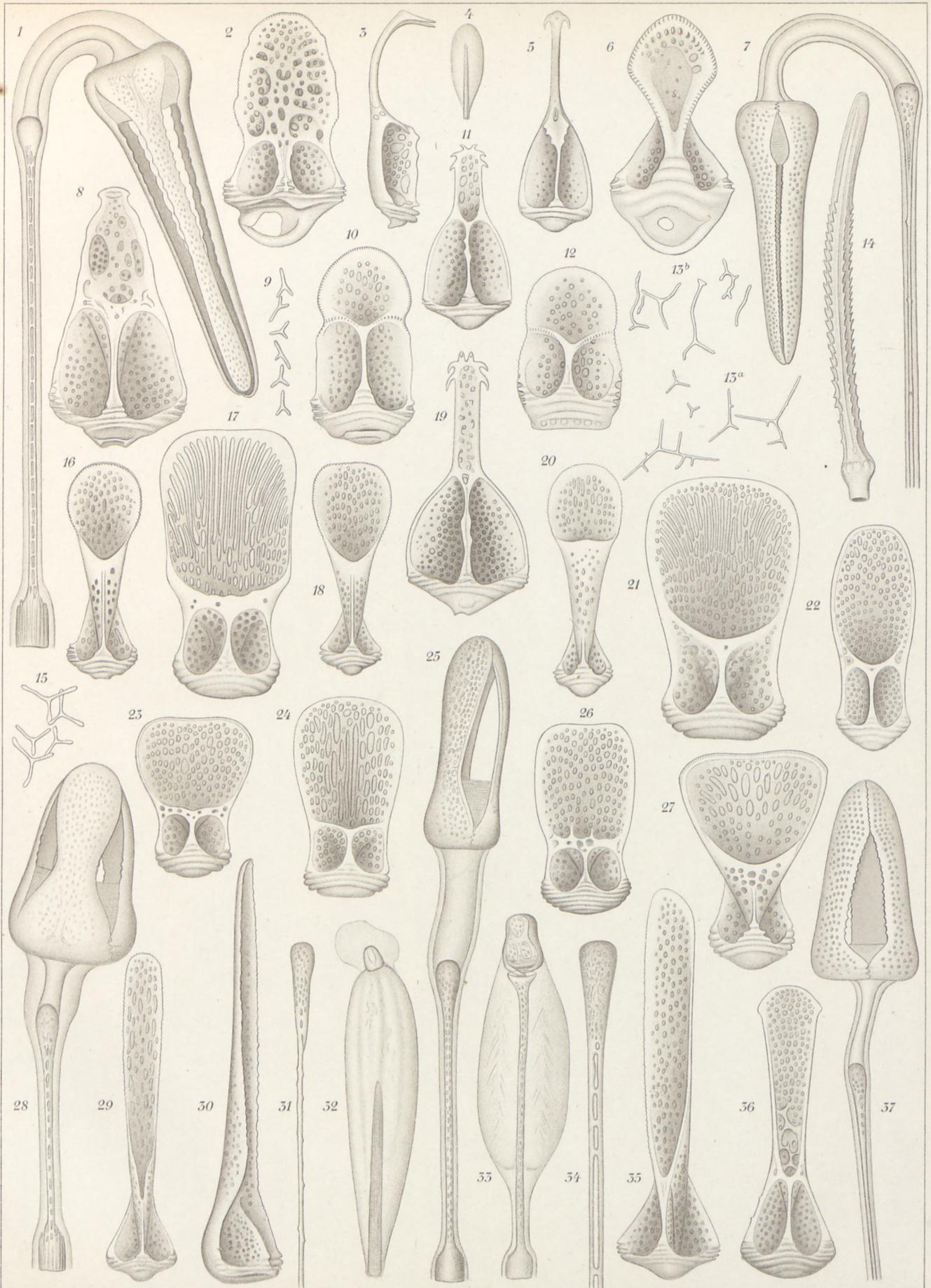
- Fig. 1. Valve of large tridentate pedicellaria of *Diadema antillarum*. Zeiss. AA. Oc. 2.  
 — 2. — - small — — — — *mexicanum*. — — 3.  
 — 3. — - tridentate pedicellaria of *Astropyga pulvinata*. Zeiss. AA. Oc. 3.  
 — 4. — - ophicephalous — - *Centrostephanus Rodgersii*. Seibert. Obj. II. Oc. 0.  
 — 5. — - tridentate — — large form, of *Echinothrix calmaris*. Seib. Obj. II. Oc. 1.  
 — 6. — - — — — small — from the buccal membrane of *Diadema Savignyi*;  
     side view (comp. Pl. V. 24). Zeiss. Apochr. 8·0. Comp. Oc. 4.  
 — 7. Valve of tridentate pedicellaria of *Diadema globulosum*. Zeiss. AA. Oc. 2,  
 — 8. — - — — — large form, of *Diadema Savignyi*. Zeiss. AA. Oc. 1.  
 — 9. Tridentate pedicellaria, large form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.  
 — 10. Valve of tridentate pedicellaria, small form, of *Diadema antillarum*; front view (comp. Pl. V.  
     13). Zeiss. AA. Oc. 3.  
 — 11. Valve of ophicephalous pedicellaria of *Chaetodiadema granulatum*. Zeiss. D. Oc. 1.  
 — 12. — - tridentate pedicellaria of *Cænopedina mirabilis*. Zeiss. Apochr. 8·0 Comp. Oc. 4.  
 — 13. Tridentate pedicellaria, large form, of *Echinothrix calmaris*. Seib. Obj. 0. Oc. 0.  
 — 14. Valve of tridentate pedicellaria, large form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.  
 — 15. — - — — — (I form, small), of *Astropyga radiata*. — — —  
 — 16. — - ophicephalous — — of *Diadema antillarum*. Zeiss. D. Oc. 1.  
 — 17. Spicules from tube feet of *Echinothrix calmaris*. Zeiss. AA. Oc. 1.  
 — 18. Valve of ophicephalous pedicellaria, small form, of *Aspidodiadema antillarum* („microtuberculatum“, „Challenger“, st. 122). Seib. Obj. II. Oc. III.  
 — 19. Valve of tridentate pedicellaria (II. form) of *Astropyga radiata*. Zeiss. AA. Oc. 3.  
 — 20. — - — — — large form, of *Diadema mexicanum*. — — 2.  
 — 21. — - — — — small — - *Echinothrix calmaris*. Seib. Obj. II. Oc. I.  
 — 22. — - — — — large — - *Diadema saxatile*; side view. Zeiss. AA. Oc. 1.  
 — 23. Tridentate pedicellaria, small form, of *Diadema saxatile*. Zeiss. Apochr. 16·0. Comp. Oc. 2.  
 — 24. Spicule from tube foot of *Echinothrix diadema*. Zeiss. AA. Oc. 1.  
 — 25. Valve of an ophicephalous pedicellaria, large form, of *Aspidodiadema Jacobyi*. Zeiss. AA. Oc. 1.  
 — 26. — — — — — — — — — — *tonsum*. Seib. Obj. II. Oc. 0.  
 — 27. Spicules from tube foot of *Echinothrix diadema*. Zeiss. AA. Oc. 1.  
 — 28. Tridentate pedicellaria of *Plesiodiadema microtuberculatum* („Challenger“, st. 134). Zeiss. AA. Oc. 2.  
 — 29. Valve of tridentate pedicellaria, large form, of *Diadema saxatile*, from the inside. — — 1.  
 — 30. — - — — — — — — — — *Echinothrix calmaris*. Seib. Obj. 0. Oc. III.



## Plate IV.

Stephanocidaris bispinosa 30. Plesiadiadema antillarum 8, 16, 29, 33, 35. Pl. microtuberculatum 12, 18. Aspidodiadema Jacobyi 10, 20. Diadema antillarum 28. D. Savignyi 37. D. saxatile 26, 31, 34. Astropyga radiata 9, 17. A. pulvinata 21. Chætodiadema granulatum 1, 4, 13, 14, 15, 24, 32. Echinothrix calamaris 7. E. diadema 23, 25, 36. Centrostephanus longispinus 2, 11. C. Rodgersii 19, 22. Micropyga tuberculata 27. Cænopedina mirabilis 3, 5, 6.

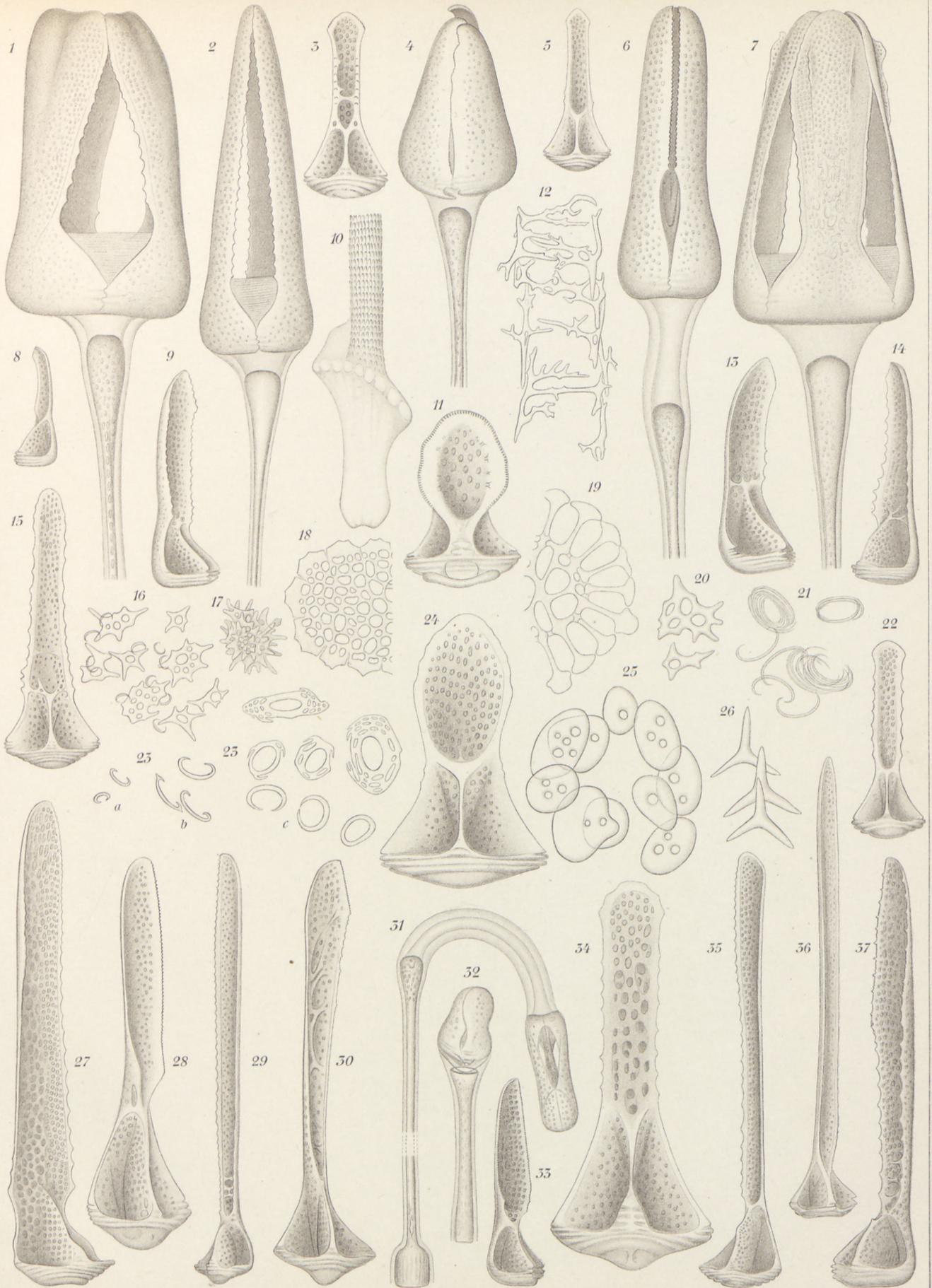
- Fig. 1. Tridentate pedicellaria of *Chætodiadema granulatum*. Zeiss. AA. Oc. 1.
- 2. Valve of ophicephalous pedicellaria of *Centrostephanus longispinus*. Seib. Obj. II. Oc. I.
- 3. — - globiferous pedicellaria of *Cænopedina mirabilis*; side view. Zeiss. D. Oc. 1.
- 4. „Claviform“ pedicellaria, small form, of *Chætodiadema granulatum* (comp. Fig. 32). Zeiss. a\*. Oc. 3.
- 5. Valve of globiferous pedicellaria of *Cænopedina mirabilis*; front view. Zeiss. D. Oc. 1.
- 6. — - ophicephalous — — — — Zeiss. Apochr. 8·0. Comp. Oc. 4.
- 7. Tridentate pedicellaria, small form, of *Echinothrix calamaris*. Seib. Obj. 0. Oc. III.
- 8. Valve of ophicephalous pedicellaria, large form, of *Plesiadiadema antillarum*. Seib. Obj. II. Oc. I.
- 9. Spicules from tube foot of *Astropyga radiata*. Zeiss. AA. Oc. 2.
- 10. Valve of ophicephalous pedicellaria, small form, of *Aspidodiadema Jacobyi*. Zeiss. D. Oc. 1.
- 11. — - globiferous (claviform) pedicellaria of *Centrostephanus longispinus*. Seib. Obj. II. Oc. III.
- 12. — - ophicephalous pedicellaria, small form, of *Plesiadiadema microtuberculatum*. Zeiss. D. Oc. 1.
- 13. Spicules of *Chætodiadema granulatum*; a. from abactinal, b. from buccal tube foot. Zeiss. D. Oc. 1.
- 14. Actinal spine of *Chætodiadema granulatum*. <sup>16</sup>/<sub>1</sub>.
- 15. Spicules of *Chætodiadema granulatum*; from actinal tube foot. Zeiss. D. Oc. 1.
- 16. Valve of triphyllous pedicellaria of *Plesiadiadema antillarum*. Seib. Obj. II. Oc. III.
- 17. — - — — — - *Astropyga radiata*. Zeiss. D. Oc. 1.
- 18. — - — — — - *Plesiadiadema microtuberculatum*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
- 19. Valve of globiferous pedicellaria of *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. 0.
- 20. — - triphyllous — - *Aspidodiadema Jacobyi*. Zeiss. D. Oc. 1.
- 21. — - — — — - *Astropyga pulvinata*. Zeiss. D. Oc. 1.
- 22. — - — — — - *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. I.
- 23. — - — — — - *Echinothrix diadema*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
- 24. — - — — — - *Chætodiadema granulatum*. Zeiss. D. Oc. 1.
- 25. Tridentate pedicellaria, small form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
- 26. Valve of triphyllous pedicellaria of *Diadema saxatile*. D. Oc. 2.
- 27. — - — — — - *Micropyga tuberculata*. Zeiss. D. Oc. 1.
- 28. Tridentate pedicellaria, large form, of *Diadema antillarum*. Zeiss. Apochr. 16·0. Comp. Oc. 2.
- 29. Valve of tridentate pedicellaria of *Plesiadiadema antillarum*. Zeiss. AA. Oc. 3.
- 30. — - — — — - *Stephanocidaris bispinosa*. Zeiss. AA. Oc. 2.
- 31. Stalk of pedicellaria of *Diadema saxatile*. Zeiss. A. Oc. 3.
- 32. „Claviform“ pedicellaria of *Chætodiadema granulatum*. Zeiss. a\*. Oc. 3. (Comp. Fig. 4.)
- 33. — — — — — - *Plesiadiadema antillarum*. Zeiss. AA. Oc. 2.
- 34. Stalk of pedicellaria of *Diadema saxatile*. Zeiss. AA. Oc. 2.
- 35. Valve of triphyllous pedicellaria of *Plesiadiadema antillarum* („*Aspidod. microtuberculatum*“  
Chall. Macio.). Seib. Obj. II. Oc. I.
- 36. Valve of tridentate pedicellaria, small form, of *Echinothrix diadema*. Zeiss. AA. Oc. 3.
- 37. Tridentate pedicellaria, small form, of *Diadema Savignyi*. Zeiss. Apochr. 16·0. Oc. 2.



## Plate V.

Stephanocidaris hispinosa 20, 25. Plesiadiadema antillarum 4, 32. Pl. microtuberculatum 30. Aspidodiadema tonsum 6, 31. A. Jacobyi 28. Diadema antillarum 13. D. mexicanum 1. D. Savignyi 7, 9, 24. D. saxatile 2, 5, 8, 12, 14, 15. Astropyga radiata 27. Chætodiadema granulatum 10, 18, 19, 22, 35. Echinothrix calamaris 3, 11. Centrostephanus longispinus 29. C. Rodgersii 34. Micropyga tuberculata 33, 37. Opechinus spectabilis 21. Salmacis spheroides 23. Microcyphus annulatus 17. Psammechinus rufus 16. Parasalenia gratiosa 36. Echinometra oblonga 26.

- Fig. 1. Tridentate pedicellaria, large form, of *Diadema mexicanum*. Zeiss. Apochr. 16·0. Oc. 2.  
 — 2. — — — — — *saxatile*. Zeiss. Apochr. 16·0. Oc. 2.  
 — 3. Valve of tridentate pedicellaria, small form, of *Echinothrix calamaris*. Seib. Obj. II. Oc. I.  
 — 4. Ophicephalous pedicellaria, large form, of *Plesiadiadema antillarum*. Zeiss. AA. Oc. 3.  
 — 5. Valve of tridentate pedicellaria, small form, of *Diadema saxatile*; front view (comp. Fig. 8).  
 Zeiss. AA. Oc. 3.  
 — 6. Tridentate pedicellaria of *Aspidodiadema tonsum*. Zeiss. AA. Oc. 3.  
 — 7. — — — — — large form, of *Diadema Savignyi*. Zeiss. Apochr. 16·0. Comp. Oc. 2.  
 — 8. Valve of tridentate pedicellaria, small form, of *Diadema saxatile*; side view (comp. Fig. 5).  
 Zeiss. AA. Oc. 3.  
 — 9. Valve of tridentate pedicellaria, small form, of *Diadema Savignyi*. Zeiss. AA. Oc. 2.  
 — 10. Spine of *Chætodiadema granulatum*; basal part.  $\frac{8}{1}$ .  
 — 11. Valve of ophicephalous pedicellaria of *Echinothrix calamaris*. Zeiss. Apochr. 8·0. Comp. Oc. 4.  
 — 12. Spicules from the partition wall of abactinal tubefoot of *Diadema saxatile*. Zeiss. AA. Oc. 1.  
 — 13. Valve of tridentate pedicellaria, small form, of *Diadema antillarum*; side view (comp. Pl. III.  
 10). Zeiss. AA. Oc. 3.  
 — 14. Valve of tridentate pedicellaria of *Diadema saxatile*; side view (comp. Fig. 15). Zeiss. AA. Oc. 3.  
 — 15. — — — — — front — ( — — 14). — — 2.  
 — 16. Plates and spicules from buccal membrane of *Psammechinus rufus*; in the natural position.  
 Zeiss. AA. Oc. 3.  
 — 17. Plate from buccal membrane of *Microcyphus annulatus*. Zeiss. Apochr. 8·0. Comp. Oc. 2.  
 — 18. Transverse section of the outer end of a large actinal spine of *Chætodiadema granulatum*.  
 Zeiss. AA. Oc. 3.  
 — 19. Transverse section of large abactinal spine of *Chætodiadema granulatum*. Zeiss. AA. Oc. 3.  
 — 20. Spicules from the genital organs of *Stephanocidaris hispinosa*. Zeiss. D. Oc. 1.  
 — 21. — — — — — buccal membrane of *Opechinus spectabilis*; natural position. Zeiss. D. Oc. 1.  
 — 22. Valve of small tridentate pedicellaria of *Chætodiadema granulatum* (comp. Fig. 35). Zeiss. AA. Oc. 3.  
 — 23. Spicules of *Salmacis spheroides*; a, c. from the genital organs, b. from the stone canal. Zeiss.  
 Apochr. 8·0. Comp. Oc. 4.  
 — 24. Valve of small tridentate pedicellaria from the buccal membrane of *Diadema Savignyi*; front  
 view (comp. Pl. III. 6). Zeiss. Apochr. 8·0. Comp. Oc. 4.  
 — 25. Spicules from the intestine of *Stephanocidaris hispinosa*. Zeiss. D. Oc. 1.  
 — 26. — — — — — tube foot of *Echinometra oblonga*. Zeiss. D. Oc. 1.  
 — 27. Valve of tridentate pedicellaria, large form, of *Astropyga radiata*. Zeiss. AA. Oc. 1.  
 — 28. — — — — — of *Aspidodiadema Jacobyi*. Zeiss. AA. Oc. 3.  
 — 29. — — — — — - *Centrostephanus longispinus*. Seib. Obj. 0. Oc. 0.  
 — 30. — — — — — - *Plesiadiadema microtuberculatum*. Zeiss. AA. Oc. 2.  
 — 31. Triphyllous pedicellaria of *Aspidodiadema tonsum*. Zeiss. AA. Oc. 3.  
 — 32. Ophicephalous — — — — — small form, of *Plesiadiadema antillarum*. Zeiss. AA. Oc. 3.  
 — 33. Valve of small tridentate pedicellaria of *Micropyga tuberculata* (comp. Fig. 37). Zeiss. AA. Oc. 3.  
 — 34. — — — — — tridentate pedicellaria of *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. 0.  
 — 35. — — — — — - *Chætodiadema granulatum* (comp. Fig. 22). Zeiss. AA. Oc. 1.  
 — 36. — — — — — - *Parasalenia gratiosa*. Zeiss. AA. Oc. 1.  
 — 37. — — — — — - *Micropyga tuberculata* (comp. Fig. 33). Zeiss. AA. Oc. 1.

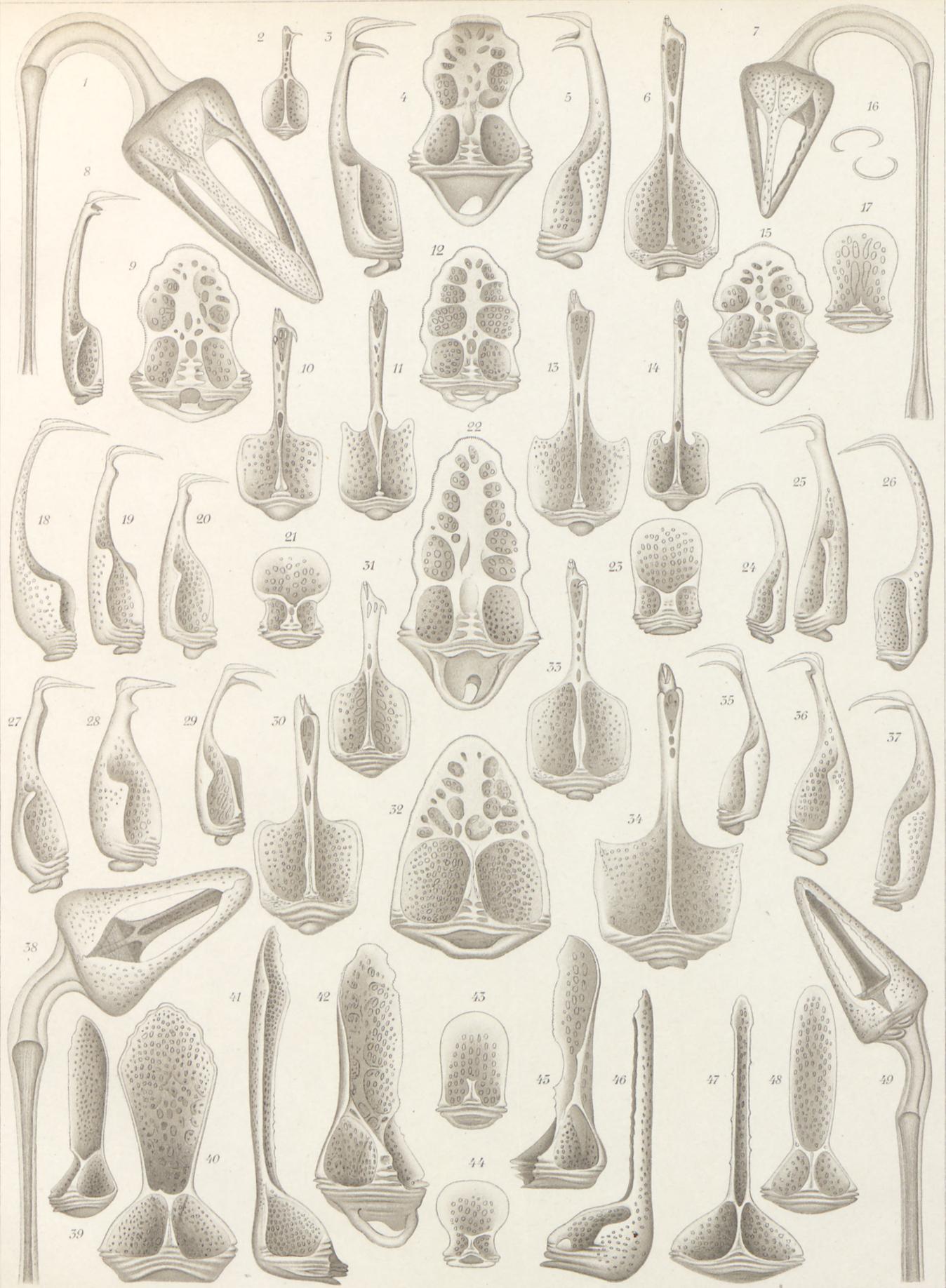


## Plate VI.

Opechinus variabilis 27. O. spectabilis 42. Temnopleurus toreumaticus 8, 14, 22, 49. T. Hardwickii 32, 34. T. Reevesii 3, 10, 12. Salmacis sphaeroides 1, 11, 41. S. bicolor 2, 4, 23, 26, 39, 40. S. virgulata 7, 18, 46, 47. Pleurechinus bothryoides 5, 6, 38. Pl. maculatus 20, 44. Pl. siamensis 16, 36. Pl. scillae 13. Pl. ruber 28. Pl. Döderleini 35, 43. Salmacopsis olivacea 25, 30. Microcyphus maculatus 19. M. annulatus 15, 29, 31. M. elegans 24. Mespilia globulus 17. Amblypneustes formosus 9, 37. A. pallidus 48. A. grossularia 21, 33. Gymnechinus inconspicuus 45.

For all the figures of this plate a Zeiss instrument was used.

- Fig. 1. Tridentate pedicellaria of *Salmacis sphaeroides*. AA. Oc. 1.  
 — 2. Valve of globiferous pedicellaria of *Salmacis bicolor* (comp. large form Fig. 26). AA. Oc. 3.  
 — 3. — - — - — - *Temnopleurus Reevesii*; side view (comp. Fig. 10). Apochr. 8·0. Oc. 1.  
 — 4. Valve of ophicephalous pedicellaria of *Salmacis bicolor*. AA. Oc. 3.  
 — 5. — - globiferous — - *Pleurechinus bothryoides*; side view. D. Oc. 1.  
 — 6. — - — - — - front — — —  
 — 7. Tridentate pedicellaria of *Salmacis virgulata*. AA. Oc. 1.  
 — 8. Valve of globiferous pedicellaria of *Temnopleurus toreumaticus*; side view (comp. Fig. 14). Apochr. 8·0. Oc. 1.  
 — 9. Valve of ophicephalous pedicellaria of *Amblypneustes formosus*. Apochr. 8·0. Oc. 1.  
 — 10. — - globiferous — - *Temnopleurus Reevesii*; front view (comp. Fig. 3). Apochr. 8·0. Oc. 1.  
 — 11. Valve of globiferous pedicellaria of *Salmacis sphaeroides*. AA. Oc. 2.  
 — 12. — - ophicephalous — - *Temnopleurus Reevesii*. Apochr. 3·0. Oc. 1.  
 — 13. — - globiferous — - *Pleurechinus scillae*. D. Oc. 1.  
 — 14. — - — - — - *Temnopleurus toreumaticus*; front view (comp. Fig. 8). Apochr. 8·0. Oc. 1.  
 — 15. Valve of ophicephalous pedicellaria of *Microcyphus annulatus*. Apochr. 8·0. Oc. 1.  
 — 16. Spicules from buccal membrane of *Pleurechinus siamensis*. D. Oc. 1.  
 — 17. Valve of triphyllous pedicellaria of *Mespilia globulus*. D. Oc. 2.  
 — 18. — - globiferous — - *Salmacis virgulata*. AA. Oc. 2.  
 — 19. — - — - — - *Microcyphus maculatus*; side view (comp. Pl. VII. 20). Apochr. 8·0. Oc. 1.  
 — 20. Valve of globiferous pedicellaria of *Pleurechinus maculatus*; side view (comp. Pl. VII. 17). D. Oc. 1.  
 — 21. Valve of triphyllous pedicellaria of *Amblypneustes grossularia*. D. Oc. 1.  
 — 22. — - ophicephalous — - *Temnopleurus toreumaticus*. Apochr. 8·0. Comp. Oc. 4.  
 — 23. — - triphyllous — - *Salmacis bicolor*. Apochr. 8·0. Comp. Oc. 4.  
 — 24. — - globiferous — - *Microcyphus elegans*; side view (comp. Pl. VII. 38). D. Oc. 1.  
 — 25. Valve of globiferous pedicellaria of *Salmacopsis olivacea*; side view (comp. Fig. 30). Apochr. 8·0. Comp. Oc. 4.  
 — 26. Valve of globiferous pedicellaria, large form, of *Salmacis bicolor* (comp. Fig. 2). AA. Oc. 3.  
 — 27. — - — - — - of *Opechinus variabilis*; side view (comp. Pl. VII. 2). Apochr. 8·0. Comp. Oc. 4.  
 — 28. Valve of globiferous pedicellaria of *Pleurechinus ruber*; side view (comp. Pl. VII. 6). D. Oc. 1.  
 — 29. — - — - — - *Microcyphus annulatus*; side view (comp. Fig. 31). D. Oc. 1.  
 — 30. — - — - — - *Salmacopsis olivacea*; front view (comp. Fig. 25). Apochr. 8·0. Comp. Oc. 4.  
 — 31. Valve of globiferous pedicellaria of *Microcyphus annulatus*; front view (comp. Fig. 29). D. Oc. 1.  
 — 32. — - ophicephalous — - *Temnopleurus Hardwickii*. Apochr. 8·0. Oc. 1.  
 — 33. — - globiferous — - *Amblypneustes grossularia*. AA. Oc. 3.  
 — 34. — - — - — - *Temnopleurus Hardwickii*; front view (comp. Pl. VII. 21). Apochr. 8·0. Oc. 1.  
 — 35. Valve of globiferous pedicellaria of *Pleurechinus Döderleini*; side view (comp. Pl. VII. 10). D. Oc. 1.  
 — 36. — - — - — - *siamensis*; — — ( — Pl. VII. 14). —  
 — 37. — - — - — - *Amblypneustes formosus*; — — ( — Pl. VII. 4 ). —  
 — 38. Tridentate pedicellaria of *Pleurechinus bothryoides*. Apochr. 8·0. Oc. 1.  
 — 39. Valve of small tridentate pedicellaria of *Salmacis bicolor*. AA. Oc. 3.  
 — 40. — - large — — — — (comp. Pl. VII. 1). AA. Oc. 2.  
 — 41. — - tridentate pedicellaria of *Salmacis sphaeroides*. AA. Oc. 2.  
 — 42. — - — - — - *Opechinus spectabilis*. Apochr. 8·0. Oc. 1.  
 — 43. — - triphyllous — - *Pleurechinus Döderleini*. D. Oc. 2.  
 — 44. — - — - — - *maculatus* — 1.  
 — 45. — - tridentate — - *Gymnechinus inconspicuus*. D. Oc. 1.  
 — 46. — - — - — - *Salmacis virgulata*; side view. AA. Oc. 3.  
 — 47. — - — - — - front — — —  
 — 48. — - — - — - *Amblypneustes pallidus*. Apochr. 8·0. Comp. Oc. 4.  
 — 49. Tridentate pedicellaria of *Temnopleurus toreumaticus*. AA. Oc. 1.



## Plate VII.

Opechinus variabilis 2, 7, 49. O. spectabilis 18, 19, 27, 45. Temnopleurus toreumaticus 3, 28. T. Hardwickii 21. T. Reevesii 37. Salmacis bicolor 1. S. virgulata 40. S. dussumieri 15. Pleurechinus bothryoides 5, 9, 51. Pl. maculatus 17. Pl. siamensis 14, 44, 53. Pl. similis 25. Pl. ruber 6. Pl. Döderleini 10, 48. Salmacopsis olivacea 23. Mespilia globulus 16, 22, 33, 47. Microcyphus maculatus 20, 31. M. elegans 38. Amblypneustes formosus 4, 13. A. ovum 11, 50. A. pallidus 12, 42. A. grossularia 52. Holopneustes purpurascens 32. Psammechinus rufus 34, 43. Gymnechinus pulchellus 8, 29, 36, 41, 46. G. versicolor 24, 26, 30. G. inconspicuus 39, 54. Echinometra oblonga 35.

For all the figures of this plate a Zeiss instrument was used.

- Fig. 1. Valve of tridentate pedicellaria, large form, of *Salmacis bicolor* (comp. Pl. VI. 40). AA. Oc. 2.  
 — 2. — - globiferous — of *Opechinus variabilis*; front view (comp. Pl. VI. 27). Apochr. 8·0. Comp. Oc. 4.  
 — 3. Valve of tridentate pedicellaria of *Temnopleurus toreumaticus*. AA. Oc. 3.  
 — 4. — - globiferous — - *Amblypneustes formosus*; front view (comp. Pl. VI. 37). D. Oc. 1.  
 — 5. — - triphyllous — - *Pleurechinus bothryoides*. D. Oc. 1.  
 — 6. — - globiferous — - — *ruber*; front view (comp. Pl. VI. 28). D. Oc. 1.  
 — 7. — - triphyllous — - *Opechinus variabilis*. Apochr. 8·0. Comp. Oc. 4.  
 — 8. — - globiferous — - *Gymnechinus pulchellus* — —  
 — 9. — - tridentate — - *Pleurechinus bothryoides*. — —  
 — 10. — - globiferous — - — *Döderleini*; front view (comp. Pl. VI. 35). D. Oc. 1.  
 — 11. — - tridentate — - *Amblypneustes ovum*. AA. Oc. 3.  
 — 12. — - triphyllous — - — *pallidus*. D. Oc. 1.  
 — 13. — - — — — *formosus* — —  
 — 14. — - globiferous — - *Pleurechinus siamensis*; front view (comp. Pl. VI. 36). D. Oc. 1.  
 — 15. Spicules from *Salmacis dussumieri*; a. from genital organs, b from stone canal, c. from intestine. Apochr. 8·0. Comp. Oc. 4.  
 — 16. Valve of globiferous pedicellaria of *Mespilia globulus*; front view (comp. Fig. 22). D. Oc. 1.  
 — 17. — - — — - *Pleurechinus maculatus*; front view comp. Pl. VI. 20). D. Oc. 1.  
 — 18. — - — — - *Opechinus spectabilis*; side view. Apochr. 8·0. Oc. 2.  
 — 19. — - — — - — — front — — —  
 — 20. — - — — - *Microcyphus maculatus*; front view (comp. Pl. VI. 19). Apochr. 8·0. Oc. 1.  
 — 21. Valve of globiferous pedicellaria of *Temnopleurus Hardwickii*; side view (comp. Pl. VI. 34). Apochr. 8·0. Oc. 1.  
 — 22. Valve of globiferous pedicellaria of *Mespilia globulus*; side view (comp. Fig. 16). D. Oc. 1.  
 — 23. — - triphyllous — - *Salmacopsis olivacea*. D. Oc. 1.  
 — 24. Spicules of *Gymnechinus versicolor*; a from buccal membrane, b. from ophicephalous pedicellaria, c. from tube feet; d from globiferous pedicellaria. D. Oc. 3.  
 — 25. Valve of globiferous pedicellaria of *Pleurechinus scillæ*. D. Oc. 1.  
 — 26. — - triphyllous — - *Gymnechinus versicolor*. D. Oc. 1.  
 — 27. — - — — - *Opechinus spectabilis*. D. Oc. 1.  
 — 28. — - — — - *Temnopleurus toreumaticus*. D. Oc. 1.  
 — 29. — - tridentate — - *Gymnechinus pulchellus*. AA. Oc. 3.  
 — 30. — - — — - — *versicolor* — —  
 — 31. — - ophicephalous — - *Microcyphus maculatus*. Apochr. 8·0. Oc. 1.  
 — 32. — - — — - *Holopneustes purpurascens*. AA. Oc. 3.  
 — 33. — - — — - *Mespilia globulus*. Apochr. 8·0. Oc. 1.  
 — 34. — - tridentate — - *Psammechinus rufus*. AA. Oc. 2.  
 — 35. — - — — - *Echinometra oblonga*. AA. Oc. 3.  
 — 36. — - triphyllous — - *Gymnechinus pulchellus*. D. Oc. 1.  
 — 37. Spicules from tubefoot of *Temnopleurus Reevesii*. Apochr. 8·0. Comp. Oc. 4.  
 — 38. Valve of globiferous pedicellaria of *Microcyphus elegans*; front view (comp. Pl. VI. 24.). D. Oc. 1.  
 — 39. Tridentate pedicellaria of *Gymnechinus inconspicuus*. Apochr. 8·0. Oc. 1.  
 — 40. Valve of ophicephalous pedicellaria of *Salmacis virgulata*. AA. Oc. 3.  
 — 41. — - — — - *Gymnechinus pulchellus*. Apochr. 8·0. Comp. Oc. 4.  
 — 42. — - — — - *Amblypneustes pallidus*. — — —  
 — 43. — - — — - *Psammechinus rufus*. Apochr. 8·0. Comp. Oc. 4.  
 — 44. — - — — - *Pleurechinus siamensis*. D. Oc. 1.  
 — 45. Tridentate pedicellaria of *Opechinus spectabilis*. AA. Oc. 3.  
 — 46. Spicules from globiferous pedicellaria of *Gymnechinus pulchellus*. D. Oc. 3.  
 — 47. Valve of tridentate pedicellaria of *Mespilia globulus*. D. Oc. 1.  
 — 48. — - ophicephalous — - *Pleurechinus Döderleini*. D. Oc. 1.  
 — 49. — - — — - *Opechinus variabilis*. Apochr. 8·0. Comp. Oc. 4.  
 — 50. — - — — - *Amblypneustes ovum*. AA. Oc. 3.  
 — 51. — - — — - *Pleurechinus bothryoides*. Apochr. 8·0. Comp. Oc. 4.  
 — 52. — - — — - *Amblypneustes grossularia*. — — —  
 — 53. — - triphyllous — - *Pleurechinus siamensis*. D. Oc. 1.  
 — 54. — - — — - *Gymnechinus inconspicuus*. D. Oc. 1.

