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Notes on some Scandinavian Echinoderms, with descriptions of two new Ophiurids.

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Notes on some Scandinavian Echinoderms, with descriptions of two new Ophiurids.

By
Dr. **Th. Mortensen.**

The preparation of the volume on the Echinoderms for the work „Danmarks Fauna" has made it a necessity for me to enter on several questions, systematic or nomenclatorial, concerning some of the Echinoderms of our seas. The said work being of a more popular character and in the same time written in the Danish language I deem it my duty to publish in a separate paper, partly the description of a pair of new species of Echinoderms from the Scandinavian seas, partly a few critical notes on some of these species, relating now to their specific characters, now to nomenclatorial questions connected with them.

The notes here given have mainly reference to the Ophiurids. That no Holothurian is mentioned in this paper needs not mean that I have nothing to say regarding that group. It is in the first line due to the fact that I have not yet had the opportunity of working up the Holothurians for the said work. But, in any case, I have thought it proper to publish these notes without any further delay.

1. Ophioscolex purpureus Düben & Koren (Fig. 1).

Recently Grieg has come to the result that this species cannot really be distinguished from *O. glacialis* M. & Tr. but that it is nothing but a smaller boreal variety (or racial form — „Avændring" — of the more robust arctic species *O. glacialis*[1]). The result

[1]) See especially: James A. Grieg. Bidrag til kundskapen om Hardangerfjordens fauna. Bergens Museums Arbok 1913, 1, p. 125—30. Also the same authors: Sognefjordens Echinodermer. Arch. f. Math. & Naturvid., XXXII, Nr. 11, 1912, p. 8.

of my examination of quite an extensive material of the two named forms is absolutely at variance with the result arrived at by Grieg, whereas I must, upon the whole, confirm the statements of M. Sars (Norges Echinodermer, p. 8—12). I hope the following notes will convince also Grieg that there cannot be the slightest doubt that *O. purpureus* is a very well distinguished species, which —

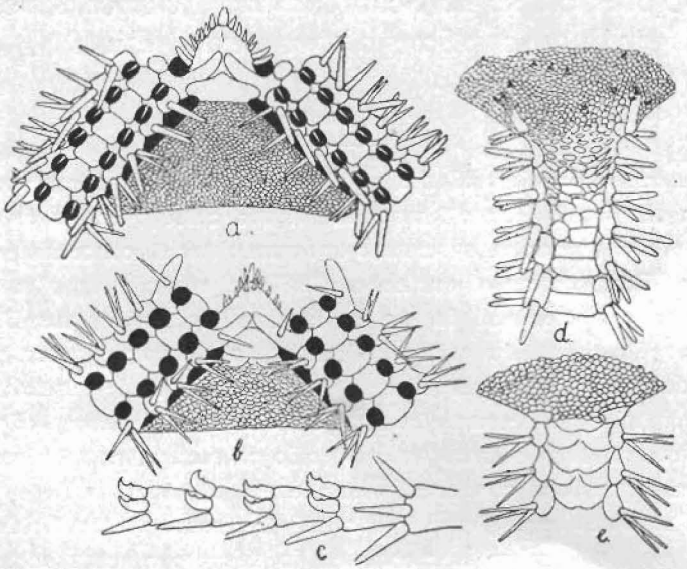

Fig. a, c, d. *Ophioscolex purpureus*; b, e. *O. glacialis*. a, b. ventral side, d, e. dorsal side, showing radial shields and base of arm. c. side view of arm, outer part. $^6/_1$.

on a closer examination — is always easily distinguishable from *O. glacialis*.

The mouth papillæ do not afford any very reliable distinction between the two species; but, upon the whole, they are somewhat more numerous in *purpureus* than in *glacialis*, as mentioned by Sars; they are generally 6—10 in *purpureus*, distributed along the whole mouth edge, the two outer ones being as a rule larger than the rest; in *glacialis* there are 3—6 papillæ, situated at the inner part of the mouth angle, in larger specimens sometimes with an irregular bunch of papillæ at the point. The mouth shields and adoral plates afford more reliable distinguishing characters, especially the latter. In *glacialis* the mouth shields are small, triangular, and the adoral plates carry a spine, sometimes two,

over the second tubefoot; in *purpureus* the mouth shields are considerably broader and there is no spine on the adoral plates. (Fig. 1, a—h).

While the ventral plates are about of the same shape in the two species, the dorsal plates look very different. In *glacialis* they are so little developed as to be observable only on a microscopical examination; what is seen in dried specimens is not the dorsal plates, as Sars believed, but only the vertebræ (Fig. 1, e). In *purpureus* they are well developed, covering the whole dorsal side of the arm, so that in dried specimens the vertebræ are not seen; in the inner part of the arm they are irregular in shape, farther out there are two of them for each joint, as correctly described by Sars (Fig. 1, d). — A microscopical examination of the skin covering the dorsal side of the arm shows, however, that the only real difference in the dorsal plates of the two species is this, that they are much more delicate in *glacialis* than in *purpureus*; the shape is in reality the same, and also in *glacialis* they are divided in two parts exactly as in *purpureus*.

A very good, and perfectly constant, distinguishing character is afforded by the armspines. In *O. purpureus* the two upper spines in the outer part of the arm are transformed into hooks, which is never the case in *glacialis* (Fig. 1, c). This feature was noticed by Sars (p. 9), who also gave a good figure to illustrate it (Pl. I, fig. 10); only he makes the wrong statement that it is the two lower spines which are thus transformed, while in fact it is really the two upper, contrary to what is otherwise the rule in Ophiurids, where spines are transformed into hooks. — It is, indeed, curious that Grieg has overlooked this fact; had he noticed these transformed spines, he would certainly never have come to the result that *O. purpureus* should be nothing but a variety of *glacialis*. The difference in the general character of the armspines — thick and smooth in *purpureus*, thin and slender, covered with a thick coat of skin in *glacialis*, is well pointed out by Sars and is seen also in the figures.

To these characters must be added the absence of footpapillæ in *glacialis* and the presence of one, slender footpapilla in *purpureus* — though perhaps not constantly present at all the pores, as maintained by Grieg; these papillæ are very slender and in-

conspicuous, especially when standing erect; in specimens not dried they are seen to support a small triangular flap of skin covering the base of the tentacle at its proximal side. Further the disk of *O. purpureus* is set with scattered, small spines, while in *glacialis* it is entirely smooth. In alcoholic specimens these spines are hard to see, but I have found them quite constantly in dried specimens, though in varying numbers. Also the radial shields are longer and more developed in *purpureus* than in *glacialis* (Figs. 1, d, e). — In the internal anatomy there seems to be no essential difference between the two species.

O. glacialis grows to a much larger size than *purpureus*; the largest specimens of the former species at my disposal measure ca. 35 mm in diameter of disk, while the largest specimens of *purpureus* that I have seen, measure only ca. 15 mm in diameter of disk.

The presence of spines on the disk of *O. purpureus* approaches this species to the genus *Ophiobyrsa* and makes it doubtful, whether the latter can really be maintained as a separate genus. This, of course, sounds rather paradoxical, since *Ophiobyrsa* is regarded in modern classification of Ophiurids (Matsumoto) as the type of a separate subfamily, *Ophiobyrsinæ*, of the family *Ophiomyxidæ*, the difference between the two subfamilies even being regarded as „very sharp". Nevertheless, I think I am right, and the supposed differences between the two subfamilies appear to me rather unessential and confluent. At present, I cannot, however, enter on a detailed discussion of the question, — also for the reason that the material of *Ophiobyrsa* and related genera available is rather unsatisfactory.

2. Ophiomitrella clavigera (Ljungman) (Fig. 2).

The species described by Ljungman under the name of *Ophiactis clavigera* was shown by Lütken[1]) to have nothing to do with the genus *Ophiactis*, its true affinities being with the genus *Ophiacantha*. Thinking that this species might possibly be identical with O. Fr. Müller's „*Asterias tricolor*", he then named it *Ophiacantha tricolor* (Abgd.). The latter identification, however,

[1]) Lütken. Additamenta ad hist. Ophiuridarum. III. p. 32 (50).

is beyond doubt a mistake, the „*Asterias tricolor*" being evidently an *Ophiothrix* (perhaps *O. Lütkeni*). — But in any case Lütken saw correctly the affinity of this Ophiurid with the Ophiacanthids. Lyman („Challenger" Oph. p. 201) removed the species to his new genus *Ophiolebes*, and since then it has been left there by the few authors who have mentioned it, thus by myself in Conspectus Faunæ Groenlandicæ, Echinodermer[1]) and by H. L. Clark in his Catalogue of Recent Ophiurans.[2]) Doubtless it is also possible to find among the species referred to *Ophiolebes* such as bear a considerable resemblance to *O. claviger*. Nevertheless, if we compare it with the type species, *O. scorteus* Lym., with its thick investing skin, covering disk and arms and concealing even the armplates, it is evident that it is by no means nearly related to that species and that it can hardly belong to the same genus. And then it proves to fit so well to the diagnosis of the genus *Ophiomitrella* Verrill that I cannot hesitate in referring it to that genus. Farran, in his paper on the deep-water Asteroidea, Ophiuroidea and Echinoidea of the West Coast of Ireland (Fisheries Ireland, Sci. Invest. 1912. VI. (1913), p. 44), also suggested that the species ought to be removed from the genus *Ophiolebes* and „placed with that group of species which includes *Ophiacantha normani* Lyman, *Ophiacantha cataleimmoida* H. L. Clark, *Ophiacantha oididisca* H. L. Clark, *Ophiomitra globulifera* Koehler, *Ophiomitra relicta* Koehler and *Ophiomitrella cordifera* Koehler". This is, on the other hand, a „group" no less unnatural than that from which Farran suggests to remove the species in question; and, moreover, he still leaves the species in the genus *Ophiolebes*. (I shall not enter on a discussion of the other species referred to *Ophiolebes*, but I have no doubt that they do not rightly belong there all of them).

In the „Échinodermes provenant d. campagnes du yacht Princesse Alice"[3]) Koehler describes and figures (Pl. XXIX, 1—2) a species, *Ophiomitrella cordifera*, which is evidently very closely related to, perhaps even identical with *O. clavigera*. The distinguishing characters are, judging from Koehler's description and

[1]) Medd. om Grønland. XXIII. 1913. p. 361.
[2]) Mem. Mus. Comp. Zool. Vol. XXV. 1915. p. 193.
[3]) Res. Camp. Scientif. Monaco. Fasc. XXXIV. 1909. p. 192.

figures, the somewhat more globular shape of the stumps on the disk in *cordifera* and the different form of the oral shield and the dorsal plates. The latter, however, are rather variable in *clavigera*, in some specimens (notably in one of Ljungman's cotypes from the Skagerrak) very distinctly rhombic, in others with the outer border more rounded. The oral shield I have never seen exactly of the shape given by Koehler for *cordifera*, but it is also rather variable in shape, often quite irregular. Also the length of the spines varies to no small extent, thus in the cotype mentioned they are distinctly shorter and thicker than in the specimen figured here (from Greenland). The stumps on the disk I have never seen so globular as Koehler figures them, but I would not be inclined to think that character alone a valid specific difference. I am therefore very much inclined to think that *O. cordifera* will prove to be identical with *clavigera*. — I would suggest also the possibility that *Ophiolebes acanella* Verrill is identical with *O. clavigera*. From the description given by Verrill it is impossible to see how it is to be distinguished from that species; but as no figures have, so far as I know, been published of *O. acanellæ*, nothing can be said definitely about the question.

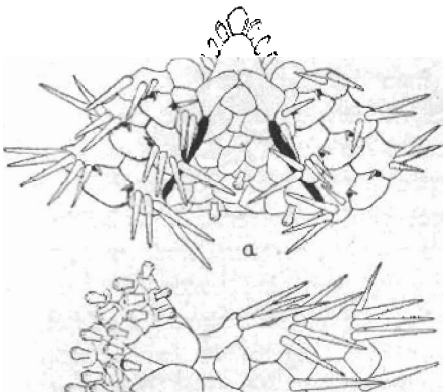

Fig. 5. *Ophiomitrella clavigera*.
a. ventral side. b. dorsal side. 9/1.

As I have shown in my paper on „Hermaphroditism in viviparous Ophiurids“ [1]) this species is viviparous and, besides, a proterandric hermaphrodite. Moreover, it is interesting in being the host of a very remarkable (as yet undescribed) parasitic Crustacean, probably a Copepod, with 4 egg sacs. The specimens infested by the parasite are totally castrated by it.

3. Ophiocomina nigra (O. F. Müller).

It was pointed out by Lyman (Challenger-Ophiuroidea. p. 168) that this species, hitherto named *Ophiocoma nigra*, differs from

[1]) Acta Zoologica. I. 1920.

the other species of the genus *Ophiocoma* in having hollow arm-spines as also in having a large and thick peristomial plate, this plate being narrow, linear, divided in two pieces in the other species. — Although stating that the character of the hollow spines draws this species towards the genus *Ophioconis*, Lyman leaves it in the genus *Ophiocoma*, to which it was referred by the previous authors (Forbes, Müller & Troschel, Lütken), and there it has remained until now H. L. Clark in his Catalogue of Recent Ophiurids p. 205 has taken the rather startling step of removing it to the genus *Ophiacantha*, and moreover of changing the old species name *nigra* (O. F. M.) into *sphærulata* Pennant, designating it thus *Ophiacantha sphærulata* (Penn.). Before giving up the old, well known name of this common Scandinavian Ophiurid, however, a careful examination of the questions involved is needed. It is evident, that only the most cogent reasons can induce us to follow Clark in adopting that totally unfamiliar name instead of the name *Ophiocoma nigra*, familiar not only to all the naturalists of Scandinavia and Northern Europe, but, it may well be said, to Zoologists in general.

There are two main questions here: 1) to which genus it should really be referred, 2) the identification with Pennant's „Asterias sphærulata".

The differences between *O. nigra* and the other species of *Ophiocoma* pointed out by Lyman are real enough; especially the character of the spines is a noteworthy difference. To this I would add another conspicuous difference. In all the tropical species of *Ophiocoma* the teeth are provided with a very conspicuous point of an enamel-like structure (also found in *Ophiomastix*); in *O. nigra* the teeth are devoid of this structure. (Lyman, Chall. Oph. p. 168, mentions this point in the anatomy of *Ophiocoma*, stating that the teeth have „a quasi-enamelled grinding end" and gives a figure therof, Pl. XLII, Fig. 13, which does, however, hardly convey a very good impression of this striking feature; he does not notice that it is not found in *O. nigra*). — It seems to me that these points of difference are really of sufficient weight for removing our North Atlantic species from the genus *Ophiocoma*. — Most probably also the larvæ will prove to differ essentially; however, this point is not yet sufficiently established.

As pointed out by Lyman *O. nigra* recalls to some extent the genus *Ophioconis*. However, this resemblance is evidently a more superficial character. *Ophioconis* (with its subdivisions) is referred by Matsumoto — and correctly I do not doubt — to the family of Ophiodermatidæ; its appressed arm-spines alone afford a very prominent difference from *O. nigra*; there is no necessity for a detailed discussion of the relations between these forms; surely nobody would maintain in earnest that *O. nigra* could belong to that genus.

But then *Ophiacantha*! In view of the fact that the Ophiacanthidæ and the Ophiocomidæ are referred by Matsumoto to two different orders, the former to the Læmophiurida, the latter to the Chilophiurida, one should expect that Clark had produced very strong reasons for removing *O. nigra* to *Ophiacantha*. This he has not at all done. Without entering on a discussion of Matsumoto's orders, which I do not think quite acceptable — especially the order Læmophiurida, comprising the Ophiacanthidæ and the Hemieuryalidæ, is, in my opinion, quite unnatural — I must state that I find the referring of *O. nigra* to the genus *Ophiacantha* quite unjustifiable. In regard to the inner anatomy it is about intermediate between *Ophiacantha* and the typical *Ophiocoma*'s, though somewhat nearer to the latter. The wings of the first vertebræ are decidedly larger than in *Ophiacantha*, though not nearly so large as in *Ophiocoma*. (— Apparently the strong development of the wings in *Ophiocoma* has some connection with the peculiar mouth armature; the powerful muscles attached to these wings must enable it to very active movements with its jaws, and the enamel point of the teeth in the same time bear witness of an exceptional masticating power —). In regard to the peristomial plates and the articulation between the genital plate and the radial shield it is much more like *Ophiocoma* than *Ophiacantha*. Thus there is no support for its affinity to *Ophiacantha* to be found in its inner anatomy. And then there is a very essential difference, which Clark appears to have completely disregarded, viz. the presence of tooth papillæ in *O. nigra*, which character is not found in *Ophiacantha*. And — in spite of all efforts, especially by Matsumoto, to find characters of greater systematic value — it is hardly possible to point out such structures of greater value than the mouth armature. But this character

decidedly assigns to *O. nigra* a place among the Ophiocomidæ, not among the Ophiacanthidæ. It is also worth mentioning that the black color of *O. nigra* would make it absolutely unique among the Ophiacantha's, while it is the usual coloration among the Ophiocoma's.

After all I cannot doubt that the natural place of *O. nigra* is among the Ophiocomidæ, but that it must form a separate genus within that family.

Having been informed by my friend, Prof. R. Koehler, Lyon, that he has come to the same result and, in a memoir now in press, has proposed the name *Ophiocomina* for the new genus established for this species, I can only accept that name.

Regarding the second point, the identification with Pennant's „*Asterias sphærulata*", I cannot agree with Clark either. Pennant's figure of this species (British Zoology, Vol. IV, 1777, Tab. XXXII, fig. 63) is so poor that it is really impossible to identify it with any degree of certainty; that it is one of those species with not appressed spines, is certain, but it may be said equally well — or badly — to represent any of the three common British Ophiurids to which this character applies, viz. *Ophiopholis aculeata*, *Ophiothrix fragilis* and *Ophiocoma nigra*. (*Amphiura* is out of question). The text (Op. cit. p. 63) does not mention a single feature which could give the definite proof that the species meant is *O. nigra*. It runs thus: „Ast. with a pentagonal body, smooth above the aperture; below five-pointed; between the base of each ray a small globular bead; the rays slender, jointed, taper; hirsute on their sides." It is a model of a bad description. To change the commonly used and familiar specific name *nigra* on account of this description and figure into *sphærulata* seems to me quite unpardonable. If it were a thing greatly to be desired to make this change it might perhaps be done on this account, since there is a possibility that Pennant really meant *O. nigra* with his *Ast. sphærulata*; but since it would undeniably be a most undesirable change, there is really not the slightest reason to do so, even for those who want to carry out the priority rule literally, without regard to the unhappy consequences of that fatal rule.

The name of this species must then be: *Ophiocomina nigra* (Abildgård).

The form described by Sars[1]) as *Ophiocoma Raschi* cannot be maintained as a species separate from *O. nigra*. All the characters pointed out by Sars as specific differences from *O. nigra* (the shape of the ventral plates, the shape of the mouth shields, the number of mouth papillæ) are so variable that they cannot afford any reliable distinguishing character. Also the number of armspines can be 7 on the proximal armjoints in the typical *O. nigra*, as it is in *O. Raschi*. — After having examined the type specimens of *O. Raschi*, which were kindly lent me for examination by Dr. E. Arnesen of the Kristiania Museum, I cannot have the slightest hesitation in declaring that *Ophiocoma Raschi* Sars is nothing than a more robust deep water variety of *O. nigra*. I am informed by Prof. Koehler that he has come to the same result. — From another point of view it would be more natural to regard the large form occurring in the Atlantic from the Azores to Norway as the typical form and the smaller form occurring in the Kattegat and the Norwegian fjords — partly in very shallow water, on Laminariæ — as a minor, somewhat dwarfed variety. Since, however, the latter is the form described by Abildgård, there can, from a litterary point of view, be no question that this must range as the typical form of the species.

4—5. **Amphiura borealis** (G. O. Sars) and **Amphiura securigera** (Düb. & Kor.).

(Fig. 3, a—f).

These two species appear to be, upon the whole, comparatively rare, being mentioned rather seldom in literature, and the material preserved in the museums is quite scarce. The discovery by the late Miss Elisabet Petersson of the Gothenburg Museum that *Amph. borealis* is viviparous induced me to undertake a more close examination of this species, which led to the further discovery that the species is also a proterandric hermaphrodite.[2]) The material of the species preserved in the Copenhagen Museum being insufficient for the anatomical research I applied to the Bergen Mu-

[1]) G. O. Sars. Bidrag til Kundskaben om Dyrelivet på vore Havbanker. Forh. i Vidensk. Selsk. Christiania. År 1872. (1873). p. 109.

[2]) See the authors paper „Hermaphroditism in viviparous Ophiurids". Acta Zoologica. I. 1920.

seum for some more material, which was very kindly sent me, together with a few specimens of *Amph. securigera*, which latter species I wanted likewise to study. On receiving this material I was surprised in finding, partly that a confusion of the two species *A. borealis* and *securigera* had taken place, partly that among the specimens sent there was one representing a third species of *Amphiura* not only new to the Scandinavian fauna, but also new to science, viz. that described below as *Amphiura Griegi* n. sp.

The reason why these species have been confounded,[1]) evidently, is this, that no quite satisfactory figures have been given of *A. securigera* (— although it must be conceded that the figures given by Düben & Koren[2]) show most of the specific characters quite distinctly —), while no figures at all have been given of *A. borealis*. I have therefore thought it desirable to point out more precisely the characters distinguishing the said species, giving in the same time figures of both.

The main distinguishing character of the species *borealis* and *securigera* is found in the shape of the radial shields and in the scaling of the disk (Figs. 3, b, e). The radial shields are narrow, linear and parallel in *securigera*, while in *borealis* they join at their outer end but are diverging inwardly. In *A. securigera* the disk is entirely naked, with merely a trace of scales at the inner end of the radial shields; in *borealis* the disk is distinctly scaled, the scales being very well developed round the radial shields, while in the middle of the disk they are more sparse, lying not quite close together and not overlapping. In the interradii the scales gradually disappear, so that the disk is naked towards the margin. — The statement of Sars (Norges Echinodermer, p. 14) that on drying the specimens of *A. securigera* very thin, imbricating microscopical scales appear distinctly, is in disagreement herewith. I can hardly doubt that in this case Sars must have mistaken specimens of *borealis* for *securigera*. In all the specimens of *securigera* that I have seen the skin is perfectly naked; on clearing the skin in

[1]) I have also seen another case (not published), where *A. borealis* was identified as *A. securigera*, and probably such confusion will prove to be only too common.

[2]) Düben & Koren. Öfversigt öfver Skandinaviens Echinodermer. K. Vet. Akad. Handl. 1844. Tab. VI. 3—6.

Canada balsam it is seen that there is really not a trace of scales in the middle of the disk, while only a very few, small scales are found covering the inner end of the radial shields.

Another character, the length of the arms, which is, according to Sars, 6—7 times the diameter of disk in *borealis*, while in *securigera* it is as much as 12—15 times the diameter of disk,

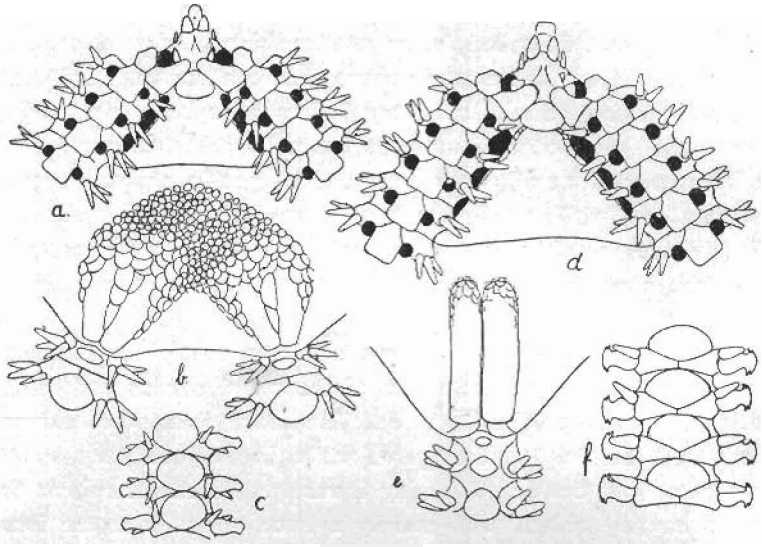

Fig. 3. a—c. *Amphiura borealis*; d—f. *A. securigera*.
a. and d. ventral side, b. and e. dorsal side, c. and f. part of arm from the dorsal side, showing the widened armspines. $^{14}/_{1}$.

gives also a good distinguishing character — when well preserved specimens are dealt with; unfortunately, these species appear to be very fragile, the arms very easily breaking, so that this character is practically of very little use. One small tentacle scale may occur fairly regularly farther out on the arms of *securigera*; in *borealis* I have never seen a trace thereof. In the oral parts and ventral plates (Figs. 3, a, d) no distinct difference exists between the two species, whereas the dorsal plates afford a good distinguishing character, being more rounded in *borealis* than in *securigera*, and also contiguous in *borealis*, while they are distinctly separated from one another in *securigera*. Finally the development of the axeshape of the second armspine is much stronger in *securigera* than in *borealis* (Figs. 3, c, f).

To these differences come the important characters from the inner anatomy, *borealis* being viviparous and hermaphroditic (proterandric), with only one single interradial gonod at each bursa, while *A. securigera* is not viviparous and has 3—4 gonads at the interradial side of the bursæ and — sometimes, at least, — one at the adradial side (observed only in a male specimen).

The two species are thus in reality so distinct that, on a careful examination, the identification can never be doubtful, but it may sometimes be necessary to dry the specimens in order to see the characters distinctly.

It might seem superfluous thus to discuss the differences between these two species, since according to the recent classification of Ophiurids they are referred to different genera, viz. *securigera* to the genus *Amphiodia* Verrill, while *borealis* is retained in the genus *Amphiura* s. str. It is, however, by no means superfluous to discuss their distinguishing characters, partly in view of the fact that they have really been confounded, partly because the difference between the two said genera is so very slight, consisting in fact only in a little difference in the mouth papillæ, *Amphiodia* having two outer mouthpapillæ, while *Amphiura* s. str. has only one. I find, moreover, that this character is by no means constant in *securigera*, and also in *borealis* there are sometimes two outer mouth papillæ. To refer these two species to different genera for this sole reason seems to me quite unreasonable, the two species being otherwise so closely alike that there can be no doubt, they are really nearly related. In fact, I think Sars is quite right in regarding them as related to *Amphiura filiformis* — which has the same peculiar axeshaped armspine, though not so strongly developed. In case these species should be separated from *Amphiura* s. str. the old name *Ophiopeltis* Düb. Kor. would have to be used for them, not the name *Amphiodia* Verril. But I do not think there is sufficient reason for a generic distinction.

It is funny to see that Bell in his Catalogue of British Echinoderms (p. 121) declares *A. securigera* „allied to *A. squamata*, perhaps only a variety of it". Even if he has not seen a specimen of *securigera*, the merest glance at the figures given by Düben & Koren (which he quotes) ought to have shown him that these forms have nothing with one another to do.

I may mention in this connection that I have got a specimen of *A. securigera* from the Eddystone grounds off Plymouth during a stay at the Biological Station at Plymouth in the summer of 1913. The species accordingly is found off the South Coast of England and evidently is distributed round the British Coasts (though perhaps not at the North Sea Coasts), but must have been overlooked. — On the other hand I may assert that it is an error when Clark in his Catalogue of Recent Ophiurans (p. 250) gives the Baltic Sea as the locality of *A. securigera*. Not a single Echinoderm occurs in the greater part of the Baltic; in the Western part a few Echinoderms occur, but among them only a single species of Ophiurids, *Ophiura albida*. It may be gathered from this fact that also the statement of A. H. Clark[1]) that *Antedon petasus* occurs in the Baltic is based only on an error of labels.

6. Amphiura Griegi n. sp.

(Fig. 4, a—d).

Disk 5.5 mm in diameter; arms five. Middle of disk covered by very small imbricating scales, among which no primaries can be distinguished; towards the edge of the interradii they disappear completely, the outer part of the disk thus remaining naked. The scales surrounding the radial shields are somewhat larger and, in the single, dried, specimen, these scales make a very conspicuous border round the radial shields, contrasting notably against the other scales of the disk. There are about 8 scales in a transverse line in the narrowest part between each two neighbouring radial shields. The radial shields are rather large, more than half the radius of the disk; they are pear-seed shaped, separated throughout by a wedge of narrow, slightly elongated scales. **The dorsal plates are** distinctly wider than long, with the outer edge nearly straight, the whole inner edge making a regular halfcircle; at the base of the arm they are somewhat narrower, the inner edge not so distinctly rounded. The oral shields are almost rhomboidal, with the outer end truncated; adoral plates rather broad. Two oral papillæ, the outer one cylindrical, spinelike. **The papilla of the first oral tent-**

[1]) Notes sur les Crinoides actuels du Muséum d'hist. naturelle de Paris. Bull. Mus. d'hist. Nat. 1911, p. 256. („Mer Baltique, un bel exemplaire").

acle distinct, spiniform, inwards directed. Disk on the under side totally naked, except for a few scales, which may be seen at the edge of the genital slits at their inner end. First ventral plate small, hexagonal. The following ventral plates with truncated inner edge and very slightly concave outer edge; the sides are nearly straight. In the inner part of the arm they are slightly longer than broad, farther out as broad as long. Two tentacle scales, the abradial slightly larger than the adradial. 6 armspines, the lower one a little longer than the rest, which are about equal to the armjoint in length. The four middle spines generally have an indication of a widening at the point.

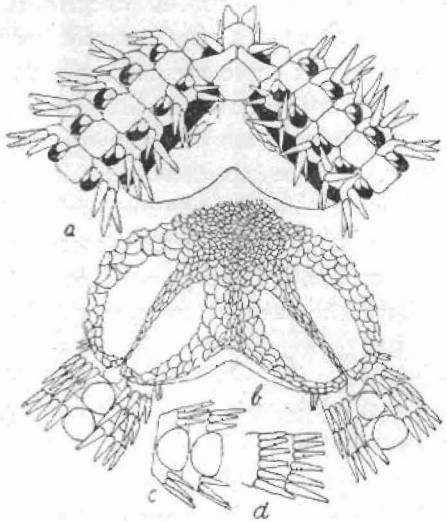

Fig. 4. *Amphiura Griegi.*
a. ventral side; b. dorsal side; c. part of arm, dorsal view; d. armspines. 16/1.

Only one specimen, in very poor condition, with all the arms broken a little distance beyond the disk. — The two figures must partly be regarded as restaurations. The specimen was taken by J. Grieg at Jondal, Hardanger, Norway, in 70—100 meters.

This species is evidently closely related to *A. arcystata* H. L. Clark[1]) with which it agrees in all main features. On account of the great variability of the latter species it is not easy to indicate quite reliable specific differences between the two species, especially since only one specimen is available of the new species. But a careful comparison between this specimen and the figures of *arcystata* given by Clark appears to me to leave no doubt that they are specifically different. Moreover, I have sent the figures of my specimen to H. L. Clark, who after having compared them with his youngest specimen of *arcystata* (6 mm) declares that they are really different; *A. Griegi* has a coarser scaling,

[1]) H. Lyman Clark. North Pacific Ophiurans in the collection of the United States National Museum. Bull. U. S. Nat. Museum. 75. 1911. p. 145.

longer radial shields, different upper arm plates and more pentagonal oral shields; also the tentacle scale of the side arm plate is bigger. Further the number of armspines is different; the young specimen of 6 mm of *arcystata* (which is somewhat larger than the type of *A. Griegi*) „rarely has 6 armspines, and usually there are but 4; these are more slender, more diverging and longer than in the specimen of *A. Griegi*".

Judging from the single specimen of *A. Griegi* in hand there can thus be no doubt that it is really a distinct species, though nearly related to *arcystata*. The latter species being known only from off the Californian coast and from the Japanese Seas it is, of course, not very probable either that the Scandinavian form should be identical with it.

7. Ophiactis nidarosiensis n. sp. (Fig. 5).

Diameter of disk ca. 2.5 mm; arms 12—15 mm long. Disk covered with rather coarse scales, sparsely set with short spines. Primary plates not distinct. Radial shields about half the length of radius of the disk, separated throughout by a linear series of 2—3 scales. The ventral side of the disk covered with a more delicate scaling, generally without spines. Arms 6, sometimes 5, very rarely 7; the dorsal plates are rather broadly in contact in the inner part of the arm, with a truncate inner end and the outer edge forming a high arch; they are sligthly longer than broad. Ventral armplates distinctly longer than broad, with a narrow, truncated inner apex; the first ventral plate is comparatively large, longer than broad, the second is about as broad as long. One rounded tentacle scale. The sideplates are rather prominent, carrying four, farther out three spines. On fullgrown arms the upper

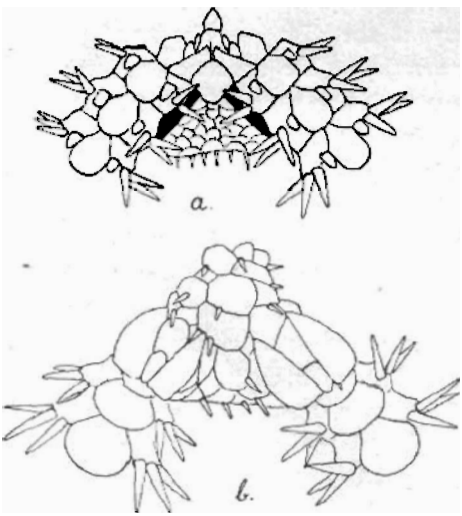

Fig. 5. *Ophiactis nidarosiensis*. a, ventral side. b, dorsal side. $^{15}/_{1}$.

spine, near the base of the arm, may be distinctly longer, thinner and more smooth than the other, but this is no constant character. The three lower spines are equal sized, about the length of the arm joint. They are finely serrate and slightly bihamulate. Mouth-papillæ two, sometimes only one, on each side of mouth angle, the outer one the larger; they are generally erect. Adoral plates large, mouth shield almost rhomboidal, as long as broad, with rounded-truncate outer angle. — There is sometimes a trace of redbrown color at the base of the spines in fullgrown arms.

The species is selfdividing; all stages of reproduction of half the disk with its three arms are met with. The fact that three and three arms are of the same size means that, in case self-division takes place more than once, the division line remains the same. One exception from the rule was seen, however, a recently divided specimen having three arms of different length, one of them belonging distinctly to the reproduced, not yet fully grown half; in this case accordingly this second division took place after another line than the first.

Several specimens were found by the author in the Trondhiem-fjord, in the following localities: Skarnsund, ca. 200 meters, off Tautra, ca. 200 m, and off Rødberg, ca. 300 m, in July 1911. Further, some specimens from Hellefjord, 200 fms, taken by the Norwegian North Atlantic Expedition 1876—78, wrongly identified as *O. abyssicola*, are really this species. Doubtless the species will be found to be widely distributed over the North Atlantic.

Evidently this species is related to *Ophiactis hirta* Lyman. („Challenger" Oph., p. 118, Pl. XX, Figs. 4—6). It differs from that species, besides in the number of arms (7 in *O. hirta*, 6 in *nidarosiensis*), in the shape of the ventral plates, which are shorter in *O. hirta*, only as long as broad; also the mouth shield appears to be somewhat different in shape, and the mouth papillæ are smaller in *O. hirta* than in *nidarosiensis*. Finally the size of *O. hirta* was 4.2 mm in diameter of disk or nearly twice the size of the largest specimens of the present species.

Judging from these differences there can hardly be any doubt that this species is not identical with *O. hirta*, as one would also beforehand be inclined to expect in view of the fact that *O. hirta*

was found off N. S. Wales. The importance of this latter fact is, however, considerably lessened through Koehler's identification of a specimen from off the Azores as *O. hirta*.[1]) There is, however, a possibility that it was really the present species, which Koehler had before him. It is especially noticeable that the specimen from the Azores had only six arms, while the type of *O. hirta* has seven. Unfortunately the question cannot be settled at present, because the specimen has been lost. I sent a copy of my figures to Prof. Koehler asking him to compare his specimen therewith. The specimen being then sent to him from the Museum in Monaco it was lost on the way. The occurrence of *O. hirta* in the Atlantic must then remain problematic, until new material is available, since it cannot be denied that there is much more reason to suppose that the specimen in question really belonged to *O. nidarosiensis*, which will doubtless prove to occur over a great part of the North Atlantic, than to *O. hirta* known otherwise only from off Australia.

H. L. Clark[2]) suggests that Koehler's specimen was only a young *O. abyssicola*. I would not think it possible that Koehler could make such a mistake, *O. abyssicola* being already in its quite young stages (I have examined specimens less than 2 mm diameter of disk) quite easily recognizable. Clark's suggestion, however, leads to the question of the relation of the present species to *O. abyssicola*. The fact that *abyssicola* has five arms, would seem beforehand to make it certain that these species have nothing with one another to do. This is, however, not a character sufficiently constant for distinguishing the two species thereby alone; specimens of *O. nidarosiensis* with only 5 arms, and, very rarely, even with 7 arms occur; on the other hand, also *O. abyssicola* may exceptionally have 6 or even 7 arms. But the two species are otherwise so sharply distinguished that there can, by a careful examination, not be the slightest possibility for mistaking one species for the other. Especially the dorsal plates afford an excellent distinguishing character, triangular, with an acute inner point, well separated, and with a nearly straight outer edge in *abyssicola*, contiguous, with a truncated inner angle and the outer edge

[1]) Res. d. Campagnes scientif. Monaco. Fasc. XXXIV. 1909. p. 171.

[2]) H. L. Clark. Brittle-Stars, new and old. Bull. Mus. Comp. Zool. LXII. 1918. p. 310.

very highly arched in *nidarosiensis*. Also the mouth shields are quite different in shape, distinctly broader than long in *abyssicola*, as long as broad in *nidarosiensis*. The ventral plates are also broader in *abyssicola* than in *nidarosiensis*. Then I have never seen an indication of selfdivision in any of the numerous specimens of *abyssicola*, that I have examined, while nearly every specimen of *nidarosiensis* shows selfdivision to have taken place more or less recently. — It may not be superfluous to state that these differences hold good also for small specimens of *abyssicola*, not larger than those of *nidarosiensis*.

8. **Amphilepis norvegica** Ljungman.

E. v. Marenzeller in his memoir of the Echinoderms of the Eastern Mediterranean [1]) gave reasons for regarding Forbes' *Amphiura florifera* [2]) as the same species as *Amphilepis norvegica* Ljungman. This result has not met with a general acceptance. Grieg has accepted it in his paper on „Bukkenfjordens Echinodermer og Mollusker". [3]) but in his later papers he always uses the name *norvegica*, and especially Koehler and H. L. Clark retain the name *norvegica*, the latter author, in his „Catalogue of Recent Ophiurans" (p. 224) taking *A. florifera* Forbes as a synonym of *Amphiura Chiajei*.

The question needs reexamination. First, it is certain that *Amph. norvegica* does occur in the Eastern Mediterranean; that was shown definitely by Marenzeller; having myself got a pair of specimens from the Mediterranean, dredged by the „Thor" at St. 134. $^{15}/_{7}$ 1910 (37° 37' N. 10° 17' E.) I can only confirm Marenzeller's statement; the Mediterranean form cannot be distinguished from the Scandinavian, not even as a variety. Herewith, however, is not given the proof that Forbes' *florifera* was really this species. Is it then only a young specimen of *Chiajei*, as maintained by Ludwig, Lyman and Clark? The fact stated expressly by Forbes, that it has only 3 armspines would seem to

[1]) **Berichte** d Commission f. Tiefsee-Forschungen XVI. Zoolog. Ergebnisse V. Echinodermen, gesammelt 1893—1894. Denkschr. d. Ak. d. Wiss. Wien. LXII. 1895. p. 17.

[2]) E. Forbes. On the Radiata of the Eastern Mediterranean. I. Ophiuridæ. Trans. Linn. Soc. XIX. 1843. p. 150.

[3]) Stavanger Mus. Årsberetn. 1896. p. 38.

exclude the possibility of a confusion with *A. chiajei* which has already at a size corresponding to that of *A. florifera* 4—5 arm-spines, a difference which Forbes could scarcely be supposed to have overlooked. Also the fig. 10 of Forbes' paper, giving the underside of the arm of *florifera*, in all its imperfectness seems to show that it could not be a young specimen of *A. Chiajei*. I cannot, therefore, agree with the authors who make *A. florifera* simply a synonym of *A. Chiajei*.

On the other hand, I do not see that Marenzeller has given an undisputable proof that Forbes' *Amph. florifera* is identical with Ljungman's *A. norvegica*. I would point out two facts, which are at variance with such identification. First, the primary plates of the disk are by no means so conspicuous in *norvegica* and do not lie so close together as shown by Forbes; they are very distinctly separated from the central plate by several small scales. It is also hardly conceivable that Forbes could have represented the characteristic rhombic figure of the radial shields of *norvegica* so poorly (Fig. 13). More weight I would, however, ascribe to the mouth shield (the „ovarian" or „genital" plate, as it is designated by Forbes). He states that to be trilobed in *florifera* and shows that in his fig. 12. This does not at all agree with *A. norvegica*. The fact being thus that there are such specially noted characters of *florifera* which do not agree with *norvegica*, it must be regarded as doubtful that *florifera* is really identical with *norvegica*, and there is then really no necessity for taking the undesirable step of changing the commonly used name of the species so well described by Ljungman.

It may be mentioned here that I have found on some specimens from the Trondhjemsfjord a small organism attached to the underside of the disk and arms, which appears to be a *Loxosoma*. I have observed it later on also on some specimens from Mangerfjord, near Bergen, received from Prof. Brinkmann, dredged in March 1920.

9. Ophiura texturata Lamarck.

The fact that H. L. Clark in his „Catalogue of Recent Ophiurans" (p. 323) has identified this species with the „*Asterias ophiura*" of Linnæus, naming it *Ophiura ophiura* (Linn.) makes it

necessary to take up the question about the name with which this species should be designated, the more so as there is a general disagreement among recent authors about this matter. The species is named *Ophiura texturata* (Lmk.) Forbes by Lütken and, in some of his works, by Koehler, while more recently the latter author adopts the name *Oph. lacertosa* (Linck.). Lyman („Challenger" Oph. p. 76) names it *Ophioglypha ciliata* Ljn. (should be Retzius). In Bell's „Catalogue of the British Echinoderms" it is named *Ophiura ciliaris* (Linné) and the same name is used by Grieg. — I shall discuss these names in chronological order.

That the „*Stella lacertosa*" of Linck[1]) is really the species understood by *Oph. texturata* Lmk. is very probable; it is especially a noteworthy fact that the fig. 4, Taf. 2 of Linck's work apparently shows the pores along the midline of the ventral side of the arms, a feature so eminently characteristic of this species. But then Linck is pre-Linnean and not strictly binomial, and according to the rules cannot therefore come into consideration.[2])

The *Asterias ophiura* of Linnæus (Syst. Naturæ, Ed. X, 1758, p. 662) evidently comprises all the true Ophiurids then known by him, as is evident from the literary references under the species. The diagnosis „A. radiata radiis quinque, corpore orbiculato quinquelobo" does, of course, not give the slightest hint at any definite species. In the Museum of Upsala are preserved two specimens labelled *Asterias ophiura* Linn., from the Museum Gust. Adolphi. It is quite possible that they represent the type of Linnæus' *Asterias ophiura*, but it is not certain, and the original labels have been destroyed. But whether they are the types or not, they are not identical with our *Oph. texturata*; they belong to the genus *Ophioderma* (both specimens apparently the same species). If it were certain that these specimens are the types of *Asterias ophiura* Linn., there might be reason for changing the name *Ophioderma* into *Ophiura* (as Lyman did, though for other reasons). Since,

[1]) De Stellis marinis liber singularis. 1733. p. 47. Taf. 2. fig. 4.

[2]) Another thing is that, in cases where it would be very desirable to preserve a pre-linnean name, I would not omit doing so on account of the rule. But it cannot be said to be especially desirable to keep the name *lacertosa* Linck for this species, the more so as the name *lacertosa* was used by Lamarck in quite another sense.

however, there is no certainty for their being really the type specimens, such change would be quite unjustified That there is not the slightest foundation for changing the name *Oph. texturata* into *Ophiura ophiura* is so evident, that one cannot help wondering that Clark has ventured to do so.[1])

In the XII. edition of „Syst. naturæ" (1766, p. 1101) Linnæus establishes a species *Asterias ciliaris*. It is evident that, if this species can be recognized with certainty to be the same as our *O. texturata*, this name must be adopted. The diagnosis is not much better than that of *A. ophiura*, running thus: „A. radiata imbricata, radiis utrinque ciliatis". Bell, in „Some Notes on British Ophiurids"[2]) comes to the result that the ***A. ciliaris* is really identical with *O. texturata*, concluding from Linnæus' reference** to the figures of Barrelier; „an inspection of the figures of Barrelier shows that what we have called *O. ciliata* is taken to be meant". Looking up the figures in Barrelier's work[3]) I was really astonished. These figures are so primitive that it is quite impossible to say which species can be meant — all that can be said is, that they represent an Ophiurid, the curved arms indicating that it is not an *Ophiura*, more probably an *Ophiothrix* that is meant. To take these figures as a proof that the *Asterias ciliaris* of Linnæus is our *O. texturata* is simply absurd. Neither is there in the text a single word that could prove it to be *O. texturata*. — That Linnæus states of *A. ciliaris*: „habitat in Oceano australiori et indico" is, of course, also a fact decidedly against identifying this species with the European *O. texturata*.

We then come to the name *Asterias ciliata* Retzius.[4]) It is not impossible that it can really be the same as our *Ophiura texturata*, although there is nothing in the description to show it definitely. But, anyhow, this name cannot come into consideration, since the name was preoccupied by O. Fr. Müller,[5]) as **Bell has** correctly pointed out. The diagnosis of *Ast. ciliata* given by Müller: „radiata,

[1]) I am indebted to my friend T. Gislén for the information of the specimens of „*Asterias ophiura*".

[2]) Ann. Mag. Nat. Hist. 1891. 6. Ser. VIII. p. 341.

[3]) Jac. Barrelier. Plantæ per Galliam, Hispaniam et Italiam observatæ. Paris 1714. Tab. 1295, fig. 1.

[4]) A. Retzius. Dissertatio sistens species cognitas Asteriarum. 1805. p. 29.

[5]) Zoologiæ Danicæ Prodromus, 1776. p. 235.

spinis asperis latitudine radii longioribus" shows cleary that it could not be any of the species of the recent genus *Ophiura*; most probably it is *Ophiothrix fragilis*.

Finally, we come then to Lamarck's *Ophiura texturata*. The type specimen does not exist any more, as Prof. Joubin kindly informs me. The diagnosis given by Lamarck (Animaux sans vertèbres. 1816. II. p. 542) does not give the definite proof that it is really the present species which is meant, but in any case there is nothing in it that does not suit to it. But then he refers to the *Stella lacertosa* of Linck, Tab. 2, fig. 4, which is, as stated above, almost beyond doubt this species. Also his statement that „ses rayons vus en dessous présentent l'aspect de cinq petites tresses" (plaits) is indeed very appropriate. — On the other hand, the figures in the Encyclopédie Méthodique, Pl. 123, figs. 2, 3, to which reference is also made under *O. texturata*, certainly do not represent our species; possibly it is *O. albida*, but it is much too inaccurate to allow determining with certainty which species it really represents. However, this is less important, since the species figured by Linck is the first referred to.

After all it seems then the only possible course to adopt the name *Ophiura texturata* Lamarck for this species.

10. **Ophiura albida** Forbes.

Regarding this species I would only record some observations on parasites found to infest it.

A number of specimens, which I received recently from the Swedish Zoological Station, Kristineberg, dredged off Lysekil, were found to be infested with a rather large Trematod, lying free in the stomach. As many as 6—7 specimens of the parasite were found in a single Ophiuran, generally only 2—4; out of 9 specimens of the Ophiurid only one was devoid of the Trematod. I am informed by my friend Prof. Th. Odhner, Stockholm, that this Trematod is the young stage of *Fellodistomum fellis* (Olsson), which is found very commonly and in great numbers in the gallbladder of *Anarrhichas lupus*, which fish is known to feed on Echinoderms. No other Trematods being known from Echinoderms this case is quite noteworthy. (Cuénot[1]) has found a Cercaria in *Oph.*

[1]) L. Cuénot. Commensaux et Parasites des Échinodermes (II. Note). Rev. Biol. Lille. Année 5. 1892.

albida and *Ophiothrix fragilis*; he describes it under the name of *Cercaria capriciosa*). — (I may mention in this connection that I have found a Trematod occurring quite usually in the gonads of the sea-urchin *Mespilia globulus* at Misaki, Japan).

It is worth pointing out that the occurrence of this parasite in *Oph. albida* appears to be rather local. I have opened many specimens of this species from different localities in the Danish Seas, but never observed the parasite in it. Doubtless this has a direct relation to the distribution of the host of the mature Trematod, so that the young stage of the Trematod will probably be found to occur in the Ophiurid only in such places where the Anarrhichas occurs.

In a few specimens of the same Ophiurid from off Skagen I have found a pair of Nematods lying in the body cavity. They are young and unidentifiable; they will doubtless prove to belong to a species living in some fish that feeds on this Ophiurid.

11. Henricia sanguinolenta (O. F. Müller).

In Müller & Troschel's „System der Asteriden", p. 127, is mentioned a starfish from Bohuslän, preserved in the Museum of Stockholm, „von dem wir es zweifelhaft lassen müssen, ob es zum Genus Solaster oder Chætaster gehört". During a visit to Stockholm in the fall of 1919 Prof. Th. Odhner called my attention to this specimen, which he thought must be identical with *Henricia sanguinolenta*. I could only confirm his view; it is really only a large specimen of this species, as would also have to be expected on account of the locality from which the specimen came.

On examining some living specimens I noticed that the small spine placed in the ambulacral furrow, below the ambulacral spines, is tipped with a skincap considerably larger than the spine itself, so that it is seen protrude between the tubefeet. Most probably some sensory function is attached to it.

12. Echinocyamus pusillus (O. F. Müller).

H. L. Clark in his Memoir on the Clypeastridæ [1]) has changed this commonly used name into *Echinocyamus minutus*, maintaining

[1]) Hawaiian and other Pacific Echini. The Clypeastridæ, Arachnoididæ, Laganidæ, Fibulariidæ and Scutellidæ. Mem. Mus. Comp. Zool. Vol. XLVI. 1914. p. 61.

that „when Pallas' description of his *Echinus minutus* is carefully examined in connection with his fig. 25, pl. 1, and due consideration is given to his remarks about habitat and occurrence, it is almost impossible to doubt that his name was given to the fibulariid which O. F. Müller two years later called *Spatagus pusillus*". It is therefore necessary to change the name *pusillus* into *minutus*.

On examining Pallas' description of this „*Echinus minutus*" it is, however, easily seen that he does not name any *Echinus minutus* at all. He writes[1]): „In Tabula I hujus fasciculi sub figura 24 & 25 Echinos minutos adjeci, de quibus hic verbiculus", which means „I have added some small sea-urchins". Nowhere does he name a species „*Echinus minutus*"; if that were the case he would not have omitted a reference to it in the index at the end of the fascicle, where all the species described are very carefully named; but it is not found there. It is thus beyond any doubt that the name *pusillus* has the priority, even after the strictest interpretation of the priority rule, being published in 1776. The fact that Gmelin[2]) in 1788 and Blainville[3]) in 1834 made the same mistake as Clark now has made again in 1914 does not alter the fact that there is no „*Echinus minutus* Pallas".

Furthermore it is beyond doubt that, even if Pallas had really meant to give the scientific name *Echinus minutus* to these small sea-urchins, that name could not rightly have been used for *Echinocyamus pusillus*. It is true, there is no doubt that his figure 25 really represents this species, which becomes quite evident from his statement „Abundat hic autem inter minuta testacea arenæ Belgicæ"; there is no other Echinoid occurring at the Belgian coasts with which it could be confounded, and I have myself a number of specimens collected at the sandy beach near Ostende. But Pallas refers to two different forms with his „Echinos minutos"; the first of them, fig. 24, „priore icone expressus subglobosus ex Orientali India crebro adfertur"; this species is beyond doubt a *Fibularia*, and if there had really been an „*Echinus minutus* Pallas" the name would then have to be applied to this

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[1]) P. S. Pallas. Spicilegia Zoologica. Fasc. X. 1784. (p. 34).
[2]) Linnæus. Systema naturæ. Ed. XIII. cura Gmelin 1788. p. 3194.
[3]) H. de Blainville. Manuel d'Actinologie. 1834. p. 214.

East Indian form, not to the second form referred to by Pallas, that from the Belgian coast.

The priority rule has, indeed, done harm enough in a number of cases, where change of names could not be avoided. It is not unreasonable to ask that at least no change of old generally used names should be made without the most careful consideration of all the questions connected with each case.

13. Antedon petasus (Düb. & Kor.).

(Fig. 6, a—h.).

The observations on the embryology of this species recorded in the author's paper „Notes on the development and the larval forms of some Scandinavian Echinoderms" [1]) have revealed the fact that quite noteworthy differences exist between *Antedon petasus* and the allied species *A. adriatica, mediterranea* and *bifida* in regard to their development. Thus, while in the three latter species the eggs remain attached to the pinnules until the embryo is hatched as a fully formed larva with its ciliated bands etc., in *A. petasus* the eggs [2]) are free, probably pelagic and the embryo is hatched before the appearance of the ciliated bands. Also in the embryological processes, especially as regards the enterocoel vesicles and the entoderm, very remarkable differences appear to exist between the said species.

These facts naturally lead to the question, whether then *A. petasus* can really belong to the same genus as the other species named; the question was hinted at in the paper quoted, but the discussion thereof was left for the present occasion.

In the revision of the genus *Antedon* s. str. given recently by A. H. Clark [3]) the species referred to the genus are divided in two groups, one, comprising *A. mediterranea* Lmk. and *adriatica* A. H. Clark, being characterized by the long, approximately uni-

[1]) Vid. Medd. Vol. 71. 1920. p. 150.

[2]) I regret having omitted to state in the paper quoted that the eggs of *A. petasus* show most distinctly the same peculiar structure of the follicular membrane as is found in *Ant. mediterranea*. (Comp. Ludwig. Die Bildung der Eihülle bei Antedon rosaceus. Zool. Anzeiger. III. 1880. p. 470).

[3]) Beiträge zur Kenntniss d. Meeresfauna Westafrikas, herausgeg. v. W. Michaelsen. Hamburg. Lief. 2. 1914. Echinoderma II. Crinoidea. p. 313-318.

form cirri composed of 18—30 segments, of which the distal are little, if any, shorter than the proximal and not compressed laterally, and by the long arms composed of long segments, the other, comprising *A. petasus* (Düben & Kor.), *bifida* (Pennant), *moroccana* A. H. Clark, *dübeni* Bölsche and *Hupferi* Hartlaub, being characterized by the short cirri, with generally only 10—15 segments, of which the distal are laterally compressed and, in lateral view, broader and shorter than the proximal, and by the short and comparatively stout arms, composed of short segments.

A considerable part of the material of Crinoids possessed by the Copenhagen Museum being at the present time in the hands of A. H. Clark in Washington, I have no opportunity of examining all the species mentioned above, but must in the main confine myself to a comparative study of the species *bifida*, *mediterranea* and *petasus*.

In case *A. petasus* should rightly be referred to another genus than those species which differ from it in their embryological development (*A. adriatica*, *mediterranea* and *bifida* — and also *A. moroccana*, judging from a statement in a letter from A. H. Clark that this is the species studied by Perrier) one should expect to find it differing from the other species, at least, in some marked external features that could justify a generic distinction. However I fail to find any such special feature. It would really seem more natural to distinguish as separate genera or subgenera the two groups established by Clark[1]) than to make *A. petasus* a separate genus, distinct from another genus comprising *mediterranea* and *bifida* and the other species named. *A. petasus* decidedly agrees with the *bifida*-group in the important charracters of the cirri and arms. On the other hand it differs quite markedly from *bifida* in the character of its oral pinnules, these being much more thorny in the latter. But to ascribe so great importance to this single feature as to

[1]) The character mentioned by Clark as distinguishing the two groups that in the *mediterranea*-group the distal segments of the cirri are not compressed laterally, which they are in the *bifida*-group does not seem to me to hold good; they are or (at least) may be just as much compressed in *mediterranea* also. On the other hand I would add another conspicuous difference between the two groups, namely that in the *mediterranea*-group the first genital pinnule is the fourth, while in the other group (at least in the species I have examined) it is the third.

make it a generic character seems to me unjustified. A. H. Clark has suggested in a letter to me that the rudimentary side and covering plates of the pinnules might afford a characteristic difference, being comparatively well developed in *petasus*, while they appear to be lacking in the other species. This does, however, not hold good. It is true, they may be lacking in *bifida*, but this is no constant feature. J. Grieg[1]) has given a figure showing them just as well developed in *bifida* as in *petasus*, and I find them quite similarly developed in some specimens of *bifida*, although they appear to be lacking in the majority of the specimens. Also in *mediterranea* I find them almost as well developed as in *petasus*.

The necessary conclusion is then that there is no reason for a generic distinction of *A. petasus* from the other species of *Antedon* s. str., in spite of the remarkable differences in their embryology. We have simply to accept the fact that closely related forms may show surprisingly great differences in regard to their development. — A parallel case is that of the Echinoids *Toxocidaris* (or *Heliocidaris*) *tuberculata* and *erythrogramma*, the former having a typical pelagic larva, the latter direct development without any indication of a pluteus-stage[2]); another similar case is afforded by *Amphiura filiformis* and *borealis*, the former having small eggs and a typical *Ophiopluteus* larva while the latter is viviparous, having large, yolky eggs, the embryos doubtless developing directly. In both these cases the species undoubtedly are closely related and must be referred to the same genus.

I may take the opportunity of mentioning here that I have observed on specimens of *A. petasus* from the Swedish Zoological Station, Kristineberg, a small *Loxosoma* attached to the pinnules, generally between the tentacles, where it is by no means easy to see. I have not examined it more closely, so that I cannot say,

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[1]) James A. Grieg. Echinodermen von dem norwegischen Fischereidampfer „Michael Sars" in den Jahren 1900—1903 gesammelt. II. Crinoidea. Bergens Mus. Aarbog 1903. Nr. 5. p. 33.

[2]) Th. Mortensen. Preliminary note on the remarkable shortened development of an Australian sea-urchin, Toxocidaris erythrogrammus. Proc. Linn. Soc. N. S. Wales. Vol. XL. 1912. p. 203.
Th. Mortensen. On the development of some Japanese Echinoderms. Preliminary Notice. Annot. Zooiogicæ Japonenses. VIII. 1914. p. 545.

whether it is possibly identical with any known species; but it is certain that it is not identical with *Loxosomella antedonis*, the species that I found attached to the cirri of *Hathromethra prolixa*.[1])

During a visit to the Swedish Biological Station, Kristineberg, in the summer of 1918, with the object of studying the development of *Antedon petasus* (and other Echinoderms) I found one day on examining a lot of this Crinoid a most curious abnormal specimen having some of its oral pinnules developed into true arms. Realizing, of course, at once the unusual interest afforded by this specimen, I was anxious to have it preserved with the utmost care in order that it might be possible to give a good photographic figure of it. Through some unfortunate circumstances, which need not be specified, it happened, however, that this special care resulted in the specimen breaking several of the arms, curving up the rest. It is therefore out of question to give a photographic figure of it that would be of any use, and I must content myself with giving some detail figures of the peculiar armstructures to illustrate the following description.

The anterior and the left anterior arms are quite normal. On the right anterior radius the anterior arm has the first oral pinnule on both sides transformed (Fig. 6, f.); the pinnule of the inner side has only two side branches near the point — it can hardly be said that they represent true pinnules, it has much more the character of a simple branching —; the pinnule on the outer side has developed into a true arm, almost as large as the main arm. The four inner joints retain the character of pinnule joints; on the fifth is developed a pinnule, and from here the joints take on the character of true armjoints, carrying pinnules in the normal way. Only the inner part is preserved, the part from the 6th pinnule being lost. There are no syzygies on the preserved part. The two lower

[1]) Th. Mortensen. A new species of Entoprocta, Loxosomella antedonis, from North-East Greenland. Danmark-Exped. til Grønlands Nordøstkyst 1906—1908. Bd. V. 8. (Medd. om Grønland. XLV. 1911).

This species has recently been found to occur also on *Heliometra glacialis* (R. C. Osburn. Bryozoa of the Crocker Land Expedition. Bull. Amer. Mus. Nat. Hist. XLI. 1919. p. 606.)

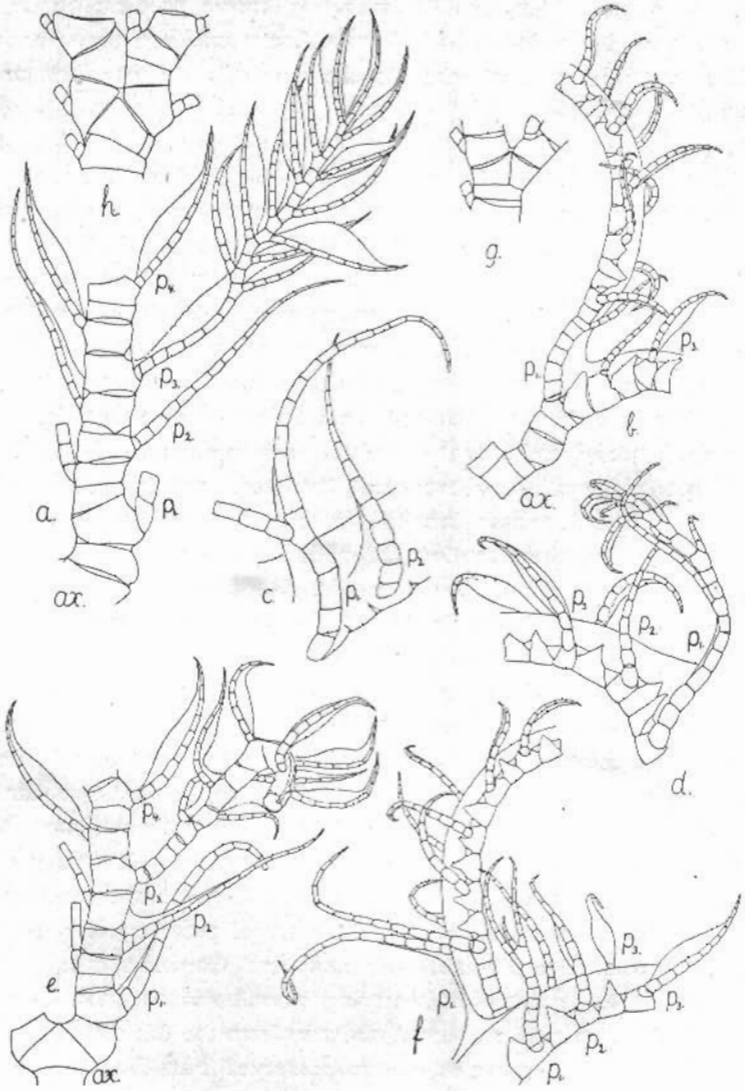

Fig. 6. *Antedon petasus.*
a. showing a case of p3 developing into an arm. b. inner p1 of left posterior radius, posterior arm, developed into an arm. c. dichotomously branched p1 of right anterior radius. d. outer p1 of left posterior radius, posterior arm, transformed into a small arm. e. another case of p3 developing into an arm. f. right anterior radius, anterior arm, with inner p1 slightly branched, outer p1 transformed into an arm. g. longitudinally divided epizygal joint. h. irregular armdivision.
All the figures 6/1.

pinnules have the character of oral pinnules; from the third tentacles are developed, but none of pinnules preserved carry genital organs. — The posterior arm of the same radius has also both the first pinnules transformed. That on the outer side has developed into a small, but true arm, the pinnules beginning on the 8th joint. The point is broken; the part left carries three pinnules on each side, the second of them having the tentacles developed. The first pinnule of the inner side of the arm has developed into a true arm, larger than that of the outer pinnule, but distinctly more slender than the main arm. The pinnules begin on the 4th joint. The point is broken; the preserved part carries 5 pinnules on each side, the lower ones of which are developed as oral pinnules.

In the right posterior radius the oral pinnules of the anterior arm are normal, while the first pinnule on the inner side of the posterior arm is developed into a small arm, the first pinnule being found on the 8th joint. The point is broken; the preserved part carries four pinnules on each side, the first of them being developed as an oral pinnule.

In the left posterior radius both arms have both their first pinnules transformed into arms. On the posterior arm the first pinnule of the outer side forms a small, slender arm (Fig. 6, d.), the first pinnule being found on the 8th joint; after this follow two joints without pinnule, then four joints carrying pinnules placed regularly alternating, again a joint without a pinnule and then a joint carrying a pinnule, the arm finally ending in a pinnule-like point provided with tentacles as the other pinnules. The first pinnule on the inner side of this arm has developed into a large arm, very nearly as strong as the main arm (Fig. 6, b.). The five proximal joints have the character of true pinnule joints; the 6th carries a pinnule on the distal side, then follows a joint without a pinnule and the 8th joint again carries a pinnule on the distal side. From here the joints have the character of true armjoints, even forming syzygies (the 9—10th, the 16—17th joint and then every third joint), and carrying pinnules in the normal way. The point is broken, the preserved part carrying eight pinnules on each side, not counting that on the 6th joint. The lower one on each side has the character of an oral pinnule, although not very pronounced. None of the pinnules carry genital organs

On the anterior arm of the same radius the first pinnule of the outer side has very much the same character as that of the outer side in Fig. 6, f., having only four branches or pinnules at the point, the first occurring on the 9th joint; the first pinnule of the inner side of the arm has developed into a small arm, the pinnules beginning to appear with the 5th joint. It presents the unusual feature that the three lower pinnules are all on the same, proximal side; after the third pinnule follow four joints without pinnules then one with a pinnule on the distal side, whereafter the little arm ends in a pinnule-like point, carrying tentacles as the usual pinnules; also the first pinnule on this arm carries tentacles and has thus not the character of an oral pinnule.

Having found this remarkable specimen, I was, of course, on the look out after other similar abnormalities, and I succeeded in finding, among several hundreds of specimens of this Crinoid five more showing interesting abnormalities, although none of them approaches the first specimen in regard to excessive development of the pinnules. I shall describe briefly also these specimens.

One of them has the first pinnule on the outer side of the anterior arm of left posterior radius developed into a small arm almost like that shown in Fig. 6, d. The three lower pinnules are found on the distal side, the first of them on the 6th joint; then follows one pinnule on the proximal side, and a pinnule-like termination of the whole structure. The ambulacral furrow is well developed in the whole length of this oral pinnule. The other arms present no anomalous structures.

A third specimen has the first pinnule on the outer side of both arms of right anterior radius dichotomously branched (Fig. 6, c.). The one of the anterior arm divides at the 4th, that of the posterior arm at the 5th joint. Both branches are equally developed and retain their characteristic structure throughout. This case then represents a simple dichotomy and is of no special interest. — Three other specimens show simple dichotomy of one of the arms, the division occurring in two of the cases immediately above a syzygy. One of them (Fig. 6, g.) shows the interesting feature that the epizygal joint is divided after a longitudinal line. In the other case one of the branches begins with a syzygy. The third specimen

(Fig. 6, h.) has the joint below the division split up somewhat irregularly, and the branches have the two lower joints coalesced. — These cases of dichotomy, although worth mentioning, do not afford any special interest.

Considerably more interest attaches to two specimens having each one pinnule developed into a true arm. In one of them it is the third pinnule on the outer side of the posterior arm, left anterior radius, which is developed as shown in Fig. 6, a. The proximal part has the character of a true genital pinnule, but from the 8th joint pinnules are developed regularly alternating as in a true arm, the joints of the main pinnule assuming a much more robust character than the normal pinnule joints, although not so robust as normal armjoints. The 15—16th joints form a syzygy and the third joint thereafter again is a syzygy. There are 6 pinnules to each side, all except the last one on the distal side having the genital organs strongly developed. After the 6th pinnule the main axis continues and ends as a usual pinnule.

In the other specimen it is the third pinnule on the outer side of the anterior arm of the right anterior radius, which has developed into an arm (Fig. 6, e). The four proximal joints have the character of true pinnule joints, only somewhat more robust than usual. From the fifth joint pinnules are developed, alternating regularly, and the joints of the main axis assume the character of true armjoints, the 10—11th forming a syzygy. The point of the arm is broken, the preserved rest carrying four pinnules on each side, all of which have the character of genital pinnules. The basal part of the main pinnule does not carry a genital organ, which was the case in the former instance.

No other abnormalities occur in the two last mentioned specimens.

It is a very noteworthy fact that in the arms developed from the oral pinnules no genital organs are found, while in those developing from the genital pinnules all the pinnules, also the lowermost of them, have well developed genital organs. This is, of course, in accordance with the structural difference between oral and genital pinnules, the genital rhachis not sending a branch into the former, while the water vessel is found there normally, so that the pinnules on the arms developing from the oral pinnules can have the water vascular apparatus completely developed.

The interest attached to these curious specimens is much more than that of curiosity, this remarkable development of pinnules into arms having a very distinct bearing on the question of the morphological value of pinnules.

A. H. Clark, in his „Monograph of existing Crinoids“ [1]) has pronounced some very startling ideas as to the morphological value of pinnules, ideas which are directly connected with his theory that the ancestors of Crinoids are — the barnacles.

The alleged derivation of Crinoids (and Echinoderms upon the whole) from Arthropods, of course, makes it necessary to seek some structure that might be regarded as the homologon of the Arthropod appendages. Clark finds such structures in the pinnules and the cirri, stating (Op. cit., p. 274) that „it is probable that the pinnules and the cirri represent the original type of Crinoid appendage, and these appendages were arranged in five pairs, the two components of each pair being, so to speak, back to back; but both the pinnules and the cirri have become enormously reduplicated, while in addition the former have come to lie along either side of long body processes of subsequent development“. Also the elongate marginal cirri of some Comatulids, like *Heliometra*, *Promachocrinus* etc. are regarded as a kind of tactile organs „distantly suggesting the antennæ of arthropods“.

This interpretation of pinnules and cirri as the homologon of Arthropod appendages has further led to the assertion that „pinnules beyond the second segment are merely elongated tentacular processes in which a skeleton is formed as needed“, as are also the cirri „a long tentacular structure with no phylogenetic history“ (Op. cit. p. 272).

The development of pinnules into arms of exactly the same structure as the normal arms in the specimens of *Antedon petasus* here described, decisively proves that the pinnule joints — also those beyond the second — have the same fundamental value as the brachials and necessarily leads to the conclusion that the pinnules morphologically represent arms; they are on physiological grounds reduced to organs specially adapted for generative, nutritive and respiratory functions, but retain a latent, potential power

[1]) Bull. U. S. National Museum. 8.2 I. 1915.

of developing in the same way as normal arms. No support for the barnacle theory can be derived from the structure and morphology of the pinnules, or from the cirri, which are structures of quite another morphological value than that of the pinnules.[1])

[1]) A further discussion of these problems is given in the authors „Studies in the development of Crinoids"; Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. XVI. 1920. p. 80—82.

5—6—20.

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