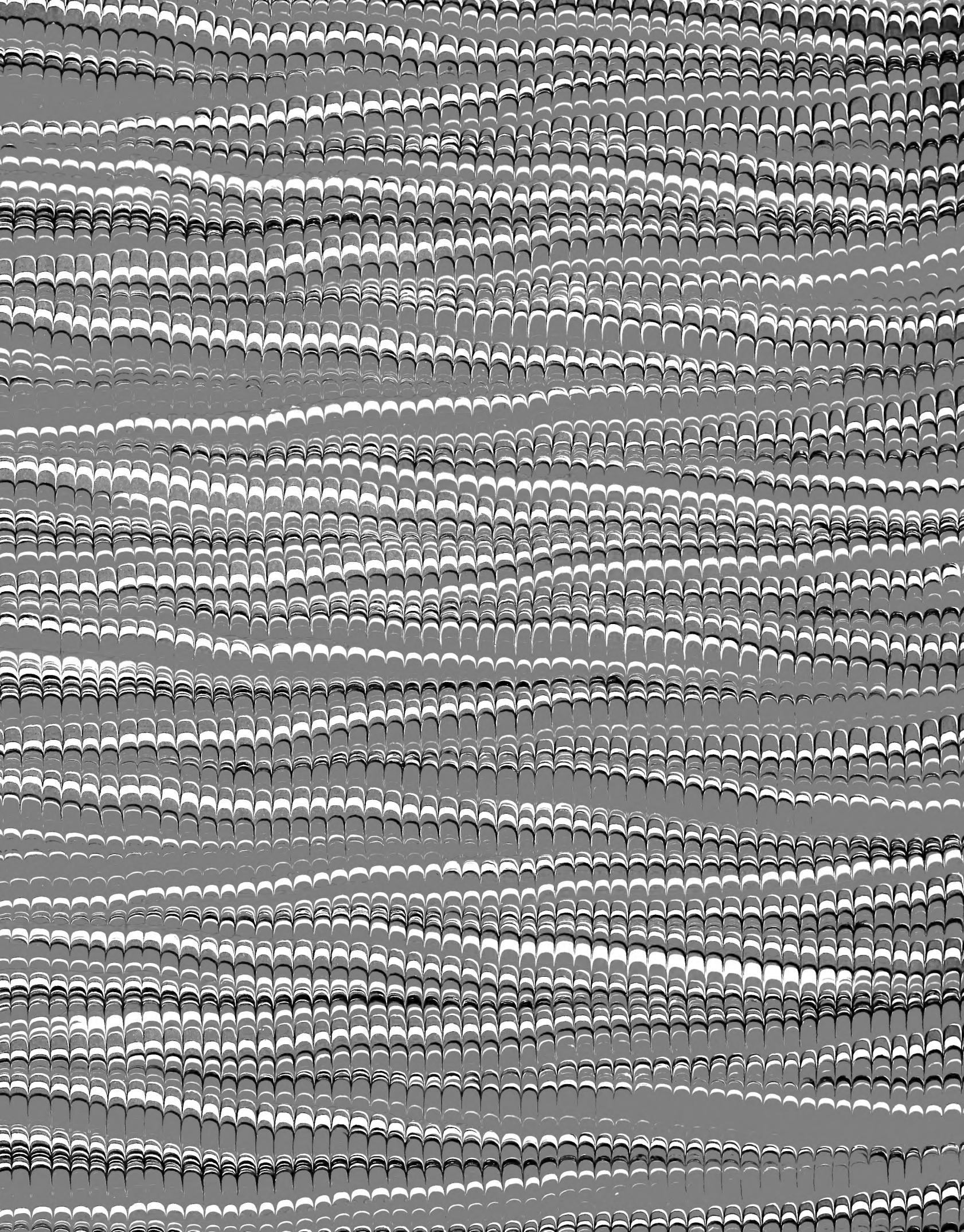
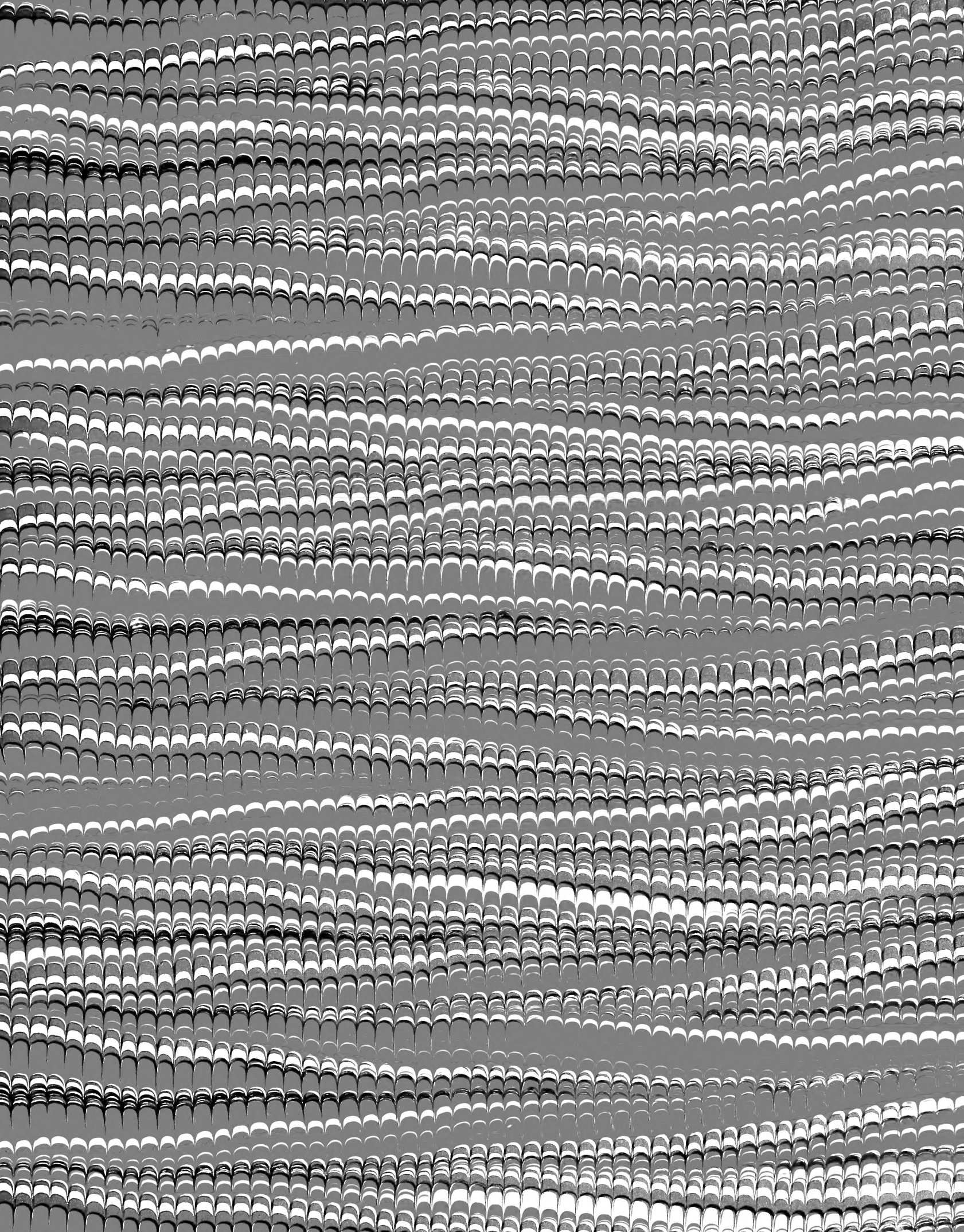


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# ECHINODERMATA

BY

JAMES A. GRIEG

WITH 5 PLATES, 10 ILLUSTRATIONS IN THE TEXT, AND CHARTS

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REPRINTED FROM

**REPORT OF THE SCIENTIFIC RESULTS OF THE "MICHAEL SARS" NORTH ATLANT. DEEP SEA EXPED. 1910**

CARRIED OUT UNDER THE AUSPICES OF THE NORWEGIAN GOVERNMENT AND THE SUPERINTENDENCE OF

SIR JOHN MURRAY, K. C. B. and DR. JOHAN HJORT

VOLUME III PART 2

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JOHN GRIEG, BERGEN



# ATMOSPHERIC

## CONCENTRATIONS

OF

VARIOUS

COMPONENTS

IN THE AIR





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# ECHINODERMATA

FROM

THE „MICHAEL SARS” NORTH ATLANTIC DEEP-SEA EXPEDITION 1910

BY

JAMES A. GRIEG

WITH 5 PLATES, 10 ILLUSTRATIONS IN THE TEXT AND CHARTS





A very rich and interesting material of echinoderms was collected in the summer of 1910 during the cruise of the "Michael Sars" in the North Atlantic. The material which contained 92 species and 67 genera is distributed, as follows:

<i>Holothurioidea</i> :	14 genera	21 species
<i>Asteroidea</i> :	24 „	30 „
<i>Ophiuroidea</i> :	13 „	22 „
<i>Echinoidea</i> :	13 „	15 „
<i>Crinoidea</i> :	3 „	4 „

The greater and most interesting part of the collections was taken from the great depths of the North Atlantic, *Peniagone ferruginea*, one of the species found there, is new to science, and *Peniagone wyvillii* taken in the Bay of Biscay by the "Michael Sars" is new to the Atlantic region. It was previously known only from the Pacific. Several of the others are likewise of great interest from a zoogeographical point of view, as their vertical as well as their horizontal distribution has been extended by the explorations of the "Michael Sars". I may thus mention *Bathybiaster robustus* and *Solaster abyssicola* which were previously known only from the east coast of North America. The cruise of the "Michael Sars" furnished proofs that they occur also on the east Atlantic side; for *Bathybiaster robustus* was found west of Ireland (stat. 95) and the Hebrides (stat. 101), and *Solaster abyssicola* north of the Azores (stat. 88). The northern boundary of *Psilasteropsis patagiatus* and *Astronyx locardi* was formerly the Bay of Biscay. The "Michael Sars" found the firstnamed species off the Hebrides (stat. 101) and the latter off Ireland (stat. 95). *Benthodytes glutinosa* was previously taken only by the "Talisman" in the Sargasso Sea and south of the Azores at depths of 3 175 to 3 432 m. The "Michael Sars" collected the species off the entrance to Gibraltar, 2 603 m. (stat. 35) and besides a very young individual at the intermediary depth of about 1 400 m. southwest of Ireland (stat. 92). Under the description of the various species, however, an account of their horizontal as well as their vertical distribution will be given.

Only one haul was made in the cold area north of the Faroe-Shetland ridge (stat. 102) where 9 species were taken, all characteristic of the Norwegian Sea. Five of them are found principally in the cold area and occur only exceptionally in the warm and then in the border region only. The other four species on the other hand occur in the cold, as well as in the warm, area, where they have a wide distribution. But they are likewise wanting within the Atlantic region proper. They may perhaps be carried as larvae into the Atlantic by the south-going cold ocean currents across the ridge that divides it from the Norwegian Sea, but they do not settle there. It should be stated that three typical warm water species were also obtained at stat. 102, viz: *Plutonaster bifrons*, *Psilaster andromeda* and *Zoroaster fulgens*, but there is every reason to assume, as I shall show more fully below, that they did not live in the locality, but had accidentally remained clinging to the trawl from the foregoing station (stat. 101), where several specimens of these species were taken.

The difference between the deep-sea faunas of echinoderms of the Norwegian Sea and the Atlantic appears very distinctly by comparing stat. 101 and 102 which lie on either side of the Faroe-Shetland ridge. Neither of the localities gives a complete picture of the echinoderm faunas of the Atlantic and the Norwegian Sea, respectively, as several characteristic species are wanting in the collections from both stations; but the picture is more complete at stat. 101 than at 102. At the former 13 species were collected; five of these are known, besides from the Atlantic, also from the banks bounding the Norwegian Sea, the other 8 species on the other hand are restricted to the Atlantic region (I leave out of account here that some of them may also occur in the Pacific and Indian Oceans), but none of them are met with in the cold area of the Norwegian Sea.

Both regions may have genera in common, thus, to mention a few of them, *Bathybiaster*, *Ophiopleura* and *Pourtalesia*; but they are represented by different species. *Bathybiaster robustus*, *Ophiopleura aurantiaca* and *Pourtalesia wandeli* occur within the Atlantic region, while *Bathybiaster vexillifer*, *Ophiopleura borealis* and *Pourtalesia jeffreysi* live in the cold area of the Norwegian Sea.

## HOLOTHURIOIDEA.

### *Mesothuria verrilli* Théel.

*Holothuria verrilli* Théel, Bull. Mus. Comp. Zool., vol. 13, 1886, p. 6.  
<sup>7</sup>/<sub>5</sub>. stat. 25 A, 35° 36' N., 8° 25' W., 2300 m., yellow mud. One specimen.  
<sup>18</sup>/<sub>5</sub>. stat. 35, 27° 27' N., 14° 52' W., 2603 m., yellow mud. Common.  
<sup>23</sup>/<sub>5</sub>. stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud. Two specimens.

Koehler<sup>1)</sup>, Hérouard<sup>2)</sup> and Ludwig<sup>3)</sup> consider *Mesothuria verrilli* as a variety of *M. intestinalis*. Von Marenzeller<sup>4)</sup> also seems inclined to take this view, while Østergren<sup>5)</sup> and R. Perrier<sup>6)</sup> on the contrary maintain that they are distinct species. Judging from the material at my disposal I fully agree with the two last-mentioned scientists on this matter.

*Mesothuria verrilli* was first captured by the "Blake" off the West Indies, 760 to 1797 m. It was later taken in the Mediterranean and off the west coasts of Europe and North Africa between 45° 59' and 22° 57' N. Bathymetrical range on the east Atlantic side, 280 to 2518 m.

### *Mesothuria maroccana* R. Perrier.

(Pl. 1, fig. 1).

*Mesothuria maroccana* R. Perrier, Comptes Rendus de l'Acad. des Sci., tome 126, 1898, p. 1665.

<sup>18</sup>/<sub>7</sub>. stat. 88, 45° 26' N., 25° 45' W., 3120 m., sand and yellow mud. A somewhat contracted specimen, 59 mm. long, 22 mm. broad, 17 mm. thick. The lateral ambulacral papillae are as much as 5 mm. long. Colour gray. The specimen agrees very closely in the arrangement of the ambulacral papillae, the form of the calcareous deposits, etc. with the description that Perrier gives of this species.

*Mesothuria maroccana* was hitherto known only from two specimens taken off the west coast of Morocco, 2105 to 2200 m.; but the variety of *Holothuria murrayi* described by Théel<sup>7)</sup> and collected by the "Challenger" off Gibraltar (stat. 5, 35° 47' N., 8° 23' W., 1995 m., temp. 3.6° Cel.) most likely also belongs to this species. The *Mesothuria murrayi* from the Azores described by Hérouard<sup>8)</sup> seems likewise to belong to this species.

<sup>1)</sup> Koehler: Echinodermes, Res. Sci. Camp. du "Caudan", Fasc. 1, 1896, p. 106.

<sup>2)</sup> Hérouard: Holothuries, Res. Camp. Sci., Monaco, Fasc. 21, 1902, p. 18.

<sup>3)</sup> Ludwig: Ark. und subark. Holothurien, Fauna Arctica, Bd. 1, Lief. 1, 1900, p. 138.

<sup>4)</sup> v. Marenzeller: Holothuries, Res. Camp. Sci., Monaco, Fasc. 6, 1893, p. 7.

<sup>5)</sup> Østergren: Subfamilie Synallactinidae unter den Apsidochiroten. Festschrift for Lilljeborg, 1896, p. 347.

<sup>6)</sup> R. Perrier: Holothuries, Exp. Sci. du "Travailleur" et du "Talisman", 1902, p. 307.

<sup>7)</sup> Théel: Holothurioidea 2, Rep. Sci. Res. "Challenger", Zool., vol. 14, part 39, 1885, p. 187, pl. 9, fig. 3.

<sup>8)</sup> Op. cit., p. 23.

### *Pseudostichopus villosus* Théel.

*Pseudostichopus villosus* Théel, Holothurioidea 2, Rep. Sci. Res. "Challenger", Zool. vol. 14, part 39, 1885, p. 170.

<sup>8</sup>/<sub>6</sub>. stat. 53, 34° 59' N., 33° 1' W., 2615 to 2865 m., yellow hard clayey mud. One specimen, length 70 mm., breadth 24 mm.

The "Challenger" found *Pseudostichopus villosus* in the northern as well as in the southern part of the Atlantic, also in the Pacific, Antarctic and southern part of the Indian Oceans, 3016 to 5307 m., temp. 0.06 to 2.3° Cel. The "Princesse Alice" took it off the west coast of Morocco and the Azores, 3745 to 4360 m. *Pseudostichopus villosus* has therefore a world-wide distribution. According to the explorations of the "Michael Sars" its bathymetrical distribution is now 2615 to 5307 m.

### *Bathyploetes tizardi* Théel.

*Stichopus tizardi* Théel, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 696.

<sup>6</sup>/<sub>5</sub>. stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. Two specimens.

Ludwig („Arktische und subarktische Holothurien“, p. 158) gives the range of this species as 44 to 60° N. According to more recent explorations the southern limit must be extended to 20° 41' ("Talisman") and the northern limit to 63° 30' N. or to the Trondhjemsfjord. Bathymetrical distribution, 255 to 1615 m.

### *Deima atlanticum* Hérouard.

(Pl. 1, figs. 2, 3).

*Deima atlanticum* Hérouard, Bull. Soc. Zool. de France, vol. 23, 1898, p. 88.

<sup>21</sup>/<sub>5</sub>. stat. 48, 28° 54' N., 24° 14' W., 2800 to 3000 m. One specimen.

The specimen, 94 mm. long and 63 mm. broad, has 11 tube-feet, 3 pair of lateral and 5 pair of dorsal papillae (I have used the term proposed by Ludwig in the Albatross "Holothurioidea")<sup>1)</sup>, 14 tentacles with 2 to 8 small retractile processes. Colour of specimen in alcohol white.

*Deima atlanticum* was previously taken only by the "Princesse Alice" between Portugal and the Azores (stat. 753, 39° 50' to 39° 54' N., 20° 18' to 20° 27' W., 4360 m.). It is closely related to *Deima fastosum* Théel of the Pacific Ocean and it is also recorded under that name in Murray and Hjort's "Depths of the Ocean" (p. 541, fig. 384). It may, however, be easily distinguished from that species by the absence of a conical knot on the calcareous plates.

<sup>1)</sup> Mem. Mus. Comp. Zool., vol. 17, no. 3, 1894, p. 63.

***Oneirophanta mutabilis*** Théel.

(Pl. 2, figs. 1 &amp; 2).

*Oneirophanta mutabilis* Théel, Bih. K. Sv. Vet. Akad. Handl., Bd. 5, no. 19, 1879, p. 6. tab. 1, figs. 4-6.

<sup>19</sup>/<sub>4</sub>. Stat. 10, 45° 26' N., 9° 20' W., 4700 m., yellow mud, temp. 2.56° Cel. 10 specimens.

The largest specimen was 108 mm. long and 47 mm. broad. It had 12 tube-feet on either side, 10 lateral and 6 dorsal papillae. The middle ambulacrum of the trivium had 5 very small tube-feet, two of them quite near the anus. The fifth pair of dorsal papillae were smaller than the rest. Another specimen, 60 mm. long, 27 mm. broad, had 12 tube-feet on the right and 13 on the left side. The middle ambulacrum of the trivium had 4 tube-feet. There were six pairs of lateral and dorsal papillae. The smallest specimen, 37 mm. long, 15 mm. broad, had 7 tube-feet on the right and 8 on the left side. The middle ambulacrum of the trivium had 3 tube-feet. The specimen was unfortunately a little mutilated, and therefore the number of lateral and dorsal papillae could not be exactly determined.

In the remaining specimens the number of tube-feet varied between 10 and 14 pairs on either side. In 2 specimens they were arranged in distinct double rows on either side. In a third this arrangement was found on one side only, on the other side they formed a single row. The number of lateral papillae varied between 4 and 10 on either side, and the dorsal papillae, between 5 and 8. In the specimen depicted (pl. 2, fig. 1.) the third and fifth pair of dorsal papillae were smaller than the rest. The same was the case in a second specimen; in the other specimens only 5 pairs were smaller. Colour in life, transparent.

Calcareous plates and deposits agree entirely with those in *Oneirophanta mutabilis*. I have therefore referred the specimens to this species, the more as the variations in the number of papillae and tube-feet come within the limits given by Théel<sup>1)</sup> and Ludwig<sup>2)</sup> for this greatly varying species.

*Oneirophanta mutabilis* has a world-wide distribution. The "Challenger" captured it in the Atlantic region off Montevideo, and the "Talisman" in the Bay of Biscay. It is further known from the Indian Ocean and the Pacific, Bathymetrical range, 2516 to 5307 m. The "Challenger", "Blake" and "Michael Sars" found the bottom temperature varying between 0.2° and 2.56° Cel.

1). Théel: Holothurioidea I, Rep. Sci. Res. "Challenger", Zool., vol. 4, part 13, 1881, p. 62.

2). Ludwig: Albatross Holothurioidea, p. 70.

***Laetmogone violacea***Théel.

*Laetmogone violacea* Théel, Bih. K. Sv. Vet. Akad. Handl., Bd. 5, no. 19, 1879, p. 11, Tab. 1, figs. 14a—d.

<sup>10</sup>/<sub>4</sub>. Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. Three specimens.

<sup>5</sup>/<sub>5</sub>. Stat. 23, 35° 32' N., 7° 7' W., 1215, m. yellow mud, temp. 10.17° Cel. 8 specimens.

<sup>6</sup>/<sub>5</sub>. Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. 9 specimens.

There are besides 2 specimens without definite locality.

The "Michael Sars" took numerous specimens of this species in 1902 south of the Faroe-Iceland banks (stat. 76a, 59° 28' N., 8° 1' W., 1100 to 1300 m., temp. 8.07° Cel., and stat. 79, 61° 7' N., 9° 33' W., 750 m.).

*Laetmogone violacea* is known from the Atlantic, the Bay of Bengal, the Indian Archipelago, and the Pacific. Within the Atlantic region it appears to have its principal distribution on the east side, where it was found in a number of localities from the Faroe-Iceland banks to the Azores and the west coast of North Africa. On the west Atlantic side it is only recorded from the Davis Straits and the Bredefjord, Greenland (Mortensen<sup>1)</sup>). Bathymetrical range, 225 to 1739 m. Bottom temperature 2.2 to 10.17° Cel.

***Laetmogone wyvilli thomsoni*** Théel

*Laetmogone wyvilli thomsoni* Théel, Bih. K. Sv. Vet. Akad. Handl., vol. 5, no. 19, 1879, p. 10, tab. 1, figs. 12—13.

<sup>10</sup>/<sub>4</sub>. Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. 3 specimens.

<sup>6</sup>/<sub>5</sub>. Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. 3 specimens.

<sup>25</sup>/<sub>5</sub>. Stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud. One specimen.

*Laetmogone wyvilli thomsoni* is known only from the east side of the Atlantic region, where it was previously taken by the "Caudan" in the Bay of Biscay and by the "Princesse Alice" off the Azores. It ranges from 28° 8' to 49° 38' N., while *L. violacea* is found from 20° 41' to 61° 7' N. *Laetmogone wyvilli thomsoni* is further known from the Antarctic, the Pacific and the Indian Archipelago. Bathymetrical distribution, 631 to 3294 m. Bottom temperature, 0.3—9.2° Cel.

***Benthogone rosea*** Koehler.

*Benthogone rosea* Koehler, Echinodermes, Res. Sci. Camp, du "Caudan", Fasc. 1, 1896, p. 114, tab. 1, figs. 2, 3, tab. 3, fig. 36, tab. 4, fig. 46.

<sup>6</sup>/<sub>5</sub>. Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. 5 specimens.

<sup>7</sup>/<sub>5</sub>. Stat. 25 A, 35° 36' N., 8° 35' W., 2300 m., yellow mud. 10 specimens.

1) Mortensen: Conspectus Faunae Grønlandicae, Echinodermes, 1913, p. 322.

<sup>23</sup>/<sub>5</sub>. Stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud. One specimen.

<sup>27</sup>/<sub>7</sub>. Stat. 95, 50° 22' N., 11° 44' W., 1797 m. Common. Two specimens were preserved.

The largest specimen was 220 mm. long and 47 mm. broad. Several specimens had retained some of the colouring. Judging from these the colour of the ventral surface was a deeper dark violet than in the specimen depicted by Koehler. It was very light violet on the dorsal surface, while Koehler's specimen has a yellowish hue.

*Benthogone rosea* is an east Atlantic species, previously taken by the "Caudan" in the Bay of Biscay, and by the "Talisman" off the Azores and the west coast of North Africa. Horizontal distribution, 20° 41' to 50° 22' N., bathymetrical range, 1103 to 2300 m.

***Peniagone wyvillii* Théel.**

(Pl. 3, figs. 3—5).

*Peniagone wyvillii* Théel, Holothurioidea 1, Rep. Sci. Res. "Challenger", vol. 4, part 13, 1881, p. 42, pl. 10, figs. 3, 4, pl. 44, figs. 5, 7, pl. 37, fig. 6.

<sup>8</sup>/<sub>6</sub>. Stat. 53, 34° 59' N., 33° 1' W., 2615 to 2865 m., yellow hard clayey mud, 5 specimens.

The two best preserved specimens measured:

Total length to the point of the dorsal processes .....	92 mm.,	73 mm.
Basal length .....	62 "	54 "
Greatest breadth .....	27 "	24 "
Height .....	29 "	25 "
Length of the biggest dorsal processes .....	22 "	16 "
Breadth of the biggest dorsal processes .....	11 "	9 "

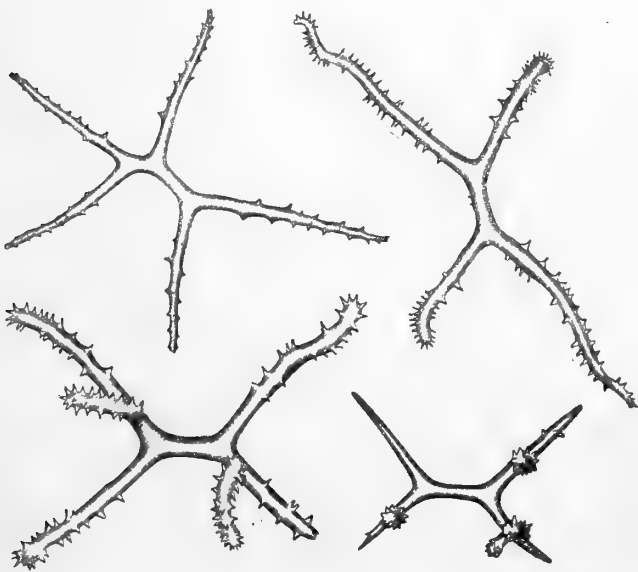


Fig. 1. Calcareous deposits from the body of *Peniagone wyvillii* Théel.

8 tentacles and 6 ambulacral papillae along both sides of the ventral surface. The hindmost of these papillae is situated at 7 mm. from the anus in the largest of the specimens. There is a space of 6 to 7 mm. between the papillae respectively. The largest papillae are 9 mm. long. Besides these large papillae three very small ones are found at the lower border of the anus. The disc of the tentacles is 5 mm. broad. The body, and more especially the dorsal surface, is very sparsely covered with calcareous deposits. They are cruciform and spiny and frequently furnished with protuberances (fig. 1). The calcareous deposits of the ambulacral papillae like those of the body are in part cruciform in part rod-shaped (fig. 2). The spicules may sometimes be branched. The calcareous deposits of the tentacles resemble those of the ambulacral papillae. But while the cruciform deposits are most frequent in the papillae, the spicules predominate in the tentacles.

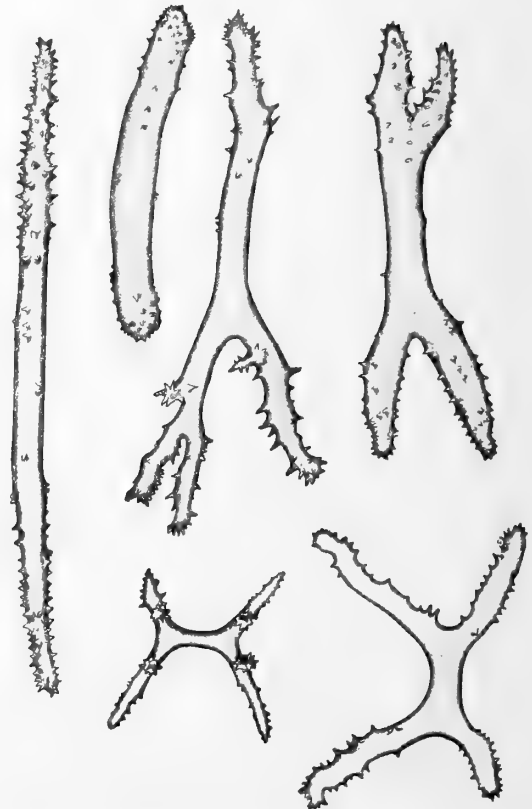


Fig. 2.

Calcareous deposits from the tube-feet of *Peniagone wyvillii* Théel.

The colour of the specimen in formol was hyaline reddish, put into alcohol it changed to grayish. The disc of the tentacles was pale red.

The specimens agree closely in appearance with *P. wyvillii*, and I have therefore referred them to that species. Théel indeed states that *P. wyvillii*, like the other species of the genus *Peniagone*, has 10 tentacles,



while I found only 8 in the 3 specimens whose tentacles were intact. This difference cannot be of great significance, however, for, judging from the material at hand, the tentacles are apparently easily lost, but as easily restored. It is therefore probable that my specimens also originally had 10 tentacles.

*Peniagone wyvillii* is new to the Atlantic region, as it was previously collected only by the "Challenger" off Christmas Island (stat. 271, 0° 33' S., 151° 34' W., 4438 m., temp. 1° Cel.).

*Peniagone ferruginea* n. sp.

(Pl. 1, figs. 4—6.)

<sup>3</sup>/<sub>5</sub>. Stat. 48, 28° 54' N., 24° 14' W., 2800 to 3000 m.

One specimen which measured:

Total length to the point of the dorsal processes .....	34 mm.
Basal length to mouth .....	25 "
Largest breadth of body .....	14 "
Height of body .....	6 "
Length of largest dorsal processes .....	10 "
Breadth of dorsal processes .....	10 "

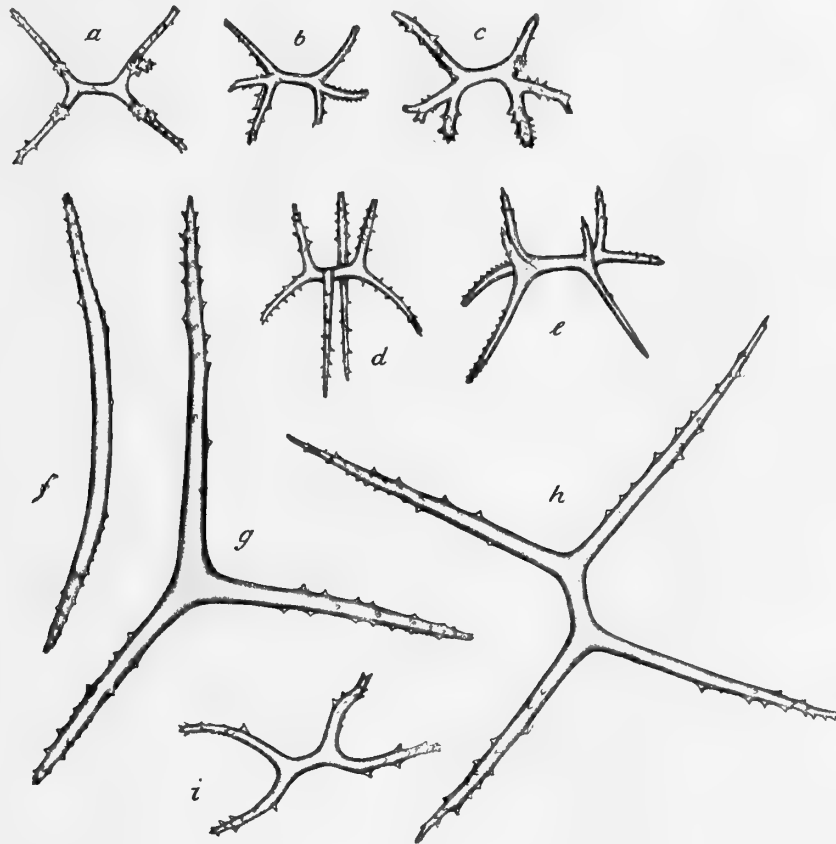


Fig. 3. Calcareous deposits from *Peniagone ferruginea* n. sp. a—c from abactinal surface, d, e from actinal surface, f—h from the tentacles, i from the tube-feet.

The body is oval and about twice as long and one half as high as it is broad. The somewhat elongated mouth is situated on the anterior ventral surface. The anal opening is sub-dorsal, about 1.5 mm. above the posterior extremity of the body. There are ten tentacles with a disc diameter of 3 mm. and provided with retractile processes. 5 ambulacral papillae are situated on either side of the edge of the posterior half of the body. The largest of these are 4.5 mm. long and 2.5 mm. broad. The hindmost papilla is situated at 2 mm. from the anus. The space between the papillae is 1.5 to 3 mm. respectively. Besides these large ambulacral papillae there are three very small papillae directly below

the anus. On the dorsal surface, at the base of the dorsal processes there are two small papillae on either side, 1.5 mm. in length and 0.5 mm. in diameter.

The body-wall is very thin and, together with the ambulacral papillae and the tentacles, is abundantly furnished with calcareous deposits. The dorsal deposits are chiefly composed of spiny crosses with arms provided with small processes (fig. 3 a). These processes may frequently be as strongly developed as the branches which give the deposits a rather irregular shape (figs. 3 b, c). Simple, smooth, cruciform deposits and some peculiar saddle-formed ones may likewise be found, but they are rare. The deposits of the ventral surface are similar

to those of the dorsal surface, but the saddle-formed ones (figs. 3 d, e) predominate there, while the cruciform deposits are more scarce. More or less spiny crosses (fig. 3 f) are frequent in the ambulacral papillae. In other respects the same forms of deposits are found as in the body. The rod-shaped spicules (fig. 3 g) are characteristic of the tentacles. They may be more or less spiny and more or less curved. Figs. 3 h, i represent forms which are likewise frequently found in the tentacles. There are besides the same forms as occur in the body.

The colour of the disc of mouth and tentacles is dark bluish-violet, the rest of the animal, plain grayish rusty-brown.

The specimen, kept in alcohol, is not very well preserved, as it has become rather contracted and a tip of the right lateral process is torn off. Also some of the tentacles and lateral ambulacral papillae are wanting. The forms of the animal given by me (pl. 1, figs. 4—6) are therefore in part reconstructed.

At a first glance the specimen reminds one of *Periamma rosea* described by Perrier<sup>1)</sup> in his monograph on the holothurians of the "Travailleur" and "Talisman". The calcareous deposits show, however, that it does not belong to this species, nor even to the genus *Periamma*, but that it is a *Peniagone* — I recognize the genera of *Elpidiidae*, adopted in the classification given by Perrier in the monograph mentioned<sup>2)</sup>. Perrier recognizes 12 species of *Peniagone*, four of them from the Atlantic, three from the Indian Ocean, four from the Pacific, and one from the Antarctic. Koehler and Vaney<sup>3)</sup> added three species from the Indian Ocean to this number<sup>4)</sup>. The specimen herein described differs from all of the species cited, by its external form as well as by the structure of the deposits. It must therefore constitute a new species which I call *Peniagone ferruginea* on account of the rusty-brown colour of the specimen.

***Peniagone azorica* v. Marenzeller.**

*Peniagone azorica* v. Marenzeller, *Holothurians*, Res. Camp. Sci. Monaco, Fasc. 6, 1893, p. 12, tab. 1, fig. 4, tab. 2, fig. 5.

<sup>18/7.</sup> Stat. 88, 45° 26' N, 25° 45' W, 3120 m., sand and yellow mud. One specimen.

The specimen measured 78 mm. in length, 22 mm. in breadth. It was therefore considerably larger than v. Marenzeller's type-specimen which measured 50 and

13 mm., respectively. The dorsal processes were 19 mm. in length, 8 mm. broad at the base. It had, like v. Marenzeller's specimen, 21 ambulacral papillae, 9 of which were placed along either side of the body, and 3 at the anus. The largest were 8 mm. in length. The disc of the tentacles was 4 mm. wide.

I may add to the description which v. Marenzeller and Herouard<sup>1)</sup> give of the deposits of this species, that they were numerous, not only in the body but also in the tentacles, where they existed chiefly as straight or curved rods of different sizes. Sometimes the rods were branched. Irregularly branched and cruciform deposits, some of them similar to those on the ventral surface, occurred also, though sparingly (fig. 4).

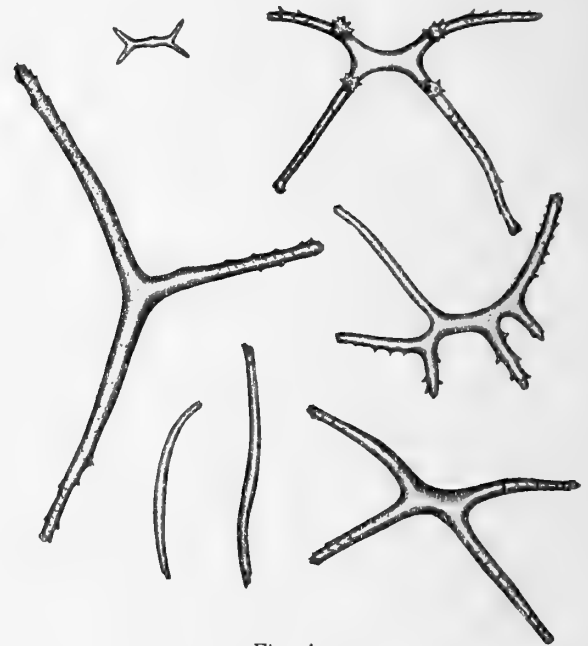


Fig. 4.

Calcareous deposits from the tentacles of *Peniagone azorica* Marenz.

*Peniagone azorica* was previously found only off the Azores by the "Hirondelle" and "Princesse Alice". According to the explorations of the "Michael Sars" its horizontal distribution will be from 38° 8' to 45° 26' N. Bathymetrical range, 2870 to 4020 m.

***Euphronides auriculata* R. Perrier.**

*Euphronides auriculata* R. Perrier, *Comptes Rendus de l'Acad. Sci.*, tome 123, 1896, p. 902.

<sup>7/5.</sup> Stat. 25 A, 35° 36' N, 8° 25' W, 2300 m., yellow mud. Two specimens.

The best preserved specimen was 70 mm. long and 13 mm. broad.

<sup>1)</sup> Op. cit., p. 42, tab. 6, figs. 21—25.

<sup>1)</sup> Op. cit., p. 419, tab. 13 fig. 10—12, tab. 20 fig. 1—11.

<sup>2)</sup> Op. cit., p. 405.

<sup>3)</sup> Koehler and Vaney: *Investigator Deep-See Holothurioidea*, 1905.

<sup>4)</sup> The two species, *P. ealcareae* and *P. discrepans*, described by Sluiter in "Die Holothurien der Siboga Expedition" evidently do not belong to the genus *Peniagone*, I have therefore paid no regard to them.

The posterior dorsal process was 20 mm. long and situated at a distance of 16 mm. from the posterior extremity of the body. The two anterior dorsal processes were 6 mm. long and situated at a distance of 21 mm. from the anterior extremity of the body. The other specimen was 83 mm. long.

The ventral deposits were cruciform, as noted by R. Perrier in his monograph of the holothurians of the "Travailleur" and "Talisman"<sup>1)</sup>. There were besides straight or curved deposits, as well as all transition-forms between them and the cruciform ones. The most common form of the dorsal deposits was that described by Perrier (pl. 20, fig. 12). But there were also found more simple cruciform deposits similar to those on the ventral surface.

*Euphronides auriculata* is an east Atlantic species taken by the "Travailleur" and "Talisman" off the west coast of Morocco and the Canary Is. The "Challenger" collected it off Gibraltar (stat. 5, 35° 47' N., 8° 23' W., 1995 m., temp. 3.1° Cel.); for, as Perrier correctly remarks, the example of *Euphronides depressa* Théel<sup>2)</sup> taken at the last-named locality differs from the two specimens found off Juan Fernandez (stat. 300, 33° 42' S., 78° 18' W., 2516 m.) and must therefore be referred to *E. auriculata*, and this is moreover confirmed by the fact that the "Michael Sars" found the last-named species in the same waters in which the "Challenger" specimen was taken. The horizontal distribution is from 27° 31' to 37° 47' N. Bathymetrical range, 1918 to 2300 m.

#### *Benthodytes gigantea* Verrill.

*Benthodytes gigantea* Verrill, Am. Journ. Sci., ser. 3 vol. 28, 1884, p. 216.

<sup>30/6.</sup> Stat. 70, 42° 59' N., 51° 15' W., 1100 m., temp. 3.7° Cel. 4 large and some very young specimens.

The specimens were unfortunately so very badly preserved, that it was impossible to give a good illustration of this species of which only a sketchy drawing by Verrill exists<sup>3)</sup>. I merely give an outline drawing of the actinal surface showing the arrangement of its ambulacral papillae (fig. 5), as this is not clearly seen in Verrill's figure. It is unnecessary to give a detailed description of *Benthodytes gigantea*, as Verrill's description is very exhaustive. I shall therefore confine my remarks to the calcareous deposits, as they were not dealt with by Verrill.

The body was scantily furnished with three-rayed deposits, whose points were slightly branched or provided with a small perforated plate (fig. 6). The deposits of the ten-

tacles, whose form may be best explained by the accompanying illustration (fig. 7), were comparatively more numerous than those of the body.

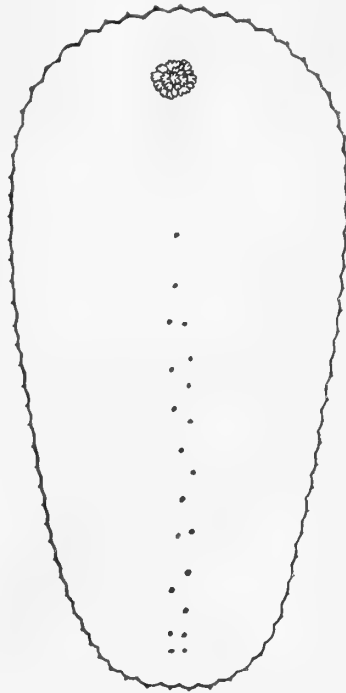


Fig. 5. Diagrammatic view of the actinal surface of *Benthodytes gigantea* Verr., illustrating the arrangement of the tube-feet.

The best preserved of the large specimens measured 298 mm. in length. Anterior breadth 84 mm., posterior breadth 61 mm. According to Verrill this species generally attains a length of 250 to 300 mm., and a breadth of 75 mm. It may however be as much as 475 mm. long and 127 to 152 mm. broad.

The very young specimens were 10—14 mm. long and 4—5 mm. broad.

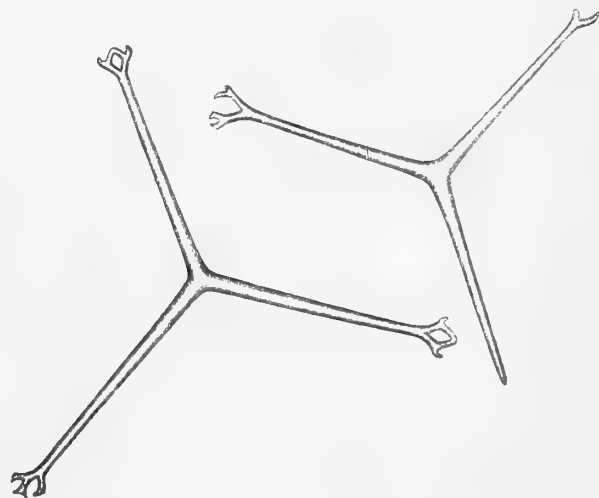


Fig. 6. Calcareous deposits from the body of *Benthodytes gigantea* Verr.

<sup>1)</sup> Op. cit. p. 437, tab. 20, fig. 13.

<sup>2)</sup> Théel, Challenger Holothurioidea 1, p. 93.

<sup>3)</sup> Verrill, Res. Explor. "Albatross" 1883 (1885), pl. 10 fig. 31, pl. 11 fig. 31 a, b.

*Benthodytes gigantea* is known only from the north-eastern coast of North America. The "Albatross" found it in a number of localities, very numerous in some of them, off the coast of New England at a depth of 1691 to 3720 m. According to the explorations of the "Michael Sars" the bathymetrical distribution will be 1100—3720 m.



Fig. 7.

Calcareous deposits from the tentacles of *Benthodytes gigantea* Verr.

***Benthodytes typica*** Théel.

(Pl. 3 fig. 6, 7).

*Benthodytes typica* Théel, Holothurioidea 1, Rep. Sci. Res. "Challenger" Zool., vol. 4 part 13, 1881, p. 103, tab. 27 fig. 7, tab. 35 fig. 4, tab. 38 fig. 5.

<sup>8</sup>/<sub>6</sub>. Stat. 53, 34° 59' W., 33° 1' W., 2615—2865 m., yellow hard clayey mud. One specimen, whose dimensions were as follows: length 94 mm., breadth in front 21 mm., in the middle 39 mm., behind 32 mm.

As may be seen from pl. 3 figs. 6 & 7 the animal has an elongated body with a greatest breadth of about 40 per cent of its length. It was rounded in front and straight cut behind with an incision at the anus. I ought to mention that the animal was slightly mutilated a little below the mouth. It is therefore possible that it had been much contracted, whereby the border between forepart and body had become a little too distinct. The brim was narrow in front, but broad along the sides of the body.

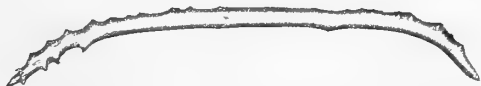


Fig. 8. Spicules from the body of *Benthodytes typica* Théel.

There were 20 tentacles. The middle ambulacrum of the trivium had about 30 papillæ in each row. The dorsal ambulacra have each 5 or possibly 6 small papillæ. The body was scantily covered with thorny calcareous rods (fig. 8). The rods of the ventral surface seem also a little more thorny.

The colour of the fore part was a deep, dark violet which extended a little over on the dorsal surface of the body. The middle part of the trivium, as well as the canals connected with the ambulacral systems, were of the same colour, which in the case of the canals, could be distinctly seen through the brim. The dorsal surface was bluish transparent. The disc of the tentacles was yellowish brown.

The specimen contained well developed eggs, with a diameter of 1.3 mm.

The specimen agreed in most of its characteristic with *Benthodytes typica* but differed from it in the form. The typical *B. typica* is oval, while the specimen in question was elongated. This difference may however be due to preservation or other accidental circumstance. Moreover the present specimen had 5, or possibly 6, papillæ in each of the dorsal ambulacra while Théel's species is said to have "about eight". The papillæ are so small, however, as to be easily overlooked. I therefore do not attach much importance to this difference and refer the specimen to *B. typica* as it agreed in all other characteristics with that species, as already stated.

*Benthodytes typica* was taken by the "Challenger" off Gibraltar (Stat. 5, 35° 47' N., 8° 23' W., 1995 m., temp. 3.1° Cel.). Afterwards it was taken by the "Hirondelle" off the Azores at 2870 m. Furthermore Théel<sup>1)</sup> records it, though doubtfully, from the West Indies and the Gulf of Mexico, 1885—3514 m. Its horizontal distribution on the East Atlantic side is from 34° 59' to 41° 40' 41" N., on the West Atlantic from about 15° to 24° 33' N.

***Benthodytes glutinosa*** R. Perrier.

(Pl. 3, figs. 1 & 2).

*Benthodytes glutinosa* R. Perrier, Comptes Rendus de l'Acad. des Sci., tome 123, 1896, p. 903.

<sup>18</sup>/<sub>6</sub>. Stat. 35, 27° 27' N., 14° 52' W., 2603 m., yellow mud. One specimen, 62 mm. long. 21 mm. broad. A coloured drawing of the specimen preserved in formol is given on pl. 3, figs. 1 & 2

<sup>23</sup>/<sub>7</sub>. Stat. 92, 48° 29' N., 13° 55' W., 2000 m. wire. One very young specimen, 13 mm. long, 4.5 mm. broad.

The structure of this species, like the others of the genus *Benthodytes*, shows that it is a natatory animal. The young specimen from stat. 92 gives a further proof of this. It was taken in the next to the lowest gear, a young fish trawl set with 2000 m. wire, consequently at a depth of about 1400 m. The lowermost gear was set with 3000 m. wire or a depth of about 2000 m.<sup>2)</sup> There

<sup>1)</sup> Bull. Mus. Comp. Zool., vol. 13, no. 1, 1886, p. 2.

<sup>2)</sup> In accordance with my statement in "Brachiopoda, Lamelli-branchiata etc." (This rep., vol. 3, part. 2, p. 5). I have estimated the depth at <sup>2</sup>/<sub>3</sub> of the length of the wire (cfr. Brinkmann: Pelagic Nemerteans, this rep. vol. 3, part. 2, pag. 10.)



was unfortunately no sounding at stat. 92, but judging from the maps of the depths in the North Atlantic the depth can not have been less than 3000 m. The specimen must therefore have been taken about 1600 m. above the bottom.

*Benthodytes glutinosa* was previously taken by the "Talisman" off the Azores and in the Sargasso Sea. According to the explorations of the "Michael Sars" its horizontal distribution will be from 27° 27' to 48° 29' N., the bathymetrical distribution from 1400 to 3432 m.

***Benthodytes janthina* v. Marenzeller**

*Benthodytes janthina* v. Marenzeller, *Holothurians*, Res. Camp. Sci., Monaco, Fasc. 6, 1893, p. 10, tab. 1, fig. 3, tab. 3, fig. 4.

<sup>19</sup>/<sub>4</sub>. Stat. 10, 45° 26' N., 9° 20' W., 4700 m., yellow mud-  
temp. 2.56° Cel. One specimen, 220 mm. long. 83 mm. broad.

A coloured sketch made immediately after the animal had come on deck shows that the colour of the ventral side was intensely violet, that of the dorsal side light violet, considerably lighter than in the specimen illustrated by v. Marenzeller, the colour of which agrees more with that of the ventral side in the specimen under discussion. In alcohol the ventral side is a deep blackish blue, the dorsal side light grayish blue.

*Benthodytes janthina* was previously found by the "Hirondelle" and the "Princesse Alice" off the Azores and the west coast of Morocco. The "Michael Sars" collected the species in the Bay of Biscay, hence its horizontal distribution will be from 34° 4' to 45° 26' N., the bathymetrical distribution from 2252 to 4700 m.

***Cucumaria abyssorum* Théel.**

*Cucumaria abyssorum* Théel, *Holothurioidea* 2, Rep. Sci. Res. Voy. "Challenger", Zool. vol. 14, part 39, 1886, p. 66, tab. 4 fig. 6, 7, tab. 5 fig. 1, tab. 16 fig. 6.

<sup>18</sup>/<sub>5</sub>. Stat. 88, 45° 26' N., 25° 45' W., 3120 m., sand and yellow mud. 3 specimens.

Théel and Ludwig<sup>1)</sup> have given a very detailed description of this species to which I shall merely add that the majority of the calcareous deposits in the tentacles are composed of bowed rods whose form may be seen from the present figures (figs. 9 a—c). They very much resemble the deposits in the ambulacral papillæ. Fig. 9 d is an extreme form of this type. Further straight rods, as well as a few scattered cruciformed deposits (fig. 9 e) are found in the tentacles.

*Cucumaria abyssorum* was taken by the "Challenger" in the Antarctic, Indian, and southern part of the Pacific Oceans, 3516—4061 m., temp. 1.2—2° Cel. The "Alba-

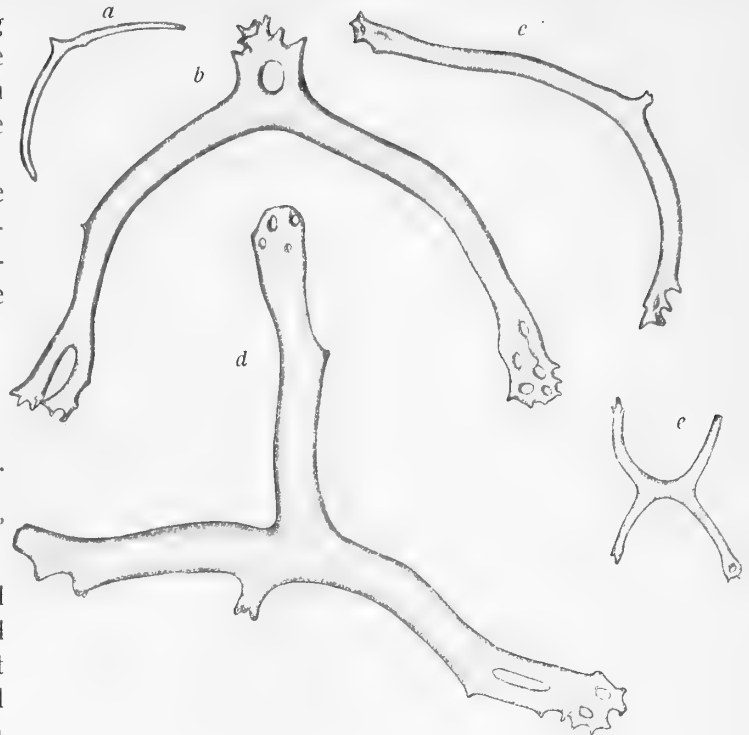


Fig. 9.

Calcareous deposits from tentacles of *Cucumaria abyssorum* Théel.

ross" took it off the west coasts of Central America and Mexico, 1656—4084 m., temp. 2.1—2.9° Cel. and the "Hirondelle" at the Azores, 2870 m. Thus the species has a world-wide distribution.

***Holothuria tubulosa* Gmelin.**

*Holothuria tubulosa* Gmelin, *Syst. Nat.*, ed. 13, 1788, p. 3138.

<sup>20</sup>/<sub>5</sub>. Stat. 37, 26° 6' N., 14° 33' W., 39 m., shingle. Common.

The specimens were chestnut brown on the dorsal and lemon yellow on the ventral side.

*Holothuria tubulosa* is known from the Mediterranean, the Canaries and the south west coast of France. The bathymetrical distribution is 0—40 m.

***Stichopus tremulus* Gunnerus.**

*Holothuria tremula* Gunnerus, *K. Sv. Vet. Akad. Handl.*, vol. 28, 1767, p. 119, tab. 4, fig. 3.

<sup>10</sup>/<sub>4</sub>. Stat. 3, 49° 32' N., 10° 49' W., 184 m., fine sand. Rather common.

<sup>10</sup>/<sub>4</sub>. Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. Several specimens.

Ludwig states in "Arktische und subarktische Holothurien" (p. 136) that the northern border of *Stichopus tremulus* is at 71°, the southern at 43° or the northern coast of Spain, and that its bathymetrical distribution is from 18—1229 m. The researches of the "Talisman" and

<sup>1)</sup> Ludwig: *Albatross Holothurioidea*, p. 122.

the "Travailleur" show, however, that its southern distribution extends to Cape Garnet, or to 25° 41' N. and that it descends to a depth of 1918 m.

***Labidoplax digitata*** Montagu.

*Holothuria digitata* Montagu, Transact. Linn. Soc., vol. 11, 1815, p. 22, tab. 4, fig. 6.

<sup>3</sup>/<sub>5</sub>. Stat. 21, 35° 31' N., 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. One specimen.

*Labidoplax digitata* is known from the Mediterranean and the west coast of Europe northward to Great Britain. Its bathymetrical distribution is from 18—618 m.

## ASTEROIDEA

***Pontaster tenuispinus*** Düben & Koren.

*Astropecten tenuispinus* Düben & Koren, Kgl. Vet. Akad. Handl. 1844 (1846), p. 251, tab. 8, figs. 20—22.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>. Stat. 102, 60° 57' N., 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. Common.

The largest specimen measured: arm-radius 77 mm., disc-radius 14 mm., the smallest specimen was 33.5 mm. and 6.5 mm. respectively. In 10 specimens of different sizes varied r:R, between 1:4.47 and 1:5.9.

The specimens belong to the variety *platynota* Sladen<sup>1)</sup> from the cold area of the Faroe-Shetland channel. They have a paired arrangement of the marginal plates, spatuli-form pedicellariæ and a not very prominent papularium. The armature of the adambulacral and marginal plates as well as the dorsal papillæ was large and well developed.

***Benthopecten spinosus*** Verrill.

(Pl. 4, fig. 1).

*Benthopecten spinosus* Verrill, Amer. Journ., ser. 3, vol. 28, 1884, p. 218.

<sup>30</sup>/<sub>6</sub>. Stat. 70, 42° 59' N., 51° 15' W., 1100 m., temp. 3.7° Cel. One specimen.

<sup>26</sup>/<sub>7</sub>—<sup>27</sup>/<sub>7</sub>. Stat. 95, 50° 22' N., 11° 44' W., 1797 m., temp. 3.5° Cel. 5 specimens.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>. Stat. 101, 57° 41' N., 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. 12 specimens.

All the specimens were more or less mutilated. Only in 4 specimens from stat. 101 was at least one of the arms intact. These four specimens measured:

	mm.	mm.	mm.	mm.
Arm-radius .....	52	48	38	32
Disc-radius .....	7	6	5.5	5
Breadth of arm at base.....	7	5.5	5	5
r:R .....	1:7.4	1:8	1:6.9	1:6.4
A:R .....	1:7.4	1:8.7	1:7.6	1:6.4
Number of dorsomarginal plates.....	27	26	22	20

<sup>1)</sup> Sladen: Asteroidea, Rep. Sci. Res. "Challenger", Zool. vol. 3, 1889, p. 29, tab. 6, fig. 7, tab. 7, figs. 3 & 4.

The largest specimen has a disc-radius of 11 mm. Thus all of the specimens were younger individuals. Verrill mentions specimens that were twice as large as the largest of the specimens from the "Michael Sars".

The species varies greatly with respect to the disc-oversing as well as the armature of the adambulacral and marginal plates, as pointed out by Verrill. 5—6 papillæ are normally found in the inner row on the adambulacral plates, but the number may vary between 4 and 7. One large papilla and a small one outside of it are normally found in the transverse row. But two large papillæ may also occur, one outside the other as in *Pararchaster semisquamatus* Sladen, or a small papilla may be situated on either side of the large papilla. Also two small papillæ may be found instead of the small one outside the large one. One or two large spines besides some very small ones are found on the ventro-marginal plates. One large spine is most commonly found on the dorso-marginal plates, two such spines being an exception. Moreover most of the plates have some spinelets most commonly grouped around the large spine. These spinelets were in some specimens entirely wanting however (pl. 4, fig. 1). Of the large spines the one on the medial odd plate of the disc-angle is larger and stouter than the rest. In a specimen from stat. 95 (disc-radius 8 mm.), this spine was 8.5 mm., while those on the adjoining plates measured 6 mm. In an other specimen from stat. 101 (disc-radius 5 mm.) these measurements were 5.5 mm. and 3.5 mm. respectively.

In two specimens, the medial odd marginal plates were bifurcated in one of the angles of the disc. The bifurcation included not only the dorsal but also the ventral plate. Each of these plates was furnished with a large spine.

The peculiar "spiracle-like or double comb-formed" pedicellariæ on the actinal interradial area were observed only in some of the larger specimens. The number of pedicellariæ seems to vary greatly. They were absent in some specimens, while a number of them were met with in others of a similar size. The inter-radial areas have a varying number of pedicellariæ even in the same individual. Thus 0—1—2—1—2 pedicellariæ were observed in a specimen from stat. 95 (disc-radius 8 mm.). No pedicellariæ could be found between the ventro-marginal plates.

Verrill<sup>1)</sup> has correctly referred *Parachaster semisquamatus* var. *occidentalis* and *Parachaster armatus* described by Sladen in his report on the "Challenger" Asteroidea<sup>2)</sup>, to that species. *Pararchaster fisheri* E. Perrier

<sup>1)</sup> Proc. U. S. Nat. Museum, vol. 17, 1894, p. 245. Cfr. Amer. Journ. ser. 3, vol. 49, 1895, p. 129.

<sup>2)</sup> Op. cit. p. 10 & 19, tab. 1 figs. 5—6, tab. 4, figs. 5—6.

a specimen of which was taken by the "Talisman" off the west coast of North Africa must likewise be referred to it<sup>1)</sup>. The agreement between these species is clearly demonstrated by comparing Perrier's and Verrill's figures.<sup>2)</sup> I ought to state that pedicellariæ are wanting in Verrill's drawing of the specimen, while Verrill himself makes mention of such. The main difference between these forms is then that the pedicellariæ between the ventro-marginal plates are wanting in *Benthopecten spinosus* (*Pararchaster armatus*). But it is difficult to determine how constant this character is, as only one example of Perrier's species exists. Most probably it is very variable, however, as indeed indicated by that very specimen. The number of pedicellariæ on the left side of the arms was 1 to 2 with a rudimentary third on one arm, on the right side 1 to 3. Arm *a* had 5 pedicellariæ, *b* 4, *c* 3 and a rudimentary fourth, *d* 3 and *e* 3. Most probably Mortensens *Pararchaster nov. sp.* (*P. fisheri* Perrier aff.) from the slope south of Iceland ("Thor" 1903 stat. 164)<sup>3)</sup> must be referred to *Benthopecten spinosus*.

The "Challenger" has taken *Benthopecten spinosus* off the east coast of North America between 37° 25' and 42° 8' N., at 2269—3111 m., temp. 2.33—3.33° Cel., as well as off Portugal. According to Verrill it is distributed along the east coast of North America between 35° 10' and 42° 47' N., from 1319—3698 m., but being most common at a depth of 2200—2900 m. It is further recorded by Verrill from the Mexican Gulf, 2334—2617 m., and from Jamaica, 2999 m. The "Thor" took it south of Iceland (stat. 164, 62° 10.8' N., 19° 36' W., 2094 m., temp. at depth of 1850 m., 2.75° Cel.), the "Helga" off the west coast of Ireland (51° 22' N., 12° 41' W., 1797 m.) and the "Talisman" off the west coast of North Africa (1883, stat. 73, 25° 39' N., 18° 26' W., 1435—1056 m.). *Benthopecten spinosus* thus appears to be a deep-sea species whose distribution includes the entire northern part of the Atlantic and the habitat of which is restricted to the waters whose temperature is not below 2.33° Cel. I may mention for comparison with the temperatures given above, that the "Albatross" in 1883 found a bottom temperature not lower than 2.78° within the range of distribution of this species.

<sup>1)</sup> E. Perrier: Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1894, p. 263, tab. 20, fig. 2.

<sup>2)</sup> Transact. Connecticut Acad., vol. 10, 1900, p. 217, tab. 30, fig. 7 a.

<sup>3)</sup> Schmidt: Fiskeriundersøgelser ved Island og Færøerne i sommeren 1903 (1904) p. 24.

### *Plutonaster bifrons* Wyville Thomson.

*Archaster bifrons* Wyville Thomson, The Depths of the Sea, 1873, p. 122, figs. 17 and 74.

<sup>10/4.</sup> Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. One specimen.

<sup>6/5.</sup> Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. 15 specimens.

<sup>7/5.</sup> Stat. 25 A, 35° 36' N., 8° 25' W., 2300 m., yellow mud. Two smaller specimens.

<sup>8/5.</sup> Stat. 25 B, 35° 46' N., 8° 16' W., 2055 m., yellow mud. Four smaller specimens.

<sup>23/5.</sup> Stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud, temp. 6° Cel. 13 specimens.

<sup>27/7.</sup> Stat. 95, 50° 22' N., 11° 44' W., 1797 m., temp. 3.5° Cel. 17 specimens.

<sup>6/8—7/8.</sup> Stat. 101, 57° 41' N., 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. Common.

<sup>9/8—10/8.</sup> Stat. 102, 60° 57' N., 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. A very defective and macerated specimen, which had most likely remained in the trawl from stat. 101.

The two smallest (stat. 25 A) and two of the largest specimens (stat. 101) measured:

Arm-radius .....	33.5 mm.	37 mm.	92 mm.	97 mm.
Disc-radius .....	8 "	11 "	18.5 "	19.5 "
Number of dorso-				
marginal plates ..	25 "	26 "	37 "	38 "
r : R	1 : 4.19	1 : 3.36	1 : 4.97	1 : 4.97

The proportions of r : R varied between 1 : 3.36 and 1 : 4.47 in 10 specimens with an arm-radius of up to 55 mm. in length, but in two specimens only the proportion exceeded 1 : 4.2. In 10 specimens with an arm-radius exceeding 70 mm. the proportion varied between 1 : 3.81 and 1 : 4.97, but in one individual only it was less than 1 : 4. The relative length of the arms is subject to great individual variations, thus the smaller of the two specimens from stat. 25 A. had proportionately the longest arms, and in three specimens with an arm-radius of 45 mm. the proportion r : R varied between 1 : 4.09 and 1 : 4.74. But such individual variations apart from the measurements clearly demonstrate that the relative length of arms in *Plutonaster bifrons* increases with the age.

Colour in life, reddish violet.

*Plutonaster bifrons* is one of the most widely distributed starfishes of the East Atlantic. It is known from numerous localities between Cape Verde Is. and the Faroe-Shetland Channel or from 19° 12' to 60° 21' N., leaving out the doubtful find at stat. 102. It is besides found in the Mediterranean. The bathymetrical distribution is from 106 to 2489 m. It is a true warm-water species which was, however, captured three times in the cold

area of the Faroe-Shetland Channel ("Porcupine" 1869 stat. 57, 60° 14' N., 6° 17' W., 1156 m., ÷ 0,8° Cel. and stat. 58, 60° 21' N., 6° 51' W., 988 m., ÷ 0,6° Cel. and "Knight Errant" 1880, stat. 8, 60° 3' N., 5° 51' W., 988 m. ÷ 1,56° Cel.).

*Plutonaster agassizi* Verrill.

(Pl. 4, figs. 2—4).

*Archaster agassizi* Verrill, Amer. Journ., ser. 3 vol. 20, 1880, p. 403.

<sup>90</sup>/<sub>6</sub>. Stat. 70, 42° 59' N., 51° 15' W., 1100 m. Temp. 3,7° Cel. One specimen, measuring:

Diameter .....	154	mm.
Arm-radius .....	79	"
Disc-radius .....	24	"
Breadth of arm at 4—5 dorso-marginal plate .....	13	"
Breadth of paxillary area at same place.....	7	"
Breadth of arm in the middle .....	10	"
Breadth of paxillary area at the same place .....	4	"
Size of madreporic area.....	2,5 × 6	"
Distance of madreporic area from centre of disc.....	11,5	"
Number of dorso-marginal plates.....	31—32	
Number of ventro-marginal plates .....	30—31	
r : R .....	1 : 3,29	

The marginal plates are very small and high in the arm-angles increasing proportionately in length as they advance towards the points of the arms, where they are almost quadrate as the following measurements distinctly show:

1st dorso-marginal plate	2	mm.	long,	5	mm.	high.
10th	—	—	2,5	"	"	4 " "
20th	—	—	2	"	"	3 " "
25th	—	—	1,5	"	"	2 " "
1st ventro-marginal plate	2,5	"	"	6,5	"	"
10th	—	—	3	"	"	4,5 " "
20th	—	—	2	"	"	2,5 " "
25th	—	—	1,5	"	"	1,5 " "

The ventro-marginal plates are furnished with a well-developed conical knob, the height of which equals the length of the plates. It is wanting, however, in 3 to 6 of the outermost plates, as well as in a few of the others. The knob is rudimentary in some plates. Most of the dorso-marginal plates are bare, and only a few of them bear a little rudimentary knob.

7 to 9 papillæ were counted along the free margin of the mouth plates and also 7 to 9 adambulacral papillæ of about uniform size. Outside the latter a group of small short papillæ were found, the outermost of which corresponded in size and in form to the granules of the actinal plates. This group of secondary papillæ was arranged in 2 to 4, most commonly in 3 rows. The arrangements were not very distinct, however. No pedicellariæ were observed on the actinal face.

Although Verrill's description of *Plutonaster agassizi* is far from exhaustive it yet clearly shows that his species is identical with *Plutonaster rigidus* Sladen, and as this name dates from 1889 while Verrill's is from 1880, the latter has the priority. I agree with Koehler in referring *Plutonaster granulatus* Perrier to *Pl. agassizi*. Further *Pl. intermedius*, taken off the Antilles by the "Blake", must be referred to the species under discussion. Perrier states that *Pl. intermedius* is distinguished from *Pl. agassizi* by the presence of 8 mouth-papillæ while the other has 9, by having 7 adambulacral papillæ, while there are 9 in the other species, by having two rows of secondary adambulacral papillæ as against 3 rows in the other form, by having commonly a knob on the dorso-marginal plates, while the knob is wanting in the other form, and finally by possessing 22—27 marginal plates, while the other has 31.

The last-named difference can be of no great significance, however, as Perrier's type-specimen was a small individual. Nor is the presence or absence of knobs on the dorso-marginal plates a reliable specific characteristic. Perrier writes about the knob-covering on the dorso-marginal plates of *Pl. intermedius*: "— — — — — elles portent, en général, un piquant conique, sauf sur la moitié terminale des bras ou elles sont inermes; ce piquant peut d'ailleurs avorter accidentellement, même sur les plaques qui sont situées dans l'arc interbrachial"<sup>1)</sup>. He further says ("Stellerides des dragages du Blake")<sup>2)</sup> that the dorso-marginal plates of the interbrachial angles at least are furnished with knobs. Verrill remarks on *Pl. agassizi*: "In one large series there are among the adult specimens all gradations from those having no marginal spines whatever to those that have a large spine on nearly every marginal plates of both series. Therefore it is useless to recognize varieties on this character like the variety *semiarmata* of Sladen"<sup>3)</sup>. The specimen under discussion as before mentioned has a knob on some of the dorso-marginal plates.

The armature of the adambulacral and the mouth-plates does not seem either to afford reliable specific characters. The specimen in question has 7—9 papillæ along the free margin of the mouth papillæ. Thus the number of papillæ characteristic of *Pl. intermedius* (8) as well as of *Pl. agassizi* (9) is found in the same specimens. It is noteworthy, however, that Sladen in his description of *Pl. agassizi s. rigidus* uses the expression "about nine

<sup>1)</sup> Perrier: Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1894, p. 316.

<sup>2)</sup> Nouv. Arch. du Museum d'Hist. Natur., ser. 2 tome 6, 1883, p. 251.

<sup>3)</sup> Proc. U. S. Nat. Museum, vol. 17, 1894, p. 248.



.... spinelets" <sup>1)</sup>). He must have been aware then that the number of papillæ may vary. Some adambulacral plates of the "Michael Sars" specimen have 7 furrow-papillæ like *Pl. intermedius*, others 8 and again others 9 as in the specimen described by Sladen. The number given in Verrill's diagnosis is „about seven or eight . . . spines", which likewise shows that the number of papillæ may vary. Moreover the arrangement of the secondary papillæ is subject to variation as shown by the specimen under discussion. *Pl. intermedius* can therefore not be considered as a distinct species, but only as a variety of *Pl. agassizi*.

*Plutonaster agassizi* was first taken off the east coast of North America, where it was found by several American expeditions and by the "Challenger" at several localities between 35° 45' and 41° 53' N, 333—3111 m. It was later on taken by the "Blake" off the Antilles, 24° 24'—24° 36' N, 1524—1748 m., and by the "Michael Sars" south of New-Foundland. The Prince of Monaco took it off Madeira and the Azores and in the Bay of Biscay, 1165—1900 m. On the west Atlantic side it is distributed from 24° 24' to 42° 59' N, and on the east Atlantic side from 32° 39' to 43° 33' N. The bathymetrical distribution is 333—3111 m.

***Dytaster agassizi* Ed. Perrier.**

*Dytaster agassizi* Ed. Perrier, Echinodermes, Exp. Sci. du „Travailleur" et du „Talisman", 1894, p. 302, tab. 19, fig. 2.

<sup>18/7.</sup> Stat. 88, 45° 26' N., 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. 34 specimens.

The smallest specimen measured: arm-radius 29 mm., disc-radius 6.5 mm., the largest 61 mm. and 12 mm. respectively. r:R is thus in these specimens 1:4.46 and 1:5.08. This proportion varied, however, between 1:4.46 and 1:5.65 in 15 specimens. In the two smallest specimens only was R < 5r. I Perrier's type specimen, which was a little larger than the largest of my specimens, the proportion was R = 5.15 r.

The ventro-marginal plates commonly bear one large spine, but they may have two, particularly in the angle of the arm, and more rarely three larger spines or one large and one or two smaller spines. The dorso-marginal plates bear one spine, but as an exception those in the arm-angle may have two smaller spines. The ventro-marginal as well as dorso-marginal plates may, however, be without spines, especially in the outer half of the arms.

The mouth-plates have 10—11 papillæ along the inner free margin. The adjoining adambulacral plate has 8 papillæ, the remainder 7—10, in the outer half of

the arm not more than 6—8. Besides the furrow-papillæ two more rows of adambulacral papillæ were found with 4—5 papillæ in each row, the outermost of which was usually very indistinct, however, and its papillæ tiny.

According to Perrier the actinal areas of *Dytaster agassizi* are furnished with numerous pedicellariæ, of which he remarks: "une trentaine des ces pédicellaires couvrent presque l'aire interambulacraire ventrale, les autres sont disposés isolement le long de la gouttière ambulacraire comme les plaques dont ils dependent". The specimens examined by me have not such a great number of pedicellariæ, nor were they grouped in the manner described by Perrier. The number of pedicellariæ appears to be subject to great variations, however. In some specimens a few pedicellariæ only were found in each actinal area and there were even areas in which the pedicellariæ were entirely wanting. No specimens had more than about 20 pedicellariæ in each area, and they exhibited no grouped arrangement, but were scattered among the spines of the actinal plates. In spite of this difference I have referred the specimens to *Dytaster agassizi* Perrier as they agree with it in other characteristics. Thus the mouth- and adambulacral plates have the same armature, the actinal area has the same extension as in the specimens in questions, the 4th ventro-marginal is tangent to the 5th adambulacral plate, etc.

The colour in life is red.

*Dytaster agassizi* was first taken by the "Talisman" between Europe and the Azores, 4060 m. It was again found there by the Prince of Monaco in two localities, 4020—4360 m. According to the explorations of the "Michael Sars" its horizontal distribution will be from 38° 8' to 45° 26' N., and from 17° 58' to 25° 45' W. The bathymetrical distribution ranges 3120 to 4360 m.

***Astropecten irregularis* Pennant.**

*Asterias irregularis* Pennant, British Zoology, vol. 4, 1777, p. 52.

<sup>9/4.</sup> Stat. 1, 49° 27' N., 8° 36' W., 146 m., fine sand, temp. 9.57° Cel. One specimen which measured: arm-radius 32 mm., disc-radius 8 mm., 28 dorso-marginal plates.

<sup>10/4.</sup> Stat. 3, 49° 32' N., 10° 49' W., 184 m., fine sand, temp. 10.3° Cel. Three specimens measured: arm-radius 37—39 mm., disc-radius 9—12 mm., 27—29 dorso-marginal plates.

*Astropecten irregularis* is an East-Atlantic species, ranging from the Josephine Bank (36° 41') to the Lofoten Is. (68° 20'). It is besides recorded from Tromsø (Danielssen<sup>1)</sup>) and the Barents Sea (Hoffmann<sup>2)</sup>). I am, however, inclined to consider their records as based on misidentifications of *Leptoptychaster arcticus* as *Astro-*

<sup>1)</sup> Sladen: Challenger Asteroidea, p. 91.

<sup>2)</sup> Kgl. norske Vidensk. Selsk. Skrifter, bd. 4, h. 2, 1859, p. 159.

<sup>2)</sup> Niederländ. Archiv f. Zool., Suppl. Bd. 1, 1882, p. 9.

*specten irregularis* has not since been found again in those northern waters. Mr. Dons, keeper of the Tromsøe Museum, has thus kindly informed me that there is no specimen of *Astrospecten irregularis* in the Museum. I have not found it myself among the rich echinoderm material brought home from northern Norway and Barents Sea by Mr. Nordgaard and by the "Michael Sars".

***Bathybiaster robustus*** Verrill.

*Archaster robustus* Verrill, Amer. Journ., ser. 3 vol. 28, 1884, p. 383.

<sup>27</sup>/<sub>7</sub>. Stat. 95, 50° 22' N, 11° 44' W, 1797, temp. 3.5° Cel. 25 specimens.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>. Stat. 101, 57° 41' N, 11° 48' W, 1853, temp. 3.3° Cel. 30 specimens.

The dimensions of the largest specimens from stat. 101 were:—Arm-radius 127 mm., disc-radius 23 mm., breadth of arm at base 26 mm., 57 dorso-marginal plates. In the other specimen these figures are 80 mm., 17 mm., 18 mm. respectively and 53 dorso-marginal plates and in the third one 56 mm., 14 mm., 15 mm., 44 dorso-marginal plates. The proportions of breadth of arm to arm-radius is 1 : 4.88, 1 : 4.44 and 1 : 3.39 respectively in these specimens. The proportion r : R is 1 : 5.52, 1 : 4.72 and 1 : 4. Young individuals have proportionately broader and shorter arms than older ones, as will be even more evident from following table of measurements of some specimens from stat. 95.

Arm-radius	Disc-radius	Breadth of arm at base.	r : R	A : R	Number of dorso-marginal plates.
53	12	14	1 : 4.42	1 : 3.79	44
54	11	15	1 : 4.91	1 : 3.60	46
68	15	16	1 : 4.53	1 : 4.25	49
76	15	18	1 : 5.07	1 : 4.22	50
78	16	19	1 : 4.87	1 : 4.11	53
83	20	23	1 : 4.15	1 : 3.61	43
89	17	18	1 : 5.24	1 : 4.91	52
92	18	20	1 : 5.11	1 : 4.60	58
94	18	22	1 : 5.22	1 : 4.27	57
97	17	19	1 : 5.71	1 : 5.11	62
100	19	23	1 : 5.26	1 : 4.35	58
102	19	20	1 : 5.36	1 : 5.01	58

The measurements are in millimetres.

The table further shows that the proportion of r : R and of length of the arms to their breadth are subject to great individual variations. Thus the comparatively shortest length of arm is not found in the smallest specimen in the table but in one of middle size. Even in specimens of the same size these figures may vary. Thus

in three specimens with an arm-radius of 99 mm. the proportion r : R is 1 : 5.21, 1 : 5.5 and 1 : 5.82 respectively, and A : R is 1 : 4.71, 1 : 4.75 and 1 : 5.50.

The marginal plates are high and narrow. Apart from the innermost interbrachial plates the proximal plates are largest, gradually decreasing in size towards the points of the arms. In the largest specimen the measurements were:

1st dorso-marginal plate	1.5 mm. long	7.5 mm. high
10th	—, —	2.5 - " 7 - "
20th	—, —	2.5 - " 6.5 - "
30th	—, —	2 - " 4.5 - "
40th	—, —	2 - " 3 - "
50th	—, —	1 - " 1.5 - "

At the upper edge of the dorso-marginal plates one or, very rarely, two conical knobs were situated, which may, however, be absent in young individuals. Larger specimens have often besides these a somewhat smaller knob in the centre of the plate. In younger specimens one or two knobs are situated along the distal margin of the ventro-marginal plates of the arm-angle. In larger specimens there are 3 or, more rarely, 4 knobs. The uppermost of these is situated a little below the edge nearest the dorso-marginal plates, the lowermost near the lower edge of the plate, and the third, about the middle of it. They decrease in number towards the points of the arms, the outermost plate bearing only one knob. The knobs of the ventro-marginal plates are smaller than those of the dorso-marginal ones. They may, however, be absent in the former as well as in the latter.

The central "epiproctal cone" is large and well-developed in young individuals, but gradually disappears with age. It may, however, also be present in older individuals and was thus very distinct in a specimen whose arm-radius was 92 mm. On the other hand it was absent in one with arm-radius 78 mm.

The abactinal skeleton is composed of round or irregularly polygonal plates which join, but never overlap. Owing to the irregular shape of the plates small open spaces are formed between them in which a papula is placed. Each plate bears a little low cylindrical paxilla whose upper surface is furnished with as many as 12 granules. In the closely related *Bathybiaster vexillifer* the skeleton is composed of stellate overlapping calcareous plates, each bearing a paxilla similar in shape and appearance to that of *Bathybiaster robustus* but apparently a little more slender than in that species. The abactinal skeleton therefore affords a good specific character for these two closely related and in their habits so similar species.

The actinal skeleton is covered with scales. In some individuals several of the scales are converted into small

knobs, similar in form to those of the marginal plates, but smaller.

The long, narrow mouth-plates carry a double row of little, short and compressed papillæ, the largest specimen having about 20 in each row. The first adambulacral plate has a double row of papillæ with 12 papillæ in each row. The 2nd has 6 papillæ, the innermost of which is larger and more compressed than the rest, and resembles the large compressed middle papilla of the other adambulacral plates. These plates have 5—6 papillæ the middle one of which was larger as well as more slender and compressed than the rest and reached into the ambulacral furrow. Verrill<sup>1)</sup> writes:—"The peculiar purselike or bursiform pedicellariæ of the large inner adambulacral spines, characteristic of *Bathybiaster*, are often entirely wanting in our specimens, especially when small, and usually, when present, there are but few of them even in the large specimens. Possibly they may have been destroyed by rough usage in the dredges and washing sieves". An examination of the "Michael Sars's" specimens shows that this "purselike or bursiform pedicellaria" is identical with the "vexillum" of *Bathybiaster vexillifer*, which as demonstrated by Mortensen<sup>2)</sup> is no other than the middle papilla of the adambulacral plates, and as such it was described by me above. It is similar in form to the papilla in *Bathybiaster vexillifer*, but appears to be somewhat shorter and broader. It is often lost as already stated by Verrill, and was entirely wanting in some of the specimens examined by me; in others it was present in a few of the adambulacral plates only, and merely in a very few specimen it was found in all the plates.

***Bathybiaster vexillifer*** Wyville Thomson.

*Archaster vexilifer* Wyville Thomson, The Depth of the Sea, 1873, p. 150, fig. 25.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>. Stat. 102, 60° 57' N, 4° 38' W, 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. 24 specimens. The smallest specimen measured: arm-radius 52 mm., disc-radius 11 mm., the largest: 106 mm. and 21 mm. respectively.

*Bathybiaster vexillifer* was discovered by the "Porcupine" in 1869 in the cold area of Faroe—Shetland Channel (stat. 76, 60° 36' N, 3° 58' W, 630 m., temp. ÷ 1.1° Cel.) It was found subsequently at a number of localities in the cold area of the Norwegian Sea (the „Voeringen“, 753—2222 m., temp. ÷ 1 to ÷ 1.6°, the "Michael Sars", 600—1960 m., temp. ÷ 0.41° to ÷ 1.07°, the "Armauer Hansen", 1400 m. temp. ÷ 0.74°, the "Thor", 877—1401 m., temp. ÷ 0.58 to ÷ 0.95°, the "Princesse Alice", 1185—1865 m.

<sup>1)</sup> Proc. U. S. Nat. Museum, vol. 17, 1894, p. 256.

<sup>2)</sup> Mortensen: Echinoderms, Danmark Exp. Grønlands Nordøstkyst 1906—1908, Bd. 5 no. 4, 1910, p. 252.

and the "Danmark", 304m.) It was likewise found by Swedish expeditions in the cold area of the Norwegian Sea, but no reference to the individual localities was given. *Bathybiaster vexillifer* is thus distributed in the Norwegian Sea between 60° 36' and 79° 59' N. and between 14° 24' E., and 18° 30' W. in 304—2222 m. and in temp. ÷ 0.41 to ÷ 1.6° Cel. It is besides found off western Greenland between 64° 5' and 70° 47' N., 223—1276 m.

*Bathybiaster robustus* was taken by the "Challenger" at three localities off the east coast of North America, 2269—3111 m., temp. 2.33—2.89°. It was likewise taken there by American expeditions in several localities between 35° 10' and 41° 28' N., 1290—2665 m. All the stations belong to the warm area, as, according to the records of the cruises of the "Albatross" in 1883 and 1884, the temperatures ranged between 2.78 and 3.89° at the depths at which *B. robustus* was found. *B. robustus* was not hitherto known to occur on the east side of the Atlantic. The stations off Ireland and the Hebrides also belong to the warm area. This species is therefore a pronounced warm-water form restricted to the depths of the North Atlantic, 1290—3110 m. while the closely related *B. vexillifer*, as shown above, is a true Arctic species.

Verrill remarks about these two closely related forms, "that they may prove to be identical when a full series of each can be compared", and Koehler<sup>1)</sup> joins him in this view, as he considers *B. robustus* and its synonym *Phoxaster pumilus* Sladen<sup>2)</sup> identical with *B. vexillifer*". The two species, as I have stated before, however, have their distinct habitats, the one being restricted to the warm area of the Atlantic, the other to the cold area of the Norwegian Sea and the waters off the west coast of Greenland where the hydrographic conditions are probably also Arctic. Neither reaches the banks, that divide the Norwegian Sea from the Atlantic. This difference in distribution indicates that the species must be distinct and a closer examinations of their structure confirms this view.

In *B. robustus* the marginal plates have a more vertical position than in *B. vexillifer*, where the arms do not exhibit the rectangular straightened appearance seen in the former species. *B. robustus* has 1 to 2 spines on the dorso-marginal plates and 2 to 3, or more rarely 4, on the ventro-marginal ones. In *B. vexillifer* the dorso-marginal plate bear 0 to 1 in exceptional cases 2 spines; the ventro-marginal plates on the other hand, 1 or 2 very rarely 3 or 4 spines. In the first-named species the spines are larger than in in the other, and the

<sup>1)</sup> Koehler; Echinoderms, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 57.

<sup>2)</sup> Sladen: Challenger Asteroidea, p. 336, tab. 15, figs. 3—6, tab. 40, figs. 7—10.

uppermost spine of the dorso-marginal plates is the best developed one. In *B. vexillifer* on the contrary the lowermost spine of the ventro-marginal plates is the best developed one. In both species the spines may be absent in the marginal plates, but this is more frequently the case in *B. vexillifer* than in the other species. As stated before the "vexillum" is somewhat different.

According to Danielssen and Koren<sup>1)</sup> the colour of *B. vexillifer* is "pale yellow over the entire starfish; the marginal plates and ventral surface being paler than the other parts". Wyville Thomson gives the colour as "pale rose with a tinge of buff; the suckers semitransparent and pale pink". In *B. robustus* is according to Verrill "the colour in life, light buff or salmon". In alcohol or dried *B. vexillifer* has a yellowish white colour, while the other species is more reddish gray. These differences are of minor importance, however, and could at most justify their separation into two races or subspecies.

The divergencies in the structure of the abactinal skeleton are of more vital importance, being so great as to fully justify the separation into two species, one Arctic (*B. vexillifer*), the other an Atlantic species (*B. robustus*). In the first-named the abactinal skeleton is composed of stellate overlapping calcareous elements, in the latter on the other hand of round or polygonic plates which though joining one another, never overlap. We see here the same difference as between the Arctic *Solaster squamatus* and the boreo-arctic *Solaster papposus*. In the former the abactinal skeleton consists of overlapping scales or plates, in the latter of small calcareous rods forming a meshwork.

***Psilaster andromeda* Müller and Troschel.**

*Astropecten andromeda* Müller and Troschel, System der Asteriden, 1842, p. 129.

<sup>6</sup>/<sub>5</sub>. Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. One specimen.

<sup>30</sup>/<sub>6</sub>. Stat. 70, 42° 59' N., 51° 15' W., 1100 m. temp. 3.7° Cel. One specimen.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>. Stat. 101, 57° 41' N., 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. 23 specimens.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>. Stat. 102, 60° 57' N., 4° 38' W., 1098 m, dark sand and clay, temp. ÷ 0.9° Cel. A very defect and macerated specimen, which had most probably remained in the trawl from stat. 101.

The following table shows the dimensions of a few specimens from stat. 101. As will be seen from this table the proportion r : R varies between 1 : 3.7 and 1 : 4.8, and the breadth of arm to arm-radius 1 : 3.24 and 1 : 4.21. I may mention for comparison that in some specimens of similar dimensions from the Norwegian coast (Sogn). I found r : R = 1 : 3.7—4.3 and A : R = 1 : 3.4—3.9.

<sup>1)</sup> Danielssen & Koren: Asteroidea, Norske Nordhavs Exp., 1884, p. 89.

Arm-radius	Disc-radius	Breadth of arm at base.	Number of dorso-marginal	r : R	A : R
50	13.5	14	25	1 : 3.70	1 : 3.57
72	15	19	29	1 : 4.80	1 : 4.21
75.5	17.5	20	28	1 : 4.31	1 : 3.78
81	19	25	30	1 : 4.26	1 : 3.24
82	20	25	30	1 : 4.10	1 : 3.24
85	22	25	30	1 : 3.86	1 : 3.40
86	19	25	33	1 : 4.53	1 : 3.44
92	20	23	34	1 : 4.60	1 : 4

The measurements are in millimetres.

Several of the specimens from stat. 101 are remarkable for the abundant spiny armature of their ventro-marginal plates, particularly those of the interbrachia angles which carry 0—10 spines. 0—5 spines were found in the middle of the arm, while in the distal plates nearest the points of the arms spines were totally wanting. In Norwegian specimens I have never found more than 4 spines on the ventro-marginal plates. In the specimen from stat. 24 the plates of the interbrachial angles and those in the middle of the arm carry up to 7 spine and in the specimen from stat. 70 2—4. In the latter specimen as well as in some from stat. 101 a central spine was observed on a few of the dorso-marginal plates.

According to Perrier *Psilaster andromeda* descends to a depth of 2190 m., but this statement needs confirmation, as Perrier confused *Psilaster andromeda* and *Psilasteropsis patagiatus* (cf. Koehler<sup>1)</sup>). *Psilaster andromeda* was not hitherto with certainty known from greater depths than 1795 m. According to the explorations of the "Michael Sars" the bathymetrical range of the species is from 19 to 1853 m. But it is rare at smaller depths than 80 m.

*Psilaster andromeda* is a decided warm-water species which was, however, taken twice in the cold area of the Norwegian Sea (Porcupine 1869, stat. 76, 60° 36' N., 3° 36' W., 630 m., temp. ÷ 1.1°, "Michael Sars" 1902, stat. 37, 62° 43' N., 1° 26' E., 775 m.). This must be due to the fact that both stations are close to the warm area. The hydrographical conditions are unstable in such localities which are sometimes washed by warm Atlantic, sometimes by cold Arctic water, as a result of which they are supplied now with larvæ of Atlantic or boreal, now with those of Arctic forms. The bottom fauna will therefore consist of a mingling of southern and northern species. What I have said about *Psilaster andromeda* also applies to *Plutonaster bifrons*, which is an inhabitant of the deep water of the Atlantic and

<sup>1)</sup> Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 60 and 62.

which therefore to a still higher degree is a warm-water species, but which was nevertheless taken three times in the cold area of the Faroe-Shetland Channel.

***Psilasteropsis patagiatus* Sladen.**

*Psilaster patagiatus* Sladen, Asteroidea, Rep. Sci. Res. Challenger Zool., vol. 30, 1899, p. 232, tab. 7, figs. 11 & 12, tab. 41, figs. 3 & 4.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>. Stat. 101, 57° 41' N., 11° 48' W., 1853 m, hard clay, temp. 3.3° Cel. One specimen, measuring:

Arm-radius.....	92 mm.
Disc-radius.....	30 "
Breath of arm at base.....	36 "
Number of dorso-marginal plates.....	34 "
r : R.....	1 : 3.07
A : R.....	1 : 2.56

In the type specimen of this species the proportion r : R was 1 : 3.95 and A : R = 1 : 4.05. Koehler found in some large specimens from the collections of the Prince of Monaco the proportions r : R to vary between 1 : 4.18 and 1 : 4.72. The specimen under discussion is remarkable for its comparatively short and broad arms. It differs further from the type specimens by a more abundant spiny armature of the ventro-marginal plates, in as much as some of the plates of the arm-angles bore up to 10 spines, which recalls the armature observed in a few specimens of *Psilaster andromeda* from stat. 101. The specimens agree in other respects with the description and figures of *Psilasteropsis patagiatus* given by Sladen. 17 furrow papillæ were present on the middle adambulacral plates.

The type specimen was captured by the "Challenger" off the Cape Verd Is. The "Princesse Alice" also took it there, as well as off the coast of Morocco, at the Canary Is., the Azores and in the Bay of Biscay. The "Hirondelle" and the "Talisman" likewise collected it within the same area, though the exact localities can not be given, Perrier, as above stated, having confused the species with *Psilaster andromeda*. The "Helga" captured it off Ireland. The "Michael Sars" locality lies to the west of the Hebrides. Thus *Psilasteropsis patagiatus* is an East Atlantic species, ranging from 16° 34' to 57° 41' N. Bathymetrical distribution 1095—2165 m.

***Dorigona arenata* Ed. Perrier.**

(Pl. 4, figs. 5—8).

*Pentagonaster arenatus* Ed. Perrier, Bul. Mus. Comp. Zool., vol. 9, 1881, p. 21.

<sup>5</sup>/<sub>5</sub>. Stat. 21, 35° 31' N., 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. Three specimens, of which the two best preserved ones measured:

Arm-radius.....	88.5 mm.	90 mm.
Disc-radius.....	19 "	21 "

Distance of the madreporic plate from centre of disc.....	4 mm.	4 mm.
Size of the madreporic plate.....	2.5 × 2 "	2.5 × 2.5 "
r : R.....	1 : 4.66	1 : 4.29
Number of dorso-marginal plates.....	37	32
Number of ventro-marginal plates.....	39	39

The dorso-marginal plates are joined together, beginning with the 5th or 6th plate.

Perrier states that pedicellariæ are wanting in the marginal plates of this species<sup>1</sup>). I found pedicellariæ present, however, on the dorso-marginal as well as on the ventro-marginal plates of the three specimens mentioned above, but the number of pedicellariæ-bearing plates seems to vary considerably in the different individuals. In one of my specimens pedicellariæ were present on 6 dorso-marginal and on one ventro-marginal plate, in another specimen on 71 dorso-marginal and on 67 ventro-marginal plates and in the third specimen on 89 dorso-marginal and on 116 ventro-marginal plates. I ought to mention that one or more of the arms of all the specimens were defective, which admits the possibility that the number of pedicellariæ-bearing plates might have been greater if the specimens had been intact. Most of the plates of the interbrachial angles were furnished with pedicellariæ. They may also, though more rarely, be found on the arm plates, particularly in the distal half of the arms, but in the outermost plates they appeared to be constantly absent. The majority of marginal plates bear one pedicellaria, but both the dorso-marginal and the ventro-marginal plates may have two or very rarely three pedicellariæ.

Pedicellariæ are wanting in the inter-radial actinal area. On the abactinal surface they are restricted to the papularium and are besides, as regards number, apparently subject to great individual variations. Only 6 pedicellariæ-bearing plates were counted in the first of the specimens in question, 28 in the second, and 8 in the third. None of the plates bore more than one pedicellaria, and most of these were situated near the margin, only exceptionally farther in on the plate, as is normal in the marginal plates. As in *Pentagonaster granularis* the pedicellariæ are composed of two rounded quadrate flaps about 0.64 mm. long and about 0.23 mm. broad. Those on the marginal plates have the same form, but are somewhat smaller.

The mouth-plates carry 6—8 papillæ and the adjacent adambulacral plates have 4—5 furrow-papillæ. The number of adambulacral papillæ is 6 to 7 in the middle of the arm and up to 9 in the outer half of the arm. Behind the furrow-papillæ there are three and, at the

<sup>1</sup>). Ed. Perrier: Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1894, p. 379.



extreme point of the arm, frequently only two more or less distinct rows of papillæ, the hindmost of which equal in size the granules of the adjoining ventro-lateral plates. The number of papillæ varies in the furrow row as well as in those behind it, as will be clearly seen from the following account of the number of papillæ in 7 successive adambulacral plates of the inner half of the arm of the largest specimen: 6—2—4—3, 5—3—2—3, 5—3—3—4, 5—4—3—4, 6—4—4—3, 7—4—5—4 and 6—3—5—5.

*Dorigona arenata* occurs on both sides of the North Atlantic. It was first found by the "Blake" off the West Indies between Grenada (12° N) and 24° 36' N., at 298—1748 m., where it was later also taken by the "Albatross". On the east Atlantic side it was first taken by the "Challenger" southwest of the Canary Is. at 2791 m. The "Travailleur" and the "Talisman" took it later at 16 stations between the Canary Is. and the Bay of Biscay (44° 4' — 29° 1' N., 407 — 1805 m.) and there it was also found by the Prince of Monaco at 40 stations between 29° 6' and 47° 45' N., 1096 — 1588 m. The "Caudan" obtained it at three stations in the Bay of Biscay, 400 — 1410 m. It is finally recorded under the names of *Nymphaster protentus*, *N. subspinosus* and *N. arenatus* from the great depths west of Ireland, 381 — 1332 m. *Dorigona arenata* thus ranges on the west Atlantic side from 12° to 24° 36' N., and on the east Atlantic side from 25° 45' to 51° 23' N. The bathymetrical distribution is 298 to 2791 m.

***Paragonaster subtilis* Ed. Perrier.**

*Goniopecten subtilis* Ed. Perrier, Bul. Mus. Comp. Zool. vol. 9, 1881, p. 26.

<sup>19/4</sup>. Stat. 10, 45° 26' N., 9° 20' W., 4700 m., yellow sand, temp. 2.56° Cel. Two large unfortunately defective, specimens and a very young one. The disc-radius of the two former was 19.5 mm. and 15 mm. respectively. The small specimen measured:

Arm-radius .....	10 mm.
Disc-radius .....	4 "
r : R .....	1 : 2.5
Number of dorso-marginal plates .....	7—8
Number of ventro-marginal plates .....	8—9

The small specimen differs from the two fully developed ones in having the dorso-marginal plates more scantily covered with granules, which form a marginal border; for the rest granules are absent or a few scattered ones only occur. In the two large specimen on the other hand the plates are completely covered with granules. In like manner the ventro-marginal as well as the abactinal plates of the small specimen present more scanty granulation. The terminal plates end in two spines which are turned forward, are comparatively broadly and straightly cut off and among which 2 to 4 more spines of smaller and more slender dimensions are found.

The adambulacral plates of the two large specimens carry 4 — 8 furrow papillæ, most frequently 5 to 6, and behind them 12 papillæ arranged in three distinct rows. Pedicellariæ were absent in both specimens.

*Paragonaster subtilis* is evidently identical with *P. strictus* Perrier, which I can not but consider as the juvenile form of this species as was also indicated by Perrier<sup>1)</sup>. I agree with Koehler<sup>2)</sup> in further referring *P. elongatus* Perrier<sup>3)</sup> to the same species and likewise *P. cylindratus* Sladen<sup>4)</sup>, which was found by the "Challenger" south of the Cape Verd Is. (1° 47' N. 24° 26' W., 3386 m., temp. 2.6° Cel.)

Verrill<sup>5)</sup> remarks about the relation between *P. cylindratus* Sladen and *P. formosus* Verrill, taken of the east coast of the North America between 37° and 41° 7' N., at 2455 to 3698 m., that the latter "appears to have the adambulacral plates more salient and angular on the furrow-margin and the notches between them deeper; the furrow-spines appear to be more slender and form a more strongly curved or angular group, which is continued by three to five shorter ones in a fasciole-like row on the proximal and distal edges of the plates; there are about five on the furrow-edge proper; the spines on the actinal surface are more elongated and more regularly stellated, with a longer one in the middle of the group. —The spinules of the lower marginal plates have the same arrangements as in Sladen's species, but are slightly more slender and acute than shown in his figure; of the larger median series there are usually two or three irregular indefinite rows in the larger specimens, instead of a single definite row. These differences are, however, so slight that the two former may prove to be the same species".

One of the two larger specimens mentioned by me is a typical *Paragonaster subtilis*, the other agrees more closely with Verrill's form, which according to him I must regard as identical with *P. cylindratus*, and consequently also with *P. subtilis*, the type specimen of which was taken by the "Blake" off the Antilles (24° 33' N., 84° 23' W., 3532 m.)

*Paragonaster subtilis* must therefore be a North Atlantic species ranging on the American side from 24° 33' to 41° 7' N., 2455—3698 m., and on the European side

<sup>1)</sup> Ed. Perrier: Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1894, pag 363, tab. 24, fig. 7, tab. 25, fig. 5.

<sup>2)</sup> Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 86, tab. 4, fig. 2.

<sup>3)</sup> Ann. Sci., Nat., ser. 6, Zool. tome 19, 1885, no. 8, p. 38.

<sup>4)</sup> Sladen: Challenger Asteroidea, p. 314, tab. 51, figs. 3 & 4, tab. 53, figs. 3 & 4.

<sup>5)</sup> Proc. U. S. Nat. Museum, vol. 17, 1894, p. 257.

from 1° 47' to 45° 26' N., 2995—4700 m., bottom temp. 2.56°—3.3° Cel.<sup>1)</sup>

		R	r	r:R
		mm.	mm.	
<i>P. subtilis</i>	"Michael Sars"	10	4	1:2.5
"strictus	"Talisman"	17	5	1:3.4
"cylindratus	"Challenger"	30	8.5	1:3.53
" — " —	" — " —	51	12.5	1:4.08
" subtilis	"Blake"	60	12	1:5
" formosus	"Albatross"	74	18	1:4.11
" elongatus	"Talisman"	87	18	1:4.83

The foregoing list of specimens of which measurements exist, shows that older fully-developed individuals are more long-armed than very young ones, for while R of the smallest specimen was 2.5 r, it was 4 — 5 r in the larger specimens.

***Mediaster stellatus*** Ed. Perrier.

*Mediaster stellatus* Ed. Perrier, Mem. Soc. Zool. de France, vol. 4, 1891, p. 268.

<sup>30/6.</sup> Stat. 70, 42° 59' N., 51° 15' W., 1100 m., temp. 3.7° Cel.

Five specimens, measuring:

	mm.	mm.	mm.	mm.	mm.
Arm-radius.....	32	38.5	47	48	54
Disc-radius.....	12.5	14	17	16.5	16
Breadth of arm in the middle	4.5	4.5	6	7	7
Breadth of paxillar area in the same place.....	2.5	2.5	4	4.5	5
r:R.....	1:2.56	1:2.75	1:2.76	1:2.91	1:3.37
Number of dorso-marginal plates.....	23	28	30	29	31
Number of ventro-marginal plates.....	24	28	29	29	31

The specimens agree with the description and illustrations which Perrier<sup>2)</sup> gives of this species. The adambulacral plates bear three rows of papillæ with 4 to 6, most commonly 5 papillæ in each row, of which the furrow-papillæ are the largest. The papillæ of the outermost row agree in size and form with the granules of the adjacent actinal plates. The larger paxillæ of the abactinal plates bear 22 to 54 granules, but pedicellariæ-bearing paxillæ have at most 20 granules. The pedicellariæ are more numerous in the larger specimens, than in the smaller ones, thus evidently increasing in number with the age of the animal.

*Mediaster stellatus* is known only from the great depths south and east of New-Foundland where it was previously taken by the Prince of Monaco in 1887 at a station north-east of the "Michael Sars" locality (stat. 161, 46° 4' 40" N., 49° 2' 30" W., 1267 m).

<sup>1)</sup> "Challenger" 2.6°, "Albatross" 3.3° (3 stations) and 2.8° (one station) "Michael Sars" 2.56°.

<sup>2)</sup> Ed. Perrier: Stellerides, Res. Camp. Sci. Monaco, Fasc. 11, 1896, p. 46, tab. 4, figs. 1 — 1 d.

***Astrogonium fallax*** Ed. Perrier.

(Pl. 5, fig. 1).

*Astrogonium fallax* Ed. Perrier, Ann. Sci. Nat., ser. 6 tome 19, 1885, no. 8, p. 37.

<sup>30/6.</sup> Stat. 70, 42° 59' N., 51° 15' W., 1100 m. temp. 3.7° Cel.

Two specimens measuring:

Arm-radius.....	37 mm.	46 mm.
Disc-radius.....	11 "	14.5 "
Breadth of arm in the middle.....	5.3 "	6 "
Breadth of paxillar area in the same place.....	2.2 "	3 "
r:R.....	1:3.36	1:3.17
Number of dorso-marginal plates.....	29	35
Number of ventro-marginal plates.....	29	35

The largest specimen agrees with Koehler's figure of this species.<sup>1)</sup> In the smallest specimen some few of the ventro-marginal plates only have rudimentary spiny formations, the rest exhibit a scale-like granulation similar to that of the largest individual. The small specimen has likewise a similar armature of the adambulacral plates and similar uniform granulation of the plates of actinal area. I have therefore referred the smallest specimen also to *Astrogonium fallax*.

*Astrogonium fallax* was first found by the "Talisman" at 4 stations off the Azores, 1440 — 2220 m., and there it was also later taken by the Prince of Monaco at two stations, 1165 — 1385 m. Verrill<sup>2)</sup> further records it from the east coast of North America; but judging from Verrill's figures, this North American form appears to differ from the typical *Astrogonium fallax*. The uniform crowded granulation of the plates in the actinal area is characteristic of this species, while Verrill's drawing (fig. 2 a) exhibits a more scattered granulation, and the individual granules vary in sizes, a circumstance which was, however, also pointed out by Koehler.

***Pentagonaster dentatus*** Ed. Perrier.

*Pentagonaster dentatus* Ed. Perrier, Nouv. Arch. du Museum d'Hist. Natur., ser. 2 tome 6, 1883, p. 242, tab. 8, fig. 3.

<sup>6/5.</sup> Stat. 24, 35° 34' N., 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. Two specimens.

<sup>8/5.</sup> Stat. 25 B, 35° 46' N., 8° 16' W., 2055 m., yellow mud. Three specimens.

<sup>23/5.</sup> Stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud, temp. 6° Cel. Six specimens.

<sup>27/7.</sup> Stat. 95, 50° 22' N., 11° 44' W., 1797 m., temp. 3.5° Cel. A large specimen.

The specimens were measuring in millimetres:

<sup>1)</sup> Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 71, tab. 18, fig. 2.

<sup>2)</sup> Transact. Connecticut Acad., vol. 10, 1899, p. 190, tab. 30, figs. 2 — 2 b.

Stations	14	25 B	25 B	24	25 B	24	41	41	41	41	41	95
Diameter.....	26	42	49	56	59	62	65	70	81	83	90.5	130
Arm-radius.....	13.5	22.5	26	30	31.5	32	35	37	43	44	48.5	69.5
Disc-radius.....	9	13	14	18	16	21	21	21	26	23	30.5	47
Size of the madreporic plate ....	0.5 × 1	0.7 × 1	0.7 × 1	0.7 × 1.2	1 × 1.2	1 × 1.5	0.7 × 1.2	1.2 × 1.7	1.5 × 2	1.7 × 2	1.5 × 2	2 × 3
Distance of the madreporic plate from centre of disc .....	3	4.5	5	5.5	6	7	7	7	8	8	9	13
Number of dorso-marginal plates..	6	8	9	6-7	10	7-8	9-10	8	8-9	12	7-8	9-10
Number of ventro-marginal plates.....	7	8	9-10	7	10	8	9-10	9	9	14-15	9	10-11
r : R .....	1 : 1.5	1 : 1.73	1 : 1.86	1 : 1.67	1 : 1.96	1 : 1.52	1 : 1.67	1 : 1.76	1 : 1.66	1 : 1.91	1 : 1.59	1 : 1.48

The largest of Perrier's specimens had an arm-radius of 67 mm., and a disc-radius of 38 mm.<sup>1)</sup> It was thus but a little smaller than that from stat. 95, from which it differs by proportionately longer arms, the proportion r : R was 1 : 1.76, while in the specimen from stat. 95 it was 1 : 1.48. The latter has not, however, attained the maximum growth of this species. Farran mentions in „The deep-waters Asteroidea, Ophiuroidea and Echinoidea of the West Coast of Ireland<sup>2)</sup>” two specimens of considerably larger size, which measured respectively: R 86 mm and 95 mm, r 50 mm and 63 mm, r : R = 1 : 1.72 and 1 : 1.51.

The specimen from stat. 95 is remarkable for its short arms. Apart from a few exceptions the “Michael Sars” specimens had longer arms and in a few of them the arm-radius was even nearly twice as large as the disc-radius. According to the measurements quoted by Perrier the proportion r : R seems to vary between 1 : 1.62 and 1 : 1.78. The largest specimens had the largest arms, while in the “Michael Sars” specimens in which r : R varied between 1 : 1.48 and 1 : 1.96, the middle-sized individuals had proportionately the longest arms. Individual variation is, however, present; thus the 62 mm. specimen from stat. 24 was very short-armed (1 : 1.52); while the 59 mm. specimen from stat. 25 B had very long arms (1 : 1.96). The Prince of Monaco's largest specimen had an arm-radius of 42 mm. and a disc-radius of 24 mm, r : R = 1 : 1.75<sup>3)</sup>.

The arms were distinctly marked off in most of the specimens, the terminal plates being separated from the abactinal plates by 3 or 4 dorso-marginal ones or even by 5 plates in the most long-armed specimen.

The abactinal plates of the larger specimens were angular and furnished with one row of large round granules, but in other respects bare. In the smaller specimens, on the other hand, the majority of the plates were granulated throughout. The abactinal plates are thus originally entirely covered with granules, but the granulation disappears gradually with the growth of the individual, except along the border of the plates. It first disappears in the plates of the papularium, which in the smallest specimen bore only a ring of granules along the border, while the remaining abactinal plates were still covered with them.

The dorso-marginal plates of the large specimen from stat. 95 bore one row of granules along the border, but were otherwise bare. The ventro-marginal plates were granulated along the border nearest the dorso marginal plates, and the same was the case with a larger or smaller portion of the ventral part adjacent to the actinal plates. The ventro-marginal plates of the smallest specimens were covered with granules throughout, and the lateral portion of the dorso-marginal plates was likewise granulated, while the dorsal portion was bare. In the remaining specimens the granulation of the dorso-marginal plates was similar to that of the largest specimen, while the ventro-marginal plates presented transition forms between the granulation of the largest and that of the smallest specimen. The terminal plates were bare.

The papularium was very large and papulae were wanting only in a comparatively small interradial area from the centre of the disc to the middle interradial dorso-

1). Ed., Perrier: Echinodermes, Exp. Sci. du “Travailleur” et du “Talisman”, 1894, p. 391, tab. 25, figs. 1 a — b.

2). Fisheries Ireland, Sci. Invest. 1912, no. 6, (1913) p. 10.

3). Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 85, tab. 2, fig. 7.

marginal plates. They were likewise absent from the area nearest the marginal plates. As will be seen from the foregoing table the madreporic plate was situated nearer to the centre of the disc to its border, the distance from the centre being about one third of the disc-radius.

No pedicellariæ could be discovered in the two smallest specimens. But in the remainder on the other hand several were found. They were present in the abactinal as well as in the<sup>3</sup> dorso-marginal plates, while I did not succeed in finding them in the ventro-marginal or actinal plates. Perrier states, however, that pedicellariæ are found scattered on the actinal plates. They are very small and similar to those in *Pentagonaster granularis*, and are found on the radial as well as the interradiial plates, and in the centre of the plates as well as along the border.

The adambulacral papillæ are arranged in 3—4 rows, among which one or several isolated papillæ are sometimes found. The furrow papillæ are the largest, while those in the outermost row are shortest and similar in form to the granules of the adjoining actinal plates. As in *Pentagonaster granularis* the number of papillæ found in a row varied greatly. In some of the middle adambulacral plates of the smallest specimen there were thus: 3—3—3, 4—3—2—3, 3—1—2—3 and so on; in the 81 mm. specimen: 6—4—1—5, 6—5—6, 6—4—2—5, 5—1—5—7—2, 5—5—5 and so on; and in the 130 mm. specimen: 5—5—4—6, 4—5—1—4—2—6, 4—4—5—4 and so on. In the three specimens from stat. 25 B the adambulacral plates had three rows of papillæ with 5 to 6 papillæ in the furrow-row and 3 to 6 in the remaining rows. Some plates had besides an indefinite fourth row with 2 to 3 papillæ. In some specimens the papillæ behind the furrow-row were gathered in a cluster without definite order, instead of being arranged in rows.

The colour of the specimen from stat. 95 preserved in formol was orange-yellow on the abactinal and yellowish white on the actinal surface. The papulæ were white. The remaining specimens preserved in alcohol, had lost their colour entirely.

With respect to the interpretation of *Pentagonaster dentatus* I agree entirely with Farran, who maintains that *P. perrieri* Sladen s. *grandis* Perrier and *P. concinnus* Sladen are identical with it. *P. dentatus* is therefore a North Atlantic species and is known from the western as well as from the eastern side. It was first found by the "Blake" in the West Indies, between Grenada (12° N.) and 19° 7' N., at 75 to 2196 m. The "Talisman" later obtained it off the west coasts of Morocco and Spain (20° 32'—38° 38' N.), 930—1590 m., the "Caudan" in the Bay of Biscay, 950—960 m.; the Prince of Monaco in several localities between the Cape of Verd Is. and the Bay of Biscay (15° 17'—45° 9' N.) 1095—1804 m., and

English expeditions in several localities off the west coast of Ireland, 628—1455 m. While thus *P. dentatus* on the west Atlantic side was known only between 12° and 19° 7' N. it was found on the east Atlantic side between 15° 17' and 51° 35' N. Its bathymetrical distribution is from 75 to 2196 m.

#### *Luidia ciliaris* Philippi.

*Asterias ciliaris* Philippi, Arch. f. Naturgesch., vol. 3, 1837, p. 70.

<sup>10</sup>/<sub>4</sub>, stat. 3, 49° 32' N. 10° 49' W., 184 m., fine sand, temp. 10.3 Cel. One specimen.

<sup>20</sup>/<sub>5</sub>, stat. 37, 26° 6' N. 14° 33' W., 39 m., shingle, temp. 15.6 Cel. One specimen.

<sup>21</sup>/<sub>7</sub>, stat. 94, 50° 13' N. 11° 23' W., 1 m. net, surface. 11 specimens, and 1 m. net, 200 m. wire. 4 specimens.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 41' N. 11° 48' W., 1 m. net, 200 m. wire and <sup>3</sup>/<sub>4</sub> m. net, 600 m. wire. From each gear one specimen only was obtained.

The specimens from stat. 94 and stat. 101 were young, with remnants from the larval stage adhering. The largest of them had a diameter of 3.7 mm.

The specimens from stat. 3 and stat. 37 were on the contrary fully-developed. The specimen from stat. 3 measured: arm-radius 270 mm., disc-radius 32 mm., breadth of arm at base 28 mm., r : R = 1 : 8.44. In the individual from stat. 37 these measurements are 182 mm., 20 mm. and 16 mm. respectively, r : R = 1 : 9.1.

Both specimens belong to the variety *normani* Ludwig. Likewise three specimens taken by the "Michael Sars" in 1902 and 1906 in the northern part of North Sea<sup>1)</sup> belong to this variety.

*Luidia ciliaris* is common in the western part of the Mediterranean, but apparently absent in the eastern part (cf. Ludwig<sup>2)</sup>). It further occurs off the west coasts of Africa and Europe from the Cape Verd Is. to the Faroe and Shetland Is. In the North Sea it is known only from the north-western part, where it was collected by the "Michael Sars" and the "Poseidon" between 58° 2' and 61° 14' N. and between 2° 21' E. and 2° 19' W., 70—215 m. and it was also taken off and on by the bank-fishermen; also from the eastern coasts of Scotland and England, where it ranges as far south as Scarborough. Süßbach and Breckner<sup>3)</sup> statements "An der norwegischen Küste scheint sie selten aufzutreten und nur an ihren

<sup>1)</sup> The localities are:

1902, stat. 50, 61° 14' N. 2° 13' E., 155 m. temp. 6.78° Cel.

1906, " 287, 60° 52' N. 0° 36' E., 130 m. " 7.6° "

1906, " 299, 60° 52' N. 0° 18' E., 130 m. " 6.5° "

<sup>2)</sup> Ludwig: Die Seesterne des Mittelmeeres, Fauna und Flora des Golfes von Neapel, vol. 24, 1897, p. 80.

<sup>3)</sup> Süßbach & Breckner: Die Seeigel, Seesterne und Slangensterne der Nord- und Ostsee. Wissensch. Meeresuntersuch. N. F. Abt. Kiel, Bd. 12, 1910, p. 210.

südlichen Teilen“ seems to be founded in mistake. As far as I know, *Luidia ciliaris*, is never collected off the Norwegian coast. But there is a specimen in the Riksmuseum in Stockholm that is recorded as taken off Bohuslän (cfr. Düben & Koren<sup>1)</sup>, which is the more remarkable as *Luidia ciliaris* is not found in the eastern part of the North Sea, the Skagerak or the Kattegat. I am most inclined to think that Professor Lovén obtained the specimen from fishermen from Bohuslän, who had brought it from the fishingbanks of the north-western part of the North Sea.

Helland Hansen mention in “Farvandenens hydrografiske forhold<sup>2)</sup> that some of the salty and rather warm water of the Atlantic passes into the North Sea through the channels between Scotland and Norway. It then flows southward along the coasts of Scotland and England, until it turns eastward across the North Sea immediately north of the Doggerbank. If we mark on a chart the localities in the North Sea, where *Luidia ciliaris* was obtained, we shall find that its distribution comes within the bounds of this Atlantic current and that the southern limit of the species is where the current turns eastward. Its southernmost locality of the east coast of England, Scarborough being abreast of the Doggerbank. *Luidia ciliaris* must therefore have migrated from north into the North Sea. Some water from the Atlantic also flows through the English Channel into the North Sea, but *Luidia ciliaris* can not have come that way, as it is not found in the southwestern part of the North Sea and, in the English Channel, not east of Plymouth.

The bathymetrical distribution is 4—220 m.

***Luidia sarsii*** Düben & Koren.

*Luidia sarsii* Düben & Koren, Øfvs. Kgl. Vet. Akad. Förhandl., vol. 1. 1844 (1845), p. 113.

<sup>6</sup>/<sub>6</sub>, stat. 53, 34° 59' N. 33° 1' W., 1 m. net, 100 m. wire. A very young fully transformed specimen.

<sup>10</sup>/<sub>6</sub>, stat. 56, 36° 53' N. 29° 47' W., 1 m. net, 100 m. wire. One specimen with adhering remnants from larval stage. Diameter 4.5 mm.

<sup>24</sup>/<sub>6</sub>, stat. 64, 34° 44' N. 47° 52' W., 1 m. net, 200 m. wire and youngfish trawl, 300 m. wire. From either gear one specimen with adhering remnants from larval stage. Diameter 3 mm.

<sup>5</sup>/<sub>8</sub>, stat. 98, 56° 33' N. 9° 30' W., 1 m. net, 200 m. wire. One specimen with adhering remnants from larval stage. Diameter 4 mm.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 41' N. 11° 48' W., 1 m. net, 200 m. wire. 6 specimen with adhering remnants from larval stage. Diameter 3—4.2 mm.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., <sup>3</sup>/<sub>4</sub> m. net, 400 m. wire. Two very young, fully transformed specimens. Diameter 5 mm. and 6 mm., disc-radius 0.7 mm. and 1 mm., arm-radius 3 mm. and 3.2 mm.

<sup>1)</sup> Kgl. Vetensk. Akad. Handl., 1844 (1846), p. 254.

<sup>2)</sup> Hjort: Norges Fiskerier I Norsk Havfiske, 1905, p. 19.

***Luidia*** sp.

<sup>26</sup>/<sub>6</sub>, stat. 67, 40° 17' N. 50° 39' W., 1 m. net, 50 m. wire. One specimen with adhering remnants from larval stage. Diameter 3.5 mm.

The larva, which was not very well preserved, could not be definitely determined, but as stat. 67 is situated south of Newfoundland, it seems reasonable to assume that it belongs to one of the species of *Luidia* common along the eastcoast of North America, *Luidia clathrata* Say or *L. elegans* Ed. Perrier.

***Stichaster roseus*** O. F. Müller.

*Asterias rosea* O. F. Müller, Zool. Dan. Prod., 1776, p. 234.

<sup>10</sup>/<sub>4</sub>, stat. 3, 49° 32' N. 10° 49' W., 184 m., fine sand, temp. 10.3 Cel. One specimen.

*Stichaster roseus* is an east Atlantic boreal species that ranges northward to the banks of Tromsø (the “Voeringen” stat. 173, 69° 18' N. 14° 32' E., 549 m.). It ranges south to the Bay of Biscay (45° 18' N.), where it was obtained by the “Caudan” as well as by the “Princesse Alice”. The “Caudan” found it to be numerous at depths from 100 to 180 m. The bathymetrical distribution of the species is from 4 to 1232 m., but the typical form does not descend to below some 500 m.

***Zoroaster fulgens*** Wyville Thomson.

*Zoroaster fulgens* Wyville Thomson, Depths of the Sea, 1873, p. 154.

<sup>6</sup>/<sub>5</sub>—<sup>7</sup>/<sub>5</sub>, stat. 24, 35° 34' N. 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. Two smaller specimens.

<sup>23</sup>/<sub>5</sub>, stat. 41, 28° 8' N. 13° 35' W., 1365 m., yellow mud, temp. 6° Cel. 10 specimens.

<sup>30</sup>/<sub>6</sub>, stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7 Cel. One specimen.

<sup>9</sup>/<sub>7</sub>, stat. 75, 47° 22' N. 49° 16' W., 120 m. One specimen.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. 8 specimens.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. One very defective and macerated specimen, which had probably remained in the trawl from stat. 101.

The smallest specimen measured: Arm-radius 26.5 mm., disc-radius 6.5 mm., breadth of arm at base 8 mm., r : R = 1 : 4.08, A : R = 1 : 3.31. The remaining specimens measured: arm-radius 66—162 mm., disc-radius 6.5—15 mm., breadth of arm at base 8—13 mm., r : R varied between 1 : 6.6 and 1 : 12.36, A : R varied between 1 : 6.5 and 1 : 13.6. In some specimens taken by the “Michael Sars” in 1902 r : R varied between 1 : 6.4 and 1 : 11.5 and A : R between 1 : 6.5 and 1 : 10.5. In others mentioned by Sladen<sup>1)</sup> these figures were 1 : 6.87—1 : 10 and 1 : 7.86—1 : 9.89 respectively. From the foregoing we may infer

<sup>1)</sup> Bell: Cat. British Echinoderms, 1892, p. 88.



that the relative length as well as breadth of arm are subject to great variations and judging from the material at my disposal, older individuals appear to have proportionately longer and more slender arms than younger ones, the ratio, however, being subject to individual variations.

The colour in life was pink or white.

*Zoroaster fulgens* was discovered by the "Porcupine" in 1869 north-west of the Hebrides, 992—1304 m. It was later taken on the east Atlantic side south of Iceland by the "Thor" (921 m.), in the Faroe—Shetland Channel by the "Triton" (1016—1043 m.) and the "Michael Sars" (1100—1300 m.), west of Ireland (732—1797 m.) by the "Flying Falcon" and the "Helga"; in the Bay of Biscay, 1300 m. by the "Caudan" as well as by the "Travailleur" and the "Talisman" between 23° and 44° N., 912—1975 m. On the west Atlantic side the "Challenger" found it off North America, 2287—2470 m. and off Pernambuco, 1235 m. The "Michael Sars" obtained it east of Newfoundland, 120 m. Thus *Zoroaster fulgens* ranges from 23° to 62° 57' N. on the east Atlantic side and from 8° 37' S. to 47° 16' N. on the west Atlantic side. The bathymetrical distribution is 732 to 2470 m., there is besides one specimen from a depth of only 120 m. The bottom temperatures at the localities, where temperature measurements were made, are: "Porcupine" 5.2°, "Challenger" 3.3—4.4°, "Triton" 7.5—7.6°, "Michael Sars" 3.3—8.07°. It will be seen from the foregoing that *Zoroaster fulgens* is a true warm-water species. It must therefore be due to a mistake, as stated before, when a specimen of this species was recorded from stat. 102 which belongs to the cold area of the Faroe—Shetland Channel. The specimen must have been left in the trawl from stat. 101, where several specimen of this species were taken. The same must have been the case as regards *Plutonaster bifrons* and *Psilaster andromeda* of both of which a very defective and macerated specimen exists from stat. 102, while several specimens were taken at stat. 101. Like *Zoroaster fulgens* they are true warm-water species as stated before, and do not belong to the cold area of the Norwegian Sea. The other echinoderms taken at stat. 102, viz: *Pontaster tenuispinus* var. *platynota*, *Solaster papposus* var. *septentrionalis*, *Solaster squamatus*, *Ophiopleura borealis*, *Ophioscolex glacialis* and *Hathrometra prolixa* are on the contrary decided arctic and boreo-arctic species. The same is true of the others invertebrates found at stat. 102, which I may mention:—*Buccinum hydrophanum*, *Neptunea curta*, *Neptunea mohni*, *Philine finmarchica*, *Cuthonella abyssicola*, *Scalpellum angustum*, *Colossendeis proboscidea*, *Colossendeis angusta*, *Nymphon grossipes*, *Boreynymphon robustum* etc.

*Solaster abyssicola* Verrill.

(Pl. 5 figs. 2—4)

*Solaster abyssicola* Verrill, Amer. Journ., ser. 3, vol. 29, 1885, p. 152 and Ann. Rep. U. S. Fish. Comm. 1885, p. 541.

<sup>18</sup>/<sub>7</sub>, stat. 88, 45° 26' N. 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. Two specimens measuring:

Diameter .....	103 mm.	137 mm.
Arm-radius .....	54 "	70 "
Disc-radius .....	22 "	28 "
Breadth of arm at base.....	13—14 "	15—18 "
Height of arm at base .....	7—9 "	12—14.5 "
r:R .....	1:2.45	1:2.5
Number of arms.....	8	8
Number of inner adambulacral papillæ .....	3—4	3—4
Number of outer adambulacral papillæ .....	3—5	3—5

The abactinal skeleton is composed of stellate calcareous plates (pl. 5, fig. 4), whose four branches united with the branches of other plates forming a quadrate mesh-work. In some of these plates a branch may be absent whereby two mesh-spaces are turned into one larger of oblong rectangular form. Meshwork of irregular or triangular form may also occur, but seems to be comparatively rare. A short cylindrical paxillæ in the centre of the plate bear up to about 15 short divergent calcareous spines. The meshwork have normally 3—4 large papulæ, but the larger ones may have as many as 8. The skeleton of *Solaster endeca* (pl. 5, fig. 5) consists in part of calcareous plates similar to those of *Solaster abyssicola*, in part of short narrow calcareous rods. The network formed by the calcareous deposits is of an extremely irregular shape and bears several paxillæ, the mesh-spaces bear proportionately to their size from 1 to 7 papulæ. Besides isolated calcareous rods bearing one paxilla may be present in them, similarly as in the mesh-spaces of *Solaster papposus*.

The paxillæ in the plates of the actinal area are cylindrical and furnished with as many as 8 very small spines. They are arranged in rows and similar to the paxillæ of the abactinal skeleton, but smaller.

The outer row of adambulacral papillæ (pl. 5, fig. 3) bears 3—5 papillæ in both specimens, most often 4. They are comparatively short, covered by a thick membrane and united at the base. The inner row bears 3—4 papillæ of about uniform size and united by a membrane to half their length.

*Solaster abyssicola* has according to Verrill 5—7 adambulacral papillæ, while the two specimens under discussion have only 3—5. Notwithstanding this I have

referred the specimens to Verrill's species because they agree well with it in other characteristics. The number of papillæ apparently does not afford a very reliable specific characteristic, however. In *Solaster papposus* I have found normally 5–7 papillæ in the outer adambulacral row, but the number may vary between 2 and 9, and in several *Solaster endeca* from Hardanger 5–9 papillæ were present.

*Solaster abyssicola* was previously known only from the east coast of North America, where it was taken according to Verrill at several stations between 35° 45.5' and 39° 5.5' N., 1543–3813 m. The species therefore appears to be new to the European fauna. It is possible, however, that this was the species taken by the "Thor" in 1903 south of Iceland (stat. 166, 62° 57' N. 19° 58' W., 931 m.). For it is recorded by Dr. Mortensen under the name *Solaster n. sp.* (*S. earlii* Verr. aff.<sup>1</sup>), a species to which Verrill originally referred his *Solaster abyssicola*<sup>2</sup>).

***Solaster papposus* var. *septentrionalis* Sladen.**

*Crossaster papposus* var. *septentrionalis* Sladen, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 704.

<sup>9</sup>/<sub>8</sub>–<sup>10</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9 Cel. Two specimens measuring:

Diameter . . . . .	73 mm.	71 mm.
Arm-radius . . . . .	38 "	37 "
Disc-radius . . . . .	17 "	16.5 "
r : R . . . . .	1 : 2.24	1 : 2.24
Number of arms . . . . .	10	10
Number of paxillæ in the actinal area . . . . .	4–7	6–9
Number of inner adambulacral papillæ . . . . .	4–6	5–6
Number of outer adambulacral papillæ . . . . .	5–8	5–8

Disc arched, the arms, broad at base, taper rapidly toward the point. Paxillæ small and numerous, the largest bear about 30 spines. The abactinal skeleton consists of short, broad rods united together so as to form an irregular meshwork. In the mesh-spaces only a papula as a rule is present, there may be as many as three, however. In several mesh-spaces isolated rods occur besides. The skeleton most closely resembles that of a 77 mm. specimen of *Solaster papposus* from the Varangerfjord<sup>3</sup>).

<sup>1</sup>) Schmidt: Fiskeriundersøkelser ved Island og Færøerne 1903 (1904) p. 22.

<sup>2</sup>) Ann. Rep. U. S. Fish Comm. 1885, p. 541. Cfr. Amer. Journ. ser. 3, vol. 49, 1895, p. 200.

<sup>3</sup>) Grieg: "Michael Sars" Asteroidea, Bergens Museums Aarbog, 1906, no. 13, p. 64, tab. fig. 7.

Most of the plates of the inner adambulacral row bear five papillæ, but the number varies between 4 and 6. In the outer row 5 to 8 papillæ are found, most often 7, and those in the middle are largest, the distal ones smallest.

The colour is pink, lightest on the actinal side.

The specimens agree in all essentials with Sladen's *Solaster (Crossaster) papposus* var. *septentrionalis*, which was likewise taken in the cold area of the Faroe–Shetland Channel ("Knight Errant" 1880, stat. 2, 60° 29' N. 8° 19' W., 686 m., temp. ÷ 0.56° Cel.) I have therefore referred them to that variety. I ought to mention, however, that Sladen's form has somewhat shorter arms, and the proportion r : R is 1 : 1.94, while it is 1 : 2.24 in the two "Michael Sars" specimens. This difference is not of vital importance, however.

***Solaster squamatus* Döderlein**

*Solaster papposus* var. *squamatus* Döderlein, Wissensch. Meeresuntersuch. N. F. Bd. 4, Abt. Helgoland, Heft 2, 1900, p. 208, tab. 6, figs 5–5 c.

<sup>10</sup>/<sub>8</sub>–<sup>11</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. 0.9 Cel. Two specimens measuring:

Diameter . . . . .	76 mm.	73 mm.
Arm-radius . . . . .	43 "	38 "
Disc-radius . . . . .	21 "	18 "
r : R . . . . .	1 : 2.05	1 : 2.11
Number of arms . . . . .	10	10
Number of paxillæ in the actinal area . . . . .	5–8	4–9
Number of inner adambulacral papillæ . . . . .	4–6	4–5
Number of outer adambulacral papillæ . . . . .	5–8	4–7

These two specimens are distinguished from the two before mentioned individuals of *Solaster papposus* var. *septentrionalis*, which were likewise taken at stat. 102 by a somewhat more arched disc and comparatively shorter arms. The proportion r : R may, however, vary in *Solaster squamatus* between 1 : 1.8 and 1 : 2.6, most often it is 1 : 2.2–2.3, as will be seen from the material collected by the "Voeringen" and the "Michael Sars". The paxillæ are low, cylindrical and furnished with short spines; in *S. papposus* var. *septentrionalis*, on the other hand, they are conically pointed and bears longer spines, the middle ones longest, which further adds to their conical appearance.

The abactinal skeleton consists of scales, among which small spaces are found with most often one papillæ only. The skeleton resembles most nearly that of a 41 mm. specimens from the cold area east of Iceland ("Michael Sars", 1900 stat. 10, 64° 53' N. 10° W., 360 m., temp ÷ 0.69° Cel.)<sup>1</sup>)

<sup>1</sup>) Grieg: "Michael Sars" Asteroidea, pag. 62, tab. 1, fig. 4.

Colour in life orange-red on the abactinal surface with yellowish red paxillæ and yellowish white on the actinal surface.

*Solaster squamatus* appears to be indigenous to the cold area of the Norwegian Sea from 100—1159 m. It may, however, occasionally make its way a little into the warm area, where the temperature of the bottom-water may be comparatively high, and where the fauna consists mainly of warm-water species. The "Michael Sars" thus found it in 1902 at a locality, (stat. 85, 62° 53' N. 9° 6' W. 450 m., 3.98° Cel.) together with *Pentagonaster granularis*, *Poraniomorpha hispida*, *Ophiactis abyssicola*, *Gorgonocephalus lamarcki*, *Hathrometra tenella* etc. Among other arctic species, besides *Solaster squamatus*, which were taken at this station, I may mention, *Lophaster furcifer*, *Ophiura sarsi*, *Ophiopholis aculeata*, *Ophiacantha bidentata* etc. (cfr. Appellöf: Havbundens dyreliv<sup>1</sup>).

***Lophaster furcifer* Dübén & Koren.**

*Solaster furcifer* Dübén & Koren, Kgl. Vet. Akad. Handl. 1844 (1846) p. 243, tab. 6, figs. 7—10.

<sup>10</sup>/<sub>8</sub>—<sup>11</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. Two specimens measuring:

Diameter.....	138 mm.	72 mm.
Arm-radius.....	73 "	32 "
Disc-radius.....	31 "	12 "
r:R.....	1:2.36	1:2.67
Number of ventro-marginal paxillæ	25	20
Number of inner adambulacral papillæ.....	3—5	3—4
Number of outer adambulacral papillæ.....	3—6	3—5

The specimens belong to the group, which I called the Arctic or cold water form<sup>2</sup>). Their appearance recalls two specimens, which the Duke of Orleans found in the Kara Sea<sup>3</sup>). The interbrachial arc is rounded, and the abactinal skeleton consists of irregular stellate deposits, the branches of which unite with those of the adjacent plates, forming a meshwork. A large and robust paxilla is attached to the calcareous deposits, which in the disc-centre of the largest specimen measured about 2 mm. in height and about 1 mm. in diameter and bore as many as 20 spines covered with a thick membrane. The paxillæ of the ventro-marginal plates of the interbrachial arc measured about 2 mm. in breadth as well as in height and

bore 30 to 40 spines. The paxillæ of the actinal plates had 4—10 spines.

The colour of the specimens in life was brick-red on the abactinal surface and orange-yellow on the actinal.

Walter K. Fisher has described two forms of *Lophaster* from the northern part of the Pacific. One of them, *Lophaster furcilliger*<sup>1</sup>) ranges from Alaska to southern California and the Galapagos Is. from 351 to 2013 m., the other, *Lophaster furcilliger vexator*<sup>2</sup>) inhabits the Bering Sea and ranges south to northern California. Its bathymetrical distribution is from 137 to 640 m., it is most common, however, at depths below 370 m. Fisher states in "Asteroidea of the North Pacific and adjacent Waters, Phanerozonia and Spinulosa"<sup>3</sup>) where these two forms are described in detail, that the latter form has an intermediary position between *L. furcilliger* and *L. furcifer*. From the typical *furcifer* it differs, "in having a more open abactinal skeleton with consequently more widely-spaced paxillæ, higher paxillæ with longer spinelets, much smaller actinal paxillæ (about as in *furcilliger*) and longer adambulacral spines. If equal-sized specimens of the two forms are compared, *L. furcifer* is seen to have wide rounded interbrachial arcs which merge gradually into the ray. *Vexator* has a smaller disk, never rounded interbrachial arcs, but acute angles, the rays being sometimes swollen at base so that the marginal and adjacent abactinal paxillæ of two rays interlock. *L. furcifer* reminds one of a five-rayed *Solaster*, whereas *L. vexator* suggests a five-rayed *Crossaster*". *L. vexator* again differs from *L. furcilliger* by its larger disc, thicker arms, more robust actinal as well as marginal paxillæ, more robust abactinal spines as well as more closely joined adambulacral plates. Without further entering upon the subject Mortensens remarks in "Conspectus Faunæ Grønlandicæ. Echinoderm"<sup>4</sup>) about Fishers forms that these seem to be transition forms from *furcifer* through *vexator* to *furcilliger*, so that these forms can hardly be regarded as more than varieties of *furcifer*.

The Bergen Museum possesses very abundant material of *L. furcifer* from the Norwegian coast as well as the Norwegian Sea and extreme Arctic regions such as the Kara Sea, Spitsbergen and Jones Sound. This material shows that individuals from the Boreal regions, such as the coast near Bergen, have a pointed interbrachial arc, the arms comparatively narrow at base and tapering gradually toward the point. The individual from the neighbourhood of Bergen figured by Dübén and Koren

<sup>1</sup>) Hjort: Norges Fiskerier I Norsk Havfiske, 1905, p. 105. Cfr. Murray & Hjort: The Depths of the Ocean, 1912, p. 533.

<sup>2</sup>) Grieg: "Michael Sars" Asteroidea, p. 70.

<sup>3</sup>) Grieg: Echinodermes, Duc d'Orleans: Campagne Arctique de 1907, 1910, p. 17, figs. 11 & 12.

<sup>1</sup>) Bull. Bur. Fisheries, vol. 24, 1905, p. 312.

<sup>2</sup>) Zool. Anzeiger, vol. 35, 1910, p. 574.

<sup>3</sup>) Bull. U. S. Nat. Museum, no. 76, 1911, p. 334, tab. 794, figs. 1 & 2, tab. 114, fig. 1. tab. 116, tab. 5 and p. 338, tab. 114, tab. 2.

<sup>4</sup>) Meddel. om Grønland, vol. 23, 1913, p. 336.

must be regarded as typical for this form. Judging from Verrill's figure<sup>1)</sup> the form of *L. furcifer* occurring off the east coast of North America is of similar appearance. In specimens from Arctic regions on the other hand the arc is most often wide and rounded, and the arms broad at base tapering rapidly toward the point. This is evidently the form on which Fisher based his remarks on *L. furcifer* and it is also the form depicted in works on Arctic echinoderms. Judging, however, from the material at my disposal, the form of the arc seems to be subject to variations and this is moreover borne out by the literature on the subject. Duncan and Sladens figure of *L. furcifer*<sup>2)</sup> has but slightly rounded arcs. In two specimens in the Kara Sea by the Duke of Orleans they are a little more rounded and this is more particularly the case in the individual from the cold area of the Norwegian Sea illustrated by Danielssen and Koren<sup>3)</sup>. In a specimen from Gaasefjord, Jones Sound they are extremely wide and rounded<sup>4)</sup>. There are, however, Arctic specimens, which differ very little in their form from the Boreal. This is the case with the *L. furcifer* from the cold area of the Faroe—Shetland Channel figured by Wyville Thomson in "The depths of the Sea" (p. 119, fig. 14). A very extreme example of such Arctic forms is presented by the specimens which I illustrated on "Michael Sars Asteroidea" (p. 71, fig. 9). It reminds one of *L. fucilliger vexator*, a fact which Fisher likewise calls attention to.

The abactinal skeleton of the Arctic *furcifer* consists of stellate deposits which are united so as to form a meshwork. Its structure appears, however, to be subject to great variations. In some individuals the deposits are close up to one another, so that the meshes become small and narrow, in other examples, such as one from Jones Sound, the deposits are isolated. Between these two are all shades of intermediary forms and also a meshwork like that which characterizes *vexator* (cf. Fisher pl. 114, fig. 2 b). In the Arctic *furcifer* the paxillæ are more scattered than in the boreal form, and they are larger, more robust and have longer spines. We may find examples whose paxillæ closely resemble those of *vexator*. The same is true of the actinal paxillæ and the adambulacral armature. With abundant material of the Atlantic *Lophaster* at hand, it will not be possible to distinguish it from the Pacific form. Fisher mentions intermediary forms between *L. furcilliger* and *L. furcil-*

*liger vexator* and my material shows transition forms between the latter and *L. furcifer*. I therefore fully agree with Mortensen in considering *furcilliger* and *vexator* as hardly more than varieties of *L. furcifer*. To the varieties of this species we must possibly also refer *Sarkaster validus Ludwig*<sup>1)</sup> which was taken by the "Albatross" in 1891 between Galapagos Is. and Las Tres Marias Is., 523—1244 m., and which as already pointed out by Fisher, is a *Lophaster* and presents agreements with *L. furcilliger*.

***Pteraster reductus* Koehler.**

Pl. 5, figs. 6, 7.

*Pteraster reductus* Koehler, Bull. Inst. Oceanogr. Monaco, no. 99, 1907, p. 23.

<sup>8</sup>/<sub>6</sub>, stat 53, 34° 59' N. 33° 1' W., 2615—2865 m., yellow hard clayey mud, temp. 3 Cel. Three specimens of which the best preserved measured:

Diameter .....	37 mm.
Arm-radius .....	20 "
Disc-radius .....	15 "
Disc-radius measured on the actinal side to the marginal suture .....	12 "
Height .....	12 "
Greatest breadth of arm .....	17 "
Greatest breadth of arm measured on the actinal side between marginal sutures .....	14 "
Greatest breadth of the actino lateral area .....	5 "
Number of actino-lateral beams .....	15 "
r : R .....	1 : 1.33 "

In the two other specimens which are somewhat defective the arm-radius measured 22 mm. and 27 mm., respectively, disc-radius 13 mm. and 18 mm., greatest width of arms 16 mm. and 20 mm., r:R = 1:1.69 and 1:1.5.

Arms broad at base, tapering rapidly. Abactinal surface considerably arched, the actinal plane. Supradorsal membrane thin and fibrous. Paxillæ numerous, compact and furnished with cluster of some 20 long thin calcareous spinelets. Of the actino-lateral beams the third is longest. In the 37 mm. specimen it is 7 mm. long.

The tube-feet are large and present a paired arrangement in two rows. The innermost adambulacral plate has 6 papillæ, the remainder 5. These papillæ are united by a membrane and arranged in slightly curved, transverse rows, similarly as in *Pteraster personatus* Sladen<sup>2)</sup>. The innermost papilla is 1—1.5 mm. in length, the outermost 3—4 mm. The mouth plates are well-developed

<sup>1)</sup> Mem. Mus. Comp. Zool. vol. 32, 1905, p. 185, tab. 15, figs. 75 & 76, tab. 29, figs. 171—173, tab. 30, figs. 174—177.

<sup>2)</sup> Proceed. R. Irish Acad., ser. 3, vol. 1, 1890, p. 694, tab. 27, figs. 1—5.

<sup>1)</sup> Verrill: Res. Explr. made by the Steamer „Albatross” in 1883, 1885, tab. 16, fig. 49.

<sup>2)</sup> Duncan & Sladen: Mem. on the Echinodermata of the Arctic Sea to the West of Greenland, 1881, tab. 3, fig. 9.

<sup>3)</sup> Danielssen & Koren: Asteroidea, 1884, tab. 8, fig. 12.

<sup>4)</sup> Grieg: Echinodermata, Rep. II Norweg. Arctic Exp. in the "Fram" 1898—1902, no. 13, 1907, tab. 3, fig. 1.

and provided with a high and broad ridge along the medianline, where they are united. Six long, thin papillæ united by a membrane are arranged in a row along the horizontal edge of the mouth plates. Secondary papillæ on the actinal surface of the plates are wanting.

The colour in life of the best preserved specimen was a deep purple red, on the abactinal surface of which a slight tinge still remained. The actinal surface and the tube-feet were pale red. The other specimen had completely lost its colour. The third specimen, preserved in formol, was ash-grey on the abactinal surface and light reddish gray on the actinal surface, the tube-feet reddish grey.

Numerous light reddish grey eggs with a diameter of 0.6 mm. were found in the interradial spaces.

I have referred the specimens to *Pteraster reductus* Koehler as they agreed with that species in most characteristics e. g. in the number of mouth- and adambulcral-papillæ, as well as in number of actino-lateral beams. But they differ from the typical *P. reductus* in that their third actino-lateral beam was longest while in Koehlers species the 4th was longest. Moreover the typical *P. reductus* has longer arms, its arm-radius according to Koehler being twice the length of disc-radius. Judging from *Pteraster militaris* no great importance is to be attached to this difference, however. Koehlers coloured illustrations of *P. reductus*<sup>1)</sup> likewise differ from the colour of the best preserved one of the specimens in question. But this difference of colour is of no more importance than the relative length of arms.

*Pteraster reductus* was found 1888 by the Prince of Monaco off the Azores and was likewise taken there by him in 1896 and 97. By the find of the "Michael Sars" its horizontal distribution will be from 34° 59' to 41° 40' 41" N. and from 26° 26' 15" to 33° 1' W. The bathymetrical distribution is from 1846 to 2870 m.

#### *Hymenaster pellucidus* Wyville Thomson.

*Hymenaster pellucidus* Wyville Thomson, The Depths of the Sea, 1873, p. 220.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. A somewhat damaged specimen, measuring: arm-radius 29 mm., disc-radius 17 mm., r : R = 1 : 1.7.

The specimen had two adambulcral papillæ and two pair of secondary mouth-papillæ. Number of primary mouth papillæ four. Kalischewskij<sup>2)</sup> has established a

<sup>1)</sup> Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc 34, 1909, tab. 3, fig. 8 & 9.

<sup>2)</sup> Kalischewskij: Zur Kenntnis d. Echinodermfauna d. sibir. Eismeerer, Mem. Acad. Imp. Sci. St. Petersburg, ser. 8. vol. 18, nr. 4, 1907, p. 36, tab. 1, fig. 9.

variety *arctica* of this species with three pairs of secondary mouth papillæ, but his illustration shows only two pairs, which is what the typical form has. I agree with Koehler<sup>1)</sup> that these two forms can not be separated. An examination of the specimen collected by the "Voeringen" and the "Michael Sars" shows that the mouth-plates have 1—3 secondary papillæ<sup>2)</sup>.

*Hymenaster pellucidus* is indigenous to the Norwegian Sea and adjacent waters where it ranges from the Faroe—Shetland Channel (60° 21' N., to 81° 1' N. and from the east coast of Greenland, (Forsbladford, about 26° W.) to 114° 31' E. Perrier besides records it from the Azores<sup>3)</sup>. I am inclined to think, however, that he confused it with another species. The bathymetrical distribution is 27 to 2814 m. Most of the localities of this species belong of the cold area, but it seems to invade the warm area to some extent, as the temperatures records vary between ÷ 1.7° ("Jermak") and 3.36° ("Michael Sars" 1902, stat. 86)<sup>4)</sup>. The warm water stations, however, lie close to the limit of the cold area, and the hydrographical conditions may probably therefore vary there.

#### *Hymenaster rex* Ed. Perrier.

*Hymenaster rex* Ed. Perrier, Ann. Sci. Nat., ser. 6, Zool., vol. 19, 1885, no. 8, p. 69.

<sup>7</sup>/<sub>5</sub>, stat. 25 A, 35° 36' N. 8° 25' W., 2300 yellow mud. Two specimens, measuring:

Arm-radius .. . . . . .	32 mm.	43 mm.
Disc-radius .. . . . . .	25 "	37 "
r : R .. . . . . .	1 : 1.23	1 : 1.16

The adambulcral plates have three papillæ of which the adoral one is largest. The mouth-plates bear two pairs of secondary papillæ and three papillæ along their free border and one of the mouth-plates of the largest specimen had even 4 primary papillæ. Some 20 actino-lateral spines were counted. The valves around the osculum have 10—12 spines. The colour of the specimens in alcohol is grayish-red on abactinal surface, slightly darker on the interradial than on the radial surface. The actinal surface is dark violet, the tube-feet bluish white.

<sup>1)</sup> Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1919 p. 93.

<sup>2)</sup> Grieg: Invertebrés du Fond, Duc d'Orleans: Croisière Oceanographique, 1909, p. 54.

<sup>3)</sup> Ed. Perrier: Stellerides, Res. Camp. Sci. Monaco, Fasc. 11, 1896, p. 40.

<sup>4)</sup> The recorded temperatures are: "Porcupine" ÷ 1.3°, "Voeringen" ÷ 1.3—1.1°, "Michael Sars" 1900 ÷ 1—0.11°, 1902 ÷ 0.32°—3.36°, "Thor" ÷ 0.58°, "Belgica" 0.4°, the Russian Spitzbergen Expeditions ÷ 1.1—0.3°, "Jermak" ÷ 1.7—3.1°, "Varna" ÷ 1.4—1.2° The temperatures varied between ÷ 0.8 and ÷ 1.5° at the depths in the Kara Sea, 84—116 m., where the "Dijmphna" found this species.



The "Michael Sars" specimens agree most closely with *Hymenaster rex* Perrier among the North Atlantic species of *Hymenaster*, but differ from that species by the presence of three primary papillæ in the mouth-plates, while typical *Hymenaster rex* has four, which was, however, found also in one mouth-plate of the largest specimen. Judging from Perrier's drawing, the secondary mouth-papillæ are situated very close to the suture of the plates<sup>1</sup>); in the specimens under discussion they are placed nearer the centre of the plates. The valves around the osculum bear 10—12 spines, while *Hymenaster rex* has 14. Judging from *H. pellucidus* of which numerous specimens were at my disposal, these characteristics seem to be subject to variations. Notwithstanding the divergencies from typical *Hymenaster rex*, I refer the specimens to that species.

*Hymenaster rex* is an east Atlantic species, previously found only by the "Talisman" at three stations off the west coast of Africa between 23° 50' and 46° 4' N. and between 6° 46' and 19° 37' W., 1139—2285 m. The "Michael Sars" station also lies within these limits.

***Echinaster sepositus* Gray.**

*Rhopia seposita* Gray, Ann. Mag. Nat. Hist., vol. 6, 1840, p. 282.

<sup>26</sup>/<sub>5</sub>, stat. 37, 26° 6' N. 14° 33' W., 39 m., shingle, temp. 15.6° Cel. One specimen, arm-radius 77 mm., disc-radius 12 mm.

*Echinaster sepositus* is an east Atlantic species, ranging north to Bretagne (Roscoff) south to the Cape Verde Is. It occurs besides in the Adriatic and the western part of the Mediterranean. Bathymetrical distribution 1—1060 m.

***Cribrella abyssalis* Ed. Perrier.**

*Cribrella abyssalis* Ed. Perrier, Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1894, p. 144, tab. 11, fig. 1.

<sup>23</sup>/<sub>5</sub>, stat. 41, 28° 8' N. 13° 35' W., 1365 m., yellow mud, temp. 6° Cel. One larger, not very well preserved, specimen.

*Cribrella abyssalis* was first taken by the "Talisman" off the west coast of Morocco, 1105—1635 m. It was later found in adjacent waters by the Prince of Monaco, 1470—2165 m. According to the discovery of the "Michael Sars" its horizontal range is between 28° 8' and 38° 47' N. and between 7° 55' 45" and 28° 4' 5" W. The bathymetrical distribution is 1105—2165 m.

***Brisingella coronata* G. O. Sars.**

*Brisingella coronata* G. O. Sars, Christiania Vidensk. Selsk. Forhandl., 1871, p. 5.

<sup>5</sup>/<sub>5</sub>, stat. 21, 35° 31' N. 6° 35' W., 535 m., yellow mud, temp. 11.52 m. A defect specimen with 10 arms, whose disc-diameter was 18.5 mm., length of arm 177 mm.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 31' N. 11° 48' W., 1843 m., hard clay, temp. 3.3° Cel. A fragment of an arm.

<sup>1</sup>) Ed. Perrier: Echinodermes, Exp. Sci. du "Travailleur" et du "Talisman", 1884, p. 186, tab. 13, fig. 2.

As regards the nomenclature of this species I have followed Fisher in "New Genera and Species of Brisingidæ"<sup>1</sup>).

*Brisingella coronata* is an east Atlantic species which was first recorded by G. O. Sars from Skraaven, Lofoten, 376—564 m. It was later found in the Foldenfjord, 530 m., the Trønhjemsfjord, 376—564 m. and the Sognefjord, 130 1229 m., bottom temperature 6.3 to 6.7°. The temperature was hardly below 8°, however, at the smallest depths in the Sognefjord. It was further found by the Prince of Monaco off Vegø (1899, stat. 1052, 65° 41' N. 9° 30' 15" E., 440 m.)

In the Atlantic *Brisingella coronata* ranges from the Hebrides to the Cape Verde Is., 366—2330 m. According to Sladen the bottom temperature was 6.4 to 11° at the localities, where the "Porcupine" obtained the species. Records of temperature are wanting from the other stations. In the Mediterranean it was found in the western as well as in the eastern part, where it ranges as far as Samos and Samothrace. It occurs besides in the southern part of the Adriatic. The bathymetrical distribution in the Mediterranean is 100 to 2660 m. The "Pola" found a bottom temperature of 12.9 to 14.4° in the eastern part of the Mediterranean, but records are wanting from the two least depths (129 m. and 218 m.), at which it was taken by that vessel.

*Brisingella coronata* appears therefore to be a typical warm-water species. Its range is restricted to localities with a bottom-temperature of not less than 3.3°, its principal distribution, however, apparently occurring in waters with a bottom-temperature of not less than 6.3°

***Freyella sexradiata* Ed. Perrier.**

*Freyella sexradiata* Ed. Perrier, Comptes Rendus de l'Acad. des Sci., Tome 101, 1885, p. 442.

<sup>19</sup>/<sub>4</sub>, stat. 10, 45° 26' N. 9° 20' W., 4700 m., yellow mud, temp. 2.56° Cel. Four defect specimens as well as fragments of several arms.

Disc-diameter.....	9 mm.	10 mm.	11 mm.	11 mm.
Breath of arms at base.....	4 "	3.5 "	3.5 "	4 "
Greatest breadth of ovarian enlargement.....	7.5 "	5 "	5.5 "	6.5 "

The smallest specimen has only five arms, the others six. Koehler also found that this species may have 5 arms<sup>2</sup>).

This species like *Freyella spinosa* has two gonads in each arm and they are similarly arranged in both species. *Freyella sexradiata* thus belongs to the genus *Freyellidea*, so named by Fisher in his revision of the

<sup>1</sup>) Ann. Mag. Nat. Hist., ser. 8 vol. 20, 1917, p. 423 & 427.

<sup>2</sup>) Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 129.

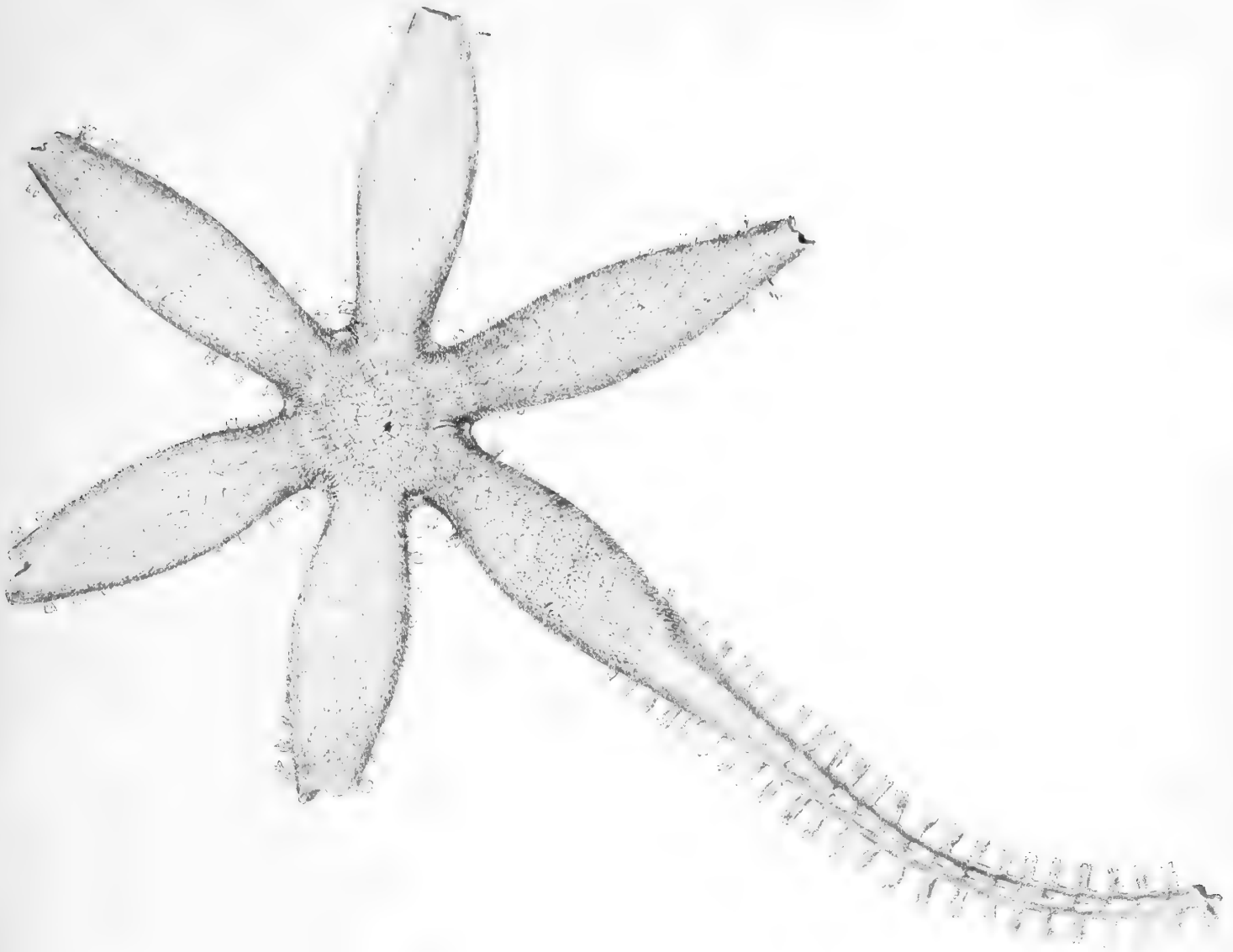


Fig. 10. *Freyella sexradiata* Ed. Perrier from stat. 10. Abactinal view, magnified 3 times.

family of *Brisingidae*<sup>1)</sup>, a name which he changed to *Freyella* in "Notes of Asteroidea II"<sup>2)</sup>.

*Freyella sexradiata* was first found in 1883 by the "Talisman" north of the Azores (stat. 134, 42° 19' N. 53° 36' W., 4060 m.) It was later taken by the Prince of Monaco at two stations between the Azores and Portugal, 4020 m. and 4360 m. The "Michael Sars" obtained it in the Bay of Biscay. *Freyella sexradiata* is therefore an East Atlantic species known up to present time only between 38° 8' and 45° 26' N. and between 9° 20' and 23° 36' W. Bathymetrical distribution is 4020 to 4700 m.

Beside it, the following species of the genus *Freyella* occur on the eastern side of the North Atlantic:

*F. edwardsi* from the Bay of Biscay and west coast of Africa, 1786 m.

*F. spinosa* from west coast of Africa and the Azores, 4060—4310 m.

*F. recta* from the Azores, 3465 m.

*F. tuberculata*, between Canary Is. and Cape Verde, 4310 m.

From the western side of the North Atlantic are known:

*F. americana* from Nova Scotia, 320 m.

*F. elegans* between Nova Scotia and Cape Hatteras, 1115—3700 m.

A *Freyella* was besides taken south of Iceland ("Thor" 1903, stat. 164, 62° 10.8' N. 19° 36' W., 2093 m.), which according to Mortensen<sup>3)</sup>, is closely relative to the last-named species.

<sup>1)</sup> Op. cit., ser. 8, vol. 20, 1917, p. 425 & 429.

<sup>2)</sup> Op. cit., ser. 9, vol. 2, 1918, p. 103.

<sup>3)</sup> Schmidt: Fiskeriundersøgelser ved Island og Færøerne i sommeren 1903 (1904) p. 24.

## OPHIUROIDEA

### *Pectinura elata* Koehler.

*Pectinura elata* Koehler, Ophiures. Exp. Sci. du "Travailleur" et du "Talisman", 1906, p. 249, tab. 18, figs. 1—3.

<sup>8</sup>/<sub>5</sub> stat. 25 B, 35° 46' N 8° 16' W, 2055 m., yellow mud, 8 specimens.

<sup>8</sup>/<sub>6</sub> stat. 53, 34° 59' N. 33° 1' W, 2615—2865 m., yellow hard clayish mud, temp 3° Cel. Two specimens.

The smallest specimen has a disc-diameter of 14 mm. the largest of 25.5 mm. Koehler states that this species has three arm-spines. I found 3 to 4 spines in all of the specimens under consideration, but the extreme arm-joints possessed only 2. One of the specimens from stat. 53 differed besides from the typical *Pectinura elata* by having the ventral surface of the disc covered with granules, in this respect agreeing more nearly with *Pectinura heros* Lyman. However, as it agreed with Koehler's species in other characteristics, such as the forms of the mouth-shields and the size of the arm spines, I have referred it to that species. The remaining specimen were typical *Pectinura elata*, apart from the somewhat divergent number of arm-spines.

*Pectinura elata* was previously taken only by the "Talisman" in 1883 at a station off the west coast of Africa, (25° 2' — 25° 6' N 19° 11' — 19° 13' W, 2325—2518 m.) Its horizontal distribution should thus at present be from 25° 2' to 35° 46' N and from 8° 16' to 33° 1' W. The bathymetrical distribution is from 2055 to 2865 m.

### *Ophiopleura borealis* Danielssen & Koren.

*Ophiopleura borealis* Danielssen & Koren, Nyt Mag. f. Naturvidensk. vol 23, 1877, p. 77, tab. 5, figs. 1—4.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub> stat. 102, 60° 57' N 4° 38' W, 1098 m. Dark sand and clay, temp. ÷ 0.9 Cel. Three specimens with a disc-diameter of 31—40 m.

*Ophiopleura borealis* has not before been recorded from the Faroe—Shetland Channel. The southern limit of its distribution in the Norwegian Sea was formerly 62° 43' N. It is a true Arctic species, known from Discovery Bay, the east coast of Greenland, the Norwegian Sea, Spitzbergen, Barents Sea, Franz Joseph Land, the Kara Sea and the Siberian Polar Sea as far as 124° 41' E. The bathymetrical distribution is 9—1411 m. It lives preferably in the cold area, but was, however, also met within the adjacent warm area (bottom temperature 1.1 to ÷ 1.39°).

### *Ophiura convexa* Lyman.

*Ophiolypha convexa* Lyman, Bull. Mus. Comp. Zool., vol 5 no. 7, 1878, p. 84 tab 3 figs. 84 & 85.

<sup>19</sup>/<sub>4</sub> stat. 10, 45° 26' N 9° 20' W, 4700 m., yellow mud, temp 2.56 Cel. Four specimens. Diameter of disc 12—15 mm., length of arm 17—27 mm.

*Ophiura convexa* was taken by the "Challenger" in the South Atlantic off the west coast of Africa, 4300 m., as well as in the Pacific, 3751—4209 m. It was later obtained by the Prince of Monaco between the west coast of Africa and the Azores (29° 5' — 39° 54' N, 16° 58' — 22° 22' 45" W, 3825—4360 m.) and by the "Albatross" off New England, 2942—4710 m. Lyman besides doubtfully records its being found by the "Blake" off the Antilles, 209—494 m.<sup>1)</sup>

Of the last-named form, which Koehler later described under the name *Ophioglypha coronata*<sup>2)</sup>. I have had a specimen for examination from St. Lucia, and after comparing it with the "Michael Sars" specimens from the great ocean depths, I agree with him in considering this shallow-water form from the Antilles as distinct from *Ophiura convexa*.

### *Ophiura concreta* Koehler.

*Ophioglypha concreta* Koehler, Bull. Soc. Zool. de France, vol. 26., 1901, p. 228.

<sup>18</sup>/<sub>7</sub> stat. 88, 45° 26' N 25° 45' W, 3120 m., sand and yellow mud, temp. 2.5° Cel. Three specimens. Diameter of disc 21—26.5 mm. breadth of arms at border of disc 3—4 mm. In all of the specimens the arms were torn off.

*Ophiura concreta* was hitherto known only from two specimens, the one found in 1901 by the Prince of Monaco off the Cape Verde Is., 2478 m., the other in 1883 by the "Talisman" off the Azores, 2995 m.

### *Ophiura irrorata* Lyman.

*Ophioglypha irrorata* Lyman, Bull. Mus. Comp. Zool., vol. 5 nr. 7, 1878, p. 73, tab. 4, figs. 106—108

<sup>18</sup>/<sub>7</sub>. Stat. 88, 45° 26' N., 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. Four specimens. Diameter of disc 15—18.5 mm., breadth of arms at border of disc 2.2—3 mm. The length of arm in the smallest specimen was 53 mm., without the point, which was wanting. One of the other arms was absent and in all of the specimens they were very defective.

*Ophiura irrorata*, like *Ophiomusium lymani*, is a world-wide species. It is known in the Atlantic from New England, the West Indies, the Bay of Biscay, Portugal, the Azores and the Canary Is. It was further found off the Cape of Good Hope, the Bay of Bengal, New South Wales, Japan, Bering Sea, the Gulf of California, the Gulf of Panama and the Galapagos Is. The bathymetrical distribution is 604—4315 m. (cf. Clark<sup>3)</sup> and Koehler<sup>4)</sup>, who also dealt with the complicated nomenclature of this species.

<sup>1)</sup> Bull. Mus. Comp. Zool. vol 10 no. 6, 1883, p. 243 tab. 4, figs. 40—45.

<sup>2)</sup> Bull. U. S. Nat. Museum no. 84, 1914, p. 12, tab. 2, figs. 3 & 4.

<sup>3)</sup> Bull. U. S. Nat. Museum, no. 75, 1911, p. 62.

<sup>4)</sup> Bull. U. S. Nat. Museum, no. 84, 1914, p. 18, tab. 1 figs. 3 & 4.

***Ophiura tessellata*** Verrill.

*Ophioglypha tessellata*, Verrill, Proceed. U. S. Nat. Museum, vol. 17, 1894, p. 290.

<sup>8</sup>/<sub>6</sub>. Stat. 53, 34° 59' N., 33° 1' W., 2615—2865 m., yellow hard clayish mud, temp. 3° Cel. Two specimens. Diameter of disc 18 mm.

<sup>18</sup>/<sub>7</sub>. Stat. 88, 45° 26' N., 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5 Cel. 15 specimens. Diameter of disc 9—24 mm.

This species was first described from the east coast of North America, where it was taken at a depth of 458—3720 m., most abundantly between 730 and 1820 m. It was later obtained by the Prince of Monaco in the Bay of Biscay, off Portugal, the Azores and the Cape Verde Is., 1267—2870 m. *Ophiura tessellata* is thus a North Atlantic species, ranging between about 39° and 41° 39' N. on the western side and between 14° 47' and 46° 52' N. on the eastern side. The bathymetrical distribution is 458—3720 m.

***Ophiura affinis*** Lütken.

*Ophiura affinis* Lütken, Kgl. danske Vidensk. Selsk. Skrifter, Nat. math. Afd., R 5, B 5, 1859, p. 45, tab. 2, fig. 10.

<sup>9</sup>/<sub>4</sub>. Stat. 1, 49° 27' N., 8° 36' W., 146 m., fine sand, temp. 9.57° Cel. One specimen.

<sup>20</sup>/<sub>5</sub>. Stat. 38, 26° 3' N., 14° 36' W., 77 m., red sand and shingle. Three specimens.

<sup>27</sup>/<sub>7</sub>. Stat. 96, 50° 57' N., 10° 46' W., 184 m., temp. 11° Cel. 6 specimen.

*Ophiura affinis* is a North Atlantic species, occurring off the coasts of North America, as well as of Europe, where it ranges as far north as the Trondhjemsfjord and south to the Mediterranean and Cape Bojador.

***Ophiocten sericeum*** Forbes.

*Ophiura sericea* Forbes, Sutherlands Journ. Voy. Baffins Bay, vol. 2, 1852, App. p. 215.

<sup>30</sup>/<sub>6</sub>. Stat. 70, 42° 59' N., 51° 15' W., 1100 m., temp. 3.7° Cel. Numerous smaller specimens. Diameter of disc 2—5 mm.

*Ophiocten sericeum* is a boreo-arctic species which has its main distribution and attains its greatest development within the Arctic regions, but which is also widely distributed within the boreal area. It was occasionally met with in the Atlantic region proper, to which stat. 70 must belong, although there were found such boreal or boreo-arctic animals as *Terebratulina septentrionalis*, *Pilidium radiatum*, *Buccinum undatum*, *Scaphander puncto-striatus* etc. In the last-named region it was thus taken by the "Thor" in 1903 in deep water south of Iceland (stat. 164, 62° 10.8' N., 19° 36' W., 2128 m., and stat. 166, 62° 57' N., 19° 58' W., 947 m.)<sup>1)</sup>

<sup>1)</sup>. Schmidt: Fiskeriundersøgelser ved Island og Færøerne Sommeren 1903, p. 22 & 23.

***Ophiocten latens*** Koehler.

*Ophiocten latens* Koehler, Ophiures, Exp. Sci. du "Travailleur" et du "Talisman", 1906, p. 267, tab. 18, figs. 11 & 12,

<sup>19</sup>/<sub>4</sub>. Stat. 10, 45° 26' N., 9° 20' W., 4700 m., yellow mud, temp. 2.56° Cel. Two specimens.

Of one of them the under surface of the disc only was existant, of the other the entire disc and a portion of one arm. This last-named specimen, whose diameter of disc was 9 mm and which consequently equalled in size the specimens from the "Talisman", agrees perfectly with the description, that Koehler gives of them. In the other, somewhat smaller specimen the form of the mouth-shields, the lateral mouth-plates and the innermost ventral arm-plates are similar to the "Talisman" specimens and I therefore also refer this specimen to Koehler's species.

*Ophiocten latens* was previously found only by the "Talisman" between the Azores and Portugal (42° 19' N. 23° 26' W., 4060 m.)

***Ophiochiton ternispinus*** Lyman.

*Ophiochiton ternispinus* Lyman, Mem. Mus. Comp. Zool., vol. 10, no. 6, 1883, p. 255, tab. 5, figs. 67—69.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. One specimen.

Diameter of disc 23 mm. The arms, which were torn off, were 4 mm. broad at the border of the disc. The largest arm-spines measured 3.5 mm. Five to six mouth-papillæ. The specimen is almost twice as large as the type-specimen, which had a disc-diameter of 12 mm. It differs from the latter by proportionately broader mouth-shields (length 2.7 mm., breadth 2.2 mm.) but agrees with it in other respects. The colour of the specimen preserved in alcohol was brownish gray.

One specimen of *Ophiochiton ternispinus* was found in 1869 by the "Porcupine" SW. of Ireland (stat. 42, 49° 12' N. 12° 52' W., 1577 m., 4.3° Cel.) It was later taken by Wandel off the west coast of Greenland (66° 49' N. 56° 28' W., 442 m.) The species is therefore most probably distributed at the great depths throughout the northern part of the North Atlantic.

***Ophiomusium lymani*** Wyville Thomson.

(Pl. 5, figs. 8—10).

*Ophiomusium lymani* Wyville Thomson, The Depths of the Sea, 1873, p. 173, figs. 32 & 33.

<sup>6</sup>/<sub>5</sub> stat. 24, 35° 34' N. 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. One specimen.

<sup>7</sup>/<sub>5</sub> stat. 25 A., 35° 36' N. 8° 25' W., 2300 m., yellow mud. 20 specimens.

<sup>8</sup>/<sub>5</sub> Stat. 25 B., 35° 46' N. 8° 16' W., 2055 m., yellow mud. Common.

<sup>18</sup>/<sub>5</sub> stat. 35, 27° 27' N. 14° 52' W., 2603 m., yellow mud. Arm fragments.

<sup>8</sup>/<sub>6</sub> stat. 53, 34° 59' N. 33° 1' W., 2615—2865 m., yellow hard clayey mud., temp. 3° Cel. One specimen.

<sup>30</sup>/<sub>6</sub> stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7 Cel. Common.

<sup>27</sup>/<sub>7</sub> stat. 95, 50° 22' N. 11° 44' W., 1797 m., temp. 3.5° Cel. Common.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub> stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. Very common.

Disc-diameter of the smallest specimens 2 mm., of the largest 33 mm. In the smallest specimens with a disc-diameter of 2 to 3 mm. (pl. 5, fig. 8) the dorsal side of the disc consists of the central plate, the five primary plates, the radial shields and two small plates placed interradially between the latter. By a disc-diameter of 4 mm. (pl. 5, fig. 9) a secondary plate between the primary plates and the radial shields is added to the disc, which thus possesses 31 plates. By a disc-diameter of 5 mm. (pl. 5, fig. 10) this number is further increased by 5 secondary plates situated interradially between the primary plates, and the number goes on increasing rapidly with continued growth of the disc. The central plates with secondary plates becomes separated from the primary plates, and these from the radial shields, and so on.

Mortensen has shown in "Smaa faunistiske og biologiske Meddelelser"<sup>1)</sup> that ophiurids of various ages are found simultaneously in shallow water at the same locality within the boreal region, and that recently transformed young were collected at the same time with one-year old, fully developed two-year old and older individuals. In Arctic waters on the other hand only a single year-class as a rule is found of the ophiurids occurring at locality. A few year-classes may, however, as an exception occur simultaneously, cfr. Mortensen: Echinoderms from East Greenland<sup>2)</sup> and Grieg: "Michael Sars Ophiuroidea"<sup>3)</sup>.

Among the ophiurids collected by the "Michael Sars" in 1910 in the North Atlantic *Ophiomusium lymani* only was represented by a greater number of specimens. In the following synoptic table the measurements of their disc-diameter will be given. As will be seen from this table the great mass of the individuals at a locality seem to belong to the same year-class. Two or three year-classes may, however, occur at the same locality, possibly more. At stat. 25 A there was a maximum of 11 individuals with disc-diameter 15—17 mm., which no doubt represented a year-class. Possibly one or two more year-classes may be found at this station, but the material was too scanty to determine this definitely. At stat. 25 B there

was a maximum of 25 individuals with a disc-diameter of 18—19 mm. The 7 individuals with a disc-diameter of 12—13 mm. may possibly represent still another year-class. Three year-classes at least occurred at stat. 70 where a group of 30 individuals afforded a maximum at 23—25 mm., a small one of six individuals at 17 mm. and a great one of 56 individuals at 4—7 mm. It is probable, however, that the 3—5 mm. examples represented one year-class, and that there was besides a fourth about 10 mm. At stat. 95 a group of 19 individuals afforded a maximum at 27—29 mm. Concerning the remaining 11 to 23 mm. sizes no definite statement can be made, as only single specimens of this group were to hand. They probably represent at least one year-class, however. At stat. 101 there was a very marked maximum at 26 to 29 mm. Besides, the smallest individuals must also represent one year-class. Thus two year-classes at least are found in that locality.

Disc-diameter in mm.	Stat.	Stat.	Stat.	Stat.	Stat.	Disc-diameter in mm.	Stat.	Stat.	Stat.	Stat.	Stat.
	25 a	25 b	70	95	101		25 a	25 b	70	95	101
Number of specimens						Number of specimens					
2	—	—	2	—	—	19	1	13	2	1	7
3	—	—	4	—	—	20	2	7	2	—	4
4	—	—	17	—	—	21	—	10	1	1	4
5	—	—	19	—	—	22	1	—	1	1	5
6	—	—	9	—	—	23	—	—	8	1	4
7	—	—	11	—	—	24	—	—	13	—	7
8	—	—	—	—	—	25	—	—	9	1	16
9	—	—	3	—	—	26	—	—	3	2	24
10	—	—	5	—	—	27	—	—	1	7	30
11	1	—	2	1	—	28	—	—	—	7	43
12	—	1	2	—	—	29	—	—	—	5	24
13	1	6	1	1	—	30	—	—	—	2	13
14	2	—	—	1	2	31	—	—	—	1	8
15	3	5	1	1	2	32	—	—	—	—	4
16	3	10	2	—	2	33	—	—	—	—	3
17	5	10	6	1	—						
18	1	12	2	—	1		20	81	126	34	203

As examples for comparison I may mention *Pectinura elata*, *Ophiura tessellata*, *Ophiocten sericeum* and *Ophiocantha abyssicola*. At stat. 25 B 8 specimens of *Pectinura elata* were taken. Seven of these had a disc-diameter of 21—25.5 mm., and one of 14 mm. The last-named individual can hardly belong to the same year-class as the rest. At stat. 88 15 specimens of *Ophiura tessellata*, (disc-diameter 9—24 mm.) were obtained, which are grouped as follows: There are three examples each of 24 mm., 21 mm. and 18 mm. Two specimens measured 20 mm. The sizes 19, 16, 15 and 9 mm. are represented by only

<sup>1)</sup> Vidensk. Meddelelser 1897, p. 321.

<sup>2)</sup> Meddel. om Grønland, vol. 29 1903, p. 82.

<sup>3)</sup> Bergens Museums Aarboog 1903 no. 13, p. 23.



one example each. The smallest of these specimens must belong to a different year-class from that of the largest, but whether representatives of a third year-class are found among them it is impossible to decide, as the material is very scanty. *Ophiocten sericeum*, which was so numerous at stat. 70 seems to have been represented there by a single year-class, and as all of the individuals measured 2 to 5 mm., they were probably one year old. 33 examples of *Ophiacantha abyssicola* were obtained at stat. 101 (disc-diameter 4—8 mm.) These specimens may be grouped as follows:

4 (1), 5 (4), 6 (6), 7 (4) and 8 (8)

(The figures in brackets represent the number of specimens; the others the size of the disc-diameter in millimetres.)

The specimens from stat. 101 are grouped about a disc-diameter of 7 mm. thus probably also represent a single year-class.

If we were to draw any conclusion from this somewhat scanty material, it must be, that what has been said in the foregoing about *Ophiomusium lymani* applies equally to all of the deep-sea ophiurids of the North Atlantic.

For the purpose of comparison I shall give in the following table a summary of the grouping of sizes in some of the North Atlantic deep-sea star-fishes, of which more abundant material is at my disposal. In determining sizes I have found it most convenient to use the radius of the disc for the star-fishes and not the disc-diameter as in ophiurids.

As the table shows there is a great abundance of specimens of *Plutonaster bifrons*, particularly from stat. 101. We find a group of 96 individuals from this locality with a disc-radius of 8 to 21 mm., and one specimen at 24 mm. The group affords two maxima; one consisting of 28 individuals at 10—11 mm. and the other of 17 at 17—18 mm. Both of these must represent a year-class. It is not possible to determine definitely whether the 24 mm. specimens belong to the older of these year-classes or whether it represents a third one, but judging by the material from stat. 41 I am most inclined to think that stat. 101 had 3 year-classes. At stat. 95 there is a large group of 16 individuals with a disc-radius of 14—20 mm. and one 8 mm. specimen, which must belong to a year-class different from the large group. If we compare these specimens with those from stat. 101, it is evident that the large group must be of the same age as the group from stat. 101 which is grouped about a disc-radius of 17—18 mm., while the 8 mm. example must belong to the youngest year-class. At stat. 41 there were three year-classes. The material comprised 14 speci-

mens, one of which measured 10 mm., another 27 mm., the remainder 14—22 mm. The latter must belong to the same year-class as the large group at stat. 95, while the 10 mm. specimen must be of the same age as the 8 mm. example in that locality. The 27 mm. specimen must belong to a third and older year-class. The material from stat. 24 is very little differentiated. It is composed of two small groups, one of 9 individuals with a disc-radius of 13—18 mm, the other of 6 individuals with a disc-radius of 18—20 mm. If we compare these groups with the material from the other localities it seems probable, that there were two year-classes at stat. 24.

The examples of *Dytaster agassizi* from stat. 88 must all belong to the same year-class, as they have a disc-radius of 6—12 mm. The 9—10 mm. group affords a maximum of 18 individuals or 53 per cent of the total number. The specimens of *Benthopecten spinosus* from stat. 101 must probably likewise represent a year-class. The features of the material were insufficiently marked, however.

Disc-radius in mm.	<i>Benthopecten spinosus</i> Stat. 101	<i>Plutonaster bifrons</i>				<i>Dytaster agassizi</i> Stat. 88	<i>Psilaster andromeda</i> Stat. 101	<i>Bathypriaster robustus</i> Stat. 101
		Stat. 24	Stat. 41	Stat. 95	Stat. 101			
		Number of specimens						
5	1	—	—	—	—	—	—	—
6	2	—	—	—	—	2	3	—
7	2	—	—	—	—	3	1	—
8	3	—	—	1	1	4	3	—
9	2	—	—	—	5	8	—	—
10	2	—	1	—	12	10	2	—
11	—	—	—	—	16	4	—	1
12	—	—	—	—	7	3	—	1
13	—	1	—	—	7	—	—	—
14	—	4	1	2	4	—	1	—
15	—	4	1	2	4	—	1	3
16	—	—	2	5	6	—	1	2
17	—	—	2	4	8	—	1	2
18	—	1	2	2	9	—	2	2
19	—	3	2	—	4	—	2	6
20	—	2	—	1	2	—	3	5
21	—	—	1	—	1	—	1	3
22	—	—	1	—	—	—	2	—
23	—	—	—	—	—	—	—	—
24	—	—	—	—	1	—	—	—
25	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—
27	—	—	1	—	—	—	—	—
	12	15	14	17	97	34	23	25

At stat. 101 23 *Psilaster andromeda* were taken which were grouped about 6—10 mm. (9 specimens) and 14—22 mm. (14 specimens). The grouping was not very distinct, however. If we compare this material with some from the Norwegian coast in the Bergen Museum, it appears that the smallest specimens (disc-radius 6—8 mm.) must belong to a year-class, different from that of the largest specimens (disc-radius 20—22 mm.) It is further evident that some of the intermediary examples (disc-radius 10—19 mm.), must represent a third year-class with a maximum at 12—15 mm. The smallest individuals must be two years old and the largest about four, and I should be inclined to consider the before-mentioned year-classes of *Plutonaster bifrons* as being of the same age as these.

The specimens of *Bathybiaster robustus* taken at stat. 101 are grouped as follows: Two individuals with disc-radius of 11—12 mm., and besides a group of 23 individuals with disc-radius of 15—21 mm. This group affords a maximum of 11 individuals at 19—20 mm. The fact that maximum included the largest individuals (there were only three larger examples at 21 mm.) seems to indicate that the two small individuals (11—12 mm.) may belong to a year-class distinct from the rest.

From the foregoing examples we may thus infer that what has been said before about the deep-sea ophiurids of the North Atlantic applies equally to the star-fishes of that region. The latter may also be represented by several year-classes in a locality, whilst only one of them is numerously represented. In my treatise "Nogen asteriders alder og aarsklasser"<sup>1)</sup> and "Remarks on the Age of some Arctic and North-Atlantic Star-fishes"<sup>2)</sup> I have entered more at length upon the subject of the grouping of the asterids occurring in a locality.

*Ophiomusium lymani* is a world-wide species, known from the Atlantic, the Pacific and the Indian Oceans, 130—3435 m. In the Atlantic where it appears to be the most widely distributed deep-sea ophiurid, it ranges north to 61° 10.8' on the eastern side and to 66° 49' on the western side.

#### *Ophiomusium planum* Lyman.

*Ophiomusium planum*, Lyman, Bull. Mus. Comp. Zool., vol. 5, no. 9, 1878, p. 218, tab. 3, figs. 46—48.

<sup>10</sup>/<sub>4</sub>, stat. 10, 45° 26' N. 9° 20' W., 4700 m., yellow mud, temp. 2.56° Cel. Three specimens. Disc-diameter 16.5—22 mm.

<sup>8</sup>/<sub>6</sub>, stat. 53, 34° 59' N. 33° 1' W. 2615—2865 m., yellow hard clayish mud, temp. 3° Cel. Three specimens. Disc-diameter 15.5—22.5 mm.

This species has normally three arm-spines, but as already pointed out by Koehler<sup>1)</sup>, it may have four, of which the uppermost is placed at some distance from the rest. Some of the specimens under discussion had, however, sometimes as many as five spines, of which the three ventral ones stood very close together, while the two others were separated by a space from them and from one another. The mouth-shields likewise seem to be subject to variations. In the smallest specimens their form resembles that of typical *Ophiomusium planum*, while those in the larger specimens are more similar to the mouth-shields in *Ophiomusium armigerum*. As, however, the specimens agree with *Ophiomusium planum* in other characters, I have referred them to that species.

In the Atlantic *Ophiomusium planum* is hitherto taken only in the northern part, but is found there on the western as well as on the eastern side. It is distributed on the west Atlantic side from 24° 3' to 37° 56' 20" N., 262—4064 m. It was first taken by the "Blake" in the West-Indies, where it was also later found by the "Albatross". The same vessel took it also off the east coast of North America. On the east Atlantic side it ranges from 15° 48' to 45° 26' N., 2325—5005 m. It was collected by the "Talisman" of the Cape Verde Is., the Canarys and the Azores, where it was later also taken by the Prince of Monaco. Finally the "Investigator" has taken it in the Gulf of Bengal, 2782—3563 m.

#### *Ophiactis abyssicola* M. Sars.

*Amphiura abyssicola* M. Sars, Oversigt af Norges Echinodermer, 1861, p. 18, tab. 2, figs. 7—12.

<sup>23</sup>/<sub>5</sub> stat. 24, 28° 8' N. 13° 35' W., 1365 m. yellow mud, temp. 8° Cel. Two specimens.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub> stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. 9 specimens.

The largest specimen measured: disc-diameter 8 mm., length of arm 40 mm. It is thus somewhat larger than Sars' type specimen.

This species is distributed along the west-coast of Norway as far as Senjen, but the northern limit of its range is 71° 25' ("Voeringen" stat. 200). It was besides found east of Shetland Is., in the Faroe—Shetland Channel, off the west coast of Ireland, on the banks between the Faroe Is. and Iceland and in the Denmark Straits. It is further recorded by Mortensen from the west-coast of Greenland, whereas I have not seen it recorded from the east-coast of North America. The Prince of Monaco took it off the Azores. It ranges therefore from 28° 8' to 71° 25' N. on the east Atlantic

<sup>1)</sup> Bergens Museums Aarbok 1916—17, Naturvidensk. Række no. 1.

<sup>2)</sup> Ann. Mag. Nat. Hist., ser. 9. vol. 3, 1919, p. 400.

<sup>1)</sup> Koehler: Ophiures, Exp. Sci. du "Travailleur" et du "Talisman", 1906, p. 265.

side. The bathymetrical distribution is 118—1853 m. As already pointed out in "Michael Sars Ophiuroidea" (p. 30) *Ophiactis abyssicola* is a true warm water species. It may, however, occasionally occur in the cold area, and was obtained there by the "Porcupine" (2 stations), the "Voeringen" (4), the "Knight Errant" and the "Triton" (one station each) and the "Michael Sars" in 1902 (2 stations).

***Amphiura chiajei*** Forbes.

*Amphiura chiajei* Forbes, Transact. Linn. Soc., vol. 19, 1843, p. 151, tab. 14, figs. 14—18.

<sup>5</sup>/<sub>5</sub> stat. 21, 35° 31' N. 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. Several specimens.

This is an east Atlantic species, ranging northward to the Trondhjemsfjord, south to the Mediterranean, the west coast of the North Africa and the Azores. Its bathymetrical range 10—1015 m., with main distribution at depths less than 200 m.

***Amphiura duplicata*** Lyman.

*Amphiura duplicata* Lyman, Ill. Cat. Mus. Comp. Zool., no. 8, part 2, 1875, p. 19, tab. 5, fig. 78.

<sup>5</sup>/<sub>5</sub> stat. 21, 35° 31' N. 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. Four rather defective specimens. Judging from the figures, which Lyman gives of this species, the specimens under discussion agree as regards the form of radial shields, mouth-shields and arm-plates more closely with those in the report on the "Challenger Ophiuroidea" (pl. 17., figs. 10—12).

*Amphiura duplicata* was first taken by the Hassler expedition off Barbados, 183 m. It was later obtained by the "Blake" at numerous stations in the West Indies, 134—2869 m. The Challenger found it off the Bermudas, 1967 m., the "Caudan" in the Bay of Biscay, 1710 m., and the Prince of Monaco off Azores, 1350—1800 m.

***Ophiolebes claviger*** Ljungman.

*Ophiactis claviger* Ljungman, Öfvs. Kgl. Vetensk. Akad. Förhandl. vol. 21, 1864, p. 365, tab. 15, fig. 4.

<sup>30</sup>/<sub>6</sub> stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7 Cel. One specimen clinging to *Acanella arbuscula* Johnst.s. *normani* Verr. Disc-diameter 5 mm.

*Ophiolebes claviger* occurs sparingly along the west coast of Norway to Grøtø, where Danielssen obtained one specimen. Mortensen records it from the Skagerack and the west coast of Greenland, and Farran from the west coast of Ireland. I have been able to examine a specimen from the east coast of North America ("Blake" stat. 306, 41° 32' 50" N. 65° 55' W, 959 m.) which the Bergen Museum received from Agassiz. To this species belongs undoubtedly the ophiurid from Nova Scotia, 167—223 m.,

which Verrill describes in "Res. Expl. made by the steamer Albatross 1883" (p. 548) under the name *Ophiolebes acanellæ*. If we compare this description with typical specimens of *Ophiolebes claviger* from the Norwegian coast, we shall find in this the same characteristics as in *Ophiolebes acanella*. It should be noted, however, that Verrill does not give any illustration of his species and that the description is very brief. It is therefore difficult to identify the species definitely.

*Ophiolebes claviger* should therefore range from 41° 32' 50" to 64° 53' N. on the west side of the Atlantic and from 50° 42' to 67° 50' W. on the east side. Its bathymetrical distribution is 167—1232 m.

***Ophiacantha abyssicola*** G. O. Sars.

*Ophiacantha abyssicola*, G. O. Sars, Christiania Vidensk. Selsk. Forhandl. 1871, p. 8.

<sup>5</sup>/<sub>6</sub>, stat. 24, 35° 34' N. 7° 35' W., 1615 m., yellow mud, temp. 8° Cel. 7 specimens.

<sup>7</sup>/<sub>5</sub>, stat. 25 A, 35° 36' N. 8° 25' W., 2300 m., yellow mud. One specimen.

<sup>8</sup>/<sub>5</sub>, stat. 25 B, 35° 46' N. 8° 16' W., 2055 m., yellow mud. Three specimens.

<sup>30</sup>/<sub>6</sub>, stat. 70, 42° 59' N. 51° 15' W., 1100 m. temp. 3.7° Cel. One specimen.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub>, stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. Rather common.

Koehler records this species as occurring throughout the Arctic waters of Europe and Asia<sup>1</sup>). But this statement must be based on a confusion with *Ophiacantha bidentata*, for *Ophiacantha abyssicola* is not known north of the Lofoten on the Norwegian coast. It was, however, taken by the "Voeringen" in two localities between Norway and Beeren Eiland (stat. 286, 72° 57' N. 21° 51' E., 408 m.) It is absent from the coasts of Finmarken and Murman and thence eastward. But it occurs along the west coast of Europe as far south as the Azores. It is further found off the east and west coasts of Greenland as well as of the east coast of North America, from which Verrill has described it under the name *Ophiacantha mille-spina*. *Ophiacantha abyssicola* is thus a North Atlantic species, ranging from 35° 34' to 72° 54' N. on the European side, and from the Bahamas (about 25°) to 63° 17' N. (64° 42' N.) on the American side. The bathymetrical distribution is 35—3508 m. It is a true warm-water species, which was, however, taken three times ("Voeringen", stat. 286, "Porcupine" 1869, stat. 54 and stat. 65) in the cold area. These cold water localities are situated very close to the warm area, however.

<sup>1</sup>) Koehler: Echinodermes, Res. Camp. Sci. Monaco, Fasc. 34, 1909, p. 182.

***Ophiacantha aristata* Koehler.**

*Ophiacantha aristata* Koehler, Res. Sci. Camp. "Caudan" dans le Golfe de Gascogne, Fasc. 1, 1896, p. 84, tab. 4, figs. 43 & 44.

<sup>23</sup>/<sub>5</sub>, stat. 41, 28° 8' N. 13° 35' W., 1365 m., yellow mud, temp. 6° Cel. One specimen. Disc-diameter 4.5 mm. Colour pink.

The type specimen was obtained by the "Caudan" in the Bay of Biscay, 1700 m. It was besides found by the "Talisman" between 22° 57' and 45° 59' N. and between 6° 29' and 31° 46' W., 822—1635 m., by the Prince of Monaco between 27° 57' 40" and 42° 30' N. and between 9° 37' 45" and 30° 28' 54" W., 1095—1743 m., as well as by the "Helga" off the west coast of Ireland (50° 42'—51° 37' N. 11° 18'—11° 56' W., 1116—1332 m.) *Ophiacantha aristata* is therefore an east Atlantic species, ranging from 22° 57' to 51° 37' N. Bathymetrical distribution 822—1743 m.

***Ophiacantha crassidens* Verrill.**

*Ophiacantha crassidens* Verrill, Amer. Journ., ser. 3, vol. 29, 1885, p. 152.

<sup>18</sup>/<sub>7</sub>, stat. 88, 45° 26' N. 25° 45' W., 3120 m., sand and dark yellow mud, temp. 2.5° Cel. One specimen (disc-diameter 11.5 mm.) which agrees well with the descriptions that Verrill, Koehler and Farran give of this species.

*Ophiacantha crassidens* is a North Atlantic species which was first taken by the "Albatross" off Cape Hatteras, 1543 m. It ranges on the European side from 38° 45' 30" to 51° 50' 30" N., 986—3120 m. It was obtained by the Prince of Monaco off the Azores, 1095—1360 m., and by the "Helga" off the west coast of Ireland, 986—1801 m.

***Ophioscolex glacialis* Müller & Troschel.**

*Ophioscolex glacialis* Müller & Troschel, System der Asteriden, 1842, p. 109, tab. 10, figs. 1 & 2.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub>, stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp. ÷ 0.9° Cel. 8 specimens.

***Astronyx locardi* Koehler.**

*Astronyx locardi* Koehler, Res. Sci. Camp. "Caudan" dans le Golfe de Gascogne, Fasc. 1, 1896, p. 88, tab. 3, fig. 25.

<sup>27</sup>/<sub>7</sub>, stat. 95, 50° 22' N. 11° 44' W., 1797 m., temp. 3.5° Cel. One specimen. Disc-diameter 24.5 mm. All of the arms were defective, the best-preserved one measured 145 mm. The specimen is but a very little larger than the type-specimens with which it agrees in all the characteristics.

*Astronyx locardi* was previously known only from the Bay of Biscay, where it was collected by the "Caudan" as well as the "Travailleur". According to the explorations of the "Michael Sars" its horizontal range will be from 44° 7' to 50° 22' N. and from 7° to 11° 44' W. The bathymetrical distribution is 411—2030 m.

***Astrochele lymani* Verrill.**

*Astrochele lymani* Verrill, Amer. Journ. ser. 3, vol. 6, 1878, p. 374.

<sup>30</sup>/<sub>6</sub> stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7° Cel. Two very young specimens, clinging to *Acanella arbuscula* Johnst. s. *normani* Verr. Disc-diameter 4 mm. and 5 mm. respectively the specimens are thus a little smaller than Verrill's type-specimen, whose disc-diameter was 7 mm.

*Astrochele lymani* is known only from the east coast of North America, 483—2933 m., where it is found in great numbers on *Acanella arbuscula* Johnst.

**ECHINOIDEA.*****Cidaris affinis* Philippi.**

*Cidaris affinis* Philippi, Wiegmanns Archiv für Naturgesch. Jahrg. 11, Bd. 1, 1845, p. 351.

<sup>21</sup>/<sub>5</sub> stat. 39 B, 26° 3' N., 15° W., 267--280 m., fine grey sand. Common. The smallest specimen had a test-diameter of 17 mm., the largest 39 mm., which seems to be the maximum size of the species. The colour of most of the smaller specimens was plain pink, but in some of them dark violet bands incircled the ambulacral areas and a violet band also sometimes surrounded the mouth and apical areas. The larger specimens were violet or brownish with primary spines plain red and with secondary violet with red points.

*Cidaris affinis* is known from the Mediterranean, the west coast of Africa and Europe and the West Indies. It is not possible at the present time, however, to state definitely its distribution, as it has been confused with *Dorocidaris papillata*. The bathymetrical distribution is 37—889 m.

I have already shown (p. 34) that the great mass of ophiurids occurring in a locality at the depths of the North Atlantic belong to the same year-class. But several year-classes may be represented in the same locality, only one of them numerous, however. The same is true of the echinoids as the following table will show. At stat. 39 B 121 specimens of *Cidaris affinis* were taken, with a diameter of 17—39 mm. The majority of these measure 17—28 mm. with a maximum of 51 individuals at 22—23 mm. There is besides a small group of 9 individuals which measure 34—39 mm. These must belong to a year-class different from the large group, which has its maximum at 22—23 mm.

At stat. 88 227 specimens of *Echinus alexandri* were obtained, test-diameter 25—46 mm. 126 specimens or 86.34 per cent measured 33—40 mm., and these afforded a maximum of 102 individuals or 40.52 per cent of the total number at 35—37 mm. This large group must represent a year-class and the few larger and smaller individuals must be representatives of other year-classes.

Test-diameter in millimetres	Number of specimens				
	Cidaris affinis Stat. 39 b	Echinus alexandri.		Echinus acutus.	
		Stat. 88	Stat. 95	Stat. 101	Stat. 23.
17.....	1	—	—	—	—
18.....	1	—	—	—	—
19.....	5	—	—	—	—
20.....	7	—	—	—	1
21.....	15	—	—	—	—
22.....	23	—	—	—	—
23.....	28	—	—	—	—
24.....	15	—	—	—	—
25.....	13	1	1	—	—
26.....	2	2	—	—	—
27.....	1	3	1	—	1
28.....	1	1	3	—	—
29.....	—	2	3	—	2
30.....	—	4	2	1	—
31.....	—	4	—	3	—
32.....	—	5	1	4	—
33.....	—	13	1	3	—
34.....	1	25	2	1	1
35.....	3	38	2	—	—
36.....	—	29	—	2	1
37.....	—	35	—	1	1
38.....	3	23	1	1	—
39.....	2	21	—	—	—
40.....	—	12	1	—	1
41.....	—	2	—	1	—
42.....	—	3	—	1	—
43.....	—	1	—	1	—
44.....	—	2	—	—	—
45.....	—	—	—	—	—
46.....	—	1	—	—	—
60.....	—	—	—	—	1
	121	227	18	19	9

The material from stat. 95 is very scanty but the examples of *Echinus alexandri* collected there seem likewise to indicate the presence of more than one year-class at the locality. The specimens of *Echinus acutus* taken at stat. 101 afford a maximum of 10 individuals at 31—33 mm., which must represent a year-class. The three individuals at 41—43 mm. form another year-class. The grouping of these year-classes can not be definitely determined, however, owing to the scantiness of the material. At stat. 23 three year-classes at least must have been present, as the smallest individual at 20 mm. and the largest at 60 mm. represent one year-class each. The remaining specimens which measured 27—40 mm. represent at any rate a third one, but judging from the conditions at stat. 101 I am most inclined to believe that they belong to two different year-classes. At stat. 4 nine individuals were collected of which six measured 62—69 mm., one 32 mm. and two 10 mm. These three groups must each represent a year-class.

What has been said above applies also to the Echinothurids. 14 specimens of *Phormosoma placenta* were taken at stat. 4, 15 at stat. 70, 14 at stat. 101 and 25 at stat. 76 A, 1902. Their measurements were as follows: Stat. 4: 60 (1), 67 (3), 70 (1), 72 (1) 73 (2), 75 (2), 77 (2), 79 (1), 83 (1).

Stat. 70: 6 (1), 8 (1), 9 (1), 10 (1), 12 (1), 14 (1), 16 (1), 26 (1), 27 (1), 54 (1), 59 (1), 61 (1), 65 (2), 71 (1).

Stat. 101: 44 (1), 48 (1), 54 (1), 63 (1), 64 (1), 67 (1), 68 (1), 69 (3), 71 (3), 75 (1).

1902, stat. 76 A: 67 (1), 73 (1), 76 (1), 78 (2), 79 (3), 80 (6), 82 (4), 83 (2), 84 (3), 85 (1), 86 (1).

(The numbers in brackets refer to the number of specimens, the others to the diameter of the test in millimetres).

As will be seen stat. 4 afford a maximum of six individuals at 73—75 mm., which must represent one year-class, while there is evidently another year-class between 60 and 70 mm. At stat. 70 we find at least a year-class at 6—16 mm., another at 26—27 mm. and a third gathered about 65 mm., perhaps also a fourth at 54 mm. At stat 101 there is a year-class grouped about 69—73 mm., and the smallest individuals must belong to a different year-class. At stat. 76 A most of the individuals are grouped about a diameter of 80 mm. and the smallest specimen must represent a different year-class. Six individuals, taken at stat. 23, show that as many as three year-classes may occur simultaneously in a locality. Their measurements were as follows:

21, 25, 38, 42, 43 and 74 mm.

16 specimens of *Aræosoma hystrix* taken in 1902 by the "Michael Sars" at stat. 76 A measured:

35, 85, 89, 96, 97, 98, 99, 102, 106, 108, 112, 131, 133 and 146 mm.

Three specimens measured 102 mm., the remaining measurements included but one individual each. Three year-classes at least of *Aræosoma hystrix* must have been found at stat. 76 A, for the largest and the smallest individual must each represent a year-class, and the third one is grouped about 102 mm.

Of *Sperosoma grimaldii* four year-classes at the least were probably present at the same station, as the specimens taken there were of the following dimensions:

90 (1), 108 (1), 109 (1), 110 (1), 114 (1), 116 (1), 122 (1), 123 (1), 127 (2), 143 (2), 145 (1), 153 (1), 154 (1), and 188 (1).

At stat. 88 (1902), there seem at least to have occurred three year-classes, as the specimens measured: 75, 94, 105, 132 and 210 mm. respectively. The four *Sperosoma grimaldii* taken at stat. 25 must likewise have represented three year-classes, as they measured: 73, 195, 208 and 220 mm. respectively.



***Dorocidaris papillata*** Leske.

*Cidaris papillata* Leske, Klein Nat. Disp., 1778, p. 61, tab. 39, fig. 2.

<sup>10</sup>/<sub>4</sub>. Stat. 3, 49° 32' N., 10° 49' W., 184 m., fine sand. One specimen. Test-diameter 55 mm.

<sup>10</sup>/<sub>4</sub>. Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. Two specimens. Test-diameter 42 mm. and 44 mm.

*Dorocidaris papillata* is a North Atlantic species which occurs on the east as well as on the west side of the ocean. It is besides found in the Mediterranean. Very common on the banks along the western coast of Norway as far as Bodø (66° 42' N., 11° 23' E.), which is the northernmost locality of the species, it has not pushed on to the Norwegian fjords, however. Its southern distribution extends at least to the Cape Verde Is. (15° 17' N., 23° 3' 45" W., Koehler), but the limits of its southern range can not be definitely fixed, as it has been confused with other species. The bathymetrical distribution is some 60 to 1800 m.

***Porocidaris purpurata*** Wyville Thomson.

*Porocidaris purpurata* Wyville Thomson, Ann. Mag. Nat. Hist., ser. 4, vol. 10, 1872, p. 302.

<sup>6</sup>/<sub>5</sub> stat. 24, 35° 34' N. 7° 35' W., 1615 m., yellow mud., temp. 8° Cel. Three specimens. Test-diameter 31 mm. and 37 mm. respectively.

<sup>23</sup>/<sub>5</sub> stat. 41, 28° 8' N. 13° 35' W., 1365., yellow mud, temp. 6° Cel. Two specimens. Test-diameter 42 mm. and 44 mm. respectively.

This species was discovered by the "Porcupine" in the Faroe—Shetland Channel, 968—991 m. (Wyville Thomson) The "Michael Sars" obtained it in 1902 on the slope of the Faroe—Iceland banks toward the Atlantic depths (stat. 79 B, 61° 7' N. 9° 33' W., 750 m.). It was further found off the south coast of Iceland, 914—957 m. (Mortensen), the west coast of Ireland, 1116—1409 m. (Sladen and Farran), the Bay of the Biscay, 950—1804 m. (Koehler), the Canary Is., 1098 m. (Koehler) and Rio Ouro, 1439 m. (Mortensen). *Porocidaris purpurata* is thus distributed at the great depths along the entire east side of the North Atlantic. It was besides taken by the "Valdivia" off the Nicobar Is., 905 m. (Döderlein).

***Aræosoma hystrix*** Wyville Thomson.

*Calveria hystrix* Wyville Thomson, Proc. R. Soc. London, vol. 18, 1869, p. 445.

<sup>10</sup>/<sub>4</sub> stat. 4, 49° 38' N. 11° 35' W., 923 m., sand and mud., temp. 9.2° Cel. Two specimens. Test-diameter 120 mm. and 140 mm. respectively.

<sup>23</sup>/<sub>5</sub> stat. 41, 28° 8' N. 13° 35' W., 1365 m., yellow mud., temp. 6 Cel. Four specimens. Test-diameter 88—109 mm.

The "Michael Sars" obtained several specimens of this species in 1902 at stat. 76 A, 59° 28' N. 8° 1' W., 1100—1300 m., temp. 8.07° Cel.

*Aræosoma hystrix* is indigenous to the eastern as well as the western side of the North Atlantic. The northern limit of its range is formed by the ridges and banks which separate the Atlantic from the Norwegian Sea. To the south it ranges to the Canary Is. The bathymetrical distribution about 180—1800 m.

***Phormosoma placenta*** Wyville Thomson.

*Phormosoma placenta* Wyville Thomson, The Depths of the Sea, 1873, p. 171 and p. 459.

<sup>10</sup>/<sub>4</sub> stat. 4, 49° 38' N. 11° 35' W., 923 m., sand and mud., temp. 9.2° Cel. Common. 14 preserved specimens measured 60—83 mm. in diameter.

<sup>5</sup>/<sub>5</sub> stat. 21, 35° 31' N. 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. One specimen, diameter 63 mm.

<sup>5</sup>/<sub>5</sub> stat. 23, 35° 32' N. 7° 7' W., 1215 m., yellow mud., temp. 10.17° Cel. Six specimens, diameter 21—74 mm.

<sup>6</sup>/<sub>5</sub> stat. 24, 35° 34' N. 7° 35' W., 1615 m., yellow mud., temp. 8° Cel. Four specimens, diameter 74—90 mm.

<sup>30</sup>/<sub>6</sub> stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7° Cel. 15 specimens, diameter 6—71 mm.

<sup>27</sup>/<sub>7</sub> stat. 95, 50° 22' N. 11° 44' W., 7 specimens, diameter 52—60 mm.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>3</sub> stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay, temp. 3.3° Cel. 14 specimens, diameter 44—75 mm.

The "Michael Sars" obtained this species together with *Aræosoma hystrix* and *Sperosoma grimaldii* in 1902 at stat. 76 A, 59° 28' N. 8° 1' W., 1100—1300 m., temp. 8.07 Cel.

The specimens from stat. 70 belong to the west Atlantic variety *sigsbei* A. Agassiz (cf. Döderlein: Die Echinoiden d. deutschen Tiefsee Expedition<sup>1)</sup>), the remainder to the typical form.

The typical *Phormosoma placenta* is an east Atlantic form ranging from the Faroe Is. and Iceland, 62° 58' N. ("Ingolf") to Cameroon, 3° 10' N. ("Valdivia") while the variety *sigsbei* has a west Atlantic distribution from the Davis Strait, 66° 49' N. (Wandel) to the West Indies, 41° 29' 45" N. ("Blake"). It is probable that the species will be met with also at the great depths of the South Atlantic, as varieties of it are known from the Pacific and Indian Oceans. The bathymetrical distribution is 275—2500 m.

***Sperosoma grimaldii*** Koehler.

*Sperosoma grimaldii* Koehler, Zool. Anzeiger, vol. 20, 1897, p. 302.

<sup>7</sup>/<sub>5</sub> stat. 25 A, 35° 36' N. 8° 25' W., 2300 m., yellow mud. Three larger specimens, diameter 195—220 mm. and a smaller one, diameter 73 mm.

<sup>23</sup>/<sub>5</sub> stat. 41, 28° 8' N. 13° 35' W., 1365 m., yellow mud. One specimen, diameter 106 mm.

*Sperosoma grimaldii* was first found by the Prince of Monaco off the Azores, 1213—1850 m. It was later

<sup>1)</sup> Wissensch. Ergebn. d. deutschen Tiefsee Expedition, Bd. 5, 1906, p. 128.

taken in a number of localities between the Bay of Biscay and the Cape Verde Is. According to Mortensen, it was collected by the "Talisman" off Morocco and the Azores and Farran<sup>1)</sup> records it from the west coast of Ireland. The "Ingolf" obtained it south of Iceland and the "Michael Sars" in 1902 south of the Faroe Is. (stat. 76 A, 59° 28' N. 8° 1' W., 1100—1300 m., 8.07° Cel.) as well as south of the Faroe—Iceland ridge (stat. 88, 63° 9' N. 13° 27' W., 880 m., 5.07° Cel.). *Sperosoma grimaldii* is therefore an east Atlantic species, ranging from 15° 17' to 63° 9' N. The bathymetrical distribution 300—2300 m.

***Hygrosoma petersi* A. Agassiz.**

*Hygrosoma petersi* A. Agassiz, Bull. Mus. Comp. Zool. vol. 8, 1881, p. 76.

<sup>7</sup>/<sub>5</sub>. Stat. 25 A, 35° 36' N., 8° 25' W., 2300 m., yellow mud. One large specimen, diameter 152 mm.

<sup>23</sup>/<sub>5</sub>. Stat. 41, 28° 8' N., 13° 35' W., 1365 m., yellow mud. Two specimens, diameter 110 mm. and 130 mm.

The primary spines were torn off in all of the specimens. The specimen from stat. 25 A, however, was pretty well preserved, also with respect to the colouring, which was intensely dark-violet with spines and tubefeet darker than the test. In the specimen depicted by Koehler in "Echinides et Ophiures provenant des campagnes du yacht l'Hirondelle"<sup>2)</sup> the latter are lighter than the test.

*Hygrosoma petersi* was first found by the "Blake" off the West Indies and the east coast of North America (between about 12° and 40° N.), where it was likewise later taken by the "Albatross" (Mortensen)<sup>3)</sup>. The Prince of Monaco obtained it off the Azores, where it was also taken according to Mortensen by the "Talisman". It is recorded by Koehler<sup>4)</sup> under the name *Phormosoma luculentum* from the Bay of Biscay, and was also later obtained there by the "Thor" (Mortensen)<sup>5)</sup>. The "Michael Sars" localities are situated off Gibraltar and Cape Bojador' *Hygrosoma petersii* must therefore range on the east Atlantic side from 28° 8' to 49° 20' N. The bathymetrical distribution on the west side of the Atlantic is 730—2240 m., on the east side 1165—2870 m.

***Salenia profunda* Duncan.**

*Salenia profunda* Duncan, Ann. Mag. Nat. Hist., ser. 4, vol. 20, 1877, p. 70.

<sup>18</sup>/<sub>7</sub>. Stat. 88, 45° 26' N., 25° 5' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. 18 specimens, diameter 10—14 mm.

The "Michael Sars" found several specimens of this species in 1902 on the slope of the Faroe-Iceland banks

<sup>1)</sup> Fisheries, Ireland Sci. Invest. 1912 (1913) no. 6, p. 54.

<sup>2)</sup> Res. Camp. Sci. Monaco, Fasc. 12, 1898, tab. 1.

<sup>3)</sup> Mortensen: Some West Indian Echinoids, 1910, p. 23.

<sup>4)</sup> Res. Sci. Camp. "Caudan", Fasc. 1, 1896, p. 92.

<sup>5)</sup> Mortensen: Echinoidea, part 2, 1907, p. 170.

toward the depths of the Atlantic (stat. 88, 63° 9' N., 13° 27' W., 880 m., temp. 5.07° Cel.) *Salenia profunda* was not previously known within the Atlantic regions north of the Bay of Biscay ("Caudan", stat. 3, 46° 26' N., 6° 58' W., 1710 m.). It ranges south to Tristan d'Acunha ("Challenger", stat. 335, 32° 24' S., 13° 5' W., 2608 m.) and was besides found in the Indian and Pacific Oceans. *Salenia profunda* is therefore a cosmopolitan species. The bathymetrical distribution is 183—3383 m.

***Echinus esculentus* Linné.**

*Echinus esculentus* Linné, Syst. Nat., ed. 10, 1758, p. 663.

<sup>9</sup>/<sub>4</sub>. Stat. 1, 49° 27' N., 8° 36' W., 146 m., fine sand, temp. 9.57° Cel. One specimen, diameter 58 mm., height of test 40 mm.

*Echinus esculentus* is a boreal species, ranging south to the coasts of Spain and Portugal and north to Oexfjord, Finmark and 69° 18' N. ("Voeringen" stat. 173 B) Bathymetrical distribution 0—1264 m.

***Echinus acutus* Lamarck.**

*Echinus acutus* Lamarck, Anim. s. Vert., vol. 3, 1816, p. 45.

<sup>9</sup>/<sub>4</sub> stat. 1, 49° 27' N. 8° 36' W., 146 m., fine sand, temp. 9.57° Cel. One specimen.

<sup>10</sup>/<sub>4</sub> stat. 3, 49° 32' N. 10° 49' W., 184 m., fine sand, temp. 10.3° Cel. Several specimens.

<sup>10</sup>/<sub>4</sub> stat. 4, 49° 38' N. 11° 35' W., 923 m., sand and mud., temp. 9.2° Cel. 9 specimens.

<sup>5</sup>/<sub>5</sub> stat. 21, 35° 31' N. 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. One specimen.

<sup>5</sup>/<sub>5</sub> stat. 23, 35° 32' N. 7° 7' W., 1215 m., yellow mud., temp. 10.57° Cel. 9 specimens.

<sup>27</sup>/<sub>7</sub> stat. 96, 50° 57' N. 10° 46' W., 184 m. temp. 11° Cel. One specimen.

<sup>6</sup>/<sub>8</sub>—<sup>7</sup>/<sub>8</sub> stat. 101, 57° 41' N. 11° 48' W., 1853 m., hard clay temp. 3.3° Cel. 19 specimens.

The specimens from stat. 1 and 96 belong to the form *flemingi Forbes*. Some of the specimens from stat. 4 may be referred to the form *microstoma* Wyville Thomson, others to *norvegicus* Düben & Koren. I give below the measurements of three *microstoma* and three *norvegicus* of about equal size:

	<i>microstoma</i>			<i>norvegicus</i>		
	mm.	mm.	mm.	mm.	mm.	mm.
Diameter of test.....	62	66.5	69	62	55.5	67
Height of test.....	34.5	55.5	39	33	39.5	43.5
Diameter of bucal area ....	13	13.5	14	16	18	20
Diameter of apical area ....	13	15	13	14.5	15	13.5
Diameter of anal area.....	6	6	7	5.5	6	6.5
Height in per cent of diameter.....	55.4	83.6	56.5	53.2	59.4	64.7

As will be seen from the foregoing numbers, the bucal area affords the only reliable distinguishing characteristic between these two forms, as it is much smaller

in *microstoma* than in *norvegicus*: Mortensen<sup>1)</sup>, however, very justly remarks that this distinction is not reliable either, as the size of the buccal area is subject to considerable variations in *norvegicus*.

*Echinus acutus* is an east Atlantic species, ranging north to the Beeren Eiland ("Voeringen", stat. 275, 74° 8' N.) and south to the Mediterranean and Cape Bojador ("Valdivia", stat. 28, 26° 17' N.) The bathymetrical distribution is 0—1280 m. It is a true warm-water species, but the variety *norvegicus* is taken in the cold area by the "Voeringen" (stat. 267, 71° 42' N. 37° 1' E., 271 m., ÷ 1.4°, and stat. 275, 74° 8' N. 31° 12' E., 269 m., ÷ 0.4°).

***Echinus alexandri*** Danielssen & Koren.

*Echinus alexandri* Danielssen & Koren, Nyt Mag. for Naturvidensk., vol. 27, 1883, p. 294, tab. 3 & 4.

<sup>18/7</sup>, stat. 88, 45° 26' N. 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. Very Common.

<sup>27/7</sup>, stat. 95, 50° 25' N. 11° 44' W., 1797 m., temp. 3.5° Cel. 18 specimens.

The test-diameter of the smallest specimen was 25 mm., of the largest 46 mm.

*Echinus alexandri* is indigenous to the great depths of the North Atlantic, where it has been found on the west as well as the east side. It ranges south to the Azores ("Princesse Alice", stat. 743, 37° 35' 45" N. 26° 26' 15" W., 1494 m.) There is no proof yet of its occurrence on the banks that separate the Atlantic from the Norwegian Sea, but it must no doubt occur there, as it has been taken by the "Voeringen" on their slope toward the Norwegian Sea (stat. 76, 69° 18' N. 14° 33' E., 980 m., ÷ 0.2°). The bathymetrical distribution is 790—3120 m.

***Echinocyamus pusillus*** O. F. Müller.

*Spatangus pusillus* O. F. Müller, Zol. Dan. Prodr., 1776, p. 236.

<sup>20/5</sup>, stat. 38, 26° 3' N. 14° 36' W., 77 m., red sand and shingle. Several specimens.

*Echinocyamus pusillus* is an east Atlantic species ranging north to the Porsangerfjord and south to the Mediterranean, Cape Bojador and the Azores. Its bathymetrical distribution is 0—800 m. (Mortensen). According to Koehler it has, however, been taken at a depth of 1250 m.

***Hemiaster expergitus*** Lovén.

Tab. 5, figs. 11 & 12.

*Hemiaster expergitus* Lovén, Kgl. Sv. Vet. Akad. Handl., vol. 11, no. 7, 1874, p. 13, tab. 5, figs. 46 & 46, tab. 11, figs. 93 & 94, tab. 13, figs. 114—120, tab. 26.

<sup>18/7</sup>, stat. 88, 45° 26' N. 25° 45' W., 3120 m., sand and yellow mud, temp. 2.5° Cel. One specimen which measured:

<sup>1)</sup> Mortensen: Echinoidea, part 1, 1903, p. 149.

Length .....	53.5 mm.
Breadth .....	52.5 "
Height .....	30.5 "
Breadth of mouth .....	6 "
Breadth of anal area .....	5 "
Breadth in per cent of length ..	98.15 "
Height in per cent of length ...	57.01 "

The type specimen was 14 mm. long and the specimens described by Mortensen measured as much as 37 mm.,<sup>1)</sup> which has represented up to the present time the maximum size of this species. But as the foregoing measurements show *Hemiaster expergitus* may attain considerably larger size. The form of the spines and of the pedicellariæ agrees perfectly with the description given by Mortensen. I have therefore in spite of its large size referred the specimen to *Hemiaster expergitus*.

*Hemiaster expergitus* is a North Atlantic species, ranging from the Caribbean Sea to the Davis Straits on the west side and from Iceland to the Cape Verde Is. on the east side. The "Michael Sars" found it in 1902 on the banks north-east of the Faroe Is., "Tampen" (stat. 51, 61° 40' N., 3° 11' E., 400 m., 6.34°) but with this exception it is only known from the great depths of the North Atlantic. The bathymetrical distribution is 400—3120 m., but its main distribution seems to be at depths greater than 1000 m.

***Spatangus raschi*** Lovén,

*Spatangus raschi* Lovén, Øivs. Kgl. Vet. Akad. Førhndl. vol. 26, 1869, p. 733, tab. 13.

<sup>19/4</sup>. Stat. 4, 49° 38' N., 11° 35' W., 923 m., sand and mud, temp. 9.2° Cel. Common. 7 specimens were preserved.

<sup>27/7</sup>. Stat. 96, 50° 57' N., 10° 46' W., 184 m., temp. 11° Cel. 8 specimens, of which one was preserved.

As may be seen from the following table, the form of the test is subject to considerable variations, particularly in regards its height. While thus in the specimens from stat. 4 the breadth of the test varies between 89.8 and 94.05 per cent of the length, the height varies between 47.92 and 62.5 per cent of the length.

Length .....	81	84	86.5 (stat. 96)	87	93	96	98	100
Breadth .....	74	79	78.5	78.5	86	87.5	88	94
Height .....	45	52	45	49	57	46	55	58
Breadth of mouth .....	11	11	11.5	15	16	11	11	14
Breadth of anal area	8	8.5	8.5	8	8	9.5	9	10
Breadth in % of length	91.36	94.05	90.75	90.23	92.58	91.15	89.8	94
Height in % of length	55.56	62.5	52.02	56.32	61.29	47.92	56.12	58

All measurements are in millimetres.

*Spatangus raschi* is an east Atlantic species, ranging south to the Azores and north to the banks off Tromsøe ("Voeringen", stat. 173 B, 69° 18' N., 14° 32' E., 549 m.) It is a decided warm water species, which was only once

<sup>1)</sup> Mortensen: Echinoidea, part 2, 1907, p. 97.

taken by the "Voeringen" in the cold area (stat. 96, 66° 8' N., 3° E., 1472 m.,  $\div$  1.1°). The bathymetrical distribution is 179—1472 m., but its main distribution seems to be between 400 and 1000. m.

***Brissopsis lyrifera* Forbes.**

*Brissus lyrifer*, Forbes, British Starfishes, 1841, p. 187.

<sup>10</sup>/<sub>4</sub>. Stat. 3, 49° 32' N., 10° 49' W., 184 m., fine sand, temp. 10.3° Cel. Very common.

<sup>5</sup>/<sub>5</sub>. Stat. 21, 35° 31' N., 6° 35' W., 535 m., yellow sand, temp. 11.52° Cel. Two smaller specimens.

*Brissopsis lyrifera* is an east Atlantic species ranging north to the banks off Meløy ("Voeringen" stat. 147, 66° 47' N., 12° 8' E., 260 m.) and south to the Mediterranean and the Azores. Its bathymetrical distribution is 10—535 m. According to Farran<sup>1)</sup> it has, however, been taken at depth of 878—1299 m. off the west coast of Ireland.

## CRINOIDEA.

***Bathycrinus recuperatus* Ed. Perrier (?).**

*Bathycrinus recuperatus* Ed. Perrier, Rev. Scient. vol. 35, 1885, p. 691.

<sup>7</sup>/<sub>5</sub> stat. 25 A, 35° 36' N. 8° 23' W., 2300 m., yellow mud. One specimen, in which, however, the crown, the basals, the uppermost portion of the stem and the lowermost part of the roots were wanting. The remaining portion of it was 105 mm. long and consisted of 39 joints. The lowermost joint was 1.64 mm. in length and its breadth was 1.64 mm. at the lower and 0.92 mm. at the upper border. The uppermost joint was 2.3 mm. in length and 0.92 mm. in breadth. The joints, with the exception of the lowermost one, are cylindrical and remind one in their form and structure of those in *Bathycrinus carpenteri*. Among the *Bathycrinidae* of the Atlantic *B. recuperatus* seems to be most nearly related to *B. carpenteri* (cir. Koehler & Vaney: Note preliminaire sur les Crinoïdes du "Talisman" et du "Travailleur")<sup>2)</sup>. I have therefore, though doubtfully, referred the specimen under consideration to Perrier's species.

A mutilated specimen of *Bathycrinus recuperatus* was found in 1883 by the "Talisman" between Spain and the Azores (44° 20' N. 19° 31' W., 4255 m.).

***Hathrometra dentata* Say.**

*Alectro dentata* Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 5, 1825, p. 153.

<sup>30</sup>/<sub>6</sub> stat. 70, 42° 59' N. 51° 15' W., 1100 m., temp. 3.7° Cel. Four mutilated specimens, one of them clinging to *Acanella arbuscula* Johns. s. *normani* Verr.

This species is found off the east coast of North America, where it is common according to Verrill<sup>3)</sup> at

<sup>1)</sup> Fisheries, Ireland, Sci. Invest. 1912 no. 6, p. 63.

<sup>2)</sup> Bull. Mus. Nat. d'Hist. Natur., vol. 16, no. 6, 1910, p. 29.

<sup>3)</sup> Ann. Rap. Commis. of Fish and Fisheries 1883 (1885), p. 550.

depths of 126—1171 m. It seems further to occur off the west coast of Europe, as the "Porcupine" specimen of *Antedontenella* depicted by Carpenter in the report on the "Challenger" crinoids<sup>1)</sup> accords perfectly with the specimens from Newfoundland under consideration. The range of *Hathrometra dentata* can not, however, be definitely determined at the present time, as the species has been confused with *H. tenella* Retzius and *H. sarsii* Düben & Koren.

***Hathrometra proluxa* Sladen.**

*Antedon proluxa* Sladen, Duncan & Sladen: Memoir on the Echinodermata of the Arctic Sea to the West of Greenland, 1881, p. 77, tab. 6, figs 7—10.

<sup>9</sup>/<sub>8</sub>—<sup>10</sup>/<sub>8</sub> stat. 102, 60° 57' N. 4° 38' W., 1098 m., dark sand and clay, temp.  $\div$  0.9° Cel. Common.

*Hathrometra proluxa* is an Arctic species, ranging in the Norwegian Sea between the Faroe—Shetland Channel (60° 22') and Spitzbergen (80°) and between the east coast of Greenland (about 20° W.) and the Kara Sea (64 52' E.). It is further found off the west coast of Greenland between 63° 24' and 81° 4' N. The bathymetrical distribution is 46—1960 m. Bottom temperature 1.1— $\div$  2.1°. Most of the localities belong to the cold area, and the few warm-water stations included in its range are all situated within the border-region adjacent to the cold area, where the hydrographical conditions may change. The species must therefore be considered a cold-water form.

***Leptometra phalangium* J. Müller.**

*Alecto phalangium* J. Müller, Wiegmanns Archiv für Naturgesch., Jahrg. 7, Bd. 1, 1841, p. 142.

<sup>21</sup>/<sub>5</sub> stat. 39 B, 26° 3' N. 15° W., 267—280 m., fine grey sand. Four smaller specimens.

*Leptometra phalangium* is an east Atlantic species, ranging from the Hebrides to Madeira and the Azores. It is further found in the western part of the Mediterranean. Aust. H. Clark gives in "New Genera of Unstalked Crinoids"<sup>2)</sup> its bathymetrical range as 82 to 346 m. According to other reports it is 46—458 m. Bell<sup>3)</sup> states that *Leptometra phalangium* descends to a depth of 1281 m. I have, however, not been able to find any authority for this statement.

<sup>1)</sup> Rep. Sci. Res. Voy. Challenger, Zool., vol. 26, 1888, p. 169, tab. 31, figs 1 & 3.

<sup>2)</sup> Proc. Biol. Soc. Washington, vol. 21, 1908, p. 120.

<sup>3)</sup> Bell; Cat. British Echinoderms, 1892, p. 60.

P. S.

During the printing of the present paper a sample of bottom-material from st. 70 was handed to me for examination. It contained three species of echinoderms which have not been mentioned in the foregoing description of the echinoderm-material from the expedition. The number of echinoderm-genera and species from the "Michael Sars" Expedition 1910 is thereby raised to 68 and 95 respectively.

***Astrogonium parelii*** Düben & Koren.

*Astropecten parelii* Düben & Koren, Kgl. Vetensk. Handl., 1844  
(1846) p. 247, tab. 7, figs. 14—16.

One young specimen, diameter 18 mm., radius of arm 10 mm., radius of disc 4 mm.

***Calycaster monaecus*** Ed Perrier.

*Calycaster monaecus* Ed. Perrier, Mem. Soc. Zool. de France, vol. 4, 1891, p. 262.

One young specimen, diameter 8 mm., radius of arm 4 mm., radius of disc 2 mm. It agrees with the smallest of the four specimens described by Perrier<sup>1)</sup>.

*Calycaster monaecus* is taken only once previously, by the Prince of Monaco, at the Azores, in 1557 mm.

***Brissopsis atlantica*** Mortensen.

*Brissopsis atlantica*, Mortensen, Echinoidea, part 2, Danish In-golf Exp., vol. 4, part. 2, 1907, pag. 160, tab. 3, figs. 6, 10, 17, tab. 18, figs. 5, 9, 10, 13, 19, 20, 24, tab. 19, figs. 1, 4, 5, 11, 13, 14, 16, 22, 23, 25, 28, 30—33.

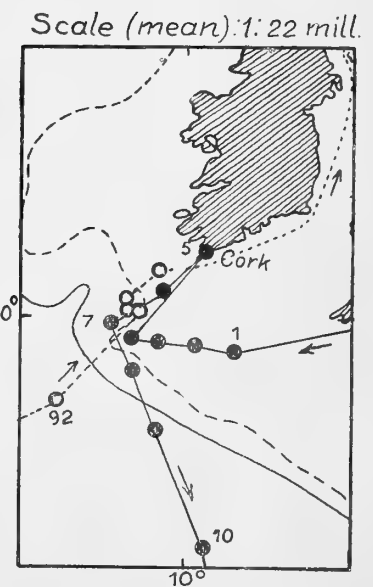
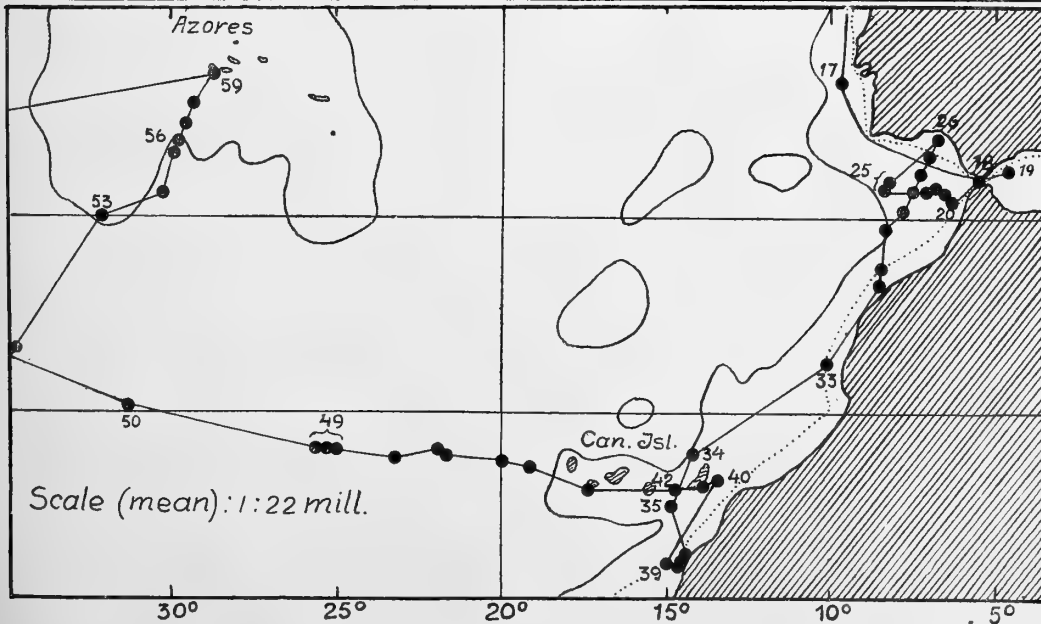
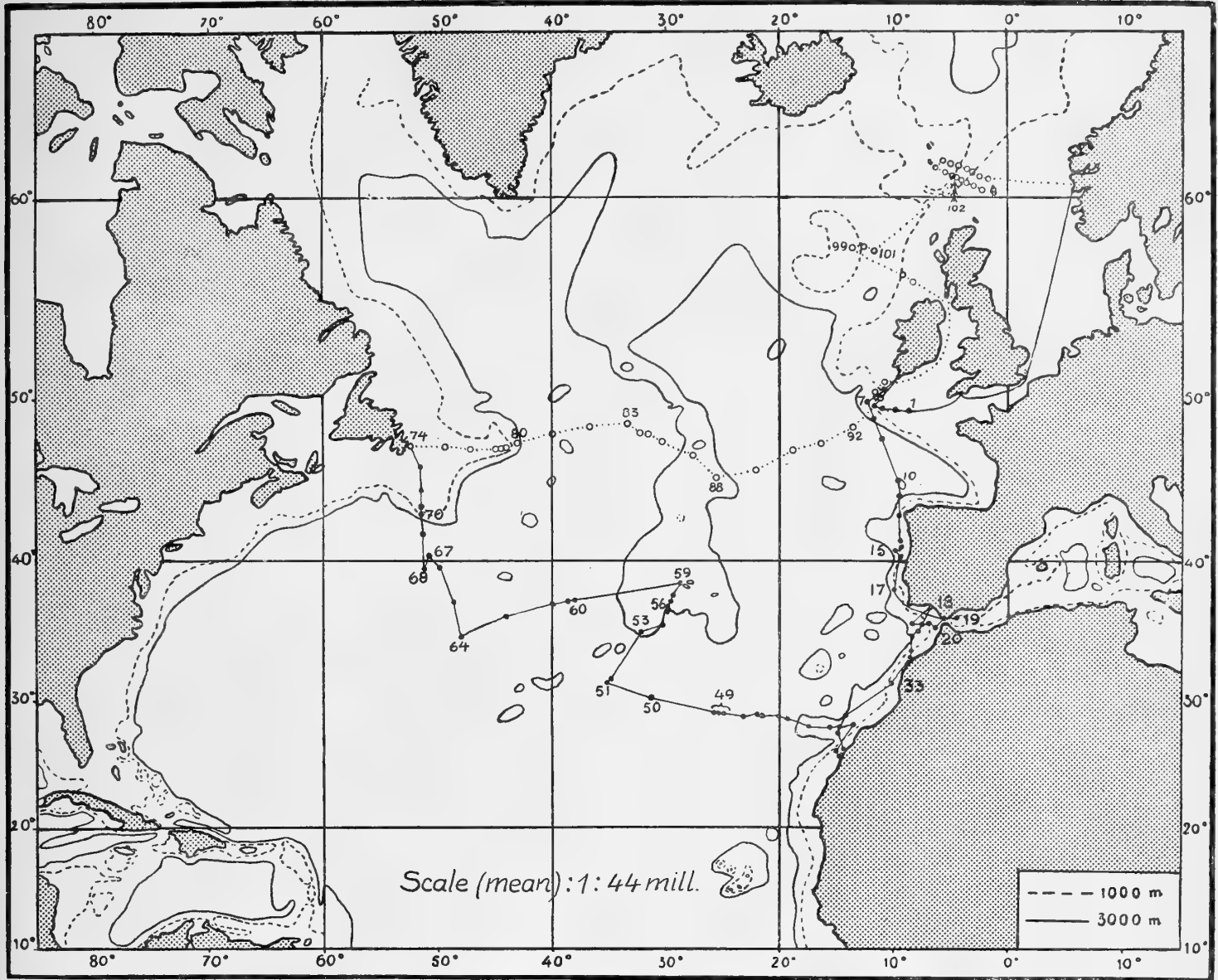
One specimen.

<sup>1)</sup> Ed. Perrier, *Stellerides*, Res. Camp. Sci. Monaco, Fasc. 11, 1896, p. 28. tab. 3, fig. 3 a.

Bergen, October 20. 1920.



Cruises of the "Michael Sars" 1910.



Outward voyage —●—●— Homeward voyage .....○.....

Portions of the voyage in larger scale in the two smaller charts. Figures denote station-numbers.

## List of stations at which Echinoderms were collected.

- Stat. 1. April 9. 49° 37' N. 8° 36' W., 146 m., fine sand temp. 9.57° Cel., trawl.  
*Astropecten irregularis*.  
*Ophiura affinis* (taken with Petersen bottom collector).  
*Echinus esculentus*, *E. acutus*.
- Stat. 3. April 10. 49° 32' N. 10° 49' W., 184 m., fine sand, temp. 10.3° Cel., trawl.  
*Stichopus tremulus*.  
*Astropecten irregularis*, *Luidia ciliaris*, *Stichaster roseus*.  
*Dorocidaris papillata*, *Echinus acutus*, *Brissopsis lyrifera*
- Stat. 4. April 10. 49° 38' N. 11° 35' W., 923 m., sand and mud, temp. 9.2 Cel., trawl.  
*Laetmogone violacea*, *L. wyville-thomsoni*, *Stichopus tremulus*.  
*Plutonaster bifrons*.  
*Dorocidaris papillata*, *Araeosoma hystrix*, *Phormosoma placenta*, *Echinus acutus*, *Spatangus raschi*.
- Stat. 10. April 19. 45° 26' N. 9° 20' W., 4700 m., yellow mud, temp. 2.56° Cel., trawl.  
*Oneirophanta mutabilis*, *Benthodytes janthina*.  
*Paragonaster subtilis*, *Freyella sexradiata*.  
*Ophiura convexa*, *Ophiocten latens*, *Ophiomusium planum*.
- Stat. 21. May 5. 35° 31' N. 6° 35' W., 535 mm., yellow sand, temp. 11.52 Cel., trawl.  
*Labidoplax digitata*.  
*Dorigona arenata*, *Brisingella coronata*.  
*Amphiura chiajei*, *A. duplicata*.  
*Phormosoma placenta*, *Echinus acutus*, *Brissopsis lyrifera*.
- Stat. 23. Mai 5. 35° 32' N. 7° 7' W., 1215 m., yellow mud., temp. 10.17° Cel., trawl.  
*Laetmogone violacea*.  
*Phormosoma placenta*, *Echinus acutus*
- Stat. 24. May 6. 35° 34' N. 7° 35' W., 1615 m., yellow mud., temp. 8° Cel., trawl.  
*Bathyploetes tizardi*, *Laetmogone violacea*, *L. wyville-thomsoni*, *Benthogone rosea*.  
*Plutonaster bifrons*, *Pentagonaster dentatus*, *Zoroaster fulgens*.  
*Ophiomusium lymani*, *Ophiactis abyssicola*, *Ophiacantha abyssicola*.  
*Porocidaris purpurata*, *Phormosoma placenta*.
- Stat. 25 A. May 7. 35° 36' N. 8. 25' W., 2300 m., yellow mud., trawl.  
*Mesothuria verrilli*, *Benthogone rosea*, *Euphronides auriculata*.  
*Plutonaster bifrons*, *Hymenaster rex*.  
*Ophiomusium lymani*, *Ophiacantha abyssicola*.  
*Sperosoma grimaldii*, *Hygrosoma petersii*.  
*Bathycrinus recuperatus* (?).
- Stat. 25 B. May 8. 35° 46' N. 8° 16' W., 2055 m., yellow mud., trawl.  
*Plutonaster bifrons*, *Pentagonaster dentatus*.  
*Pectinura elata*, *Ophiomusium lymani*, *Ophiacantha abyssicola*.
- Stat. 35. May 18. 27° 27' N. 14° 52' W., 2603 m., yellow mud.  
*Mesothuria verrilli*, *Benthodytes glutinosa*.  
*Ophiomusium lymani*.
- Stat. 37. May 20. 26° 6' N. 14° 33' W., 30 m., shingle, temp. 15.6° Cel., trawl.  
*Holothuria tubulosa*.  
*Luidia ciliaris*, *Echinaster sepositus*.
- Stat. 38. May 20. 26° 3' N. 14° 36' W., 77 m., red sand and shingle.  
*Ophiura affinis*.  
*Echinocyamus pusillus*.
- Stat. 39 B. May 21. 26° 3' N. 15° W., 267—280 m., fine grey sand.  
*Cidaris affinis*.  
*Leptometra phalangium*.
- Stat. 41. May 23. 28° 8' N. 13° 35' W., 1365 m., yellow mud, temp. 6° Cel., trawl.  
*Mesothuria verrilli*, *Laetmogone wyville-thomsoni*, *Benthogone rosea*.  
*Plutonaster bifrons*, *Pentagonaster dentatus*, *Zoroaster fulgens*, *Cribrella abyssalis*.  
*Ophiacantha aristata*.  
*Porocidaris purpurata*, *Araeosoma hystrix*, *Sperosoma grimaldii*, *Hygrosoma petersii*.
- Stat. 48. Mai 31. 28° 54' N. 24° 14' W., 2800—3000 m., trawl  
*Deima atlanticum*, *Peniagone ferruginea n. sp.*
- Stat. 53. June 8. 34° 59' N. 33° 1' W.  
1. m. net, 100 m. wire.  
*Luidia sarsii*.  
2615—2865 m., yellow hard clay mud, temp., 3° Cel. trawl.  
*Pseudostichopus villosus*, *Peniagone wyvilli*, *Benthodytes typica*.  
*Pteraster reductus*.  
*Pectinura elata*, *Ophiura tessellata*, *Ophiomusium lymani*,  
*O. planum*.

- Stat. 56. June 10. 36° 53' N. 29° 47' W.,  
1 m. net, 100 m. wire,  
*Luidia sarsii*.
- Stat. 64. June 24. 34° 44' N. 47° 52' W.,  
1 m. net, 200 m. wire and young fish trawl, 300 m. wire.  
*Luidia sarsii*.
- Stat. 67. June 26. 40° 17' N. 50° 39' W.  
1 m. net, 50 m. wire.,  
*Luidia sp.*
- Stat. 70. June 30. 42° 59' N. 51° 15' W., 1100 m., temp. 3.7° Cel.,  
young fish trawl. 1700 m. wire.  
*Benthodytes gigantea*.  
*Benthopecten spinosus*, *Plutonaster agassizi*, *Psilaster andromeda*,  
*Mediaster stellatus*, *Astrogonium fallax*, *A. parelii*,  
*Calycaster monaecus*, *Zoroaster fulgens*.  
*Ophiocten sericeum*, *Ophiomysium lymani*, *Ophiolebes claviger*,  
*Ophiacantha abyssicola*, *Astrochele lymani*,  
*Phormosoma placenta*. *Brisopsis atlantica*.  
*Hathrometra dentata*.
- Stat. 75. July 9. 47° 22' N. 49° 16' W., 120 m.  
*Zoroaster fulgens*.
- Stat. 88. July 18. 45° 26' N. 25° 45' W., 3120 m., sand and yellow  
mud, temp. 2.5° Cel., trawl.  
*Mesothuria maroccana*, *Peniagone azorica*, *Cucumaria abyssorum*.  
*Dytaster agassizi*, *Solaster abyssicola*.  
*Ophiura concreta*, *O. irrorata*, *O. tessellata*, *Ophiacantha crassidens*.  
*Salenia profundus*, *Echinus alexandri*, *Hemiaster expeditus*.
- Stat. 92. July 23. 48° 29' N. 13° 55' W., young fish trawl, 200 m. wire.  
*Benthodytes glutinosa*.
- Stat. 94. July 26. 50° 13' N. 11° 23' W., 1 m. net surface and 1 m.  
net, 200 m. wire.  
*Luidia ciliaris*.
- Stat. 95. July 26—27. 50° 22' N. 11° 44' W., 1797 m., temp. 3.5°  
Cel., trawl.  
*Benthogone rosea*.  
*Benthopecten spinosus*, *Plutonaster bifrons*, *Bathybiaster robustus*,  
*Pentagonaster dentatus*.  
*Ophiomysium lymani*, *Astronyx locardi*,  
*Phormosoma placenta*, *Echinus alexandri*.
- Stat. 96. July 27. 50° 57' N. 10° 46' W., 184 m., temp. 11° Cel., young  
fish trawl, 300 m. wire.  
*Ophiura affinis*.  
*Echinus acutus*, *Spatangus raschi*.
- Stat. 98. August 5. 56° 33' N. 9° 30' W. 1 m. net, 200 m. wire.  
*Luidia sarsii*
- Stat. 101. August 6—7. 57° 41' N. 11° 48' W., 1 m. net, 200 m. wire.  
*Luidia sarsii*, *L. ciliaris*.  
1823 m., hard clay, temp, 3.3° Cel., trawl.  
*Benthopecten spinosus*, *Plutonaster bifrons*, *Bathybiaster robustus*,  
*Psilaster andromeda*, *Psilasteropsis patagiatus*,  
*Zoroaster fulgens*, *Brisingella coronata*.  
*Ophiocyton ternispinus*, *Ophiomysium lymani*, *Ophiactis abyssicola*,  
*Ophiacantha abyssicola*.  
*Phormosoma placenta*, *Echinus acutus*.
- Stat. 102. August 9—10. 60° 57' N. 4° 38' W., 3/4 m. net, 400 m. wire.  
*Luidia sarsii*.  
1098 m., dark sand and clay, temp. ÷ 0.9 Cel., trawl.  
*Pontaster tenuispinus*, *Plutonaster bifrons*, *Bathybiaster vexillifer*,  
*Psilaster andromeda*, *Zoroaster fulgens*, *Solaster papposus v. septentrionalis*,  
*S. squamatus*, *Lophaster furcifer*, *Hymenaster pellucidus*.  
*Ophiopleura borealis*, *Ophioscolex glacialis*.  
*Hathrometra proluxa*.

## Explanation of the Plates.

### Plate I.

- Fig. 1. *Mesothuria maroccana*, R. Perrier from stat. 88, abactinal view.  
" 2, 3. *Deima atlanticum*, Herouard from stat. 48. 2 actinal view, 3 abactinal view.  
" 4-6. *Peniagone ferruginea*, n. sp. from stat. 48. 4 actinal view, 5 from the right side, 6 abactinal view.

### Plate II.

- Fig. 1, 2. *Oneirophanta mutabilis*, Théel from stat. 10. 1 abactinal view, 2 actinal view.

### Plate III.

- Fig. 1, 2. *Benthodytes glutinosa*, R. Perrier from stat. 35. 1 actinal view, 2 abactinal view.  
" 3, 5. *Peniagone wyvilli*, Théel from stat. 10. 3 actinal view, 4 from left side, 5 abactinal view.  
" 6, 7. *Benthodytes typica*, Théel from stat. 53. 6 abactinal view, 7 actinal view.

### Plate IV.

- Fig. 1. *Benthopecten spinosus*, Verrill from stat. 101. abactinal view.  
" 2-4. *Plutonaster agassizi*, Verrill from stat. 70. 2 actinal view, 3 abactinal view, 4 adambulacral and marginal plates from middle portion of arms.  
" 5-8. *Dorigone arenata*, Edv. Perrier from stat. 21. 5 abactinal view, 6 actinal view, 7 adambulacral plates, 8 two pair of marginal plates with pedicellariæ from the interbrachial arc.

### Plate V.

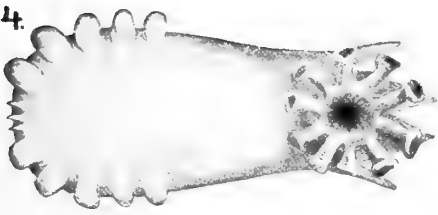
- Fig. 1. *Astrogonium fallax*, Ed. Perrier from stat. 70. Adambulacral- and marginal plates from middle portion of arms.  
" 2-4. *Solaster abyssicola*, Verrill from stat. 88. 2 abactinal view, 3 adambulacral papillæ from middle portion of arms, 4 skeleton from abactinal surface.  
" 5. *Solaster endeca*, Retzius from Bergen. Skeleton from abactinal surface,  
" 6, 7. *Pteraster reductus*, Koehler from stat. 53. 6 abactinal view, 7 actinal view.  
" 8-10. *Ophiomusium lymani*, Wyville Thomsen from stat. 70. Abactinal view. 8 disc-diameter 2 mm, 9 disc-diameter 4 mm., 10 disc-diameter 5 mm.  
" 11-12. *Hemiaster expergitus*, Lovén from stat. 88. 11 abactinal view, 12 actinal view.

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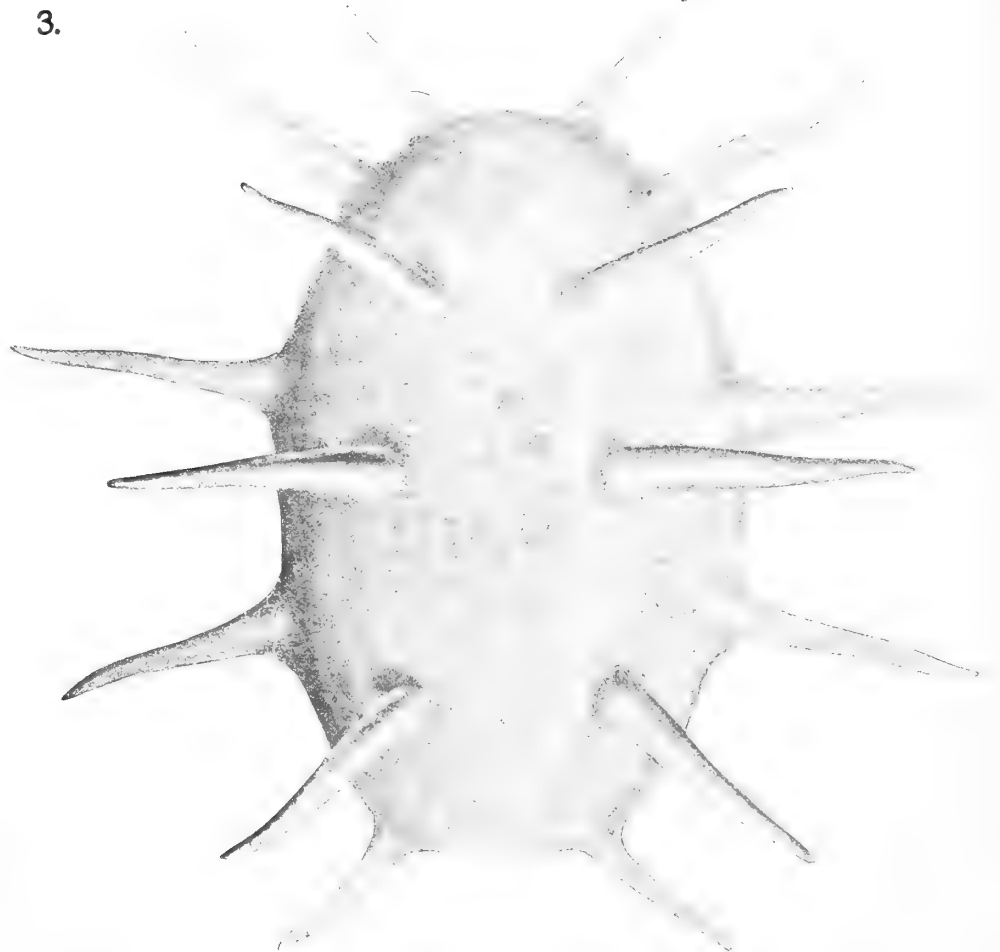
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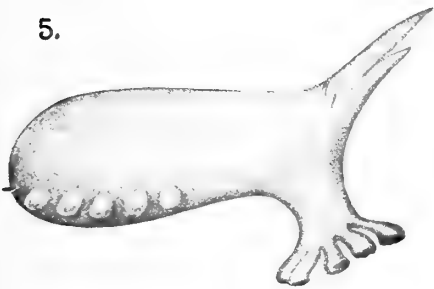
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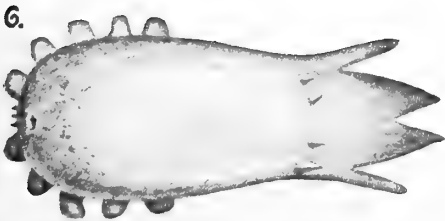
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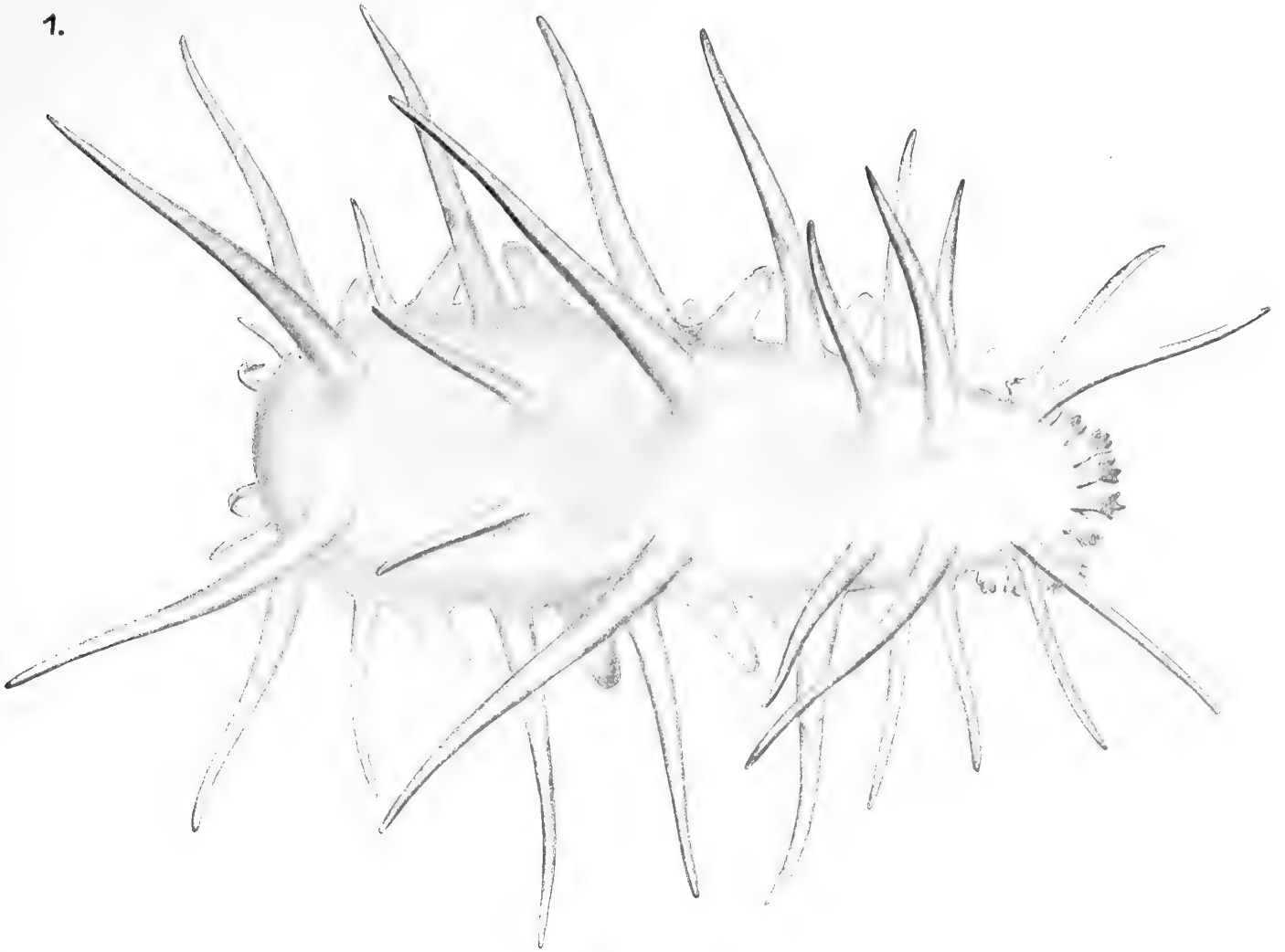
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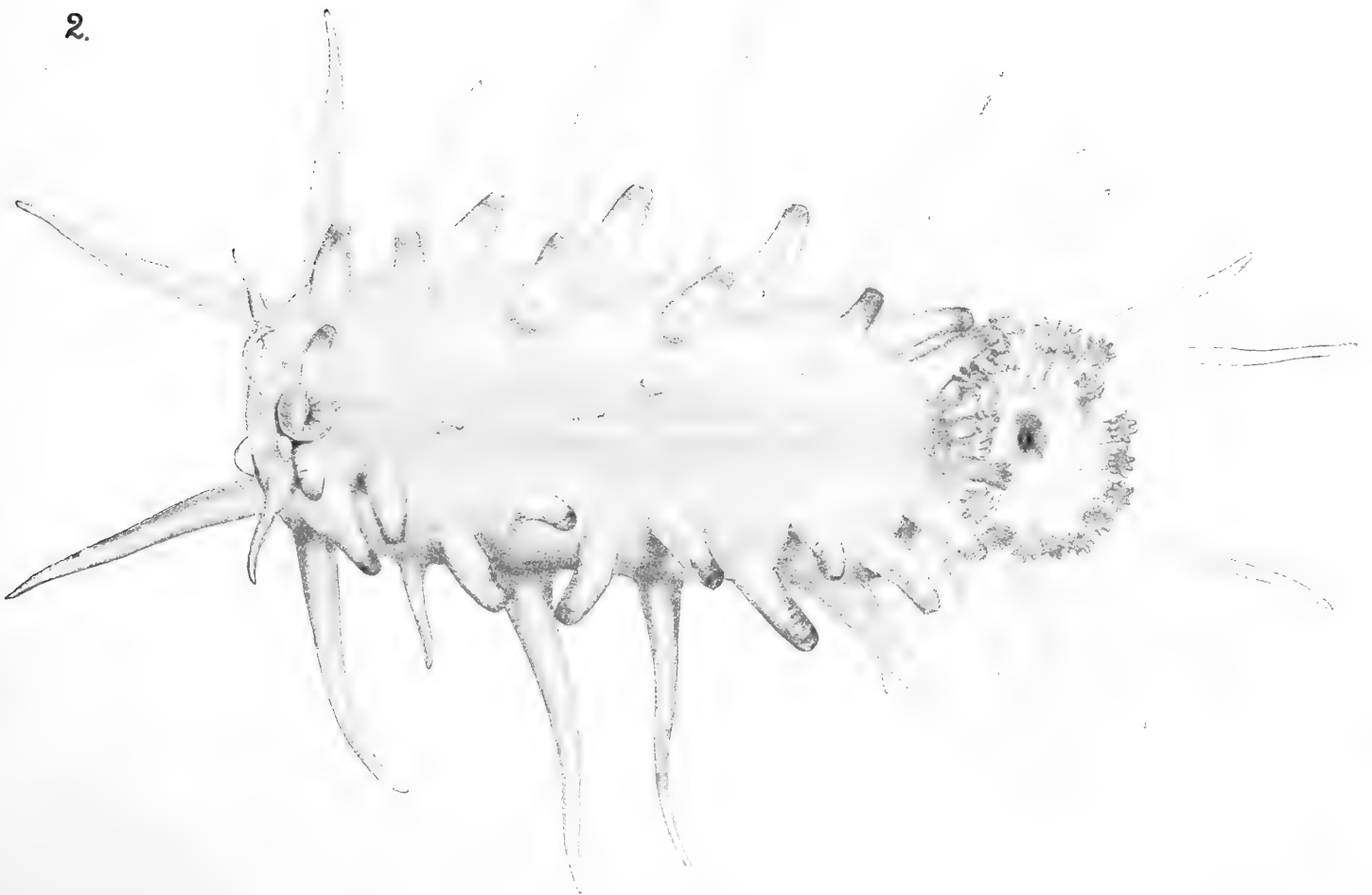




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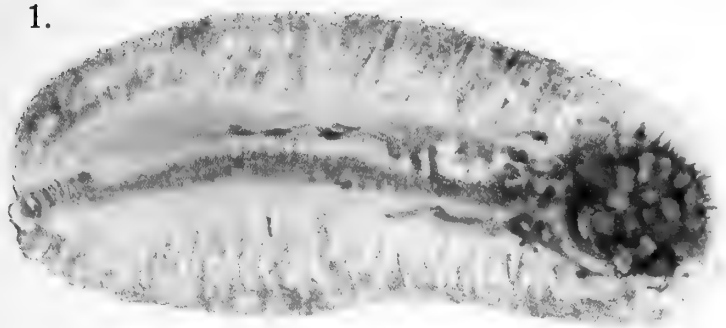


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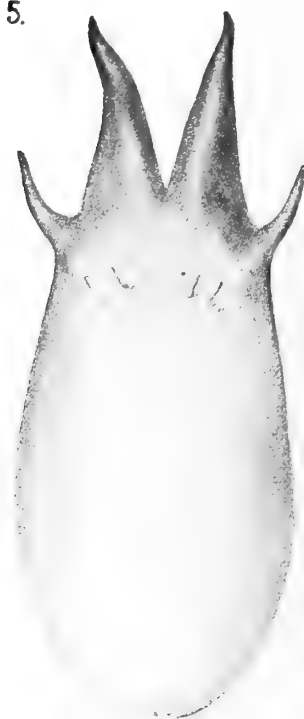
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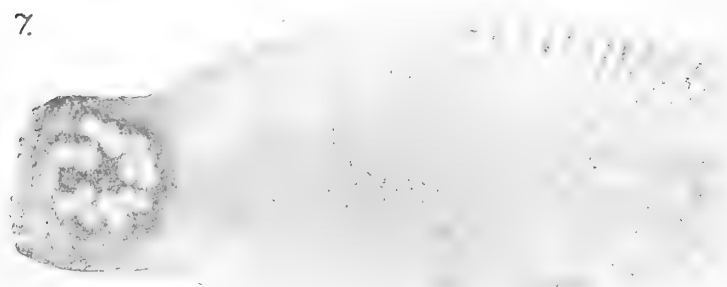
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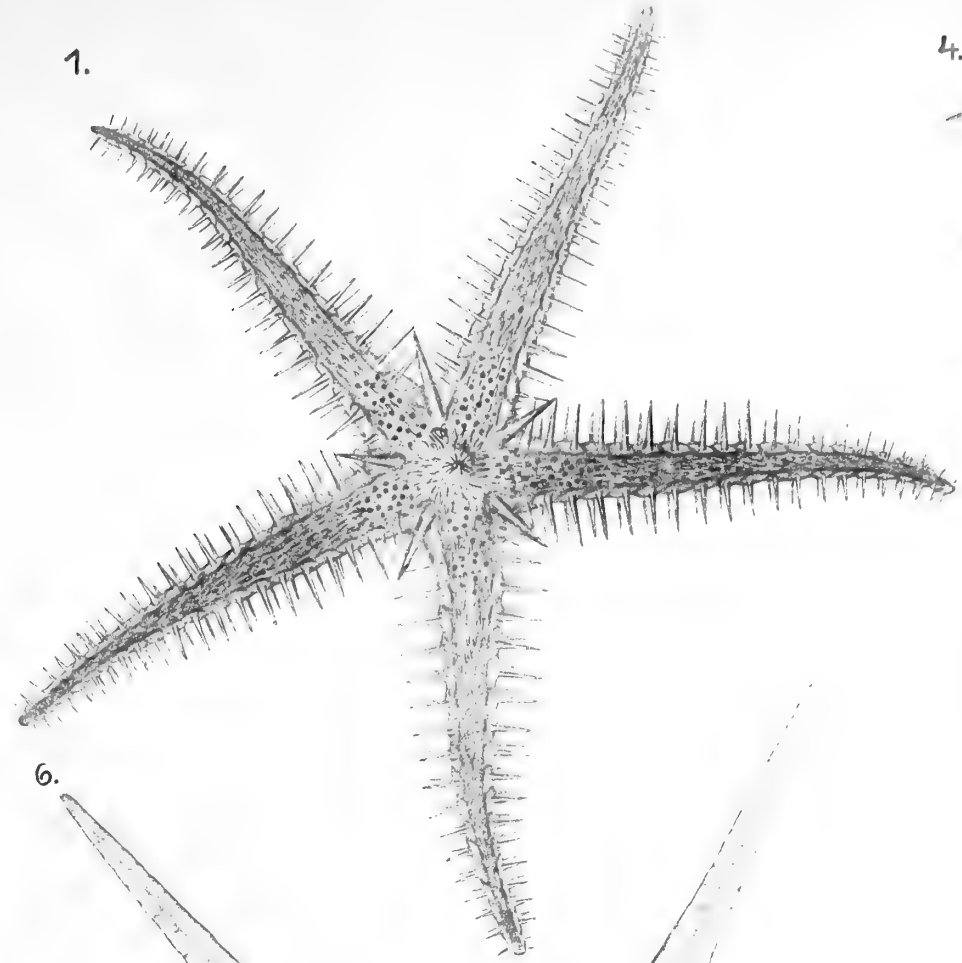
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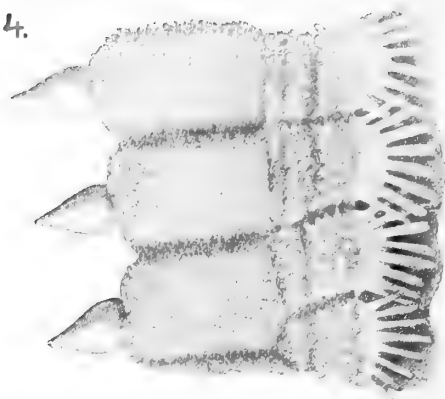




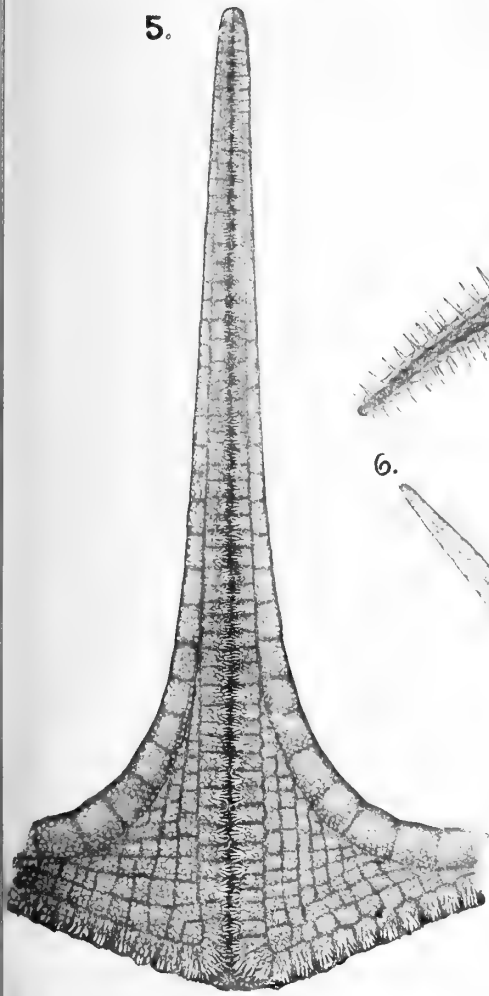
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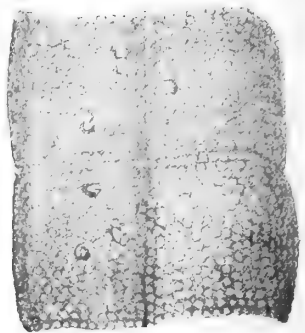
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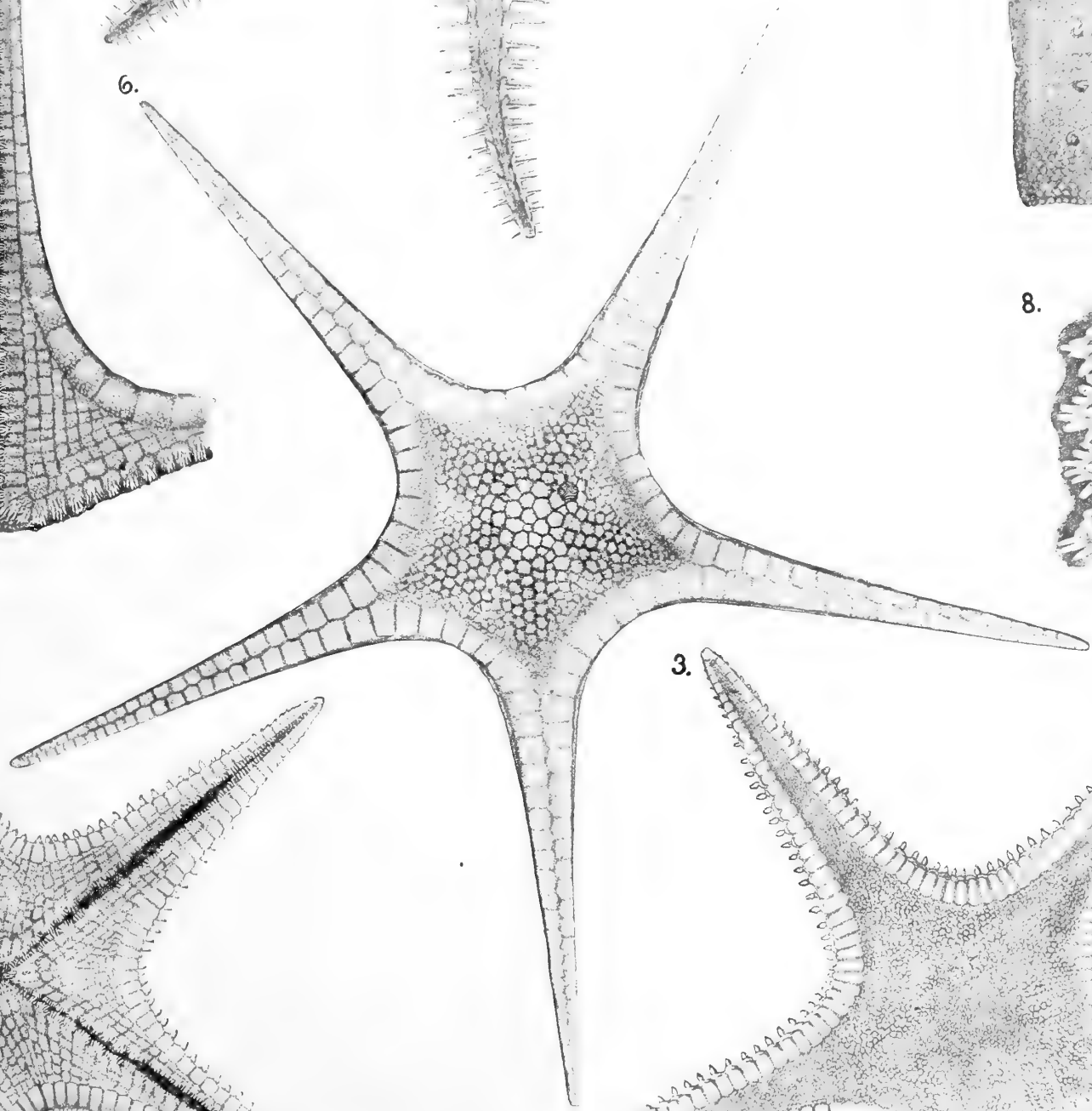
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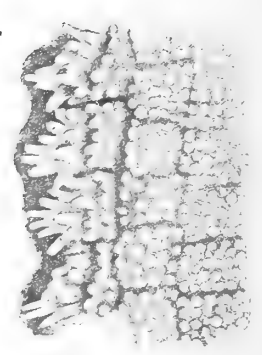
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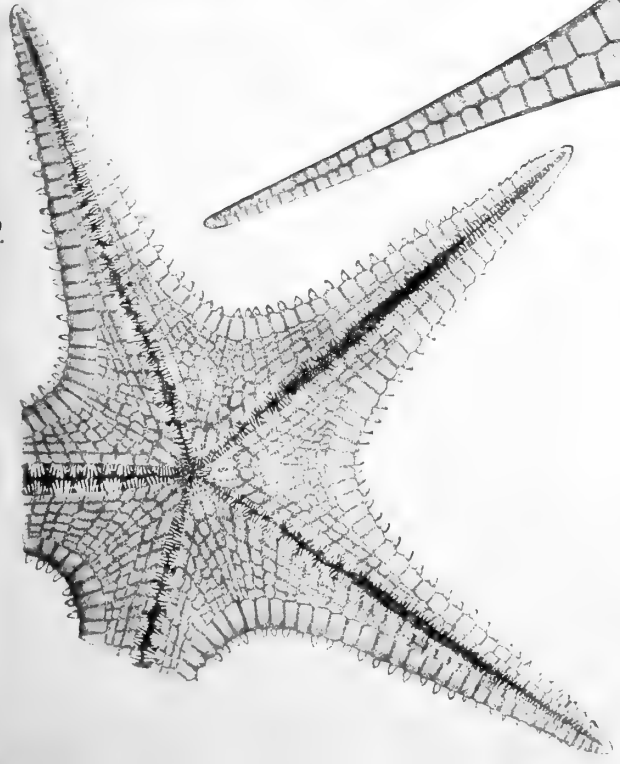
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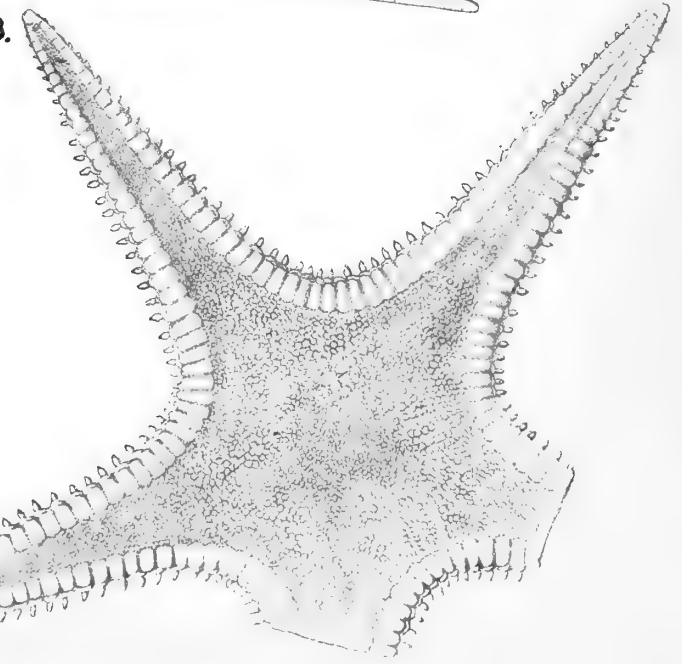
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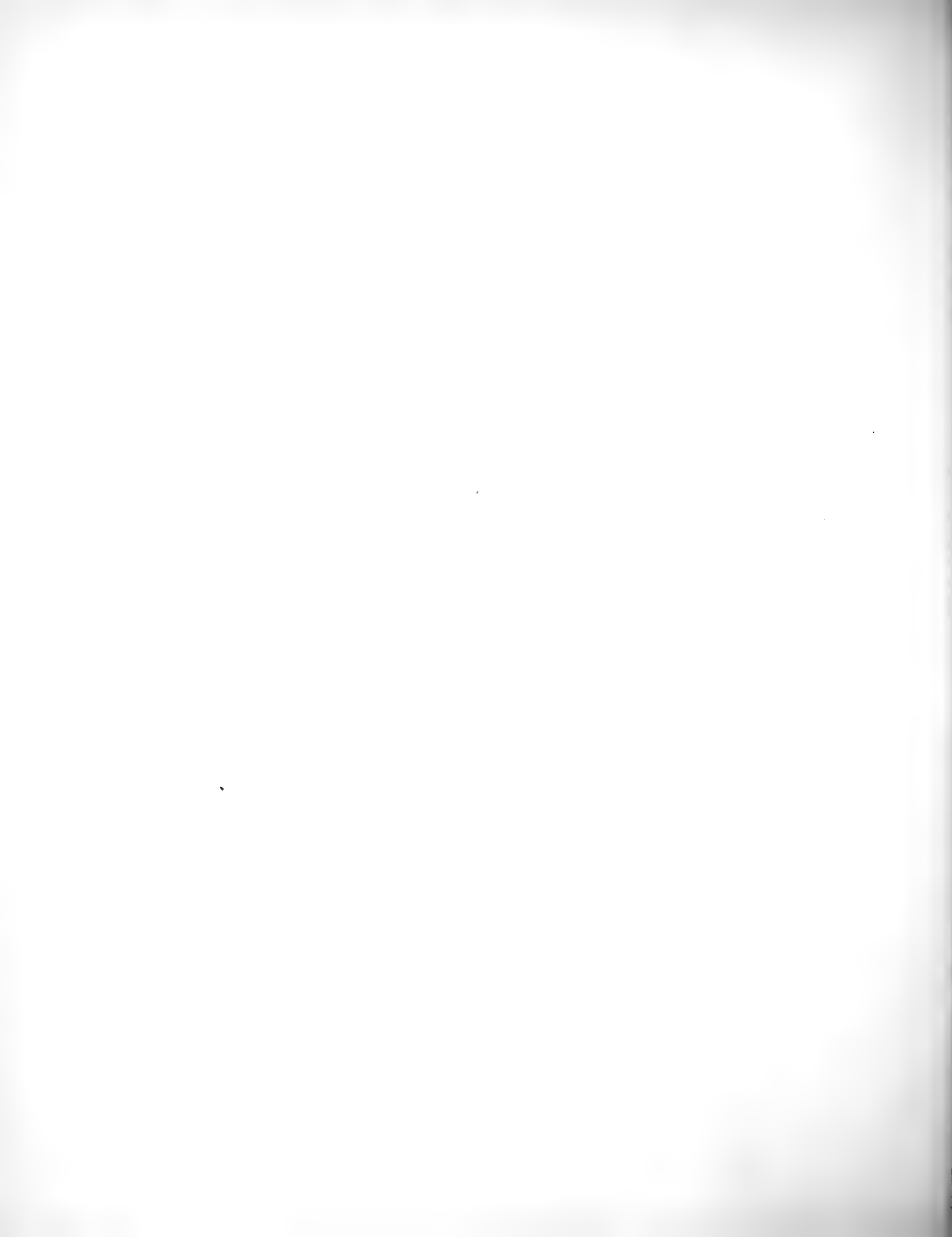
























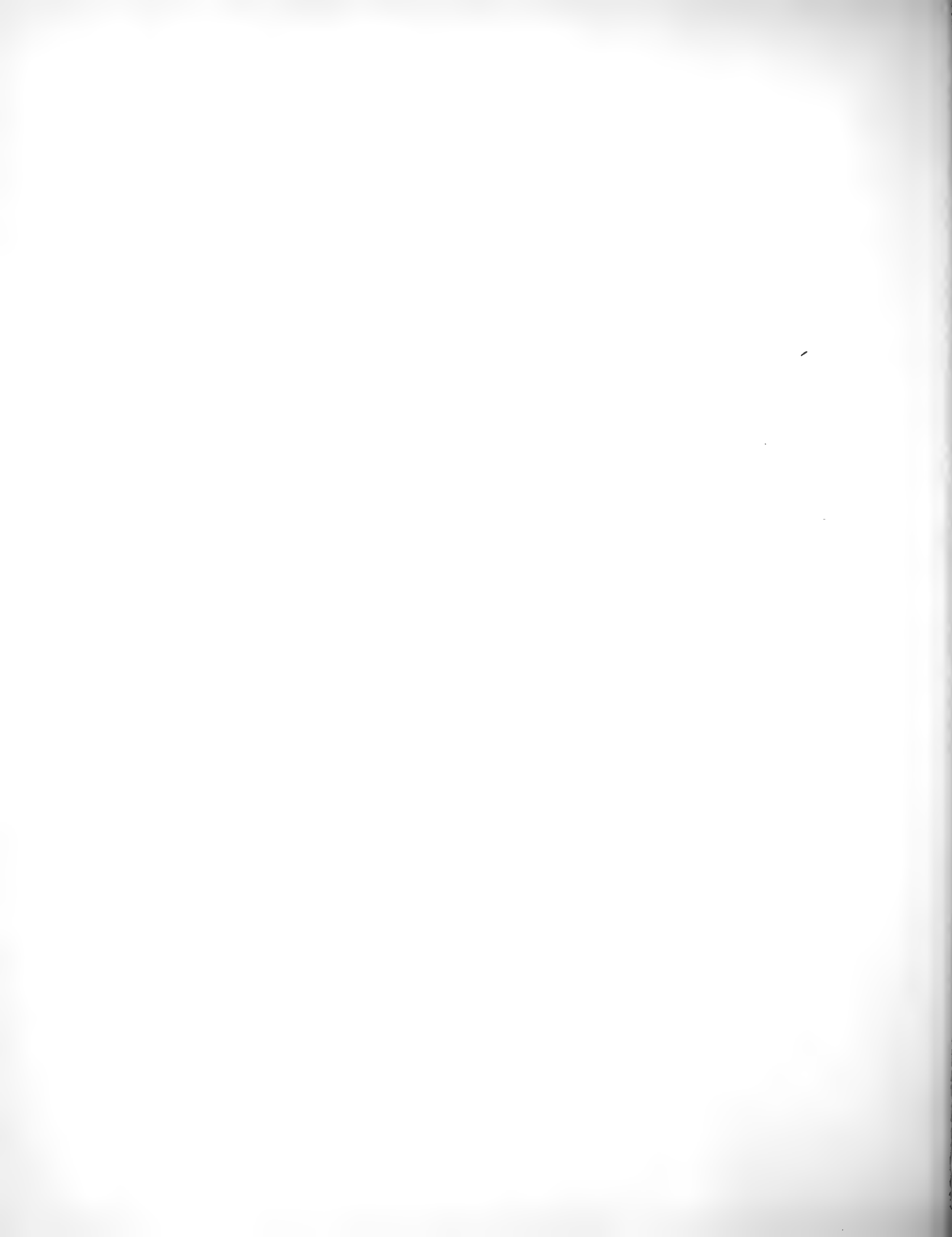








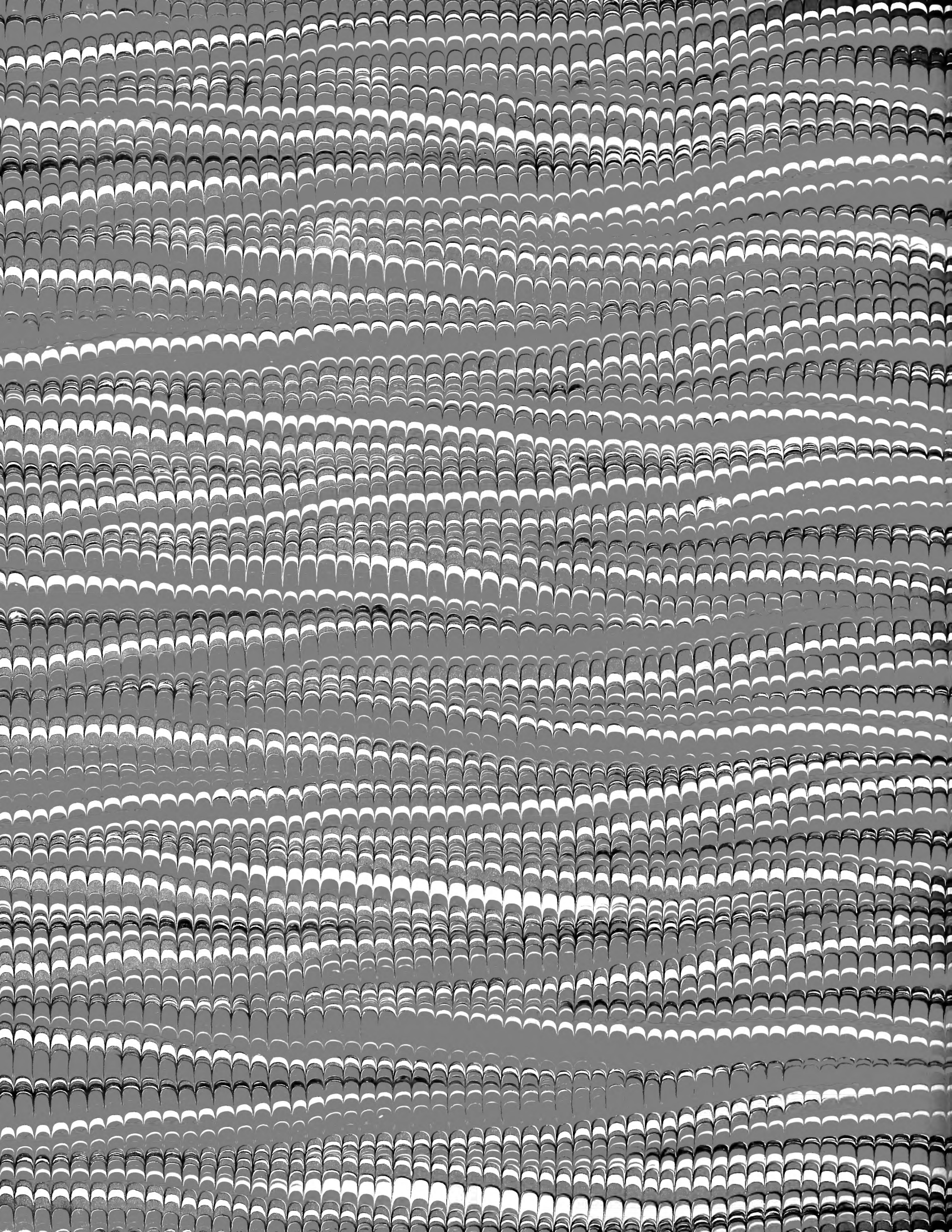




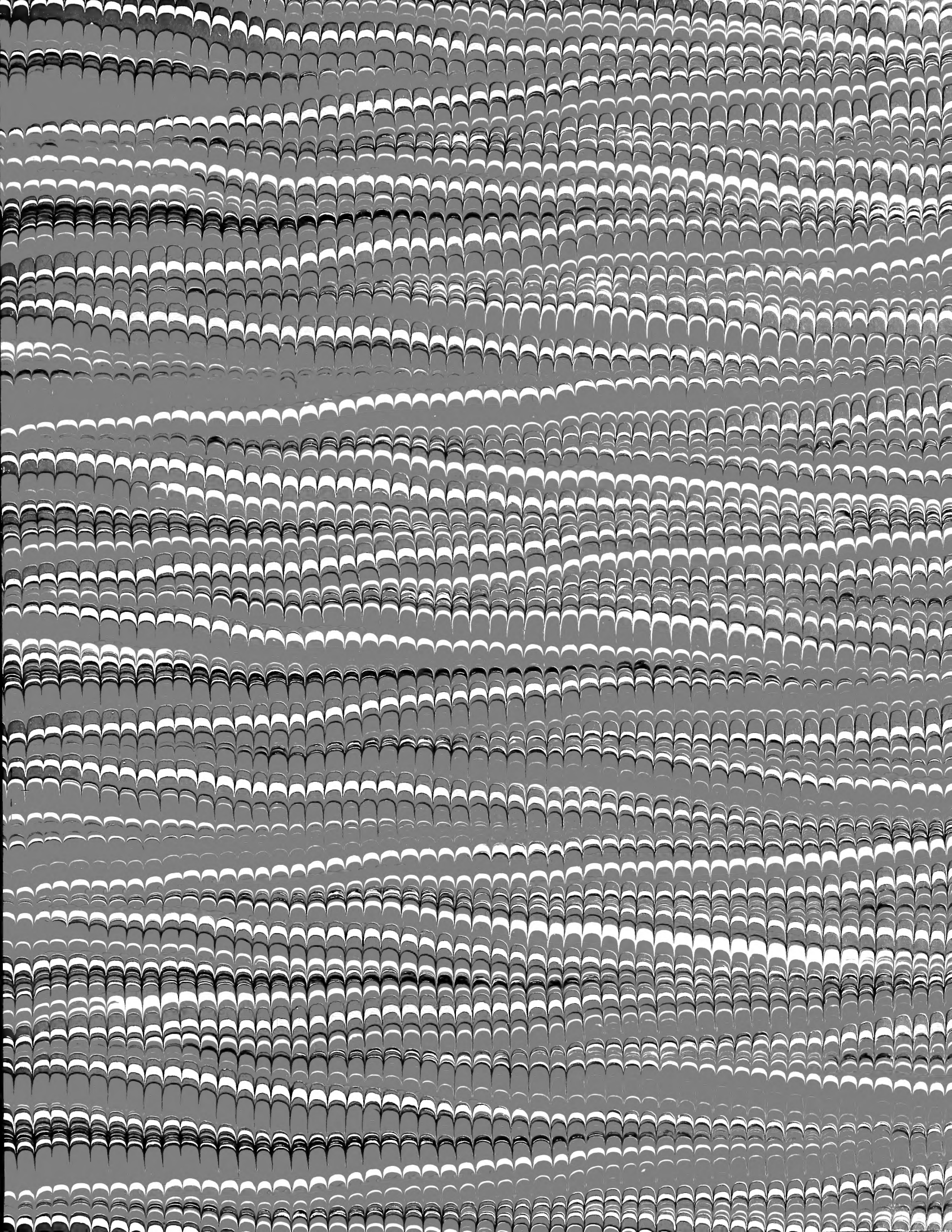














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