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UNDER LEDELSE AF LAUGE KOCH

ON THE REPRODUCTION AND LARVAL
STAGES OF THE BRITTLE-STARS
OPHIOCTEN SERICEUM (FORBES)
AND *OPHIURA ROBUSTA* AYRES
IN EAST GREENLAND

BY

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WITH 11 FIGURES IN THE TEXT AND 3 PLATES

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BIANCO LUNOS BOGTRYKKERI A/S

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During the Danish Three-Year Expedition to East Greenland regular collections of plankton at a depth of 50—0 m — vertical hauls by means of a small plankton net — were made from the southern main station on Ella Island during the period from January to September, 1932. In January and February larvæ of the bottom animals, for instance those of *Lamellibranchiata* and *Polychaeta*, had practically disappeared from the plankton, while the larval stages of *Ophiuroidea* occurred in considerable numbers.

All these *Ophioplutei* proved to belong to the same species, and as they were of frequent occurrence in the plankton, they must be assumed to originate from an extremely common bottom form. This at once restricted the investigation to the only really frequent Ophiurans within the area, viz. *Ophiura robusta* AYRES (especially found among the epifauna) and *Ophiecten sericeum* (FORBES) (characteristic of the clay bottom). Of these forms *Ophiecten sericeum* was by far the most numerous. A counting of the Ophiurans collected in the Solitærbugt — altogether about 10,000 specimens — proved that about 96 per cent. were *Ophiecten sericeum* and only about 4 per cent. *Ophiura robusta*. Further it should be noted that *Ophiecten sericeum* is of such common occurrence on the sea-floor in this region that it is a type animal for two of the zones of the *Macoma-calcaria*-community (the lower-*Ophiecten*-zone with *Pectinaria* and the deeper-*Ophiecten*-zone), where the species is present in 30—40 specimens per sq.m (cf. THORSON 1933 and 1934).

Since moreover *Ophiura robusta* — as an epifaunal animal — is limited to a very narrow belt along the coast, while despite the slight motion of the water in the fjords the above-mentioned *Ophiopluteus* was found in large numbers everywhere in the plankton, even at great depths, it was evident that it must be the larva of *Ophiecten sericeum* that was found here. As this *Ophiopluteus* has not previously been described, it seems desirable to give a more detailed description of its structure in this place.

1. *OPHIOCTEN SERICEUM* (FORBES).

Description of the *Ophiopluteus* of *Ophiecten sericeum*.

I. Typical form. Skeleton. (Pl. 1). The antero-lateral, the postero-dorsal, and the postoral rods form arms of nearly the same length; the postero-lateral arms, however, are $1\frac{2}{3}$ times as long as these. All the rods are furnished with rather strong thorns, which, however, are the largest on the postero-lateral rods. Most characteristic of the skeleton of the larva is the recurrent rod (the compound body rod).

Where such "recurrent rods" have hitherto been recorded in Ophiurid larvæ, there are always two recurrent rods on each side, one dorsal and one ventral rod, (cf. e. g. *Ophiopluteus bimaculatus* and *Ophiopluteus ramosus*, MORTENSEN 1897, pp. 82 and 86), but in the *Ophiecten* larva usually only the dorsal recurrent rod is present, while the ventral rod has disappeared. The transverse rods do not closely join those of the opposite side; they are bi- or tripartite at the end (cfr. Pl. 1 and Fig. 1, A).

Other structural features: In addition to the strongly ciliated band along the margin of the arms, a tuft of cilia is found at the posterior end. In some few of the older larvæ both the posterior enterocoel vesicles, as well as the right anterior enterocoel vesicle and the hydrocoel vesicle were distinctly visible. The stomach was of the green colour so commonly met with in Ophiurid larvæ, and the mouth and the bell-shaped oesophagus showed the same characters as most of the *Ophiopluteus* forms. A peculiar feature is the inconsiderable pigmentation of the larva. Apart from a diminutive reddish-brown pigmental spot at the apex of the postero-lateral arms the animal is quite transparent.

II. Deviations from the type. Of the total of 37 larvæ that have been examined, 86 per cent. (32 larvæ) agreed entirely with the type described above. The remaining 14 per cent. deviated more or less from this type, but all of them indubitably belonged to the same species, since, starting from the type, all of them can be classified in a distinct sequence of transitional stages. As a statistical investigation of the variation of such larvæ has not previously been made, the various deviations from the type will be briefly described below.

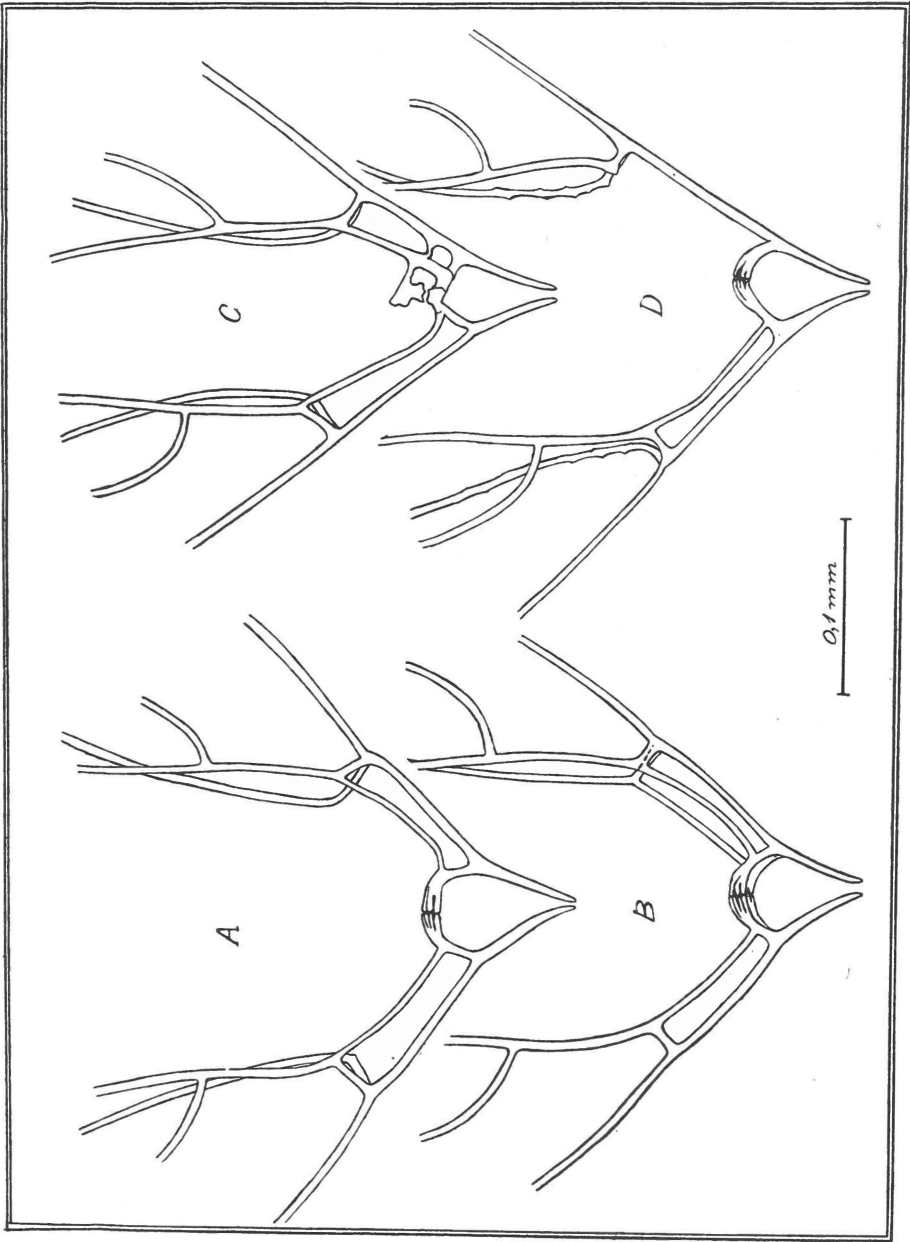


Fig. 1. Skeleton of the larva of *Ophiocten sericeum* (FORBES). A shows the type, B, C, and D variations from it.

A. Skeleton with two recurrent rods at one side and one recurrent rod at the other (fig. 1 B). This condition was observed in two specimens, one of which had two recurrent rods at one side and one recurrent rod and rudiments of another at the other side.

B. Skeleton with one recurrent rod at one side, while the body rod at the other side is simple (fig. 1 D). This was observed in two specimens out of the total number of larvæ.

C. Skeleton with one recurrent rod at each side. At one side this is abnormally connected with an extra transverse rod (fig. 1 C). This condition was observed in only one larva.

Also outside the East Greenland fjord complex it seems to be normal to this larva to have one recurrent rod at each side. In the Zoological Museum of Copenhagen there is a slide with seven specimens of *Ophiopluteus* taken in one plankton haul (150—25 m depth) at Spitsbergen (cf. BROCH 1910, p. 34). Six of the seven larvæ contained in this slide belong to the species *Ophiecten sericeum* and agree entirely with the type, while the seventh larva has a simple body rod at each side¹). That this larval form of *Ophiecten sericeum* is also found in the Spitsbergen material is quite natural, since at Spitsbergen, too, this species is one of the typical animals in the communities (cf. BROTZKY 1930 and IDELSON 1930).

Within the Franz Joseph Fjord area this larva occurs in the plankton from late in July to the end of February. From this period, however, plankton samples are only at hand from the months of July, August, January, and February, and hence nothing definite is known about the number of larvæ in the period from September to December. So much, however, can be stated that the larvæ were far more numerous in the January-samples (1932) than in the August-samples (1931), and likewise showed a decrease in number from January to the end of February. Since thus a gradual decrease in number could be ascertained from the first January-samples to the last February-samples, the climax for the occurrence of the larvæ must fall either at the beginning of January or, more probably, still earlier, e. g. in October—November—December. That this supposition is correct, will shortly be proved.

The samples from January and February contained many larvæ at a very advanced stage of development, in which the young brittle-star was distinctly visible within the larva (fig. 2). Even young, just metamorphosed, brittle-stars, still with small remnants of the larval body, were found suspended in the plankton in these months. In the August-samples, however, all the larvæ were at a much earlier stage of development, and no specimens were found in which the young

¹) Cfr. further *Ophiura robusta* p. 20.

brittle-star could be distinguished — not even in the very last days of August. Thus at the end of August larvæ of this species had occurred in the plankton for more than one month, and still none of them showed the slightest sign of forming the bottom stage. Hence it can be stated with certainty that the plankton stage of the individual larva lasts for more than one month.

Since it has thus been possible to identify this *Ophiopluteus*, and its presence in the plankton extended over the long period from July to February, it will be interesting to investigate the periods of spawning

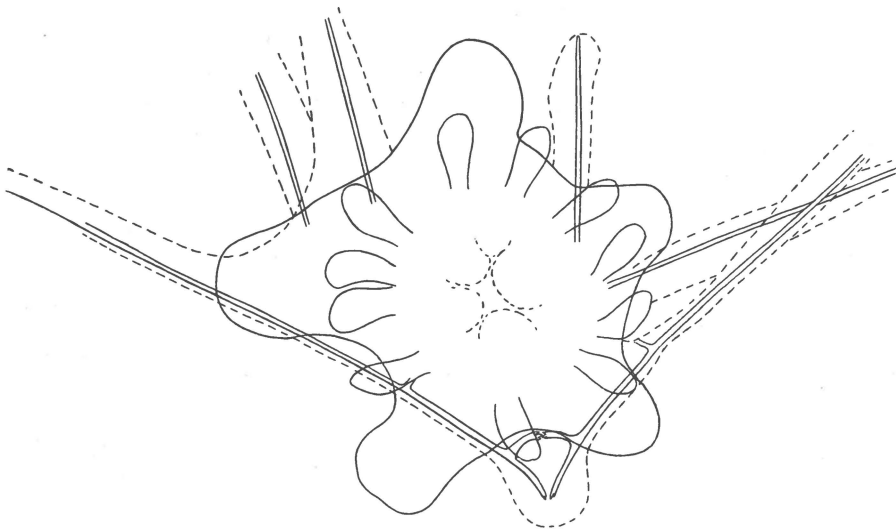


Fig. 2. Larva of *Ophiosten sericeum* (FORBES). The young brittle-star is distinctly visible within the larva. January 1932.

of the bottom form, i. a. to ascertain whether the same individuals spawn throughout the whole of the period, or whether the age and the summer temperature have an influence of any importance on the spawning. As already mentioned, a very large material of *Ophiosten sericeum* was brought back from the Solitærbugt, Ella Island, which rendered it possible to investigate the maturity of the animals.

749 specimens in all were examined — 346 of which were ♀♀ — (from the Solitærbugt 615 specimens, from Cape Hedlund 101 specimens, and from Kangerdlugsuak — midway between Scoresby Sound and Ammagssalik — 33 specimens). The diameter of the disc was measured in all specimens, and subsequently the disc was opened, and one or two gonad sacs from the base of each arm were taken out and mounted in glycerine. The material for these preparations was selected in the way that each series comprised a large number of ♀♀ (preferably c. 50)

from a certain date and a certain depth. In this way it was possible to control the influence of the date and the depth on the maturation. By a rapid inspection of all the available preparations six ovaries at different typical stages of development were next selected, so that the whole scale from quite undeveloped to fully mature ovaries was represented. These six typical ovaries were then microphotographed, and were designated in the series from the least developed to the most mature as stages of maturity 1, 2, 3, 4, 5, and 6 (cf. Pl. 3, a, b, c, d, e, f)¹). These six stages will be briefly characterised:

- Stage of maturity 1: (Pl. 3, a). Length of ovary about 0.75 mm with quantities of quite small, compact eggs. Cell boundaries very indistinct. Nuclei big, very distinct.
- Stage of maturity 2: (Pl. 3, b). Length of ovary as in the preceding stage. Ovarian membrane somewhat bigger, but not entirely filled by the egg-mass. Ova somewhat bigger than the preceding, compact. Cell boundaries distinct. Nuclei big, distinct.
- Stage of maturity 3: (Pl. 3, c). Length of ovary c. $\frac{4}{5}$ mm. Ovarial membrane entirely dilated by ova. These are somewhat bigger than at the preceding stage, richer in deutoplasm, hardly as compact, with distinct cell boundaries and nuclei.
- Stage of maturity 4: (Pl. 3, d). Length of ovary c. $\frac{9}{10}$ mm. Some ova remain at the preceding stage, others increase considerably in size, they begin to turn opaque from deutoplasm, and are fairly loose. Cell boundaries and nuclei distinct.
- Stage of maturity 5: (Pl. 3, e). Length of ovary c. 1.5 mm. Ova very big, rich in deutoplasm, joining each other rhombically. Nuclei small, but still distinct²). Often a germ-centre is seen at one end of the ovary with small undeveloped ova.
- Stage of maturity 6: (Pl. 3, f). Size of ovary as at the preceding stage. Ova very big, rich in deutoplasm, but loose, ready for spawning. Nuclear membrane gone, only the nucleolus still visible.

Each preparation was examined and assigned its number corresponding to its place in the above sequence of stages. If the preparation occupied an intermediate stage between two of the typical stages, it was designated e. g. "between 2 and 3" or "between 4 and 5", etc. Having thus registered all the preparations under the stages of maturity

¹) The photographs of the six stages of maturity are represented in exactly the same magnification ($\times 100$).

²) When these nuclei are not seen in the photograph, it is because the photographer has focussed the camera on the young immature eggs at one end of the ovary.

to which they rightly belonged, a curve of maturity could be drawn for the prepared number of ♀♀ for each date, which gave a fairly exact expression of the stage of maturity of the whole population at the particular date and depth. By next relating the curves for the various dates to each other, the closer connection between the period of spawning and the factors on which it depends could frequently be made out.

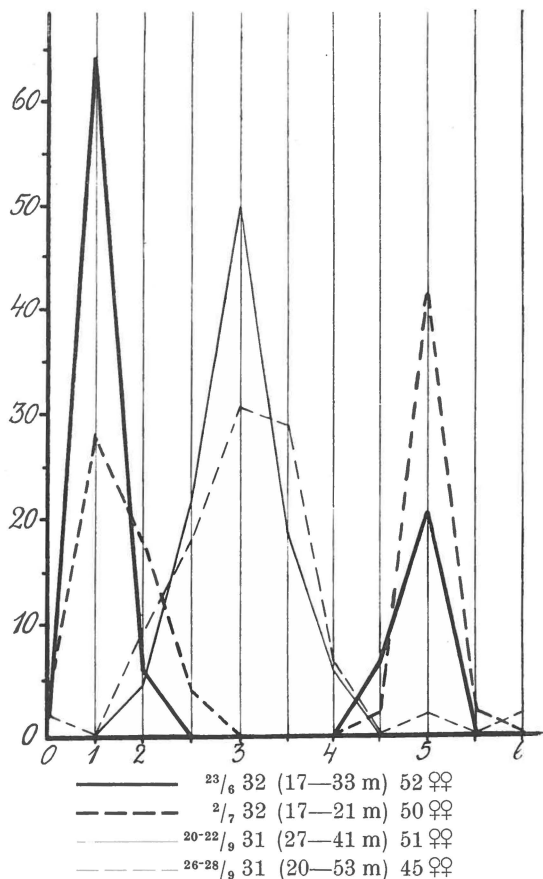


Fig. 3. Curves showing the stages of maturity of *Ophiocten sericeum* (FORBES) at different dates. Cf. further the text.

Fig. 3 shows the curves of maturity for the various series of preparations, each comprising a rather large number of ♀♀. The stages of maturity are marked on the abscissa¹⁾, while the ordinate gives the percentages of the individuals of the series found at the particular stage.

¹⁾ Stages 1 and 2 have purposely been placed closer to each other here than the other stages, the difference between these two stages being so inconsiderable that the preparations never showed an intermediate stage, but could always be referred to one or the other stage.

The result of these curves, which appears distinctly from fig. 3, will only be briefly outlined here. All the series mentioned are derived from a certain locality in the Solitærbugt, Ella Island.

June 23, 1932. 17—33 m depth. 52 ♀♀ examined. Fig. 3.
Heavy unbroken curve.

72 per cent. of the total number of specimens are entirely immature and group round stage 1, 28 per cent. have reached a very advanced stage (about maturity 5), and are thus near spawning. This summer-spawning seems to take place by a rapid maturing of relatively few eggs, from which the larvæ occurring in the plankton from the end of July to the beginning of September must be assumed to originate.

July 2, 1932. 17—21 m depth. 50 ♀♀ examined. Fig. 3.
Heavy stippled curve.

54 per cent. entirely immature, grouped round stages 1 and 2, 46 per cent. near spawning (stage 5). Hence it appears that the number of specimens in summer-spawning has increased considerably from the preceding series, although the material was taken only eight days later. The summer-spawning must thus take place very rapidly, and it will be evident that at least 50 per cent. of all the specimens take part in this spawning.

September 20—22, 1931. 27—41 m depth. 51 ♀♀ examined.
Fig. 3. Thin unbroken curve.

All the preparations group in a very acute, nearly symmetrical curve with stage 3 as the only climax. Thus all the specimens would seem to be at almost the same stage of maturity. The summer-spawning has come to an end, and the reserve of young eggs found in the ovaries of the summer-spawning specimens (cf. pl. 3, stage 5) have reached such an advanced stage of maturity that in the curve they cannot be distinguished from the specimens which have not taken part in the summer-spawning. Further, all the specimens ripen slowly — in contrast to the summer-spawning — and are ready to take part in the large spawning in October-November. This slow maturation appears from the curve for

September 26—28, 1931. 20—53 m depth. 45 ♀♀ examined.
Fig. 3. Thin stippled curve.

This, like the preceding curve, has only one summit, which, however, has moved to a point nearer stage 4 — i. e. the maturation has advanced distinctly, but slowly.

Fig. 4, in which the maturation and percentage of specimens are

indicated in exactly the same manner as in the preceding figure, shows the curves of the stage of maturity of the individuals at depths where they are exposed to positive summer temperatures (i. e. depths less than 20—25 m) and partly of the young specimens (i. e. with maximum diameter of the disc 7 mm). The results were as follows:

September 16—20, 1931. 11—21 m depth. 52 ♀♀ examined. Fig. 4. Heavy unbroken curve. Summer temperature positive.

The state of maturity is here somewhat farther advanced than in deep water at the same dates (cf. the preceding figure, curve for September 20—22). Some specimens are spawning or have already spawned (maturity 0), while the majority groups between stages 3 and 4. In deep

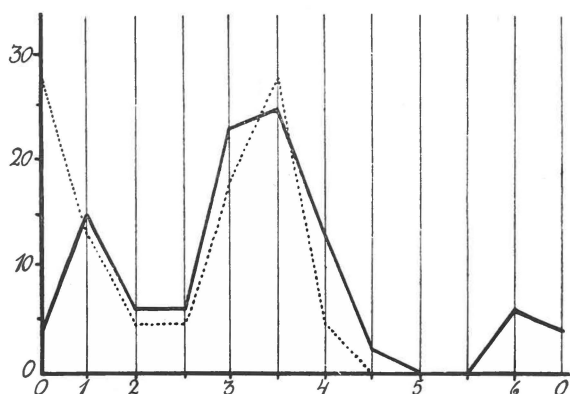


Fig. 4. Heavy line: 16–20/9, 31 (52 specimens), 11–12 m depth. Dotted line: 19/9, 31 (22 specimens), depth 22–32 m. Young individuals. *Ophiosten sericeum* (FORBES). Taken in the Solitærbugt, Ella Island, East Greenland.

water the specimens did not reach this stage till about ten days later (cf. fig. 3, curve for September 26—28). The slight percentages grouped round stage 5 can only be understood in the way that maturation takes place very rapidly at these stages.

September 19, 1931. 22—32 m depth. Young individuals. 22 ♀♀ examined. Fig. 4. Dotted curve.

A large number of the available specimens were entirely immature, among these were also some specimens with a diameter of the disc of 7 mm, while other specimens with this diameter of the disc showed the same stage of maturity as the older specimens at the same date. Thus the first time the animals spawn they seem to mature for the autumnal spawning just as early as the older specimens which have already spawned in previous years.

As already mentioned, all the curves described here are based on

material collected in the Solitærbugt, Ella Island. In many respects — i. a. in the aspect and distribution of the animal communities — this locality corresponded closely to the conditions prevailing in the outer parts of the fjord complex, whereas the inner parts of the fjord complex showed highly different conditions (cf. SPÄRCK 1933 and THORSON 1933). Hence it was of interest to examine the spawning of *Ophiocten sericeum* in these parts of the fjords also. For this examination

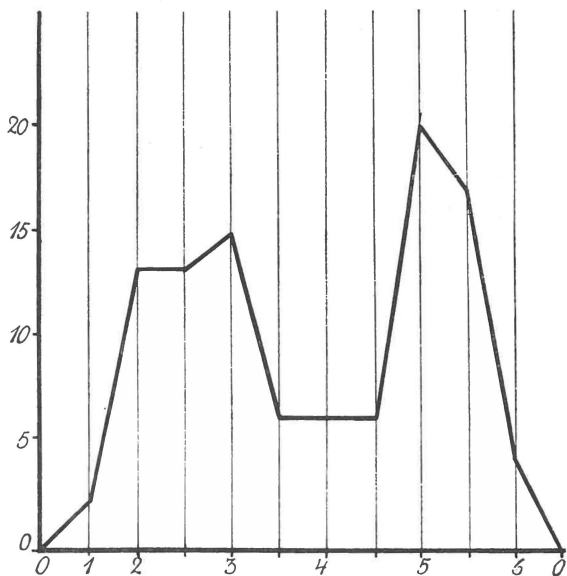


Fig. 5. Curve showing the stage of maturity of *Ophiocten sericeum* (FORBES) at Cape Hedlund on July 12–15, 1932 (54 specimens).

material from Cape Hedlund in Kempe Fjord was selected, and the results were as follows:

Cape Hedlund, July 12–15, 1932. 25–40 m depth. 54 ♀♀ examined. (Fig. 5).

The curve shows two distinct summits — one between stages 2 and 3, another between stages 5 and 6. Thus the stock is at the height of its summer-spawning (maturity 5–6), while the specimens not spawning in the summer have reached maturity 2–3, i. e. a far more advanced stage than the specimens from the Solitærbugt on July 2, 1932. This considerable difference in maturation cannot be explained solely by the difference in time between the series from Ella Island and the series from Cape Hedlund (c. 10 days). The difference is so obvious that as early as July the Cape Hedlund specimens spawning in the autumn were fast approaching the same maturity as displayed by the Ella Island

specimens at the end of September. However, other factors must be involved here. It is a well-known fact that in the interior of the fjords the ice breaks up earlier in the spring, but also forms earlier in the autumn, than in the outer fjord area, so it is easily understood why the spawning is further advanced in the former areas. The early spawning in the interior of the fjords also agrees entirely with similar conditions observed in the *Lamellibranchiata*.

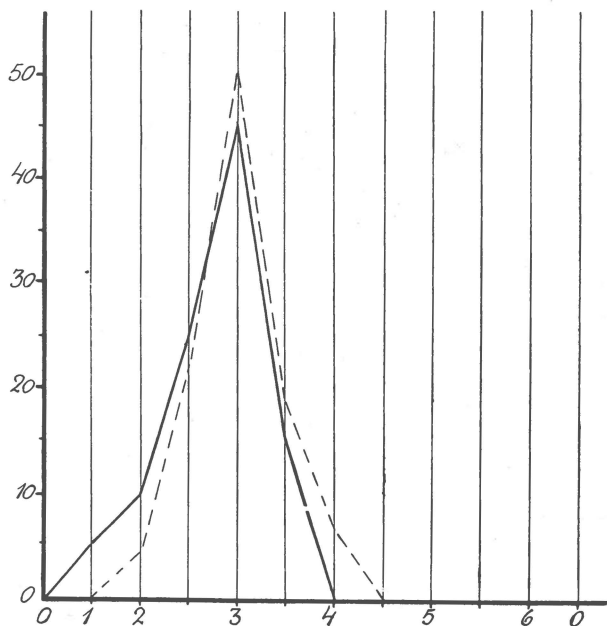


Fig. 6. Curves showing the stages of maturity of *Ophiocten sericeum* (FORBES) in Kangerdlugssuak (unbroken curve) at 50—100 m, Aug. 12—20, 1932, 20 ♀♀, and in the Solitærbugt, Ella Island (stippled curve), 27—41 m, Sept. 20—22, 1931. 51 ♀♀.

From Kangerdlugsuak Fjord midway between Scoresby Sound and Ammagssalik Dr. M. DEGERBØL (EJNAR MIKKELSEN-Expedition 1932) has brought back a rich material of *Ophiocten sericeum*. This material was kindly placed at my disposal for an investigation of the maturity, and the result is shown in the curve in fig. 6.

Kangerdlugsuak, August 12—20, 1932. 50—100 m depth.
20 ♀♀ examined. (Fig. 6).

The specimens from Kangerdlugsuak are indicated by the unbroken curve. The summer spawning is over. The curve tapers towards one climax, which occurs at maturity 3. The curve for the specimens from the Solitærbugt, Ella Island, September 20—22 (the stippled curve), has been inserted for comparison. It will be seen that the two curves

are nearly identical, i. e. the specimens from Kangerdlugsuak have already reached the same stage of maturity for the autumnal spawning as the Ella Island specimens at the end of September.

On the basis of the few registrations of temperature so far available from these regions it is impossible at present to explain why the Kangerd-



Fig. 7. The figure shows the disc of a hermaphroditic specimen of *Ophiocten sericeum* (FORBES). The dorsal part of the disc has been removed. The ovaries are indicated in black, the testes in white.

lugsuak specimens have reached a more advanced stage of maturity than the Ella Island specimens, more especially since there is no particular reason for believing that the temperature at Kangerdlugsuak should be higher than at Ella Island. The settlement of this question must be left to future investigations.

Among the 749 specimens investigated were two hermaphrodites — a phenomenon not previously known for this species and, on the whole,

very rare among Ophiurids. Fig. 7 shows the conditions in one of the individuals. At the base of one of the arms ovaries alone were found, at another only testes, while at the remaining three arms both testes and ovaries were found. The other hermaphroditic specimen is only

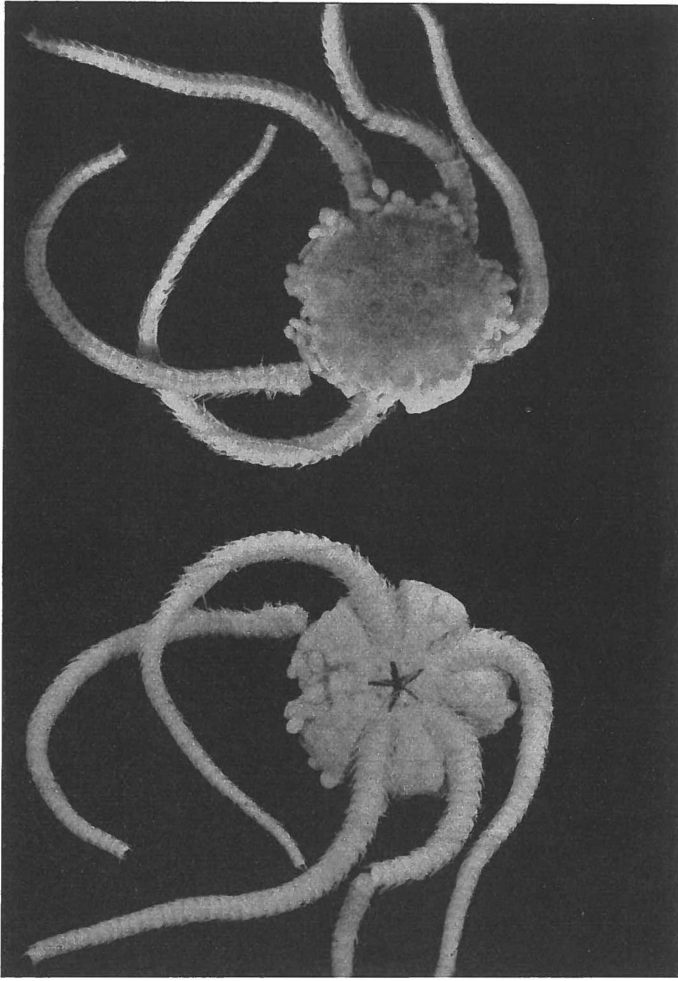


Fig. 8. *Ophiosten sericeum* (FORBES) ♂ ad. Testes very big. $\times 1\frac{1}{2}$.

known from a preparation of the gonads, the animal itself having been lost by a mishap before its hermaphroditic character had been ascertained. However, similar conditions seem to have prevailed in this as in the other specimen, but in a single gonad ova and sperma were further found together.

In the fully mature specimens of *Ophiosten sericeum* the gonads may often be very big, and are then usually a bright red colour. In

such cases they may dilate the disc so as to be visible through the thin under-side or even to bulge out through the bursae. Fig. 8 shows a big ♂ of *Ophiocten sericeum* (diameter of disc 13 mm) with mature gonads. However, the feature shown in the photograph is partially a preparation phenomenon, since normally the gonads appear less distinctly on the surface of the animal. Nevertheless, the picture gives a good idea of the size of gonads when the animals arrive at maturity.

2. *OPHIURA ROBUSTA* AYRES.

The identification of the larval stages of *Ophiocten sericeum* having been accomplished on the basis of the material secured in 1931—32, it was only natural during the summer trip of the "Godthaab" in 1933 in the Scoresby Sound fjord complex to search for the larval stages of

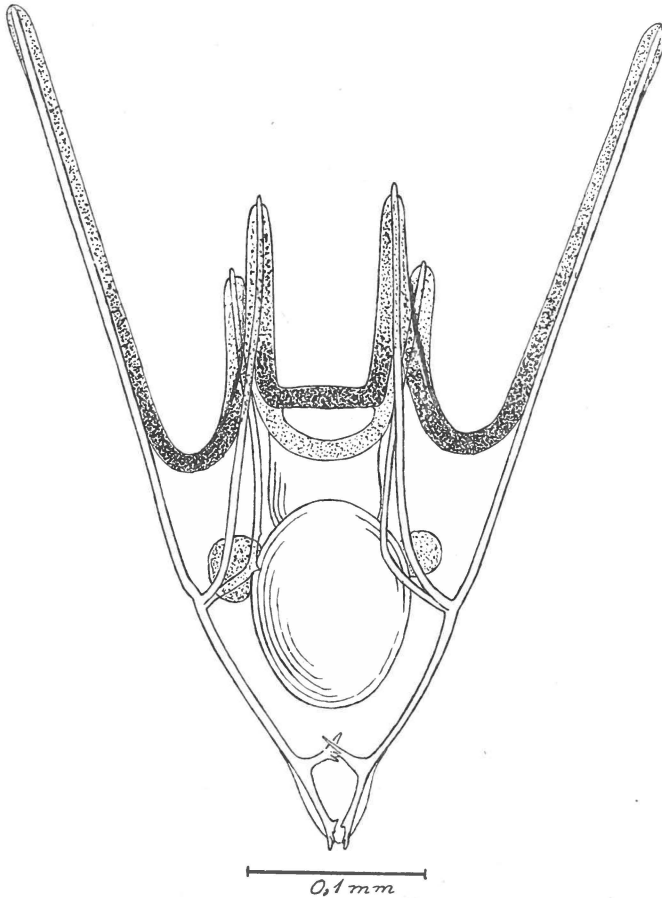


Fig. 9. *Ophiura robusta* (AYRES). Early larval stage. Cape Hope. July 13, 1933.

Ophiura robusta, which, besides *Ophiecten sericeum* is the only really frequent shallow-water brittle-star occurring in these districts. An excellent opportunity was afforded at Cape Hope at the mouth of Scoresby Sound. Here entirely pure sandy bottom at shallow water was found to be inhabited by a *Venus-fluctuosa*-community (cf. THORSON 1934, p. 33), which means that the *Ophiecten sericeum* associated with the clay bottom is totally absent here. Further, a pure algal epifauna was found at the coast, in which *Ophiura robusta* was of frequent occurrence. Thus a plankton haul taken in this place on July 13, 1933, yielded a

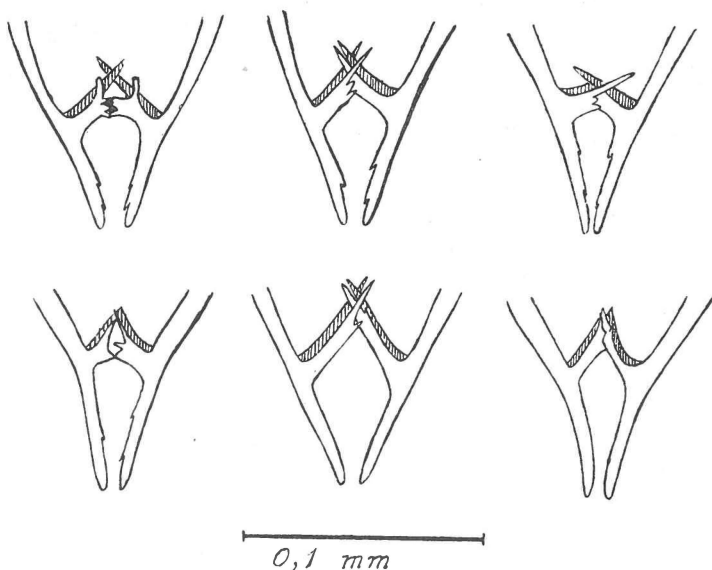


Fig. 10. *Ophiura robusta* AYRES. Six different variations of transverse rods. Cape Hope, July 13, 1933.

considerable number of a hitherto unknown Ophiurid larva, which could only be the larva of *Ophiura robusta*. The larvæ collected, all of which belonged to the same species, were young individuals of the aspect shown in fig. 9, and the postero-dorsal arms were still but slightly developed or entirely lacking. On August 14, 1933, fully developed larvæ were taken off the colony of Scoresby Sound, and the material was thus sufficient to form the basis of a description.

Description of the *Ophiopluteus* of *Ophiura robusta* AYRES (Pl. 2 and figs. 9, 10, and 11).

I. Typical form. Skeleton: The larva is much more compressed than that of *Ophiecten sericeum*. The antero-lateral and the postoral rods form arms of nearly the same length, while the postero-lateral

arms, which do not develop until at a rather advanced larval stage, only attain half that length. The postero-lateral arms are from $1\frac{1}{4}$ to $1\frac{1}{3}$ times as long as the antero-lateral arms. The arms are terete (not flat as for instance those of *Ophiura albida* FORBES), with some few, very small thorns, which make the rods appear smooth as compared with *Ophiecten*. The dorsal as well as the ventral recurrent rods are lacking. Most characteristic of the skeleton of the larva are the trans-

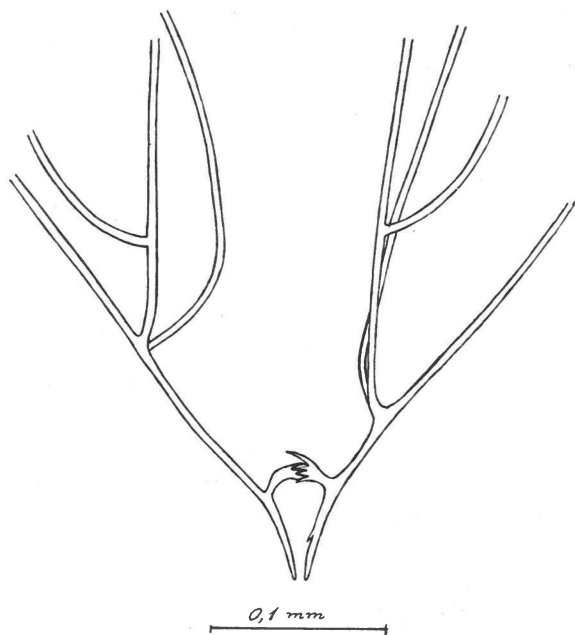


Fig. 11. *Ophiura robusta* AYRES. Deviation from the type. Kong Oscar Fjord, August 22, 1932.

verse rods. Fig. 10 shows six variations of these. They are especially distinguished by a strong thorn, which issues from the place where they join, and is directed towards the anterior end of the larva, generally intersecting that issuing from the opposite side. Besides, the transverse rods are commonly bipartite at the end. In these transverse rods alone, which seem to be of a very constant appearance, this species deviates from all formerly known *Ophioplutei*, and is thus easily recognisable.

Other structural features: In addition to the strongly ciliated band along the margin of the arms, a tuft of cilia is found at the posterior end. The enterocoel vesicles seem to become isolated very early, thus they were distinctly isolated even in larvæ at the stage shown in fig. 9. In one of the available slides the hydrocoel vesicle was visible. In the living specimens the stomach as well as the enterocoel vesicles were of a faint yellowish-brown colour, while otherwise all the larvæ examined

lacked every pigmentation, the arms being quite transparent. None of the grown-up larvæ showed even the slightest sign of forming the bottom stage.

II. Deviations from the type: Only one deviation was found, viz. a specimen in which the base of the skeleton parts of the arms on either side occurred at different distances from the posterior end of the larva, and in which only one of the transverse rods showed the characteristic thorn directed towards the anterior end of the larva (fig. 11).

Ophiura robusta, too, is known from Spitsbergen, and without being identified has been figured by BROCH (1910, p. 35, fig. 6 B). Also the seventh specimen on the slide mentioned in p. 6 belongs to this species.

Since *Ophiecten sericeum* and *Ophiura robusta* are the only two brittle stars whose larvæ occur in fairly large numbers in the East Greenland fjords, it might be anticipated that hybrids between the two species would occur there, notably since such hybrids are well known within other groups of echinoderms (cf. NÜMANN 1933). In the material of brittle-stars brought home from East Greenland two deviations from the type were found which may possibly be regarded as hybrids, for instance the form represented in fig. 1 D, which on account of its simple body rod at one side and a recurrent rod at the other is reminiscent of *Ophiura robusta* and *Ophiecten sericeum* respectively, both transverse rods, however, agreeing with the latter. The same possibly applies to the form represented in fig. 11, in which the arms occur at different distances from the posterior end of the larva, and both body rods, it is true, are simple, but where the one transverse rod is highly reminiscent of *Ophiecten sericeum*. However, the material is too slight for a final settlement of these questions.

The slides of larval stages used in this work are kept in the Zoological Museum of the University of Copenhagen.

In conclusion I wish to express my most cordial thanks to Dr. TH. MORTENSEN, whose rich experience and good advice have been of invaluable help to me.

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PLATES

Plate 1.

Late larval stage of *Ophiocten sericeum* (FORBES). The enterocoel- as well as the hydrocoel-vesicles are distinctly visible. The diagram has been drawn after several specimens of larvæ.

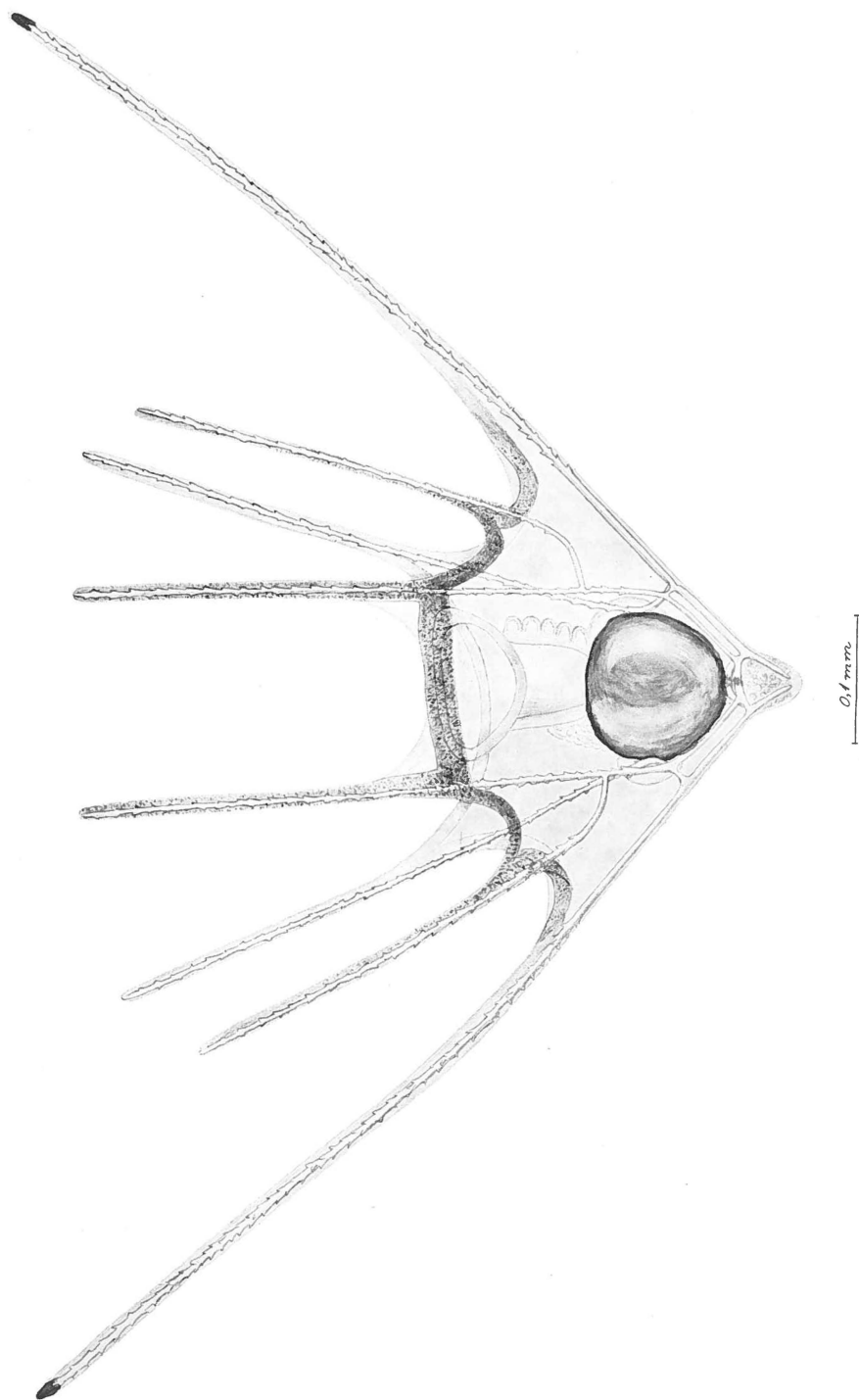


Plate 2.

Late larval stage of *Ophiura robusta* AYRES. The enterocoel vesicles distinct, the hydrocoel not yet entirely differentiated. Drawn after a preparation of a single larva.

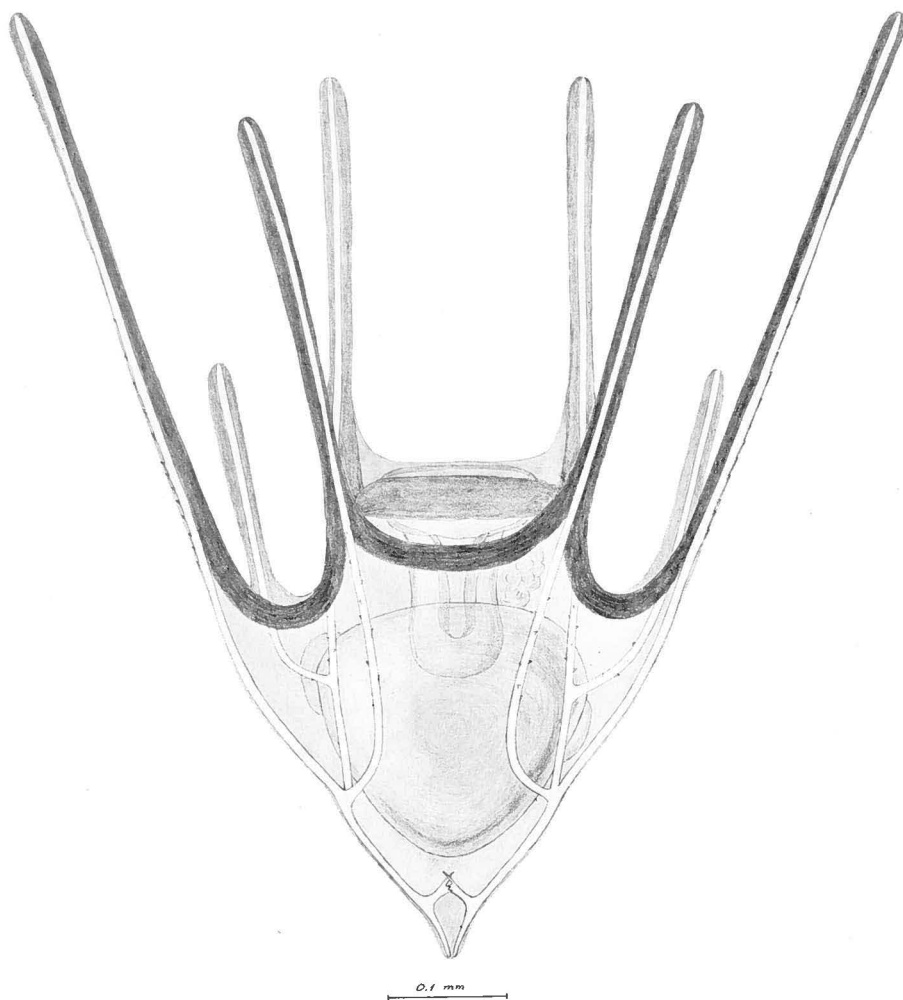
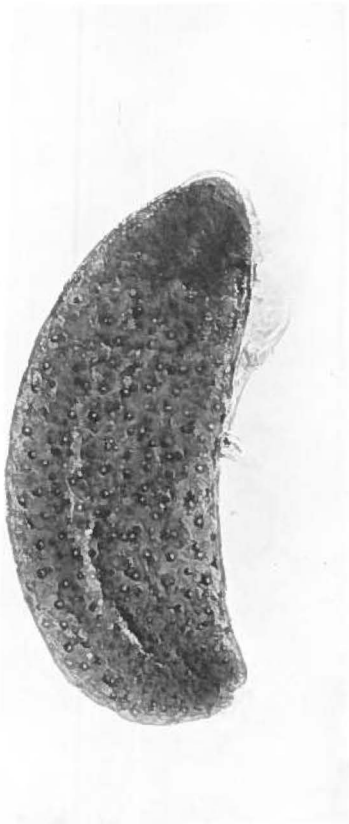
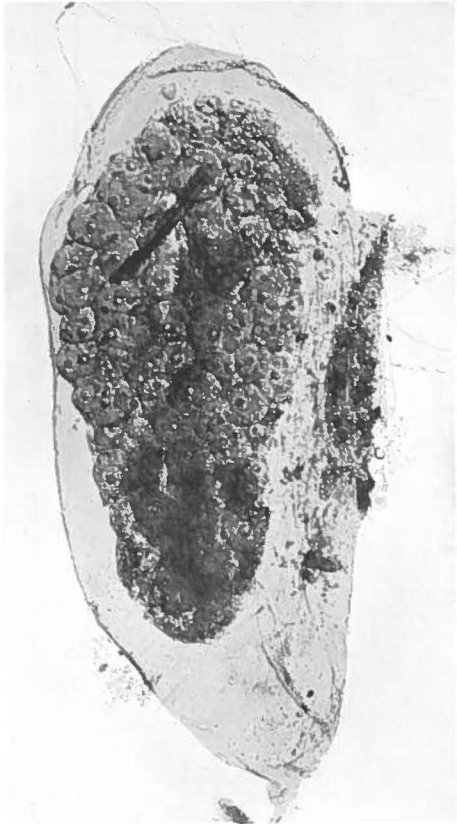


Plate 3.

showing the six different stages of maturity of the ovaries of *Ophiocten sericeum* designated in the text as stages of maturity 1, 2, 3, 4, 5, and 6 (see p. 8). All 6 ovaries are equally magnified. ($\times 100$).



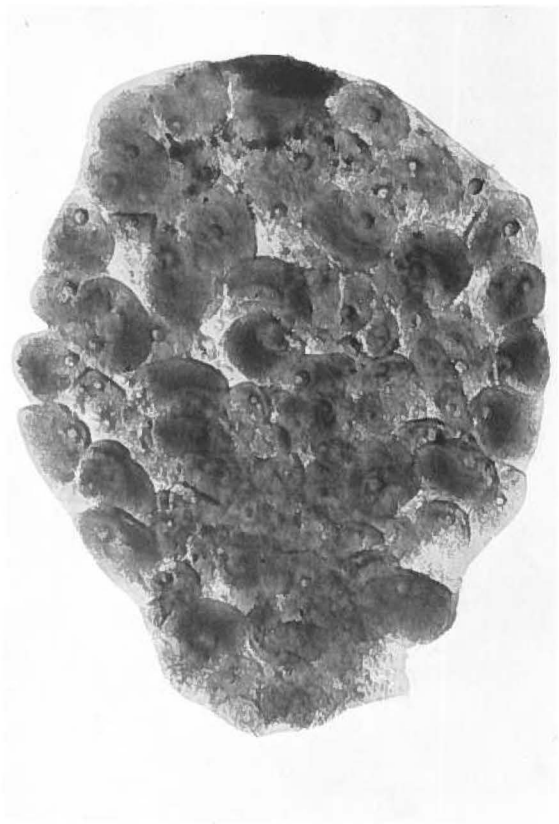
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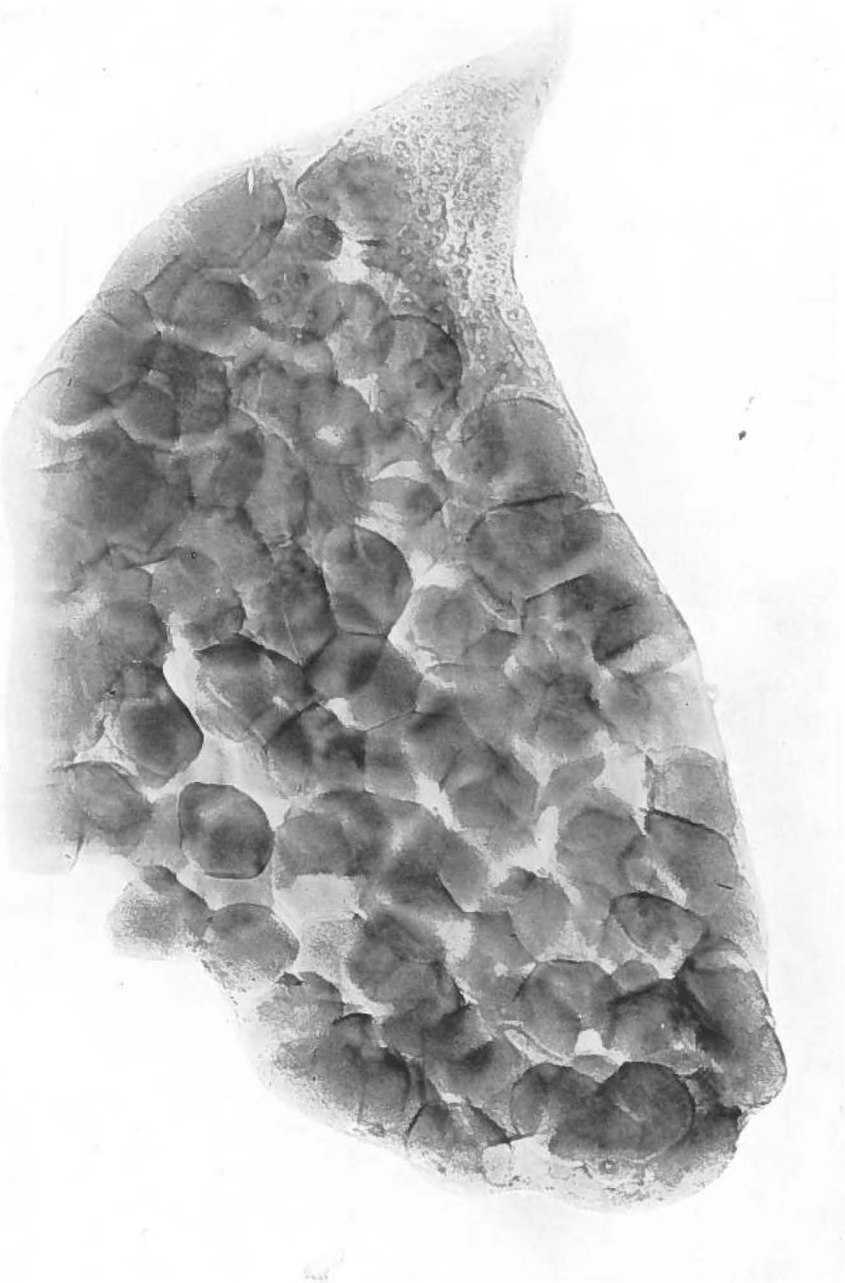
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