CEPHALOPODA

FROM THE

"MICHAEL SARS" NORTH ATLANTIC DEEP-SEA EXPEDITION 1910

BY

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WITH 2 PLATES AND 11 FIGURES IN THE TEXT

the dorsal side of the enormous fins. This is a structure of the skin similar to the one observed by JOUBIN in an Onychoteuthid and explained as a coating of scales. The French scientist applied the name of *Lepidoteuthis* to this large cephalopod, which was taken from the stomach of a whale. I have previously stated (1910, p. 6), that the structure in question is by no means a coating of scales; it is a peculiar structure of the cuticle, which only becomes plainly visible after maceration. This opinion is now considerably strengthened by the interesting new species, which I call *M. hjorti* in honour of the distinguished leader of the expedition. The five specimens taken have suffered a good deal during capture. Only one specimen is fairly well preserved, possessing both tentacles intact, and it has been represented in pl. II. The specimens were captured at the following stations:—

Stat.	52.	1200 m. w.	3 specimens, dorsal mantle-length 95, 85, 71 mm.
„	62.	3000 —	dorsal mantle, length 68 mm, both tentacles well preserved.
„	63.	?	dorsal mantle, length 55 mm badly damaged.

Also a young specimen, dorsal mantle-length 30 mm, taken at Stat. 52 1200 m. w. evidently belong to this species.

The measurements of the large specimen from Stat. 52 are as follows:

Ventral length of mantle	92	mm
Dorsal „ - „	95	„
Total breadth of both fins	102	„
Length of body to base of 4th arm	120	„
Length of right fourth arm	73	„
Length of left „ „	75	„
Length of dorsal arms	44	„
Breadth of head	41	„
Length of funnel cartilage	6	„
Maximum breadth of mantle	35	„
Diameter of eye	26	„
„ - lens	9	„

As we see from these measurements our species is above all characterised by an enormous breadth of the fins, which are located on the dorsal side of the pointed mantle and reach nearly to the anterior edge of the mantle. This character appears even in younger specimens and offers a striking point of difference from the other species of *Mastigoteuthis*, in which the fins never are so enormously developed. The fin is generally of a rhombic shape, the corners being somewhat rounded.

The head is blown up by the huge eyes, presenting cheek-like protruding folds towards the short neck. On

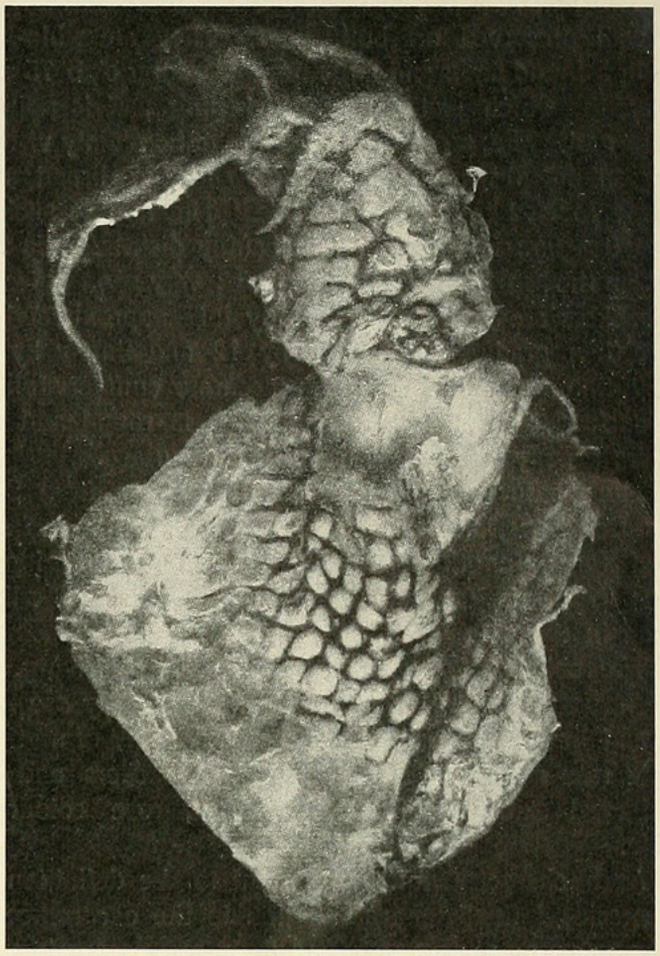


Fig. 1. *Mastigoteuthis Hjorti*. Stat. 52.

these folds are situated the two short-stalked olfactory tubercles, 2 mm long and terminating in an acorn-shaped point. The funnel is of moderate size and is surrounded by the cheek-like folds of the head. The funnel cartilage is relatively small, oval or egg-shaped, the exterior and posterior edge protruding slightly without, however, forming a distinct tragus and antitragus.

The arms are on the whole moderately long and exhibit the length-relation typical for *Mastigoteuthis* viz: 4, 3, 2, 1, They are feeble, angular, provided with 2 rows of comparatively small stalked and ball-shaped suckers, of which the largest measure 1·3 mm. in diameter. The suckers are characterised by 9 or 10 tack-shaped little teeth fringing the dorsal edge; the teeth are not pointed, and continuously decrease in size towards the sides. Protective keels or webs are poorly developed, and only the ventral arms exhibit a marked development of swimming webs or membranes. The skin of the buccal runs into 7 flaps, of which the ventral ones are triangular, somewhat close together, and fixed to the ventral side of the ventral tentacles.

The tentacles of the specimen captured at Stat. 62 are well preserved on both sides. They are whip-like, having a round stem and an enormously long club 75 mm in length, which exhibits no thickening and is pointed at the end. The protective webs are quite plainly visible, being about 0·5 mm broad and showing broad and densely located transverse muscles. The minute suckers about 0·25 mm in diameter are scantily distributed in two rows on the proximal part of the club; very soon however the suckers are gathered irregularly into approximately 4 rows, then gradually arranged by 12 and finally by 18 or 20 in an oblique row. An accurate enumeration of the suckers is difficult, as the club is round and the suckers occupy nearly two-thirds of its surface.

The gladius exhibits in a small specimen from Stat. 52 a free cone, the terminal part of which is perfectly closed for a length of 23 mm. Generally speaking it seems to be similar to the gladius previously described by me in the case of *M. cordiformis*.

The colour of our specimens is quite striking, for though not in good condition we can plainly see that fins and body both dorsally and ventrally are of a bright purple rose colour; along the rows of suckers and on the buccal skin a dark, almost black, rose colour is visible.

As a character not unimportant to the definition of the species I finally draw attention to the occurrence of light-organs on the eyes. Two light-organs are located on each side of the enormous greyish-blue eye bulb, the diameter of which is 26 mm in the largest specimen. A large light-organ 4 mm, in diameter is situated on the median inner edge level with the mouth of the funnel, and a smaller one 3 mm in diameter is noticeable in front, between the bases of the 2nd and 3rd arm. In several specimens these large and peculiar light-organs are visible through the skin.

As mentioned above this new species is marked in a very peculiar way, the skin being decorated by a pattern of rhombic figures. The rose colouring having been better preserved in the furrows between these figures, the latter become more prominent. We can thus plainly see that the marking is generally caused by diagonal furrows, separating the rhombic figures, which are about 4 mm broad on the average.

In one of the large specimens from Stat. 52 we find on the ventral side about 6 polygons in each transverse row, while the head exhibits 2 oblique rows of rhombuses, starting from the base of the 4th arm, and bordering off a triangular space containing about 5 rhombs around the funnel. In many cases, however, the rhombic character of the marking is not so regular, and we find either polygonal markings or wart-like protuberances. As the specimens have been damaged, in some cases the ventral side in others the dorsal being worn and frayed, the marking is never clearly visible in all parts of the body, but a comparison of the specimens shows that the marking occurs all over the ventral area of the body, including the fins and the bases of the 4th arms, as well as on the dorsal area of the fins.

Grimalditeuthis Bonplandi Vérany.

Loligopsis Bonplandi Vérany 1837, p. 99, pl. 1 a.
Grimalditeuthis Richardi Joubin 1898, p 101, figs. 1, 2.
— *Bonplandi* Pfeffer 1912, p. 628, pl. 47, fig, 1.

At Stat. 53 the net lowered to 2600 m captured a Chiroteuthid, which evidently belongs to the genus *Grimalditeuthis*. The tentacles and the second posterior fin have been lost, the gladius being broadly broken off at the hind part. The anterior fin is however well preserved and exhibits the squarely oval shape peculiar to this genus. The arms do not vary much in length, and their relative size may be characterised by the formula 3, 2, 1, 4. The eyes have during capture been caused to protrude a little, and the stalked olfactory tubercle is situated level with the funnel. An important feature in the genus *Grimalditeuthis* is the symphysis between the edge of the mantle and the funnel cartilage, a feature found in our specimen, which is semi-transparent and exhibits a delicate pigment consisting of purple chromatophores, situated on the dorsal parts of the head, along the gladius and on the arms. The present specimen differs from *Grimalditeuthis Bonplandi*—described by Joubin in 1900 from a beautifully preserved specimen under the name of *G. Richardi*—in lacking the bulb-shaped and strongly pigmented swelling at the end of each arm. Whether this character, however, is sufficient to establish a new species can only be learnt from future collections.

Dorsal length of mantle (from hinder edge of the fin)	56	mm
Length of neck and head	29	„
Diameter of eye	5	„
Breadth of both fins	42	„
Length of the fins	27	„

Doratopsis Rochebrune.

As mentioned in a previous paper (1910) I agree with Ficalbi in considering the neat and slender forms described as *Doratopsis* as being really larvae of *Chiroteuthis*. Full-grown specimens of *Chiroteuthis* have certainly not been taken by the expedition, but the captures include a number of juvenile forms which I consider as belonging to *Doratopsis*.

Doratopsis vermicularis Rüppell et Vérany.

Loligopsis vermicularis Rüppel 1845.
— — Vérany 1851, p. 123, pl. 40, figs. a, b.
Doratopsis vermicularis Rochebrune 1884, p. 18.
— — Chun 1910, p. 285 ff., pl. 47, fig. 3.
— — Pfeffer 1912, p. 555, pl. 46.

Stat. 64. 1000 m. w. One well preserved slender specimen.

Doratopsis lippula Chun.

Doratopsis lippula Chun 1908, p. 89, 1910, p. 291, pl. XLV, figs. 6, 7.

Stat. 51. 4000 m. w. One somewhat damaged specimen, possessing only 3 or 4 suckers on the ventral arms. The short and broad club, which is also provided with a web, is similar to the same organ described by me in *D. lippula*.

Doratopsis exophthalmica Chun.

Doratopsis exophthalmica Chun 1908, p. 89, 1910, p. 290, pl. XLV, figs. 1—5.

Stat. 90. 200 m. w. 3 specimens, evidently young stages, belong to this species. They were captured at the following stations.

Stat. 53. 1600 m. w.
„ 88. 1500 —
„ 94. 200 —

Doratopsis sp.

Young specimens of *Doratopsis* which cannot safely be identified were taken at the following stations:—

Stat. 23. 200 m. w.
„ 53. 600 —
„ 56. 100 —
„ 58. 200 —
„ 81. 200 —
„ 90. 1000 —

Cranchiidae Prosch.

The Cranchiidae might be expected to play an important part in the spoils of the expedition, but the collections contain mostly young specimens and larvae, which only in a few cases can be identified as belonging to definite genera.

Cranchia scabra Leach.

Cranchia scabra Leach 1817, p. 410, pl. XVIII, fig. 1.
— — Chun 1910, p. 328, pls. XLVIII—LX.
— — Pfeffer 1912, p. 650, pl. 47, figs. 22—28.

Stat. 52. Surface, at night: one specimen of average size, mantle-length 24 mm.
„ 51. 4000 m. w. one small specimen.

Leachia cyclura Lesueur.

Leachia cyclura Lesueur 1821, p. 90, pl. VI.
— — Pfeffer 1912, p. 650, pl. 47, figs. 2—10.

Stat. 23. 1215 m. w. Trawl, one badly damaged specimen, which can be identified by means of the 5 light-organs, situated on the eye.
„ 64. 3000 m. w. Two specimens.

Desmoteuthis pellucida Chun.

Desmoteuthis pellucida Chun 1910, p. 357, pl. LIII, fig. 1, pl. LIV.
Megalocranchia pellucida Pfeffer 1912, p. 716.

Several well preserved and adult specimens belonging to this species were taken. They are peculiar in possessing large orange-coloured pigment-spots, just as I have previously observed in a living specimen.

Stat. 10. 500 to 180 m. 2 young specimens.
„ 45. 200 m. w. dorsal mantle-length 49 mm.
„ 67. 2200 — small damaged specimen.
„ 98. 200 — dorsal mantle-length 52 mm.
„ 98. 1000 — — — 49 „
„ 101. 1000 — — — 60 „

Corynomma speculator Chun.

Corynomma speculator Chun 1906, p. 85, 1910, p. 367, pls. LV, LX, figs. 13—16.
— — Pfeffer 1912, p. 737.

Stat. 51. Surface, young specimen.
„ 64. 2500 m. w. — —

Teuthowenia megalops Prosch.

Owenia megalops Prosch 1847, p. 64, pl. I, figs. 4—6.
Teuthowenia megalops Chun 1910, p. 376.
— — Pfeffer 1912, p. 742, pl. 48, figs. 5—11, 17, 81.

Stat. 10. 200 m. w., one young specimen.
„ 45. 300 — two specimens.
„ 45. 2000 — one —
„ 51. 200 — one —
„ 58. 100 — one —
„ 63. 500 to 200 m., one specimen.
„ 64. 300 m. w., two specimens.

The specimens have nearly all shrunk, some of the characters of the species being however plainly visible.

Toxeuma belone Chun.

Toxeuma belone Chun 1906, p. 86, 1910, p. 380, pl. LVI, fig. 10, pl. LVIII, figs. 1—5.
— — Pfeffer 1912, p. 700.

This form had been taken by the "Valdivia" in the Southern Equatorial Current of the Indian Ocean, and it was very interesting to me that the present expedition

had taken four specimens in the North Atlantic. The specimens are in some cases only a little larger than the specimen described by me. The arrow like slender shape of the body, and the slightly telescopic eyes possessing two-stalked light-organs are, however, plainly recognisable in all the specimens.

Stat. 49 B. 3000 m. w.
„ 51. 4000 — Gladius about 64 mm.
„ 53. 2600 —
„ 67. 1200 — Gladius 71 mm.

Galiteuthis Suhmii Hoyle ***(Taonidium).***

Taonius Suhmii Hoyle 1886, p. 192, pl. XXXII, figs. 5—11.
Galiteuthis (Taonidium) Suhmii Chun 1910, p. 382, pl. LIX.

Stat. 64, 200 m. w. one specimen; the middle rows of suckers in the club are just developing into hooks.

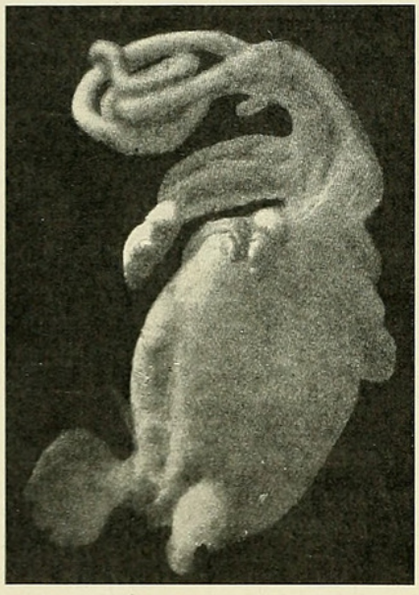


Fig. 2. *Bathothauma lyromma*, juv. Stat. 51.

Bathothauma lyromma Chun.

Bathothauma lyromma Chun 1906, p. 86, 1910, p. 389, pl. LVI, fig. 9, pl. LVII, figs. 1, 2, pl. LVIII, figs. 6, 7.
— — Pfeffer 1912, p. 753.

The rediscovery of this fantastically shaped Cranchiid, possessing enormous arms, should be of considerable interest. The specimen taken at Station 51, 700 m., has a mantle-length of 21 cm, but shows perfectly well the characters peculiar to the genus *Bathothauma*. As shown in fig. 2 the fins are wide apart even in this young specimen. The well preserved eyes posses enormous light-organs and are located on straight stalks, which have evidently been slightly damaged and broken during capture in the specimen taken by the "Deutsche Südpolar-Expedition".

Two larvae, the mantles of which are some 7 mm. in length, exhibit such a marked likeness to the present young specimen of *Bathothauma*, that I have no hesitation in considering them as belonging to this species. Even if they have shrunk to a certain extent, the position of the fins, which are separated by the broad cone of the gladius, and the extraordinary long and plump eye-stalks plainly contribute to justify this determination.

MYOPSIDA d'Orbigny.

Spirulidae Owen.

Spirula australis Lamark.
Pls. I, II, figs. 2, 3.

Some larvae of *Spirula* must be counted among the most precious spoils of the expedition. Being very inconspicuous they are easily overlooked, but when more closely considered they prove truly invaluable in extending our knowledge of *Spirula*. Some young specimens approaching in appearance the adult *Spirula* are available and we have finally a full grown specimen, mantle-length 26 mm., which, however, I regret to say, is somewhat damaged. This valuable material, comprising 8 specimens in all, was secured in the vicinity of the Canary Islands, by the aid of plankton-nets. It contributes largely to confirm the opinion, previously set forth by me (first of all in my lecture on *Spirula* to the Zoological congress at Frankfurt 1909), that *Spirula* by no means lives near the sea-bottom nor, as is very often supposed, attaches itself to rocks, but is a pelagic decapod, living in deep water. Evidently *Spirula* has a peculiar liking for the Canary current. As long ago as 1836 the corvette "La Recherche" took some very damaged specimens at the surface evidently derived from great depths, which were shortly described by Robert and also by Blainville (in 1837). Finally the only larval *Spirula* described by Joubin (Bull. Inst. Oceanogr. Monaco 1910) was also taken at the Canary islands (Ferro), during one of the cruises of the prince of Monaco.

Before giving a short description of the larvae, aided by reproductions I enumerate the examples captured:—

Stat. 34. 1000 m. w. Youngest larva, 6 mm long, with 5 visible chambers.
„ 35. 2400 — Somewhat older larva with 6 visible chambers.
„ 42. 900 — More advanced larva, total length 9 mm, 7 chambers visible.
„ 45. 3000 — Young stage, dorsal mantle-length 12 mm.

Stat. 42.	300 m. w.	Two young specimens, dorsal mantle-length 16 and 18 mm.
„ 44.	4000 —	Specimen with a dorsal mantle-length of 23 mm.
„ 45.	3000 —	Largest specimen, dorsal mantle-length 26 mm.

I have not yet examined the internal anatomy of the larvae, and describe only their external appearance, which confirms JOUBIN's description, also founded on external characters, and in certain respects completes it.

The youngest larva (pl. I, figs. 1, 2) is, like the other larvae, well preserved, and having been kept in formalin exhibits no shrinking of the mantle. It has a barrel-like somewhat clumsy shape, and at the posterior end of the body we can on the outside see 5 chambers projecting. As mentioned by JOUBIN in the case of his specimen, the latter are entirely covered by the mantle, which however is very thin just over the chambers. We may further notice the fact that the posterior part exhibits no thickening and also no obvious pigmentation. The edge of the mantle is very clean-cut, and shows as yet no traces of dorsal and ventral angles in the mantle. Particularly interesting are the small size and the position of the fins. They are spatular in shape, 0·6 mm. broad, and separated from each other by the entire breadth of the chambers. Their bases run obtusely to the axis of the body and do not reach the posterior end, which is never overlapped by the small fins.

The head section of our larva protrudes above the edge of the mantle, the broad and sturdy funnel being perfectly free and reaching the base of the arms. Interesting also is the minute size of the eyes, which are located level with the edge of the mantle. They are oval and have a longitudinal diameter of only 0·26 mm. JOUBIN has already drawn attention to the small size of the eyes.

The arms are perfectly developed, the 4th arms however being very small and stumpy. The first and second pairs of arms are almost equal in size, the third being somewhat smaller. The inner surface of all the arms is covered with minute suckers, arranged in four or five longitudinal rows. No traces of the tentacles are visible externally. In the adult animal they may be drawn into a kind of sheath and I suppose that they have already been developed. The upper jaws run into a point and, protruding a little, push the inner lips and the buccal skin aside.

The pigmentation of our larva is a little more pronounced about the head, where densely scattered light brown chromatophores with a slight touch of purple red occur. The funnel and arms are entirely devoid of chromatophores, and on the mantle they are also very faint and scarce. The edge of the mantle shows no accumulation of them, and only at the posterior end of the body, about the shell and around the whitish fins, a small gathering of chromatophores is visible.

As regards the more advanced larval stages (pl. I, figs. 3—6) I will mention them quite shortly, as their main features are similar to what has been described above. The mantle still exhibits the barrel-like shape and no trace of angles or indentations are visible in the edge of the mantle. The shell begins to appear more distinctly

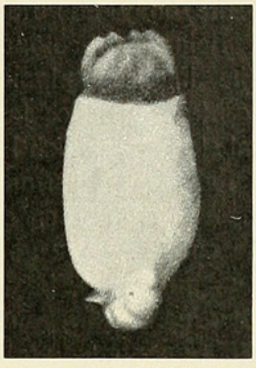


Fig. 3. *Spirula*. Young larva from Stat. 35.

Fig. 4. *Spirula*. Advanced larva from Stat. 43.

at the posterior end of the body, and we may see 6 or 7 chambers, which are very sharply defined in the largest larva from Stat. 42. The siphon is now and again faintly visible through the chambers. The latter are always covered by the thin outer skin, which in this posterior region is more profusely pigmented than in the youngest stage. The pigment on the edge of the mantle is beginning to increase and the pigment on the head part has expanded, covering the arm-bases. The fins have grown a little, but their position has not altered perceptibly. As the head is drawn far into the mantle, I can only give prominence to the fact that the tentacles are not visible in any of the more advanced larvae. The arm-cluster is however very nicely displayed, and the tentacles could not possibly be overlooked. A feature, which is faintly noticeable even in the youngest larva, has now become more prominent, for the mantle becomes somewhat thickened about the chambers of the shell and about the bases of the fins, even now indicating the limit of the so-called ovals, which, as we know, later on appear very conspicuous on the dorsal and ventral sides.

Compared to the three larvae just described, the young form from Stat. 45 (pl. II, fig. 2) exhibits a marked advance in development. The dorsal mantle-length is 12 mm, while in the oldest larva it is only 8 mm. We notice first of all that dorsal and ventral angles have developed in the edge of the mantle, but rounded

and as yet not very prominent. The fins are now larger. Their bases measure 2 mm., slanting dorsally in front and ventrally behind. The fins, 3 mm broad, do not yet overlap the posterior end of the body. The pigmentation of the mantle has advanced, the edge of the mantle and the posterior end of the body being intensely coloured. The intermediate part of the mantle seems to be poorly pigmented, but it had only in part been preserved in the case of one of the older stages. In the other cases it had been to some extent damaged, the silvered layer of the cutis appearing on the surface of the specimens. The shape of the posterior part of the body is further of particular interest (pl. II, fig. 3). Being light-coloured it is sharply distinguished from the intensely pigmented parts surrounding it, and in its centre we notice for the first time traces of a white conical structure, which I have attempted to explain as being a light-organ, surrounded by a hardly perceptible thickening. Although the specimen has been somewhat damaged, the chambers are not laid open but are covered by a thin membrane. The thickening of the mantle having now increased about the shell, the ovals provided with a thin membrane are more sharply defined. On the head the greatly enlarged eyes are conspicuous. They may be seen from the side above the edge of the mantle, and are almost entirely covered by the nearly closed fold of the lid. The diameter of the eyes would be at least 2 mm. The arms show a more powerful development than in earlier stages, but are still devoid of strong pigment like that characterising the other parts of the head.

As regards the other young specimens of *Spirula,* their shape gradually approaches to that of the adult animal. The club-section of the tentacles protrudes only a little, one might almost say timidly, among the arms. The eyes increase in size and the formation of angles in the mantle becomes more marked, the ventral ones commencing to enclose the funnel. Above all the posterior part is approaching its final development. The whitish cone of the light-organ becomes more sharply defined, and is surrounded by the thickened pigmentless moulding, the lips of the latter surrounding the light-organ and forming a faintly pit-shaped depression. Pigment has been intensely developed around the light-coloured pole and has been distributed dorsally as well as ventrally over the chambers of the shell. The pigment is almost as vigorous on the bases of the fins, which until now have been devoid of pigment. I wish finally to give prominence to the fact that the pit-shaped depression around the light-organ at the posterior end of the body becomes more and more conspicuous during development, and also that folds on the arms become visible, and the tentacles protrude more, as the animals grow up. What has been said above would in the main characterise the peculiarities exhibited by the young *Spirula.*

There is, however, one point which i should like to discuss a little further, a point specially emphasised in my description of the adult *Spirula* taken by the "Valdivia", viz. that the shell is never left bare on the dorsal or ventral side. In all the specimens of *Spirula* I find the shell covered by the thin mantle in the region of the so-called ovals. Only in the oldest specimen, the mantle of which was damaged, the chambers are now and again bared, but we recognise the frayed edge of the membrane round the bared chambers, and we may convince ourselves beyond doubt that we have to do with a damaging of this frail structure. JOUBIN in his description of the youngest larva still starts from the presumption that the chambers are normally uncovered; he attempts to explain this in quite another—and to my mind much more satisfactory—manner, than PELSENEER did. But since I have been able to show that in the fullgrown *Spirula* the chambers are never bare, one may dismiss the idea, that *Spirula* has an exterior shell. As regards the structure and development of this shell I intend to give a more detailed account in a future publication.

I may finally mention that in all those specimens where the mantle is damaged, and especially in the cases where the silvery layer of the cutis has been rubbed off, a reticular division of the muscular surface is visible, which is, however, plainly visible only in the case of the two oldest specimens, while in the young stages it appears rather as a fine granulation. I therefore once more declare myself opposed to the attempts at establishing a separate species viz.: *Spirula reticulata*, the said reticulation being a character common to all representatives of the genus, and appearing only on the surface of damaged specimens.

Sepiolidae Tryon.

Heteroteuthis dispar Rüppell 1845.

Stat. 42. 200 m. w. 8 young specimens.
„ 56. 100 — 300 m. w. 3 larvae.
„ 58. 100 — about 20 young specimens, the largest one among these—a male—possessing somewhat enlarged suckers on the third arm.

Sepiola Rondeleti d'Orbigny 1839.

Stat. 39 B. Trawl 292 m. 1 specimen.
„ 96. 200 m. w. 3 specimens.

Rossia Caroli Joubin.

Rossia Caroli Joubin 1902, Mém. Soc. Zool. France p. 135, fig. 34, 35.
— — Fischer et Joubin Exp. Travailleur et Talisman 1906, p. 331, pl. XXIV, figs. 3—8.

Stat. 70. 1100 m. w. 1 specimen. The "Michael Sars" specimen is a little smaller than the one described by JOUBIN, 1902, but it agrees fairly well with his diagnosis. This is specially the case as regards the shape of the club, which is thin, with 6 or 7 rows of small dark suckers. The body, arms, and fins exhibit a purple brownish colouring.

Loliginidae d'Orbigny.

Loligo media Linné.

Stat. 14. Trawl 69 m, about 20 specimens of average size.
„ 20. „ 153 m, one long-tailed specimen.

Loligo Forbesi Steenstrup.

Stat. 39 B. Trawl 267—280 m. One specimen, badly damaged.

Sepiidae d'Orbigny.

Sepia d'Orbignyi Férussac.

Stat. 34. 1 specimen.

Sepia officinalis Linné.

Stat. 37. Trawl 39 m. 3 specimens.

OCTOPODA.

Philonexidae d'Orbigny.

Tremoctopus atlanticus d'Orbigny.

Stat. 51. Surface. 2 specimens.
„ 53. — 4 —
„ 62. — 3 —

Argonauta Linné sp.

Stat. 45. 200 m. w. One very young larva evidently a female.
„ 49 B. 2000 — One young larva.

Quite young octopod larvae, which belong either to *Argonauta* or to *Tremoctopus* were captured at:—

Stat. 95. 2000 m. w.
„ 98. 300 —
„ 101. 200 —

Octopodidae d'Orbigny.

Octopus (Polypus) n. sp.

Stat. 58. 100 m. w. A small flesh-coloured octopod, in which the eight arms are thrown far back, is interesting in so far that the semi-gelatinous mantle encloses the funnel, only a narrow slit in the mantle being left free, as in the Chiroteuthidae. I have looked in vain for a reference to a similar arrangement, and consequently believe that we have to do with a new form.

Octopus Lothei n. sp.

Stat. 41. Trawl. 1365 m. This large octopod represents a deep-sea form, the body exhibiting a peculiar gelatinous consistency, and the perfectly smooth surface having a light greyish violet colour. Its total length is 445 mm. and the other measurements run as follows:—

Mantle-length to ventral edge of mantle about	70 mm
Posterior end of body to centre of eye..	80 „
Posterior end of body to end of funnel	100 mm
Breadth of head	70 „
Length of first right arm	360 „
— - second „ „	355 „
— - third „ „	325 „
— - fourth „ „	275 „

The roundish arms have comparatively small suckers, 4 or 5 mm. in diameter, which only protrude slightly above the surface. The dorsal arms are joined by a broad outer web, running along the dorsal area until it reaches the proximal third part of the arm. Between the first and second arms the web runs along the ventral side of the dorsal arms as far as the points broadening a little in the distal section. This is also the case as regards the ventral web of the second, and also—though not quite so pronouncedly—the third arms.

The slit in the mantle reaches to a point in the median line between the mouth of the funnel and the eyes. The comparatively large eyes are dorsally located and the funnel is not very conspicuous. The present species evidently belongs to a group of Octopoda peculiar to moderate depths, described by VERRILL as *O. Bairdii, O. lentus* and *O. piscator.* The *Octopus* figured by JOUBIN (1900, tab. III, fig. 7) as *Octopus levis*, Hoyle, also belongs to this group, but when comparing the typical specimens taken at Kerguelen with JOUBIN'S figure we recognise that the latter cannot be *Octopus levis*, which is distinguished by its reddish brown colour. JOUBIN'S drawing is also sufficient to show that the species is devoid of such webs on the arms as we have mentioned above.

Bolitaenidae n. fam.

Octopoda with entirely gelatinous body; the cranial cartilage rudimentary. Eyes widely separated, the optic nerve being lengthened. Olfactory tubercles stalked,

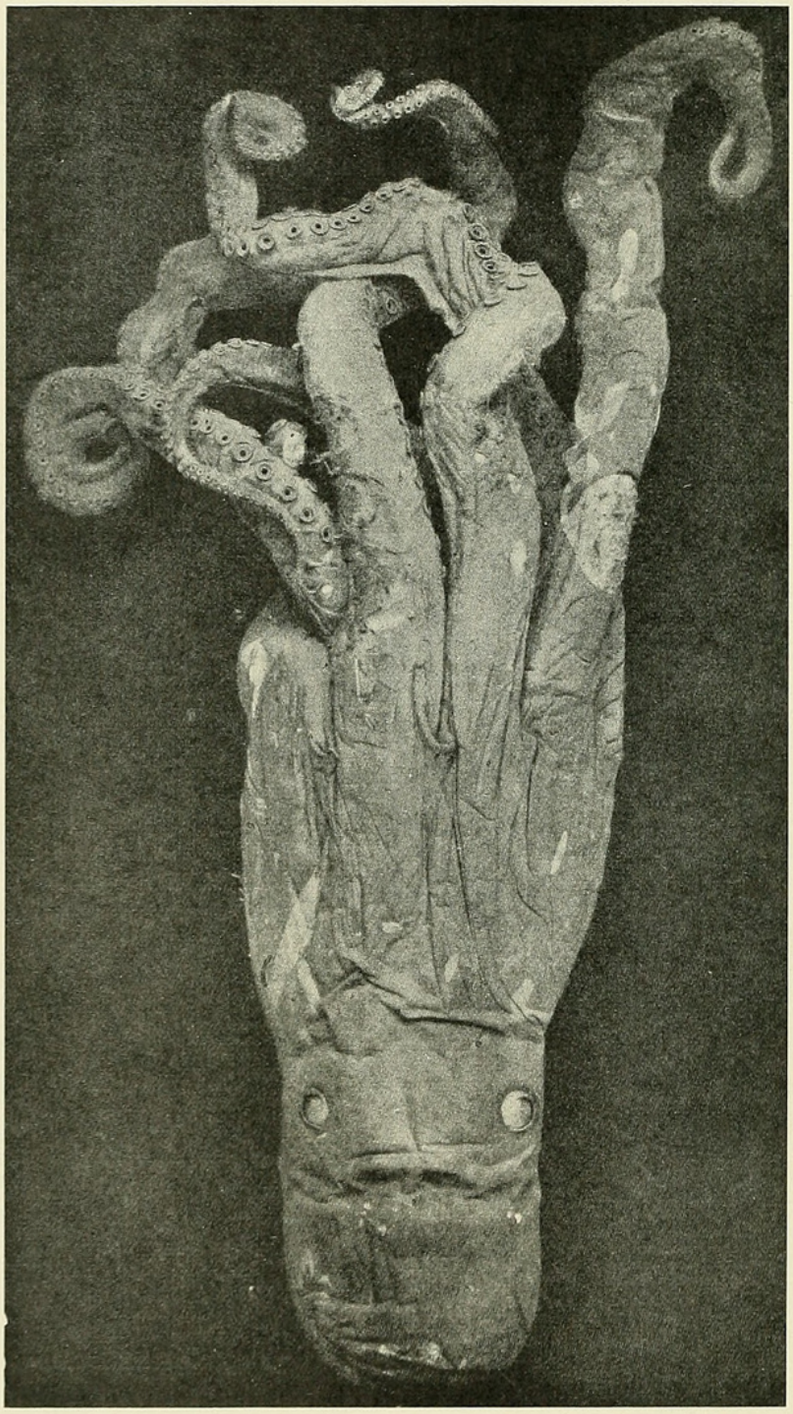


Fig. 5. *Octopus Lothei* n. sp. Stat. 41.

covered by the mantle. The third arms are the longest. The hectocotylisation implies an enlargement of all the suckers on the third right arm *(Bolitaena)*, or of the distal suckers of third right arm *(Eledonella)*. I intend in another paper to discuss more fully the reasons for establishing this new octopod family, comprising typical deep-sea forms, taken in the deep-sea nets of the expedition at various localities.

Eledonella Verrill.

Eyes comparatively small and bullet-shaped. Optic nerve strangely lengthened, arms frail, semitransparent.

Eledonella pygmaea Verrill.

Eledonella pygmaea, Verrill 1884, Trans. Connect. Acad., Vol. II, p. 145, pl. XXXII, fig. 2.

Stat. 45. 3000 m. w. 1 specimen.
„ 53. 2600 — 3 specimens, including a male having the fifth sucker (counting from the point) of the 3rd right arm enormously enlarged. The sixth and seventh suckers are smaller but still larger than the others.
„ 62. 3000 — 1 specimen.

Bolitaena Steenstrup.

Eyes elliptical, medium size. Arms coarse, non-transparent in the specimen preserved. All the suckers on the hectocotylised third arm grown large.

Bolitaena diaphana Hoyle.

Eledonella diaphana, Hoyle, Rep. Sc. Res. Challenger, Vol. XVI, 1886, p. 107, pl. IX, figs. 3—6.

Eyes elliptical, comparatively large; arms robust and in preserved specimens opaque.

Stat. 35. 2400 m. w. young specimen.
„ 53. 1600 — —„—
„ 53. 2600 — two well-preserved adult specimens.
„ 56. 300 — youngest specimen.

Small and transparent young stages of Bolitaenidae were taken at the following stations, but they are not easily referred to definite genera:

Stat. 64. 3000 m. w.
„ 92. 300 —
„ 92. 1500 —

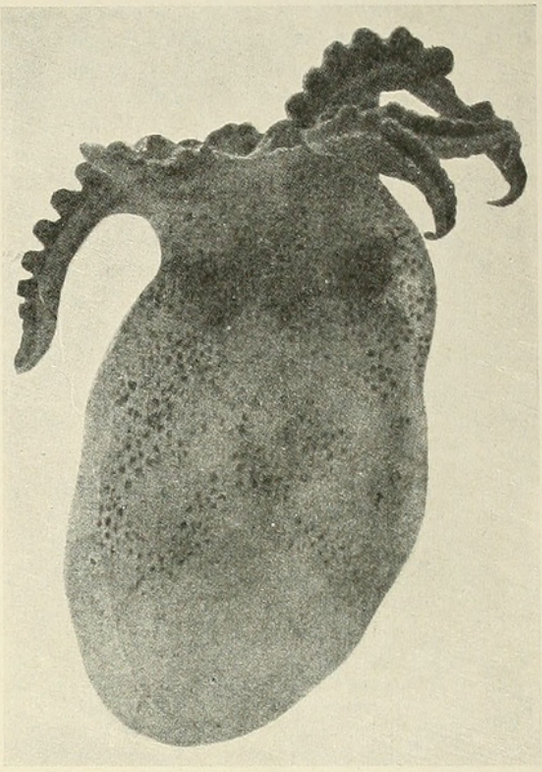


Fig. 6. *Bolitaena diaphana*. Nat. s. Stat. 53.

Cirroteuthidae Keferstein.

Opistoteuthis Agassizii Verrill.

Stat. 4. Trawl, 923 m. 4 specimens, which are very soft and considerably damaged. On the dorsal side the main colour is violet and on the ventral side chocolate brown, the light coloured suckers being very conspicuous. Judging from VERRILL's figure (Bull. Mus. Comp. Zool. Cambridge, Mass., Blake Cephalopoda, Suppl. 1883, pl. 1 & 2) the animal is longer in the median line than in transverse section. This does not apply to our specimen inasmuch as both axes are of equal length.

In two specimens I have found an enlargement in certain suckers, and I do not think I am wrong in supposing that this is connected with hectocotylisation. The largest and best preserved specimen exhibits after the sixth proximal sucker 4 or 5 broadened arm-suckers, of which the middle one is largest while the others decrease gradually in size. At the point of the arms 2 suckers are generally enlarged, sometimes abnormally so. Some of these enlarged suckers exhibit pathological alterations, being swollen and devoid of an aperture. The same condition is also found in smaller specimen, not only 4 or 5 proximal suckers but also 2 or 3 distal ones having been enlarged.

Cirroteuthis umbellata Fischer.

Cirroteuthis umbellata Fischer, P. 1883, Journ. Conchyl. XXIII, p. 402.
— — Fischer, H. et Joubin, L. Exped. Travailleur et Talisman, Cephalopodes, 1906, pag. 318, pl. XXIII, figs. 1—5, pl. XXV, figs. 9, 10.
— — Joubin, L., Camp. Scient. Monaco, Cephalopodes, 1900, p. 21, pl. I, fig. 1, pl. III, figs. 1—5, pl. XII, fig. 3.
— — Joubin, L., *Stauroteuthis hippocrepium* Hoyle, Rep. Cephalopoda Albatross, Bull. Mus. Comp. Zool. Cambr. 1904, Vol. XLIII, p. 6, pl. I, fig. 1, pl. II, fig. 1, pl. III, figs. 1—4.
— — Massy, Ceph. Dibranch. Irel. Sci. Invest. 1907. I, p. 4.

Stat. 25. Trawl, 2055 m. Well preserved specimen.
„ 52. „ 2615 m. 4 specimens.
„ 70. „ 1100 m. Badly damaged specimen.

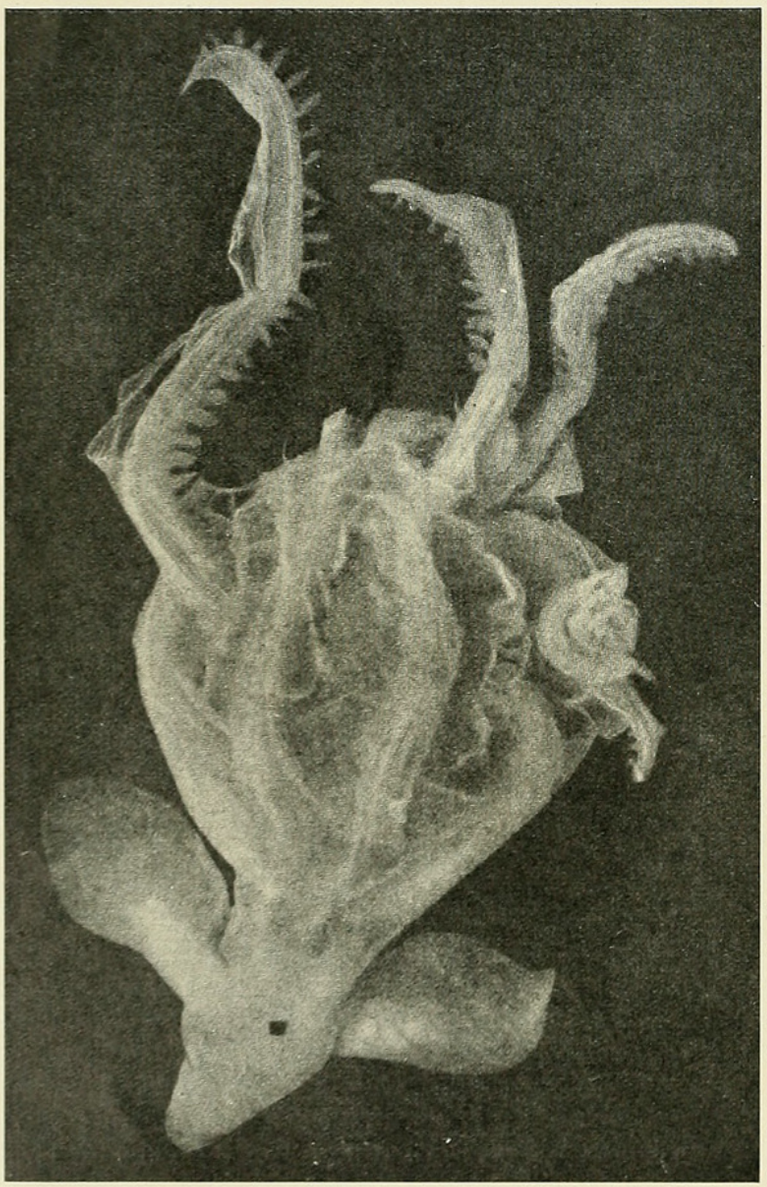


Fig. 7. *Cirrothauma Murrayi.* Photography of the preserved specimen.

I consider these specimens identical with the *Cirroteuthis umbellata* described by P. Fischer. As some of the specimens are considerable larger than the ones previously described some measurements may be recorded:

	Largest specimen	Large specimen	Small specimen
1st arm	300 mm	130 mm	72 mm
2nd „	260 „		
3rd „	230 „	104 „	
4th „	220 „	96 „	70 „
Length of fins	52 „	38 „	28 „
Length of mantle to centre of eye	83		
Diameter of eye		20 „	12 „

We note the fact that all the specimens were taken in the trawl. The coarse structure of the animal, and its likeness to *Opistoteuthis,* seem to indicate that we have to do with representatives of the genus *Cirroteuthis* which live near the bottom and form a transition to the typical bottom form *Opistoteuthis.* They are so like the genus *Opistoteuthis* that the somewhat damaged specimens at first sight might easily be mistaken for the latter.

Vampyroteuthis infernalis Chun.

Vampyroteuthis infernalis, Chun, Aus den Tiefen des Weltmeeres, 2 ed. 1903, p. 88.

Stat. 57. 2000 m. w.
„ 51. 3000 —

Two larvae, which I regret to say have been badly damaged. Their likeness to the genus *Vampyroteuthis* which I intend to describe more fully later, is so obvious, that I refer them to this genus.

Cirrothauma, n. gen.

C. Murrayi, n. sp.

Stat. 82. 3000 m. w. The present memoir ends with the description of a new and wonderful type of Cirroteuthidae, which may probably be counted among the most valuable spoils of the expedition. The specimen is a perfectly gelatinous semi-transparent cephalopod, the fragility of which recalls that of a ctenophore. Notwithstanding this, the specimen had been so well preserved in formalin, that I am able to give a suitable representation of it. Although the web on account of its excessive frailness has been torn, I consider it desirable to reproduce a photograph of the preserved specimen (fig. 7), because it conveys a good idea of this peculiar organism. The photograph shows that the posterior end of the body runs into a flap, the mantle having comparatively large fins. The eyes appear to be

strikingly small, the funnel, which is surrounded by a narrow closely fitting slit of the mantle, being long and slender. The arms are of nearly equal length, and are joined together by a web, which leaves only the distal arm-points free. The following table records the size-relations:—

Length of body from posterior end to eyes	40	mm
Ventral mantle-length to funnel	37	„
Length of each fin	39	„
„ - first right arm	108	„
„ - second „	118	„
„ - third „	100	„
„ - fourth „	110	„
Diameter of eye	3	„

The gelatinous body exhibits an exceedingly faint violet colour, and only the parts round the mouth, the proximal section of the arms, and the web exhibit the purple chocolate colour peculiar to many deep-sea forms. The animal being so transparent the arm-nerves may be traced throughout the entire length of the arms, while in the anterior region of the mantle the yellow urinary sacks and the black branchial-hearts are indistinctly visible through the mantle. Also the ganglion stellatum appears as a minute yellowish knot, situated about 10 mm. behind the eyes. Chromatophores are lacking, with the exception of a large rhombic one situated on the ventral side between the two fins.

In founding the new genus *Cirrothauma* on the present specimen, I rely mainly on a character which is unique not only among the Cirroteuthidae but among the Octopoda. If we look at the inner side of the arms (fig. 8), we find them covered with minute suckers poised on long spindle-shaped and clumsy stalks of gelatinous substance. In the middle region of the arms, the length of these stalks is 4 or 5 mm, but towards the arm-points they gradually diminish in size. The same decrease in size is also noticeable in the proximal direction, i. e. the stalks gradually assume the form of clumsy conical humps and finally disappear; the 6 proximal suckers of each arm are sessile. The number of suckers counted on each arm was strangely enough constant, viz. 36.

The adjoined photograph, fig. 8, of the arms serves better than words to illustrate the striking impression created by the sight of the whole arrangement. We may further note that the stalked suckers are evidently out of function, being flattened and devoid of the sucking pit, and smaller than the normal proximal suckers.

If we examine the spindle-shaped sucker-stalks in the middle part of the arms more closely, we find them to consist of a gelatinous connective tissue, isolated strands oi longitudinal muscles appearing on the surface of the latter, branching distally in a dichotomous manner. Out-

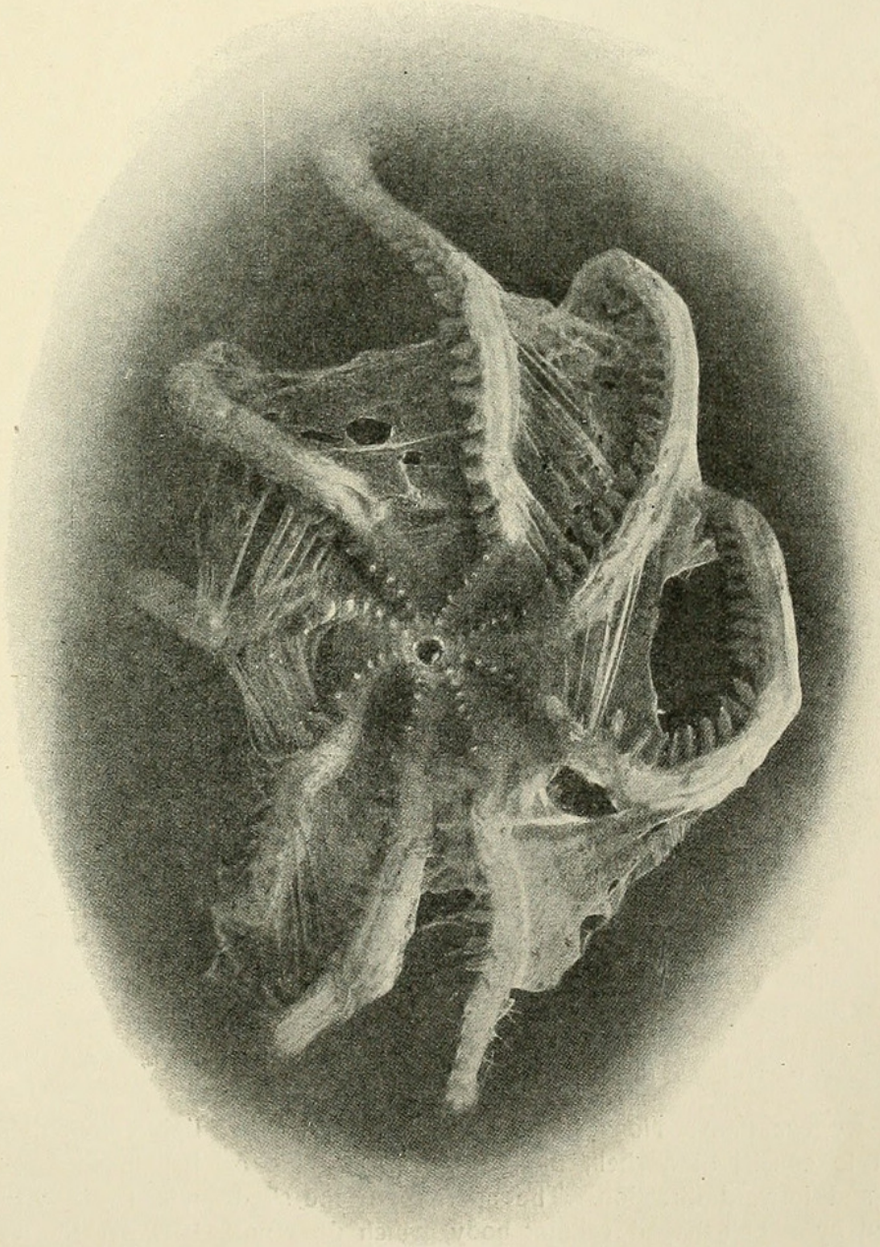


Fig. 8. *Cirrothauma Murrayi*. Oral aspect. The basal parts of the 8 arms visible.

side these we see in addition a system of exceedingly fine ring-muscles, while in the interior the capillary vessels, and also a whitish structure situated in the proximal third part of each stalk, are visible.

towards the point, thinning away towards the edge, and reminds one of the reflectors occurring in the light-organs of many Oegopsidae. It consists of a gristly substance, the scattered nuclei being surrounded by a

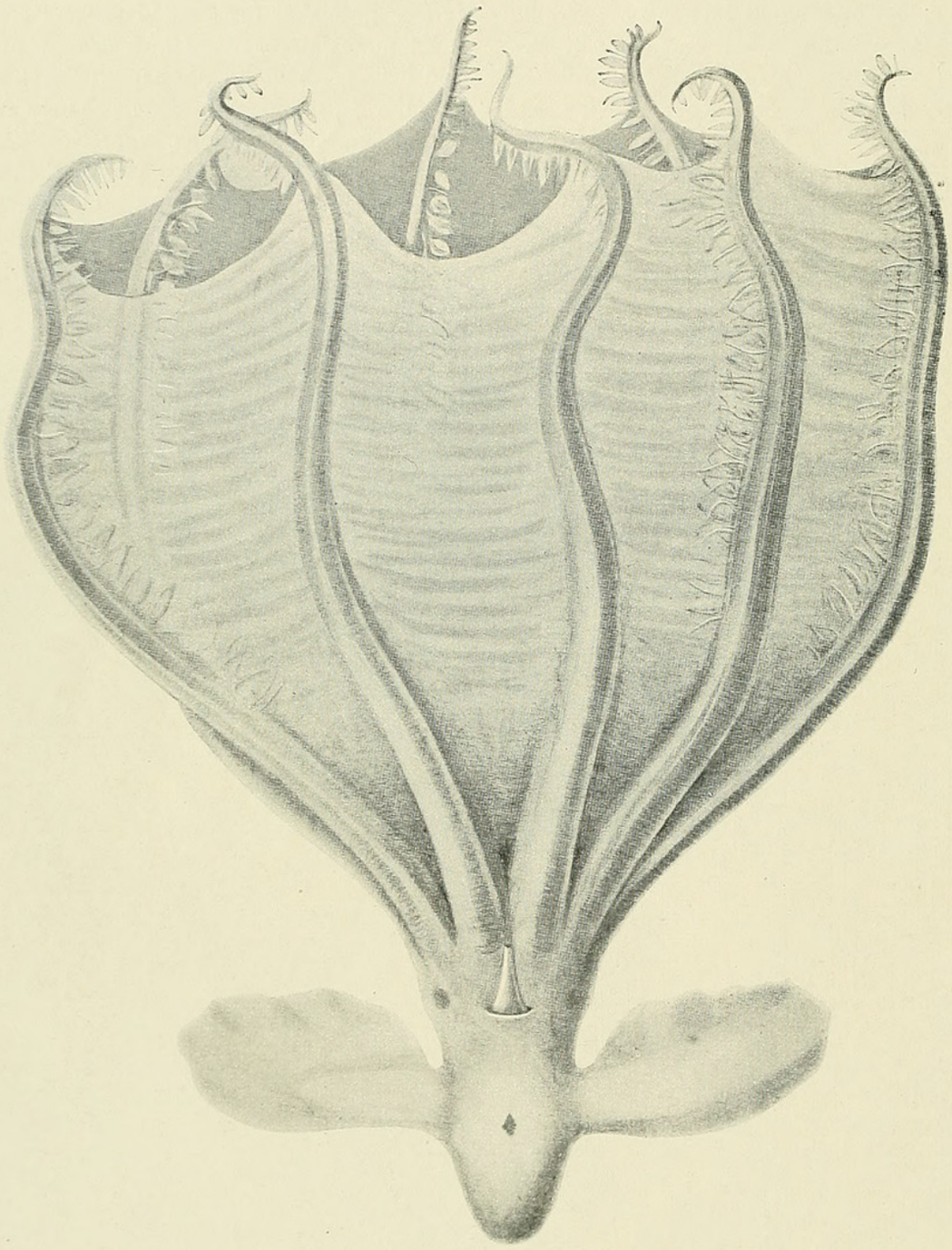


Fig. 9. *Cirrothauma Murrayi,* Ventral aspect.

If we examine sections of this whitish structure we find it to consist of a shell, the point of which has a distal and forward direction. The aperture of the shell is filled by a ball-shaped cellular body, which does not touch the edge of the shell. The latter is thickened

light-coloured area without pigment-covering. In the ball-shaped cellular body numerous small and round nuclei are visible, but there are no sharp divisions between the cells. Only on the proximal side more distinct grape-like cells occur.

I can only with some reserve venture to give an explanation of this structure. Without entering into hazy suppositions I will only point out that it first of all presents a certain likeness to a light-organ, the shell representing the reflector and the ball-shaped agglomeration of cells filling its aperture corresponding to the luminous body.

We may further mention that slender and transparent cirri alternate with the suckers or with their stalks, the longest of these cirri measuring about 7 mm. Besides this peculiar development of the arm suckers, which is unique among all known Cephalopoda, I may point to another equally surprising feature in the organisation of *Cirrothauma,* viz. that *Cirrothauma* is the only blind cephalopod known. I have already mentioned that the eye, situated between the second and third arms, is strikingly small, being only 3 mm diameter. It does not protrude, and a closer scrutiny proves it to be devoid of a lens. Seeing behind the eye, in the deep layers of the gelatinous mass, a second dark body, I decided to make a preparation of the entire structure, subsequently cutting it in sections. In this paper I will not enter into a detailed description but refer the reader to fig. 10, which illustrates the appearance of the isolated eye.

It is first of all striking that the eye as already stated is entirely buried in the jelly of the gelatinous body, the outer point of the eye being specially coated with a thick layer. The eye-bulb is almost ball-shaped, only a little flattened in front, devoid of pigment in the anterior third part, the rest being of a deep violet colour. The anterior border of the pigment is somewhat irregular, extending a little farther on the ventral side. The bulb is surrounded by a light-coloured space (a), representing the outer water-filled chamber of the eye. It is perfectly closed, and no trace of an opening is visible in our perfect specimen. This chamber overlaps the bulb behind, terminating in a ringshaped thickening, which perhaps may be explained as being homologous to the white body (alb.). The bulb is strangely thin in front and only a little thickened behind in the pigmented part. Above all the entire absence of a lens is confirmed, a fact noticeable on a merely superficial survey. Connected with this is the absence of a ciliary body and iris. The posterior side of the bulb is surrounded by gelatinous tissues, through the centre of which, as will presently be shown in detail, the optic nerve passes.

Behind the eye is located an almost equally large and also light violet coloured body (s. ven.), as previously mentioned. This body somewhat approaches the main axis of the animal, being of an irregular bullet-like shape, bulging a little behind. A large vein (v. ophth.) enters into this body, being presumably homologous to the v. ophthalmica of the normal cephalopod eye. The latter forms, as I have specially observed in *Bolitaena*, an enormous sinus around the optic ganglion. At first sight one might get the impression that the entire dark body represented an optic ganglion, but the sections show that very peculiar conditions are present, the body representing an enormous venal sac, densely filled with blood corpuscles. It is the latter which actually produce the dark

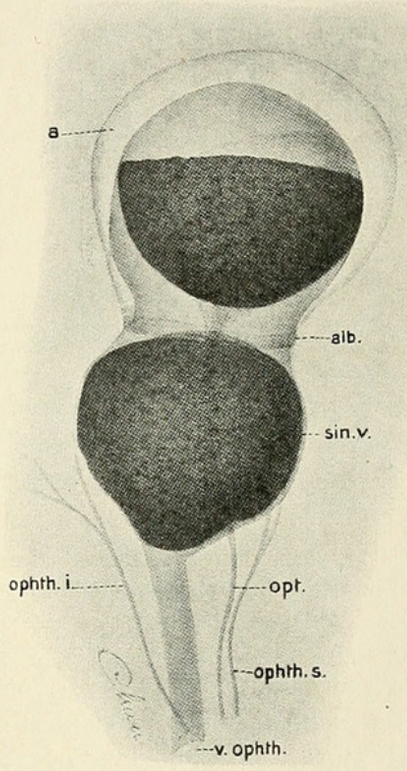


Fig. 10. Rudimentary eye of *Cirrothauma*.
a. External space surrounding the bulb. alb. White body. opth. i. Nervus ophthalmicus inferior. ophth. s. Nervus ophthalmicus superior. opt. Nervus opticus. sin. v. Sinus venosus. v. ophth. Vena ophthalmica.

colouring, and might easily induce anybody not familiar with the actual conditions to believe that one had to do with an optic ganglion filled with minute ganglion cells.

If we penetrate still deeper, the yellowish brain becomes faintly visible, sending 3 fine nerves towards the bulb. The middle one of these is the optic nerve (opt.), which is not actually rudimentary, but very thin compared with the optic nerve of other Cephalopoda. It runs right through the dark sinus venosus without forming any thickening which might be explained as the ganglion pedunculi. Between the sin. venosus and the bulb a faint knot-like swelling is noticeable, being possibly a rudimentary ganglion of the optic nerve. Single strands run from the latter place to the bulb. The difference from normal conditions is quite obvious. The optic ganglion

present in all Cephalopoda has been reduced to a faint thickening of the optic nerve just behind the bulb, and is entirely devoid of typical ganglion cells. Besides the the optic nerve we further notice two nerves approaching the surface of the bulb, branching in order to innervate the feebly developed muscle-lamellae, which are situated in the gelatinous tissues surrounding the eye. The dorsal one of these nerves corresponds to the N. ophthalmicus superior (ophth. s.), the ventral one corresponding to N. ophthalmicus inferior (ophth. i.).

Our description would be imperfect if we omitted to mention the layer, which we may consider as the retina

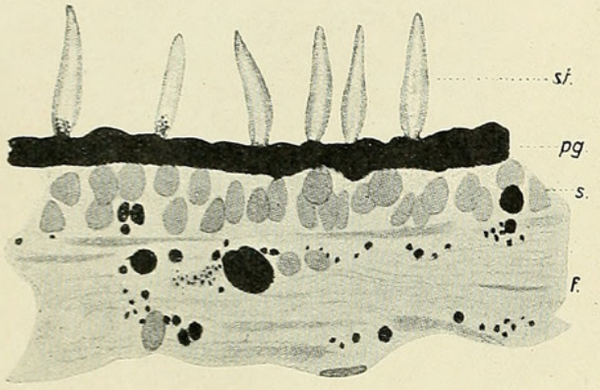


Fig. 11. Retina of *Cirrothauma*.
f. Fibrous layer. pg. Retinal pigment. s. Sense cells. st. Scattered rods.

(fig. 11). If we examine the pigmented part of the bulb somewhat closer, we find that this pigment is composed of two layers. The inner one of the layers coats the bulb with a dark and thin continuous layer, the outer one appearing on its periphery as isolated flakes or pigment granules; the dark violet hue of the bulb is mainly due to the latter. Behind the inner layer of pigment densely located nuclei are visible, being roughly arranged in two layers. They may possibly be considered as being the nuclei of pigment cells as well as nuclei of the retina cells. The degree of degeneration to which the eye has been subjected is most strikingly shown by the condition of the rods (st.). In all other Cephalopoda the latter are densely crowded and firmly welded together, exhibiting in transverse section the well known net-like structure. In our specimen however, they are widely separated from each other. They are strangely short and generally a little pointed at the free end, projecting like minute flames from the pigment-layer.

If we survey the whole of the conditions described, we recognise a reduction of the eye so far advanced, that nothing similar is known in the Cephalopoda. Among deep-sea Cephalopoda we certainly know forms with comparatively small eyes, but the very structure of the eye is never involved in the reduction. In the present case, however, we miss not only the dioptric apparatus, the lens and the ciliary body which forms the latter, but the optic nerve equally exhibits an extreme degeneration hitherto unknown in Cephalopoda. The ganglion pedunculi and the ganglion opticum are lacking, the white body which I consider as identical with the ringshaped thickening (alb.) being also rudimentary.

Finally, considering that the main layer of the retina (the layer of the rods) also exhibits an excessive degeneration, I think that I am justified in asserting—as I have done—that *Cirrothauma* is the only blind cephalopod known. The degeneration of the eye is much farther advanced than in the case of many blind vertebrates. Whether the development of light-organs in the gelatinous stalks is correlated to the degeneration of the eyes can only be settled if in future we should be lucky enough to bring one of these wonderful organisms to the surface alive and witness the organs mentioned by me actually emitting phosphorescent light.

In conclusion we may briefly discuss the question of the bathymetrical distribution of the Cephalopoda, as illustrated by the "Michael Sars" collections. In the first place we may remark that certain forms live at the bottom, having only been taken in the trawl. Typical denizens of the deep-sea mud are found in the genus *Opistoteuthis* taken at depth of 923 m. I consider the closely related *Cirroteuthis umbellata* only taken in the trawl in depths of 2615 and 2055 m as a bottom dweller, and also the large new *Octopus lothei* captured by the trawl in 1365 m. depth.

All the other Cephalopoda taken by the expedition are pelagic forms. As regards those among them which evidently prefer deep water, we have generally to do with rare guests represented usually by only a few specimens. It is impossible accurately to define the level at which they have actually been floating. During the cruise of the "Valdivia" our general impression was that the pelagic deep-sea Cephalopoda were either much rarer than the pelagic deep-sea fishes, or that they were better able to evade the nets. During the cruise of the "Michael Sars" large closing nets were employed, and the vertical range has been ascertained at least in the case of one species, viz. *Calliteuthis reversa,* which was taken at Station 52 in a haul between 1200 and 1000 m. The other closing-net hauls which yielded Cephalopoda were all made near the surface, as follows:

Stat. 10. 500—180 m. *Desmoteuthis pellucida,* 2 young specimens.
„ 63. 500—200 m. *Teuthowenia megalops,* 1 specimen.

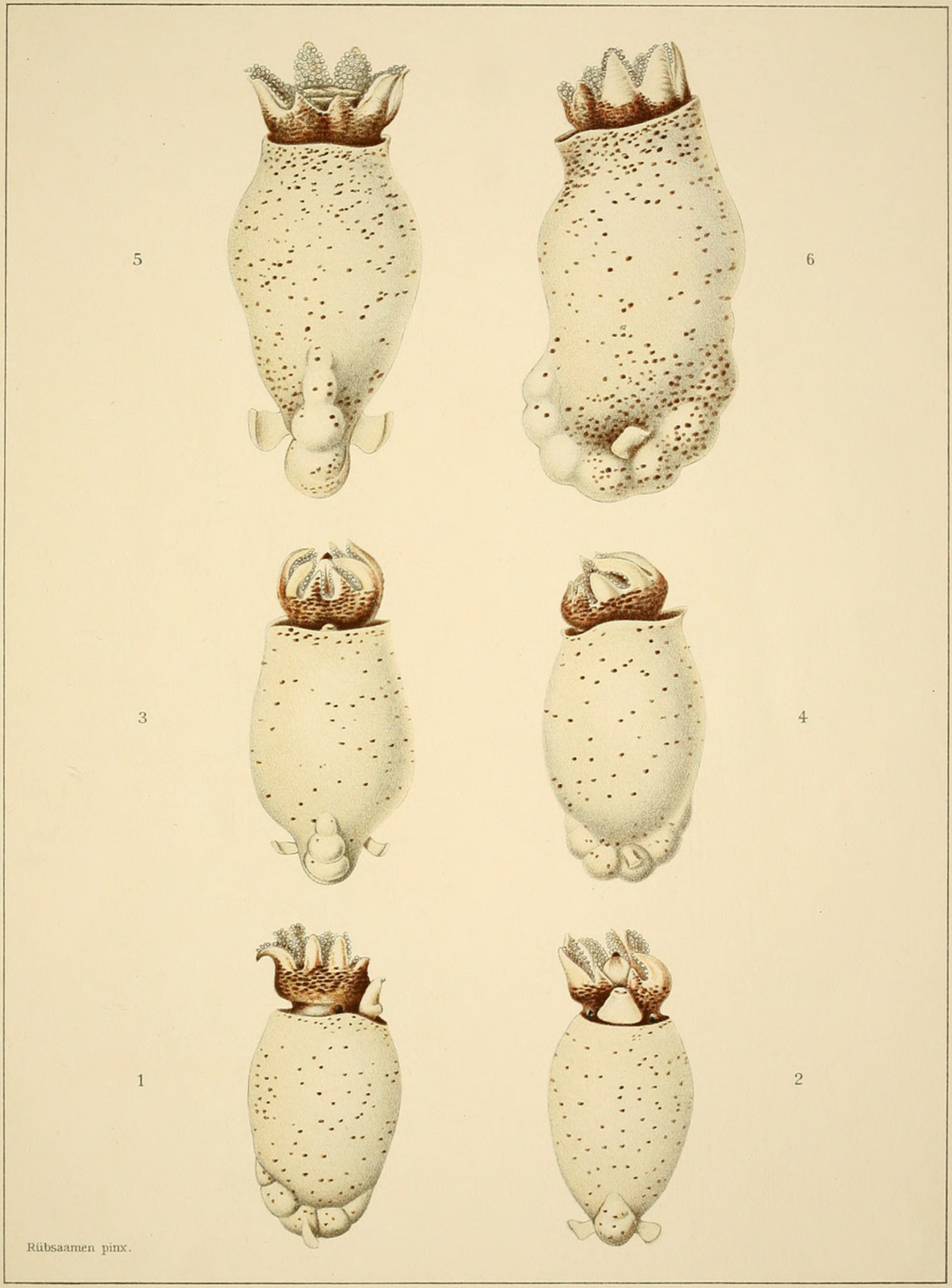
Otherwise all the rare and peculiar Cephalopoda, which from their organisation I consider as deep-sea forms, were taken by the "Valdivia" as well as by the "Michael Sars" only when large open nets were lowered to considerable depths. This applies to those forms the eyes of which according to my investigation exhibit pigment in the state peculiar to dark surroundings, and the body of which is generally provided with light-organs, very often exhibiting a gelatinous swelling.

If we examine the list of captures recorded in this report, we find that the Histioteuthidae, Veranyidae, Bathyteuthidae, Cirroteuthidae, and most of the Cranchiidae occur only in deep hauls. It is further noticeable that the larval forms have sometimes been captured in shallow water, while the adult animals have nearly all been taken in the nets lowered to greater depths.

The facts emphasized as regards the representatives of the Oegopsidae apply equally to a number of Myopsidae. Among the latter I consider the Spirulidae as pelagic deep-sea forms, having at some length attempted to show this, as well as the single specimen of *Rossia caroli*. Among the Octopoda the Bolitaenidae have representatives which are probably distributed only in deep water. Their larvae were only twice taken in nets lowered to 300 m.

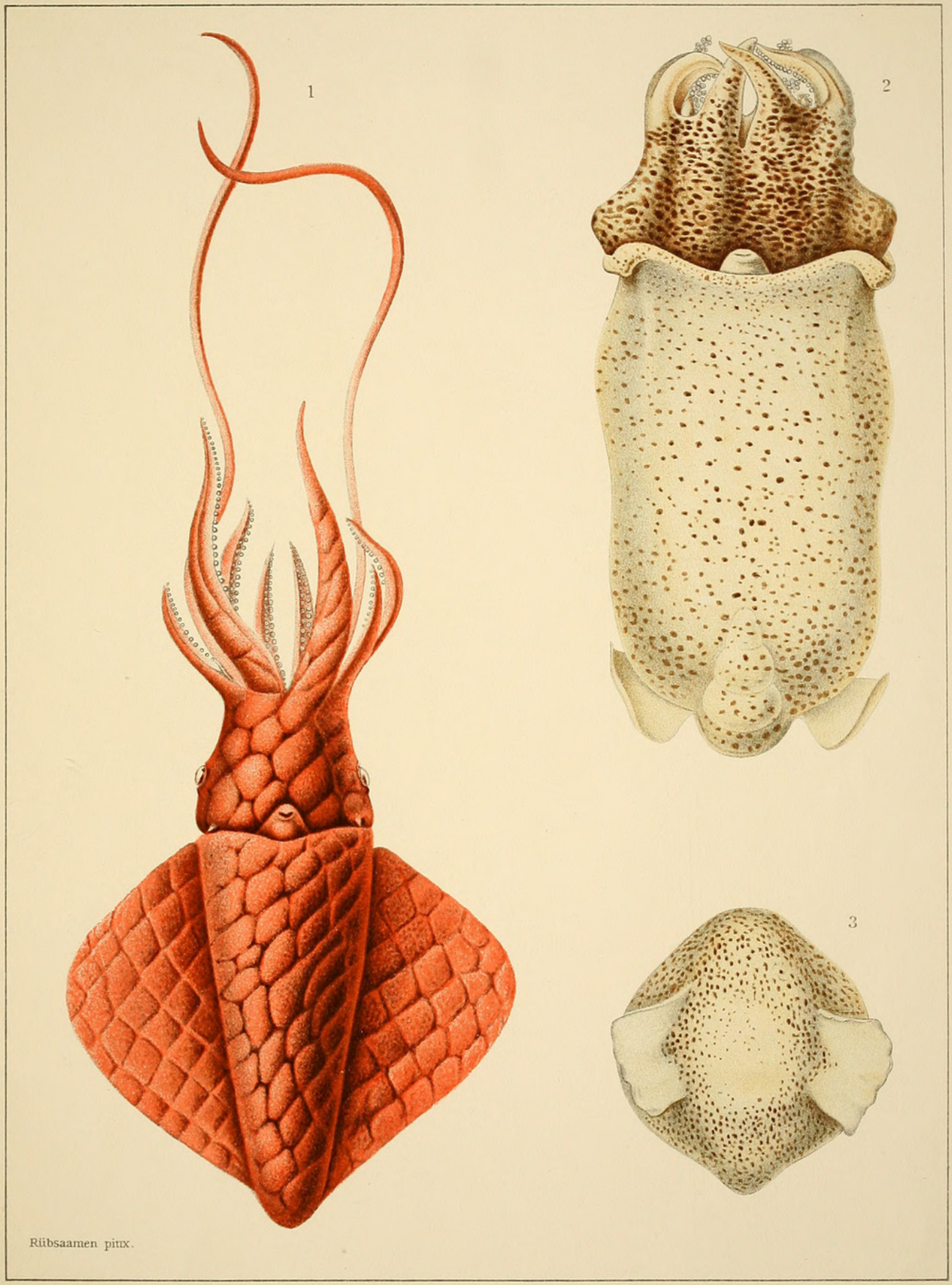
The blind genus *Cirrothauma*, one of the most precious spoils af the expedition, seems to show that among the Cirroteuthidae there are genera eminently suited to deep-sea life.

Experience from the "Deutsche Südpolar Expedition" shows that many fishes and Cephalopoda, provided with light-organs and from their structure probably deep-sea dwellers, arrive at the surface during the night. This applies in no wise to representatives of all deep-sea families, but only to certain groups. The above mentioned expedition captured *Cranchia scabra* and *Pterygioteuthis* at the surface at night, and it is noteworthy that these very forms were also taken by the "Michael Sars" in surface hauls during the night, as shown by the lists recording the captures of *Cranchia scabra* and *Pterygioteuthis Giardi*. Besides these we also notice *Brachioteuthis Riisei* which on the whole seems to prefer the surface layers. That exhausted or dead pelagic deep-sea forms may arrive at the surface has been emphasized by me before, but the expedition captured none of these.



Spirula Larvae.

Meisenbach Riffarth & Co., Leipzig.



1. Mastigoteuthis Hjorti. 2. 3. Spirula juv.

Meisenbach Riffarth & Co., Leipzig.