THE

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1933-34

VOLUME X

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THE PELAGIC TUNICATA

BY

R. B. SEYMOUR SEWELL, C.I.E., Sc.D., F.R.S.
(Lieut.-Colonel, I.M.S. [ret.])

WITH THIRTY-TWO TEXT-FIGURES AND ONE PLATE

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INTRODUCTION.

In the following Report I have dealt with the Pelagic Tunicata obtained by the John Murray Expedition to the Indian Ocean, 1933–34. The collection is not a large one for the study of the Plankton was not one of the primary objects of the Expedition, and in consequence only relatively few hauls of the Plankton-nets were carried out with the object of ascertaining what differences in the fauna could be correlated with the observed changes in the physico-chemical conditions that prevail at different depths.

I give below a list of those species that were obtained :

Class LARVACEA (= APPENDICULARIÆ).

Order COPELATA.

Fam. Fritillariidæ.

Subfam. Fritillariinæ.

Genus *Fritillaria* Quoy and Gaimard.

Subgenus *Acrocercus* Lohmann.

Fritillaria (*Acrocercus*) *formica* Fol.

Subgenus *Eurycercus* Lohmann.

Fritillaria (*Eurycercus*) *pellucida* (Busch).

Fam. Oikopleuridæ.

Subfam. Oikopleurinæ.

Genus *Oikopleura* Mertens.

Subgenus *Vexillaria* Lohmann.

Oikopleura (*Vexillaria*) *rufescens* Fol.

O. (*V.*) *dioica* Fol.

Class ACOPA (= CADUCICORDATA : THALIACEA).

Order SALPIDA (= DESMOMYARIA).

Fam. SALPIDÆ.

Group DOLICHODÆA Metcalf.

Genus *Cyclosalpa* de Blainville.

Cyclosalpa pinnata (Forskål) var. *sewelli* Metcalf.

Group POLYMARIA Streiff.

Subgroup SPHÆRODÆA Metcalf.

Genus *Salpa* Forskål.

Salpa maxima Forskål.
S. fusiformis Cuvier.
S. cylindrica Cuvier.

Subgroup CIRCODÆA Metcalf.

Genus *Ritteriella* Metcalf (= *Ritteria* Metcalf).

Ritteriella amboinensis (Apstain).

Genus *Metcalfina* Ihle.

Metcalfina hexagona (Quoy and Gaimard).

Genus *Iasis* Lahille.

Iasis zonaria (Pallas).

Genus *Thetys* Blumenbach.

Thetys vagina Tilesius.

Genus *Thalia* Blumenbach.

Thalia democratica Forskål.
T. democratica var. *orientalis* Tokioka.
T. longicauda (Quoy and Gaimard).

Group OLIGOMYARIA Streiff.

Genus *Pegea* Savigny.

Pegea confœderata (Forskål).

Order DOLIOLIDA (= CYCLOMYARIA).

Fam. DOLIOLIDÆ.

Genus *Doliolum* Quoy and Gaimard.

Subgen. *Doliolina* Borgert.

Doliolum (*Doliolina*) *indicum* Neumann.

Subgen. *Dolioletta* Borgert.

Doliolum (*Dolioletta*) *gegenbauri* Uljanin.
D. (*D.*) *valdiviæ* Neumann.
D. (*D.*) *denticulatum* Quoy and Gaimard.

Order PYROSOMIDA.

Fam. PYROSOMATIDÆ.

Genus *Pyrosoma* Peron.

Section *Pyrosomata fixata* Neumann.

Pyrosoma spinosum Herdman.

Section *Pyrosomata ambulata* Neumann.

Pyrosoma aherniosum Seeliger.
P. verticillatum Neumann.
P. verticillatum, forma *cylindricum* Metcalf and Hopkins.
P. verticillatum, forma *hybridum* Metcalf and Hopkins.
P. atlanticum (Peron).

Class LARVACEA.

Order COPELATA.

Family FRITILLARIIDÆ.

Genus *Fritillaria* Quoy and Gaimard.

Russell and Colman (1925, p. 227) have commented on the paucity of species of this genus in the collections made by the Great Barrier Reef Expedition, and they point out that in the records of the "Siboga" Expedition to the Malay Archipelago they were by no means common. In the present collection only two species are represented, each by a single example. Aida (1907, p. 4), in his account of the Larvacea of the Japanese coast, has noted that in that region the species of the genus *Fritillaria* "are always found in the swarms of *Noctiluca* together with *Kowalevskia*." A similar condition was present at Sta. 58 off the South coast of Arabia, lat. 22° 22′ 12″ N., long. 59° 57′ 30″ E. on 5th November, 1933, when enormous numbers of *Noctiluca* were swarming in the surface water and among these were the only two examples of *Fritillaria* that have been seen.

Fritillaria pellucida (Busch).

Eurycercus pellucida Busch, 1851.
Appendicularia furcata Vogt, 1854, p. 74, pl. x, figs. 1, 2.
Fritillaria furcata Fol, 1872, p. 32, pl. v, figs. 1, 2, pl. vi, figs. 1–3.
Fritillaria pellucida Lohmann, 1896, p. 32, pl. iv, figs. 1–7; Salensky, 1903, Pt. III, p. 99, pls. xii–xvi; Aida, 1907, p. 5, pl. i, figs. 9–14; Ihle, 1908, p. 92, pl. ii, figs. 24–29, pl. iii, figs. 36, 45–47, pl. iv, figs. 48, 49, 58–66; Essenberg, 1926, p. 461, figs. 85–88; Lohmann, 1931, p. 145; Russell and Colman, 1935, p. 235: Harant, and Vernières, 1938, p. 26, figs. 10, 41; Thompson, 1948, p. 66, pl. xix, fig. 4, pl. xx, figs. 1, 2; pl. xxi, figs. 1, 2.

OCCURRENCE: Sta. 58, South coast of Arabia, surface: 1 example.

REMARKS.—The body measures 0·75 mm. in length without the posterior processes. the width of the body is 0·26 mm. The length of the tail is about 1·20 times the length of the body, and its width is 0·31 of its length. The characteristic two pairs of large gland cells are present in the tail. The size of the specimen is small in comparison with examples from other regions. Busch, Vogt and Fol give the size of their examples as ranging from 1·8 mm. to as large as 3·0 mm. in length; Ihle's specimens from the Malay region measured 1·20 mm. in length, and Lohmann's examples were even smaller, measuring only 1·0 mm.

while Thompson (1948) in South-east Australian waters obtained examples that ranged from 0·6 mm. to 2·2 mm. in length.

In spite of its small size the present specimen appeared to be sexually mature: both the ovary and testis were well developed and closely resemble the condition figured by Lohmann (1896, pl. iv, fig. 5) and Fol (1872, pl. v, fig. 1).

Distribution.—This species is widely distributed throughout the warmer waters of all the great oceans.

Fritillaria formica Fol.

Fritillaria formica Fol, 1872, p. 35, pl. vii; Lohmann, 1896, p. 41, pl. vi; Ihle, 1908, p. 93; Essenberg, 1926, p. 481, figs. 119–124; Lohmann, 1931, p. 134, fig. 13; Harant and Vernières, 1938, p. 20, fig. 38; Thompson, 1948, p. 58, pl. xvii, figs. 1–3, pl. xx, figs. 3, 4.

Occurrence: Sta. 58, South coast of Arabia, surface: 1 example.

Remarks.—This specimen measures 0·63 mm. in body-length by 0·18 in breadth, and the tail measured 1·1 mm. in length. This is considerably smaller than the examples examined by Fol, in which the body measured 1·2 mm. and the tail 2·0 mm. Essenberg, however, obtained examples from the San Diego region that ranged in length of body from 0·4 mm. to over 1·0 mm.

Distribution.—Like the preceding species, it is found in the warm regions of all the great oceans, and has also managed to penetrate into the waters of the West Wind Drift (Lohmann).

Lohmann (1931, p. 134, fig. 13) has figured two forms of this species f. *digitata* and f. *tuberculata*, but their geographical distribution appears to be identical. Both forms occur throughout the tropical region and both extend their distribution into the Antarctic region.

The two above species, *Fritillaria pellucida* (Busch) and *F. formica* Fol, appear to be hardy forms capable of existing in a wide range of temperature: Lohmann (1931) has recorded their occurrence in areas in which the surface temperature of the water was as high as 28·5–29·7° C. Essenberg seems to be doubtful whether they do actually exist in water with as high a temperature as this, and states that in the San Diego region the temperature range within which they were found was from 12·8° to 14·29° C. for *pellucida*, and from 12·3° to 14·5° C. for *formica*: she points out that though Lohmann gives the surface temperature of the water at stations where catches were made, there is no means of determining whether the specimens actually came from this zone, since in most instances the tow-netting was made between the surface and some considerable depth. In the present case, however, there is no such doubt; the examples were taken in the immediate surface water and the surface temperature was 26·7° C.

In the "Siboga" collections *Fritillaria pellucida* was taken in 17 stations and *F. formica* in 8: they were the commonest species present in this region, and in the collections made by the "Valdivia" in the Indian Ocean they were the most common species between the Nicobar Islands and Ceylon, off the Seychelles, and again off the coast of East Africa in Lat. 1–6° S. They were the only species taken in the Gulf of Aden, so that their presence off the South coast of Arabia was to be expected. Lohmann and Buckmann (1926) have recorded the presence of these species as far south as Lat. 72° 20′ in hauls from 200–0 m., and the second species, *F. formica*, in a haul with the closing net between 500 and 350 m.

in lat. 54° 29′ S., long. 3° 43′ E.: there can be little doubt that these examples had been carried south in the North Atlantic intermediate current from warmer regions.

Family OIKOPLEURIDÆ.

Genus *Oikopleura* Mertens.

Oikopleura dioica Fol.

Oikopleura dioica Fol. 1872, p. 28, pl. iv, figs. 1–6; Lohmann, 1896, p. 76, pl. xvi, fig. 1, pl. xvii, figs. 4, 9; Lohmann, 1901, p. 11; Aida, 1907, p. 19, pl. iv, figs. 7–11; Kruger, 1912, p. 26; Essenberg, 1926, p. 485, figs. 125–129; Lohmann and Buchman, 1926, pp. 85, 145, figs. 17, 30², 33⁸ and 34²; Lohman 1831, p. 113; Berriil, 1950, p. 312, figs. 111 F, 112 D and 115; Harant and Vernières, 1938, p. 37; Thompson, 1948, p. 37, pl. v, fig. 2, pl. vi, figs. 1–3.

OCCURRENCE: Sta. 58, South coast of Arabia, surface: 9 specimens.

REMARKS.—As is so often the case, the present specimens appear to be relatively small: their measurements are as follows:

Body.			Tail.	
Length. (mm.).	Depth. (mm.).		Length. (mm.).	Breadth (mm.).
0·31	0·146	.	1·25	—
			1·25	—
0·383	0·187	.	1·33	0·2
0·52	0·24	.	1·53	0·2

Fol gives the length of his specimens as 1·00 mm. Lohmann obtained examples in Kiel Bight that measured 0·96 mm., and in the North Sea that were as large as 1·20 mm.: but he notes that occasionally he came across examples that were sexually mature but had a length measurement of only 0·3 or even 0·2 mm. Essenberg obtained examples in the San Diego region of the Pacific Ocean that ranged from 0·5 to over 1·0 mm.: she gives the length of the tail in her examples as being about 4 times the length of the body and its width as 0·17 of its length; in the present examples the width of the tail was only 0·13 to 0·15 the length, but this smaller figure may be due to post-mortem shrinkage.

DISTRIBUTION.—This species appears to be a very hardy one. It has been taken throughout the warm regions of all three great Oceans, Pacific, Indian and Atlantic. Its temperature range is also wide: Essenberg, quoting from Lohmann (1896), gives its range as extending from 3·2° C. to 29·5° C.; in the present instance the temperature in the surface layer in which it was taken was 26·7° C. Although usually taken in the upper layer above 200 m. depth, its ability to withstand low temperatures has enabled it in places to descend to much lower levels, and Lohmann (1896, p. 78) has recorded it from the Guinea Current in depths of 650–450 m. and 800–1000 m., the temperature in this last region being given as 5·2° C. Thompson (1948, p. 38) gives the range of temperature in which this species has been taken as 3·2° to 29·5° C.

The species possesses also a tolerance of a wide range of salinity, and Lohmann (1931, p. 114) has recorded it from the western end of the Baltic Sea in a salinity as low as 0·1‰; this tolerance enables it to exist in such estuarine regions as those of the Congo and Amazon rivers, while on the other hand it has been taken in the southern end of the Red Sea in water having a salinity of 36·95‰. It seems surprising that the species was not taken by either the "Siboga" Expedition to the Malay region or by the Great Barrier Reef Expedition.

Oikopleura rufescens Fol.

Oikopleura rufescens Fol, 1872, p. 27, pl. x, fig. 3; Lohmann, 1896, p. 74, pl. xvi, figs. 2, 4, pl. xvii, figs. 1–3, 6; Salensky, 1904, pp. 45–98, pls. vi–x; Aida, 1907, p. 17, pl. iv, figs. 1–6; Ihle, 1908, p. 114; Kruger, 1912, p. 26; Lohmann and Buckman, 1926, p. 24, figs. 16, 30[1], 33[7]; Essenberg, 1926, p. 491, figs. 136–139; Russell and Colman, 1935, p. 220; Harant and Vernières, 1938, p. 33, figs. 11, 25; Thompson, 1948, p. 35, pl. ii, fig. 4, pl. iv, figs. 2, 3, pl. v, fig. 1.

Occurrence: Sta. 58, South coast of Arabia, surface: several examples.

Remarks.—The size of the present specimens was as follows:

Body.		Tail.	
Length. (mm.).	Depth. (mm.).	Length. (mm.).	Breadth. (mm.).
0·458–0·625	0·229–0·321	1·46–2·50	—

This is somewhat smaller than the sizes recorded by Essenberg of examples taken in the San Diego region, which attained a length of 1·5 mm.; by Lohmann of examples from the Malay Archipelago which measured 0·653 mm. to 1·12 mm. in length; and by Fol, who gave the length of his examples from the Mediterranean Sea as reaching as much as 1·8 mm. in length. Thompson (1948, p. 35) obtained examples ranging from 0·4 to 1·9 mm. in body length in South-east Australian waters. This species is a warm water form and has been recorded in temperatures ranging from 11·0° C. to 29·0° C.

Essenberg (1926, p. 494) states that this species has never been taken in depths deeper than 200 m.; but Lohmann recorded specimens in a haul of the closing-net by the Plankton Expedition in the Atlantic Ocean between 1090 and 890 m., and by the "Valdivia," also in the Atlantic Ocean, between 550 and 250 m.

Class ACOPA (= CADUCICORDATA : THALIACEA).

The presence of denticulations on the external surface of the test in a number of the pelagic Tunicates has been known for many years. Herdman (1888, p. 81) called attention to these structures in *Salpa democratica* (Forskål), and pointed out that at the base of each denticulation there is a small test-cell that is "in the process of becoming a bladder cell." This denticulate condition of the test has been used by previous observers as a character for the separation of a new species, subspecies or variety in the Order Salpida: thus we have *Salpa aspera* Chamisso and *S. echinata* Herdman, both of which are now included as the forma *aspera* Chamisso of *Salpa fusiformis* Cuvier. Metcalf (1918) has described a variety of *Salpa maxima,* which he terms *tuberculata,* in which the aggregated zooid presents two thickened areas of the test which are covered with denticulations. In *Thetys vagina* Tilesius Herdman (1888) noted the presence of these small spines on the test of the solitary zooid and also of the form which he recorded as *Salpa* sp., which is now known to be the aggregated zooid of this species. Ritter and Byxbee (1905, p. 196) have recorded a similar denticulate condition of the test in certain specimens of the aggregated zooid of *Pegea confœderata* (Forskål) from the Pacific Ocean, and I have found a similar condition to be present in some examples of the solitary zooid from the Indian Ocean. In *Thalia democratica* (Forskål) denticulations are present along the processes that arise from the posterior region of the test and also around the margin of the oral and atrial apertures of the solitary zooid, and in many specimens of the aggregated zooid they form lines running along the length of the whole test; in *Metcalfina hexagona* (Quoy and Gaimard) the posterior processes of the test in the solitary zooid are similarly denticulated. In *Traustedtia multitentaculata* (Quoy and Gaimard) form *bicristata* of the solitary zooid the crests and the prominences at the two ends of the body are papillated, while in the aggregated zooid there is a large median postero-ventral pointed process, the surface of which is echinate and round the oral and atrial apertures the surface of the test is produced in a number of small papillae.

Similar small denticulations are to be found in the Pyrosomida; they occur along the three or four ridges of the triangular or quadrangular process of the test that lies just ventral to the oral aperture of the zooid in *Pyrosoma spinosum* Herdman, and Metcalf and Hopkins (1919, p. 261) have called attention to the presence of similar denticulations or papillæ at the tip of the processes of the test that overhang or surround the oral aperture in other species of *Pyrosoma*, namely *P. ovatum* Neumann and *P. atlanticum* (Peron). They remark, " outside the truncate surface, the tip of the oral test process bears numerous minute denticles, at the base of each of which lies a test cell, which doubtless either secretes the test material of which the denticle is composed, or so influences its arrangement that it takes the form of a denticle.

" These test cells are mesenchyme cells, which have wandered outside the zooids in which they arose, have migrated to a distance, and have each taken up a definite position in the test at a distance from the zooids, there to form or control the formation of a denticle." In a previous paper (Sewell, 1926, p. 77) I have pointed out that " it seems impossible to justify any separation, even as a distinct form, of those with a spinose test from those with a smooth one, though it is possible that Ritter and Farran are right in their belief that the spinose character is a mark of age." Farran (1906, p. 11) agrees with Ritter that in the case of *Salpa fusiformis* these denticulations are a mark of age, *aspera* being an older stage than the smooth *fusiformis*. Apstein (1894, p. 13) considered that it was in younger examples of *Thalia democratica* (Forskål) that these denticulations were to be found, but in my experience such a condition of the test may occur at any age up to mid-life, after which they tend to be eroded away. In the species *Pyrosoma atlanticum* (Peron) the examples in the present collection exhibit a gradual increase, following a rather late start, in the number of these small denticulations or papillæ with an increase in size and presumably of age of the colony; in the smallest examples there were no such papillæ either on the surface of the test or around the lips of the oral aperture; in somewhat larger examples they are present on the lips of the oral funnel, and in the larger examples they are seen scattered over the surface of the test; thus in this instance these papillæ would seem to be a mark of age and not of youth in a colony.

I also (*loc. cit.*, p. 65) suggested that in view of the great degree of plasticity that is found in the Salpida, to which Metcalf (1918) has called attention, and the periodic and rhythmic changes in the environmental conditions to which individuals are exposed in Indian waters (changes that may be so sudden and so great that they cause the death of many individuals), the final result may be the production of a number of variations, using this term in its widest sense.

Garstang (1933) has also put forward the view that such differences in the environment may have induced modifications in the development of certain species among the Doliolida, and that this has led to the creation of so-called "species" that are actually only modifications of a single species: and from my study of the Pyrosomida in the present collection I have come to the same conclusion, and regard a number of so-called species as stages in the gradual development of the colony (*vide infra*, pp. 57 *et seq.*).

Class ACOPA (= THALIACEA).

Order SALPIDA (= DESMOMYARIA).

Family Salpidæ.

Group Dolichodæa Metcalf.

Genus *Cyclosalpa* de Blainville.

Cyclosalpa pinnata (Forskål) var. *sewelli* Metcalf.

Cyclosalpa pinnata Metcalf, 1918, p. 9, figs. 1–14, pl. i, figs. 1, 2, pl. ii, fig. 5; Sewell, 1926, p. 68, figs. 1–4; Stiasny, 1927, p. 414, fig. A, pl. xx; Ihle, 1927, p. 24; Tokioka, 1927, p. 219; Russell and Colman, 1935, p. 210; Harant and Vernières, 1938, p. 33, figs. 2, 12 and 26; Thompson, 1948, p. 108, pl. xxxii, pl. xxxiii, figs. 1–4, pl. xxxiv, figs. 1–3.
Cyclosalpa pinnata sewelli Metcalf, 1927, p. 257.
Salpa proboscidialis Lesson, 1830, p. 25, pl. xxxiii, figs. 2, 2*a*.

Occurrence: Sta. 96, Central part of Arabian Sea, 10 m. depth: few examples of the solitary form.

Remarks.—These examples agree with the form which I recorded in a previous paper (Sewell, 1926), and which differs from the typical form in having, instead of the usual five, only four luminous organs between muscles II and VI, that between muscles I and II being absent.

The oral musculature agrees exactly with the description given by Metcalf (1918).

Distribution.—This species is widely distributed throughout the great oceans in the tropical and temperate regions. Up to now the variety *sewelli* has only been recorded from the Indian Ocean.

Group Polymyaria Streiff.

Subgroup Sphærodæa Metcalf.

Genus *Salpa* Forskål.

Salpa maxima Forskål. (Text-fig. 1.)

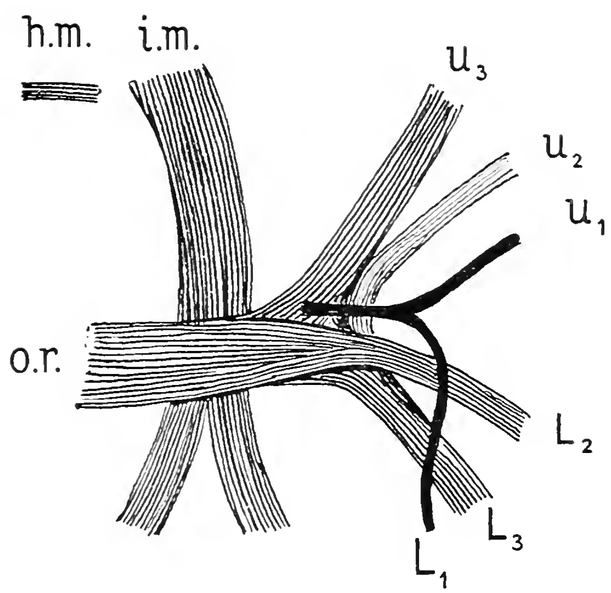
Salpa maxima Streiff, 1908, p. 21, figs. 9–14; Metcalf, 1918, p. 83, figs. 64–72; Sewell, 1926, p. 83; Stiasny, 1927, p. 419, fig. C, pl. xxi, figs. 13–15 (solitary zooid), 16–18 (aggregated zooid); Tokioka, 1937, p. 223; Harant and Vernières, 1938, p. 40, figs. 52, 61; Thompson, 1948, p. 154, pl. lxviii, figs. 1, 2, pl. lxix, figs. 1–6.

Occurrence:

Sta. 46, South coast of Arabia, surface: 3 examples of the aggregate zooid.

Sta. 95, Central part of Arabian Sea, 984–430 m.: 3 examples of the solitary zooid, 17 examples of the aggregated zooid.

Remarks.—Of the three examples of the solitary zooid taken at Sta. 95, two were normal in structure: but in the third example the Ist and IInd body-muscles are united



TEXT-FIG. 1.—*Salpa maxima* Forskål. Aggregated zooid, showing an abnormal arrangement of the oral musculature.

together in the mid-dorsal line by some of the fibres from the right part of body-muscle I being continued across the dorsal line into the left part of body-muscle II.

Aggregated zooid: With a single exception, taken at Sta. 46, all the present specimens belong to the variety *tuberculata* Metcalf. The average proportional lengths of the body and the two, anterior and posterior, processes are as follows:

	Anterior process (mm.).	Body (mm.).	Posterior process (mm.).
Sta. 46	30	43	25
	41	56	24
	47	63	42
Sta. 95	35	52	30
	35	55	30
	24	56	35
	35	64	20
	53	73	24
Average	35·7	57·75	28·75

Thus the average total length, including both the anterior and posterior processes, is 124 mm.; this is considerably larger than the example figured by Metcalf (1918, fig. 72) which appears to have had a total length of about 66 mm. The two thickened and spinose areas of the test agree with Metcalf's description.

According to Metcalf the musculature of this variety agrees with that of the typical form; but in two examples of the present collection that I carefully examined there is an interesting variation in the oral musculature. So far as I could determine, the Ist sphincter muscles in both the upper and lower lips arise from a small common retractor, that overlies but does not join the main oral retractor muscle, which divides anteriorly into the IInd and IIIrd sphincters of both the upper and lower lips. The anterior fibres of the IIIrd sphincter of the upper lip (U_3) are continued across the angle of the mouth and curl forwards and downwards to join the IInd sphincter of the lower lip (L_2). All the sphincter muscles are complete except the Ist sphincter of the upper lip, which is interrupted in the mid-dorsal line. This arrangement of the oral muscles corresponds closely with the arrangement found in the solitary zooid (*vide* Streiff, 1908, pl. i, fig. 9), except that the portion of the oral retractor muscle, which Streiff labels *za*, is markedly reduced, and does not appear to join the main retractor muscle but lies just dorsal to its commencement, where the IIIrd upper and lower sphincter muscles turn back to form the main mass of the retractor. Below the oral retractor muscle the intermediate muscle (*i.m.*) divides into anterior and posterior branches (Text-fig. 1).

In the other specimens the arrangement agrees with the description given by Streiff (1908, p. 22). The oral retractor muscles consist of two parts: the upper divides into three branches and forms the 1st upper (U_1) and the 1st and 2nd lower (L_1 and L_2) sphincters while the lower part forms the 2nd and 3rd (U_2 and U_3) upper sphincters and the 3rd lower (L_3).

Distribution.—This species appears to be rare in eastern waters. Apstein (1906*a*, p. 266 and fig. 4) has given a map showing its occurrence in the great oceans, and records only two catches in the eastern part of the south Pacific and another off Cape Horn. Tokioka (1937) has noted that Oka recorded its presence in Japanese waters, but states that he has never seen any examples from this locality. Metcalf (1918, p. 83) gives a number of records of the capture of this species in the region of the Sulu Archipelago and the Philippine Islands, all of them being from the surface waters. Thompson (1948, p. 156) states that it is of relatively common occurrence in the south-east Australian region, though the numbers taken vary from year to year, and was most common in the middle of the Tasmanian Area. Neither the "Siboga" nor the Great Barrier Reef Expedition obtained examples in the south-west Pacific region and the Malay Archipelago, and the "Valdivia" only obtained a few examples of the solitary zooid in the region to the north-east of New Amsterdam Island in the south-east part of the Indian Ocean. The "Valdivia" report unfortunately gives no indication of the actual depth at which these specimens were captured; they were taken in vertical hauls between 1800 and 2500 m. and the surface. I have recorded the occurrence of two examples of the aggregated zooid in a haul at "Investigator" Station 682 in the Laccadive Sea from 700 fathoms (1280 m.) to the surface. The present records from the Arabian Sea indicate that this species may occur at considerable depths, for 3 solitary and 17 aggregated zooids were taken in the self-closing net between 984 and 430 m. depth.

Salpa fusiformis Cuvier.

Salpa fusiformis Ihle, 1912, p. 39, figs. 37–40; Metcalf, 1918, p. 88, figs. 73–81; Sewell, 1926, p. 75; Stiasny, 1927, p. 424, text-fig. D, pl. xxi, figs. 19–21 and 22–24; Ihle, 1927, p. 26, figs. 4, 5; Harant and Vernières, 1938, p. 42, fig. 60; Thompson, 1948, p. 156, pl. lxx, figs. 1, 2, pl. lxxi, figs. 1–5; Berrill, 1950, p. 293, figs. 104D, F and I, and 106.

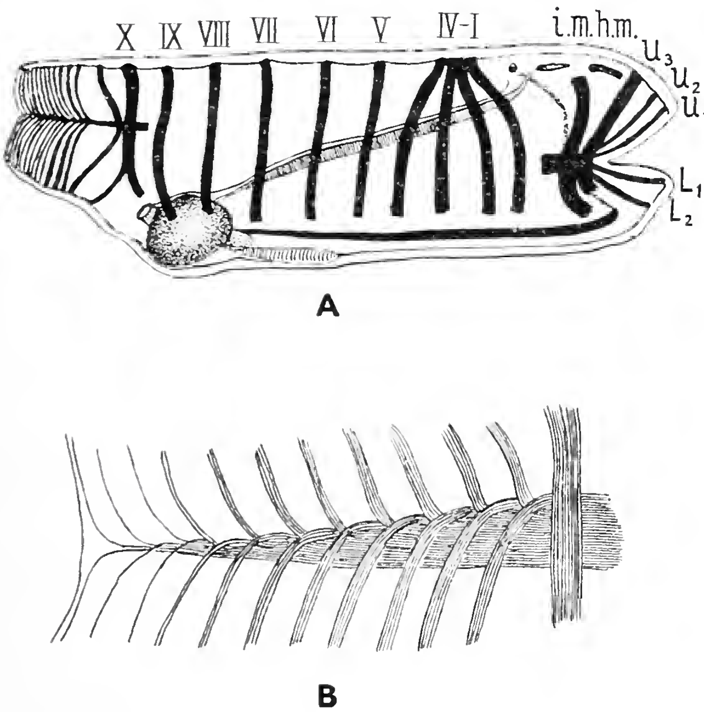
OCCURRENCE : Sta. 61, day, Northern area of Arabian Sea. 1000–0 m. : 2 examples, aggregated zooid.

REMARKS.—These examples were very small, measuring only 3·5 mm. in length.

DISTRIBUTION.—This species occurs in the warmer regions of the Pacific, Indian and Atlantic Oceans, and may occasionally be carried into higher latitudes. It has been recorded from about 60° N. in the Atlantic and 61° S. in the southern part of the Indian Ocean.

Salpa cylindrica Cuvier.

Salpa cylindrica Metcalf, 1918, p. 93, figs. 82–89 ; Sewell, 1926, p. 77, figs. 7–13 ; Stiasny, 1927, p. 429, fig. E, pl. xxii, figs. 25–30 ; Tokioka, 1937, p. 223 ; Russell and Colman, 1935, p. 217 ; Thompson, 1948, p. 161, pl. lxxii, figs. 1, 2, pl. lxxiii, figs. 1–5.



TEXT-FIG. 2.—*Salpa cylindrica* Cuvier. Solitary zooid. A, Side view of an individual possessing ten body-muscles. B, The atrial retractor of the right side.

OCCURRENCE : Sta. 7, Red Sea, 100–0 m. : large numbers of the solitary zooid.

Sta. 61, Northern area of Arabian Sea, 1000–0 m. : 2 aggregated zooids.

Sta. 95, Central part of Arabian Sea, 984–430 m. : 23 solitary and 9 aggregated zooids.

Sta. 172, Central part of Arabian Sea, 200–0 m. : 1 solitary zooid : 850–0 m., 1 aggregated zooid.

REMARKS.—*Solitary zooid :* The specimen from Sta. 172, 200–0 m. depth, is interesting, for it exhibits the variation in the oral musculature to which I called attention in a previous paper (Sewell, 1926, p. 79, fig. 9). The oral retractor gives off two sphincter muscles to each lip and in this instance all four are continuous across the middle line. There is also an additional body-muscle present, the total number being 10, instead of the more usual 9, and the Xth muscle-band divides below the level where it crosses the atrial retractor into a short stout anterior branch and a somewhat longer and more delicate posterior branch, exactly as Metcalf (1918, fig. 82) has figured for muscle IX. The atrial retractor crosses the Xth body-muscle and extends forwards for some distance but not as far as the IXth muscle. Just behind the Xth body muscle the atrial retractor is crossed by a moderately strong complete muscle-band, which in the lateral line bends forwards and comes into contact with the Xth body-muscle.

After a short course the atrial retractor commences to divide and gives off bundles of fibres which arise from the upper or dorsal border of the muscle and pass alternately ventrally and dorsally, as shown in Text-fig. 2B. There are eleven such muscle strands, and the most distal muscle of the atrial aperture is a delicate complete muscle strand that is not connected with the retractor.

This arrangement appears to differ from the account given by Streiff (1908), and copied by Metcalf, of the atrial musculature in both *Salpa maxima* and *S. fusiformis*; they show the dorsal muscle-bands arising from the atrial retractor muscle and the ventral bands crossing the atrial retractor on the outside and ending independently of it (*vide* Streiff, 1908, pl. I, fig. 10, and pl. ii, fig. 15).

Aggregated zooid: The examples of the aggregated zooid were very small and measured only about 7·0 mm. in total length. They appear to agree with the description given by Metcalf (1918).

Distribution.—This species has been recorded from the tropical region of all three great oceans, Pacific, Indian and Atlantic. It is possible that by the movement of the great water masses examples may be carried into colder regions. In order to account for the occurrence of specimens in such areas as Lat. 46° S. off Prince Edward Islands and lat. 52° S. off Kerguelen, from which, according to Herdman (1888, p. 72), the "Challenger" obtained single specimens "in bad condition", Apstein (1906*b*, p. 266) points out that through the Mozambique Current salps might be carried from the tropical area into the West Wind Drift and so be swept eastward: but the fact that these examples in the "Challenger" collection, always assuming that Herdman's diagnosis was correct, were in bad condition, suggests that they were dead and decomposing at the time of their capture.

Thompson (1948) reports that in the South-east Australian area it is limited to the more northerly regions; Russell and Colman (1935) record it from the region of the Australian Barrier Reef, but it "was not an abundant species."

Subgroup Circodea Metcalf.

Genus *Ritteriella* Metcalf.

Ritteriella amboinensis (Apstein). (Text-fig. 5A and C).

Salpa amboinensis Apstein, 1904, p. 651, figs. 2–10; Ihle, 1910, p. 34, pl. i, figs. 7, 8; Ihle, 1912, p. 44, figs. 45–47.

Ritteria amboinensis Metcalf, 1918, p. 56, figs. 29, 30; Sewell, 1926, p. 85, figs. 15, 16.

Ritteriella amboinensis Ihle, 1935, p. 528; Thompson, 1948, p. 126, pl. xlvi, figs. 1, 2, pl. xlvii, figs. 1–4, pl. xlviii, figs. 1, 2.

Occurrence: Sta. 96, Central part of Arabian Sea, 10 m. depth: a few solitary zooids.

Remarks.—I have in a previous paper (Sewell, 1926) pointed out that both the oral- and body-muscles of the solitary zooid vary in different individuals. In one example in the body-muscles, of which Metcalf (1918, fig. 30) figures eleven in his specimen, the anterior three meet in the mid-dorsal line: the IIIrd left muscle divides in the mid-dorsal line and a group of fibres swing backwards to join the IVth muscle on the right side and a similar arrangement is present in succeeding muscles till we reach the Vth muscle-band. The VIth muscle on the right side is formed by slips from both the Vth and VIth left muscles; the main mass of the VIth left muscle is joined by a branch from the VIIth left muscle to form the VIIth right muscle, and a branch from the VIIIth left muscle passes forwards across the mid-dorsal line to join the VIIIth right muscle, but the main mass of this muscle extends across the mid-dorsal line to form the IXth muscle. Thus in the posterior region of the body there is an extra muscle on the right side, the VIIIth left muscle becoming the IXth right muscle. The posterior three muscles are in touch with each other in the mid-dorsal line. In another specimen the Ist and IInd body-muscles come together in the mid-dorsal line: the IIIrd, IVth and Vth are connected by muscle-strands that cross from one to the other in the mid-dorsal line: the VIth to the IXth muscles are quite separate and form nearly complete rings round the body; and the Xth muscle divides into two in the ventro-lateral region.

DISTRIBUTION.—This species, so far as our knowledge goes, appears to be confined to the Indo-Pacific region. It has been recorded from the coast of Japan (Tokioka), the Philippine Islands (Metcalf), the Malay Archipelago (Apstein, Ihle), and from the South-eastern Australian region (Thompson) in the Pacific Ocean, and from the Nicobar Islands (Sewell) and the central part of the Arabian Sea (present record) in the Indian Ocean.

Genus *Metcalfina* Ihle.

Metcalfina hexagona (Quoy and Gaimard). (Pl. I, fig. 1; Text-figs. 3A and B, 4 and 5E.)

Salpa hexagona Ihle, 1910, p. 32, fig. 6; Ihle, 1912, p. 42, figs. 43, 44; Oka, 1915, p. 30.
Ritteria hexagona Metcalf, 1918, p. 62, figs. 35–47; Sewell, 1926, p. 87.
Metcalfina hexagona Ihle, 1935, p. 528; Thompson, 1948, p. 129, pl. xlix, figs. 1–4, pl. l, figs. 1–4.

OCCURRENCE: Sta. 68, Gulf of Oman, 1518–1491 m. depth: 2 examples and 1 empty test of the solitary zooid.

Sta. 96, Central part of Arabian Sea, 645–400 m.: 1 solitary and 2 aggregated zooids.

Sta. 120, Zanzibar area, 2926–0 m.: 1 solitary zooid.

REMARKS.—*Solitary zooid:* The length of the examples of this species ranges from 70 to 100 mm. without the posterior horns. In a previous paper (Sewell, 1926) I have suggested that the length of these horns gradually decreases proportionately to the length of the body with increasing age, or, at any rate, with increasing length; the same appears to be true of the present examples, as is indicated below:

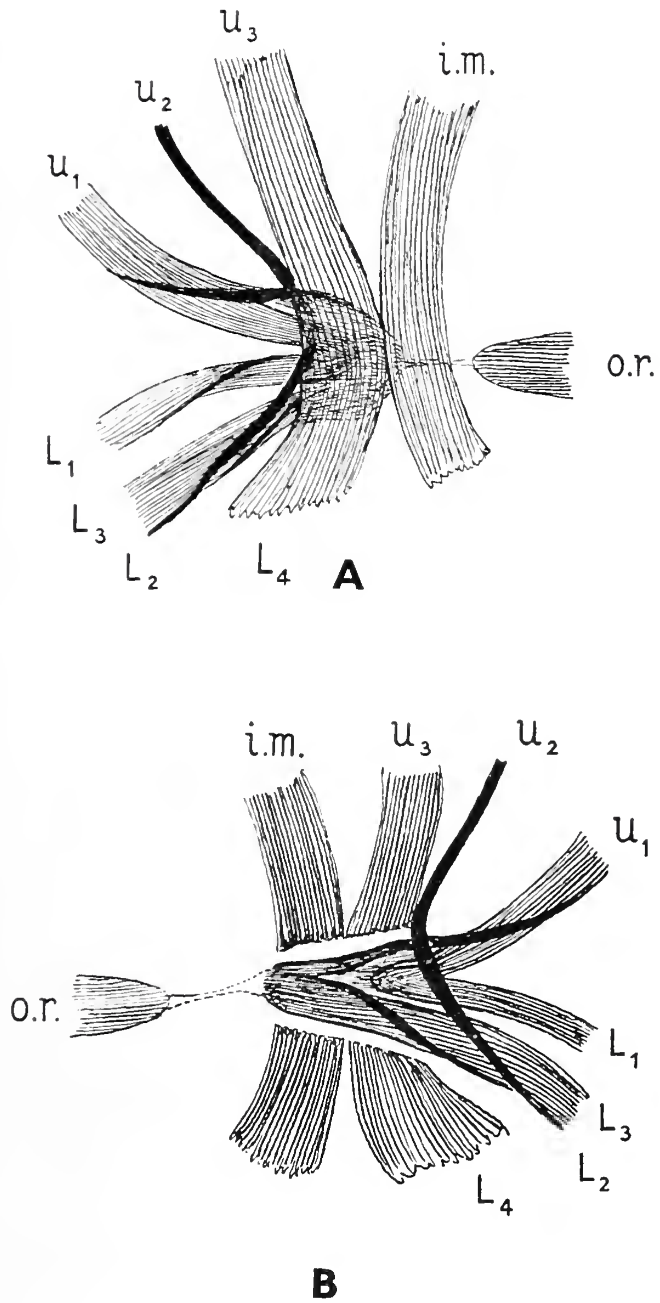
Length of body (mm.).	Length of posterior processes (mm.).	Ratio of body length to processes.
70	15	4·6 : 1
72	15	4·8 : 1
90	10	9·0 : 1
100	10	10·0 : 1

Metcalf (1918, p. 63, fig. 36) describes the arrangement of the oral musculature in the solitary zooid, as interpreted by him, as follows: "The intermediate muscle seems to be the very broad band which lies across the dorsal surface in front of the ganglion. The upper lip bears a broad IIIrd sphincter with a very delicate IInd sphincter branching from its base and a rather narrow admarginal sphincter attached at its base to both the oral retractor and the IIIrd dorsal sphincter. The lower lip has a rather narrow admarginal sphincter, continuous at each angle of the mouth with a rudimentary oral retractor muscle, whose unconnected posterior end lies horizontally between the intermediate muscle and body muscle I. A broad IInd sphincter lies near the base of the incurved flap of the lower lip. A IIIrd sphincter arises from the oral retractor in front of the IInd. It is at first broad, but soon narrows to a thread, which lies just beneath the IInd sphincter, that is, on the endodermal side of the incurved flap. . . . There are no horizontal muscles lying between the basal oral sphincter and body-muscle I, as there are in most species." I have studied the arrangement of the oral musculature in the present specimens and, so far as I can make it out, the arrangement is as follows (Text-fig. 3).

In the upper lip, when this has been everted so as to bring the muscle bands into their proper sequence, there is a fairly broad Ist sphincter muscle that, at the angle of the mouth, divides into two bundles, at the same time twisting on itself so that the upper fibres become the lower part of the muscle, both bundles of fibres run back and join the oral retractor muscle. Next to this is a smaller IInd sphincter muscle, the fibres of which on one side seem to end abruptly without joining any other muscle; but on the other side they appear to join the IIIrd dorsal sphincter muscle, and, after crossing the commencement of the oral retractor muscle, seem to be continued on as the IInd sphincter muscle in the lower lip, and this muscle-band crosses the fibres of the IIIrd lower sphincter muscle and runs parallel to it along its lower border. The Ist and IIIrd sphincters of the lower lip pass back and join to form the main mass of the oral retractor. The broad IIIrd upper sphincter muscle crosses the oral retractor and is continued on for a short distance as the IVth lower sphincter. The musculature of the body agrees closely with the description given by Metcalf (1918 p. 63 *et seq.*). Metcalf has called attention to the existence of branching strands of muscle that run horizontally between the last body-muscle and the most anterior anal sphincter muscle; in the example under review there were 10 body-muscles on the left side and 11 on the right; immediately posterior to the last body-muscle there is a small band of muscle that is in contact with the body-muscle X–XI in the mid-dorsal line but separates from it as it passes laterally, and then curves backwards and spreads out in a fan-like manner, and breaks up into separate fibres that spread out over the proximal atrial sphincter muscle and form an anastomosis with the branching muscle-fibres that run horizontally in the lateral region between the last body-muscle and the proximal atrial sphincter.

In the large specimen from Sta. 96 there is a well-developed stolon; this arises near the nucleus and passes forwards as far as the anterior border of the IInd body-muscle and then turns abruptly backwards to open through a narrow tube to the exterior near the posterior end (Pl. I, fig. 1). This stolon carried about 80 young aggregated zooids.

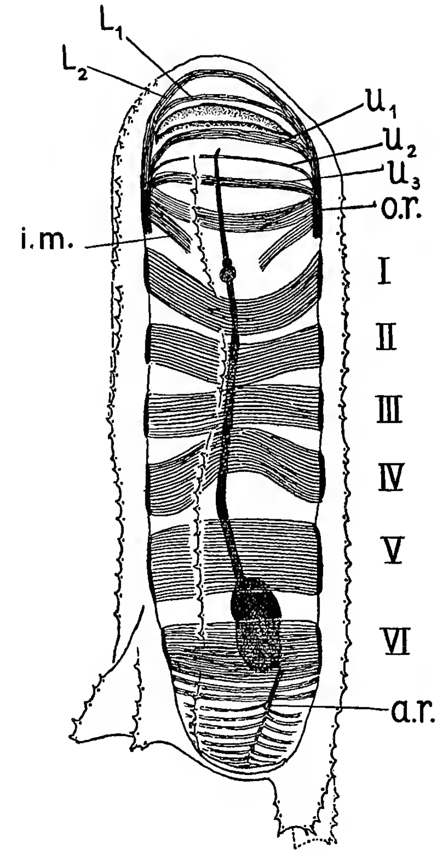
Aggregated zooid: Two well developed aggregated zooids were taken at Sta. 96; they measured 18 mm. in length. The test on the left side is produced posteriorly into an angular flange, and on the right ventro-lateral region into a pair of short truncated processes. The surface of the test is ornamented with several rows of short denticles (Text-fig. 4): in the anterior half of the body there is a long dorsal row of denticles that is continued



Text-fig. 3.—*Metcalfina hexagona* (Quoy and Gaimard). Solitary zooid. A, Oral musculature of the right side from within. B, Oral musculature of the left side from within; the parts of the U_3 and i.m. muscles, where they cross the oral retractor, have been dissected away.

with occasional interruptions back to the posterior end; on the left side a long row of denticles runs back to the posterior end where it is continued along the side of the triangular flange. On the right side a long row commences close behind the mouth-opening and is continued down the whole length of the body and then along the margin of the truncated process. Each denticle has at its base a round cell, with an oval nucleus, lying in a clear circular space. The oral- and body-muscles are as described by Metcalf (1918, p. 67, fig. 42).

An aggregated zooid from the terminal end of the stolon measures 4·7 to 5·8 mm. in length by 2·4 to 2·8 mm. in breadth. At this stage the triangular flange, in the present instance on the left side at the posterior angle, is well developed, though smaller than in the full-grown aggregated zooid ; but there is no sign of the truncated processes



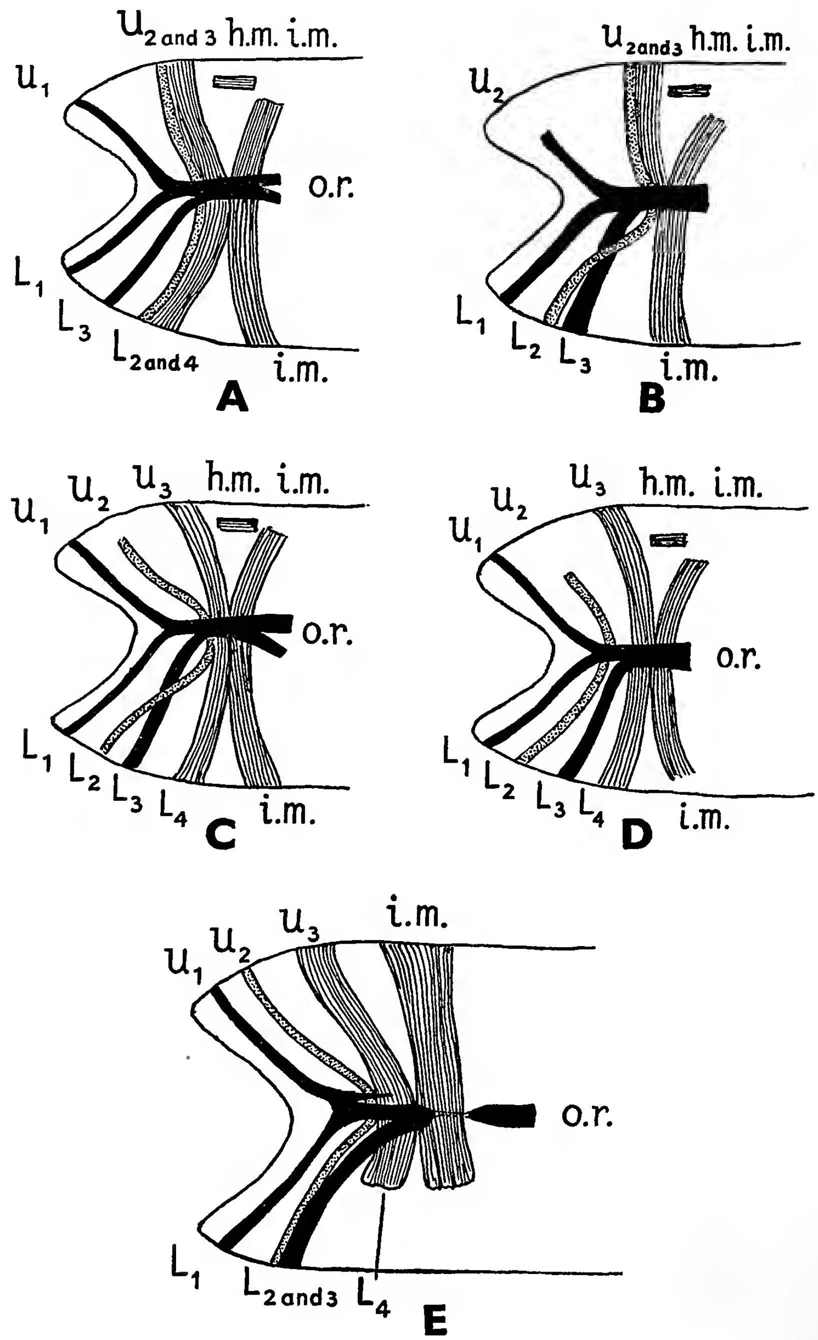
TEXT-FIG. 4.—*Metcalfina hexagona* (Quoy and Gaimard). Aggregated zooid, from the dorsal aspect.

at the right postero-lateral angle, the outer margin at this stage being rounded. The test is provided with numerous small denticles, each showing a rounded cell at its base. Two ova are present, and from the first of these a band of tissue leads up to the point between the Vth and VIth body-muscles where the embryo will eventually be located.

DISTRIBUTION.—This species is present in the warm regions of the Pacific, Indian and Atlantic Oceans, though as a rule it is taken only in small numbers. In the Indian Ocean it seems probable that the solitary form is an inhabitant of deep water. In every case the examples were taken in deep hauls of the tow-net, the depth ranging from 133 to 540 fathoms in the " Investigator " collections, and from 645 to 2926 m. in the " John Murray " collections ; and Metcalf (1918) recorded only 5 examples from the surface in the extensive collections that he examined from the region of the Philippine Islands. The aggregated zooids occur much more frequently in the surface collections, Metcalf (1918) recording over 243 examples from the surface waters round the Philippine Islands.

A comparison of the various accounts of the musculature of the oral aperture in the solitary form of the species of the genera *Ritteriella* and *Metcalfina* appears at first sight to indicate that there may be a considerable degree of variation, not only between species in the same genus, but even between individuals of the same species ; but it seems to me that to some and possibly to a large extent these differences are apparent rather than real, and have been caused by the difficulty of tracing the separate muscle-bands round the corner of the mouth owing to the inversion of the lips, and especially of the lower lip, that causes a twisting of the various bands.

The basic type of the oral musculature is seen in certain specimens of what I have taken to be *Ritteriella amboinensis* Apstein (1904, not 1906) ; in these examples, as I have shown in a previous paper (Sewell, 1926, p. 85, figs. 15, 16), there is a well developed oral retractor muscle that, at its posterior end, may be split into two parts and, anteriorly, divides into three branches ; one of these passes into the upper lip to form the 1st sphincter (U_1), and two enter the lower lip to form the sphincter muscles, the morphologically anterior of which (L_1) corresponds to the muscle U_1 of the upper lip, while the other, in the next stage of evolution, becomes the 3rd sphincter of the lower lip (L_3). The oral retractor muscle is crossed by a broad muscle band that is continuous across the mid-dorsal line and corresponds to the combined sphincter muscles U_2 and U_3 of the next stage and in the lower lip corresponds to the sphincter muscles L_2 and L_4. Behind this muscle lies a second broad band that is incomplete on the dorsal side and curves forwards to touch the posterior margin of the preceding broad sphincter muscle band and then swings backwards and passes round to join its fellow of the opposite side, forming what Metcalf terms the intermediate muscle. A similar arrangement of the oral muscles was found in an example of *Brooksia rostrata* (Traustedt) that I recorded from the region of the Nicobar Island (Sewell, 1926, p. 84, fig. 14), except that in this species the 3rd sphincter of the lower lip is prolonged into the anterior process of the body. The first change noted in the arrangement of the oral muscles is to be found in *Ritteriella retracta* (Ritter) : Ritter describes the arrangement, as interpreted by him, in the following words : " One continuous lip band, broader in dorsal lip, narrower in ventral where it divides into two and makes a sharp angle laterally. A pair of much smaller marginal bands in upper lip. A pair of short longitudinal bands in upper lip extending from broad lip-band nearly to dorsal termination of first body bands ; also a longitudinal band at each angle of the branchial orifice, extending back to the second body band and bending down into the ventral lip at its anterior end." This last muscle-band is, of course, the oral retractor muscle, and what Ritter terms the " first body band " is the muscle which Metcalf has termed the intermediate muscle. In Text-fig. 5B I have given a diagram of the musculature of this species, somewhat modified from Ritter's figure, for a careful examination of this seems to show that the anterior fibres of the broad sphincter of the upper lip separate off when crossing the oral retractor and are continued forwards across the IInd ventral sphincter. Komai (1932) describes the oral musculature of this species in the following words : " On the dorsal side there is a broad perfect sphincter (the IInd sphincter), and also a narrow imperfect sphincter (the Ist sphincter) near the lateral angle of the oral opening. A horizontal muscle stretches between the IInd sphincter and the intermediate muscle to be mentioned below ; the anterior end of the horizontal muscle almost touches the IInd sphincter. The ventral lip is inturned. There are three broad ventral sphincters, of which the IInd and IIIrd are the direct continuation of the IInd dorsal sphincter. The Ist and IIIrd sphincters are perfect muscles, while the IInd seems to be imperfect. . . . The oral retractor traverses these sphincters, as shown in Ritter's figure." In examples of what I diagnosed



TEXT-FIG. 5.—A diagrammatic arrangement of the oral musculature in the genera *Ritteriella* and *Metcalfina*. A, *Ritteriella amboinensis* (from Sewell, 1926). B, *Ritteriella retracta* (modified from Ritter, 1906). C, *Ritteriella amboinensis* (modified from Ihle, 1910). D, *Ritteriella picteti* (from Sewell, 1926). E, *Metcalfina hexagona* (from present specimens).

as *Ritteriella picteti* (Apstein) the arrangement of the oral musculature is as follows (Text-fig. 5D): the oral retractor passes forwards across the intermediate muscle and the IIIrd dorsal sphincter muscle, that is continued ventrally as the IVth ventral sphincter, and then divides into three branches: one of these passes into the upper lip to form the first sphincter (U_1), and the other two pass into the lower lip and form the Ist and IIIrd sphincters, L_1 and L_3. Near the point where the oral retractor divides a muscle, that appears to have been formed by the splitting off of a part of the posterior sphincter muscle-band, U_3 and L_4, crosses internally, the dorsal part, which is incomplete, forming the IInd dorsal sphincter U_2, and the ventral part forming the IInd lower sphincter L_2.

The upper part of this muscle appears to correspond to the small bundle of fibres that Ritter shows in his figure of *R. retracta* as passing downwards, running parallel to the anterior margin of the broad upper sphincter muscle till it reaches the retractor muscle, when it changes its direction and passing internally to the retractor, appears to run parallel to the Ist sphincter of the lower lip and crosses the IInd ventral sphincter.

Metcalf (1918, p. 58, figs. 29, 30), who has based his description of the oral musculature in *R. amboinensis* mainly on Ihle's figure, states that the oral retractor connects in front with the Ist sphincter of the upper lip and gives some fibres into the IInd lower lip sphincter. Most of the fibres of this sphincter pass on, outside the oral retractor, to form the Ist sphincter of the upper lip. The Ist sphincter of the upper lip and the IInd of the lower lip are thus connected, while the IInd sphincter and the very broad IIIrd sphincter of the upper lip continue below into the IIIrd and IVth sphincters of the lower lip: but in fig. 29 he clearly shows the Ist sphincter of the upper lip continuing into the IIIrd sphincter of the lower lip, while the IInd upper and lower sphincters are continuous; he also in this figure shows U_1 as a continuous muscle across the middle line and U_2 as incomplete, but in fig. 30 U_1 is shown as incomplete and U_2 as a complete muscle. In Text-fig. 5C I have shown my interpretation of the arrangement of these muscles, and for comparison I give in Text-fig. 5D the arrangement of the muscles in specimens that I (Sewell, 1926) attributed to *Ritteriella picteti* (Apstein).

It thus seems that throughout the series we can recognise two sets of oral muscles. The first set consists of the oral retractor, that may be split at its posterior end, as in *R. amboinensis* (Text-figs. 5A and C), a lower branch becoming separated as in Ihle's examples of this species: anteriorly this oral retractor divides into the Ist sphincter of the upper lip and two sphincters of the lower lip, the first situated admarginally and the second lying at first close behind this: some of the anterior fibres of the Ist upper and lower sphincter muscles may be continuous around the corner of the mouth. In a later stage of modification these two muscles become separated in the lower lip by another muscle that is derived from the second set, so that what was originally the IInd sphincter of the lower lip becomes the IIIrd. The second set of muscles runs dorso-ventrally. In the early stage of modification the strong muscle-band that runs across the mid-dorsal line represents the IInd and IIIrd upper sphincters combined, and this is continued internally across the oral retractor into the lower lip, where it represents the combined IInd and IVth sphincters. In a still later stage of modification a branch of this muscle separates off in the lower lip, as figured by Ritter in *R. retracta,* to form the IInd lower sphincter, and by crossing the second branch in this lip of the oral retractor comes to lie in front of it, thus making the original IInd sphincter (L_2) into the third sphincter (L_3) (Text-fig. 5B). At a still later stage a corresponding muscle slip separates off in the upper lip to form a second sphincter (U_2) (Text-figs. 5C and D). A comparison of these figures reveals a close agreement and the present opinion is that both the so-called species *R. retracta* and *picteti* are probably members of the same rather variable species (*vide* Komai, 1932), and it is not impossible that *R. amboinensis* is just another variation of the same species, though in this form the gut forms a vertical loop and does not possess a cæcum, as do the other two forms.

A further stage in the modification of the oral muscles appears to have been reached in *Metcalfina hexagona* (Quoy and Gaimard). Here the oral retractor has broken where it crosses the intermediate muscle but the anterior part divides into three branches, one passing into the upper lip as U_1 and two passing to the lower lip as L_1 and L_3. A second sphincter in the upper lip U_2 passes downwards and backwards, and according to Metcalf (1918, p. 64) is "attached at its base to both the oral retractor and the IIIrd dorsal sphincter." As I interpret the connections of this muscle-band it is continued across the retractor muscle close to the point where this divides into the Ist upper and lower sphincters and just beneath the anterior margin of the IIIrd upper sphincter; it is then continued downwards and forwards crossing the Ist and IIIrd sphincters of the lower lip and finally blending with the posterior fibres of this latter muscle, which close to its origin from the retractor is twisted, the upper fibres becoming the lower margin of the muscle (*vide* Text-fig. 3).

Genus *Iasis* Lahille.

Iasis zonaria (Pallas). (Text-fig. 6A–D).

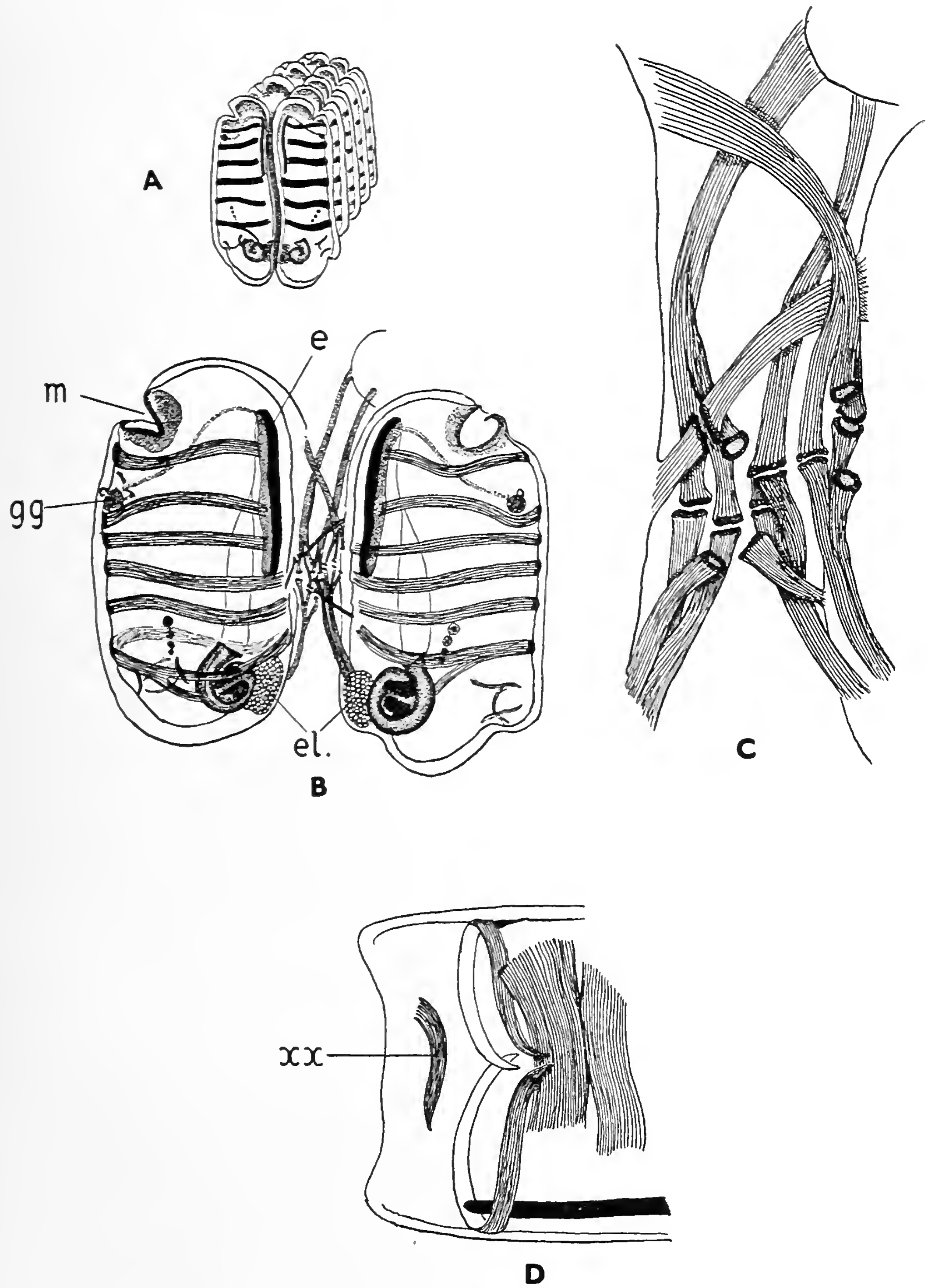
Salpa zonaria Streiff, 1908, pp. 45, 64, figs. A, K, pl. iv, figs. 31–33.
Iasis zonaria Metcalf, 1918, p. 100, figs. 90–103.
Jasis zonaria Sewell, 1926, p. 88, figs. 18, 19.
Salpa zonaria Stiasny, 1927, p. 434, fig. F, pl. xxii, figs. 31–36; Ihle, 1927, p. 28; Tokioka, 1937, p. 223; Russell and Hastings, 1933, pp. 635–640; Russell and Colman, 1935, p. 217.
Salpa (Iasis) zonaria Harant and Vernières, 1938, p. 43, figs. 53, 57; Berrill, 1950, p. 295, fig. 107.
Iasis zonaria Thompson, 1948, p. 132, pl. li, figs. 1–3, pl. lii, figs. 1–5, pl. liii, figs. 1, 2.

OCCURRENCE: Sta. 96, Central part of Arabian Sea, 645–400 m.: 8 examples of the solitary zooid.

Sta. 172, Central part of the Arabian Sea, 200–0 m.: 6 examples of the aggregated zooid.

REMARKS.—*Solitary zooid:* Of the eight examples of this form, taken at Sta. 96, seven were approximately the same size, ranging in length from 34 to 38 mm., but the ninth was much smaller, having a length of only 18 mm.

Streiff (1908) has given an account of the oral musculature in this form, but unfortunately he has not given a corresponding figure. Metcalf (1918, p. 102) states that this muscle system in his examples does not agree with Streiff's description, but this is, I think, due to Metcalf having misunderstood Streiff's account. In all the present specimens the oral musculature consists of a single sphincter in each lip, and lying at the sides of the oral aperture is a pair of comma-shaped muscle-bundles, which, as Streiff points out, encloses the mouth-opening like a pair of brackets, and these are situated in front and to the outer side of the actual sphincters; Metcalf has called attention to the different histological appearance of these muscle-bundles. Along the inturned margins of the lips there is an upper and lower sphincter muscle, both of which in my examples are continuous, thus differing from Metcalf's specimens, in which he states that they were interrupted in the middle line, and he figures a very small gap between the two ends of the dorsal sphincter (*vide* Metcalf, 1918, fig. 91). Both Streiff and Metcalf agree that at the angle of the mouth these two sphincters are united and run back a short way to form a retractor



TEXT-FIG. 6.—*Iasis zonaria* (Pallas). A, Part of the stolon of a solitary zooid. B, A pair of young aggregated zooids from the stolon. C, The "haft-organs" between two neighbouring aggregated zooids. D, The oral musculature of a specimen of the solitary zooid.

muscle, which, as Streiff has pointed out, ends on the outer side of the broad muscle-band, which Streiff terms the " Bogenmuskel," and which is the intermediate muscle of Metcalf. In most of my specimens the muscles agree with this description, but in one or two the sphincter muscles, instead of joining to form a small retractor, cross each other and end separately. Metcalf (*loc. cit.*, p. 102) remarks that " the second sphincter muscle of the lower lip, described by Streiff, and his Segelmuskel (' A ') are not represented in any of my numerous specimens." Metcalf appears to have misunderstood Streiff. The muscle which Streiff terms Segelmuskel A, is the same muscle that Metcalf in his figs. 90 and 91 terms " XX," and he has well described this pair of muscle-bands as resembling a pair of brackets at the corners of the mouth. Streiff was comparing the musculature of the solitary and aggregated zooids, and he remarks that the small second sphincter of the lower lip, which is present in the aggregated zooid, was not found by him in the solitary zooid, though he adds that it may perhaps be occasionally present for he had only two examples to study. In a previous paper (Sewell, 1920) I have confirmed the presence of the IInd sphincter in the aggregated zooid, but have never found it in the solitary zooid. It thus appears that there is no real discrepancy between Steiff's and Metcalf's accounts. Metcalf states that the sphincter in the upper lip is interrupted in the mid-dorsal line by a small break, but in the present examples this muscle is continuous.

In the solitary zooid it is usually accepted that there is only a single sphincter muscle that is followed by a wide intermediate muscle ; but in one of my examples this very wide muscle is composed of two distinct parts, as shown in Text-fig. 6D. The anterior part commences at a higher level than the posterior part and also ends ventrally slightly above the end of the posterior portion ; below the level of the retractor muscle these two parts are separate. Thus in both the solitary and aggregated zooids the wide so-called intermediate muscle is really compounded of two separate muscle-bands, which diverge slightly in the solitary zooid but cross each other in the aggregated zooid. It seems probable that the anterior portion is, in reality, the modified IIIrd sphincter muscle, and only the posterior portion represents the intermediate muscle.

The atrial musculature agrees exactly with the account given by Streiff. The Ist atrial sphincter is continuous around the margin of the aperture. The IInd sphincter arises as a single muscle-band that crosses the atrial retractor near its distal end but soon divides into two branches ; the ventral branch forms the IInd ventral sphincter and is continuous around the lower lip, but the dorsal branch divides into four or five strands that run inwards to join with their fellows from the other side in the mid-dorsal line and form the IIIrd dorsal sphincter. The IInd dorsal sphincter is a crescent-shaped band of muscle near the atrial margin. Metcalf (1918, p. 103, fig. 93) has described certain fibres that run from the reticulum of the IIIrd dorsal sphincter laterally to join the atrial retractor, but I have not been able to detect these fibres. The IIIrd ventral sphincter arises by two branches from the atrial retractor, and probably represents the fused IIIrd and IVth sphincters.

The aggregated zooid: The examples of this form that were taken at Sta. 172 were small : three specimens have a length measurement of from 6·4 to 6·8 mm., and at this stage of development the posterior end is uniformly rounded, as I have indicated in a previous paper (Sewell, 1926, fig. 19A). Two other examples measured 13·0 and 14·5 mm. in length and each was produced backwards in a smooth, conical tapering process, the proportional lengths of body and posterior process being as follows :

Length of body (mm.).	Length of posterior process (mm.).	Proportional lengths.
8·8	4·2	100 : 47·7
11·4	3·1	100 : 27·2

Ritter (1905, p. 77) has recorded that in some of his examples this posterior process equalled half the length of the body. At the two ends of the smaller barrel-shaped specimens there are three "haft-organs," as figured by Streiff (1918, pl. xxii. fig. 35), and a pair is situated in the mid-ventral line between the IInd and IIrd body-muscles opposite the posterior end of the endostyle.

The oral musculature agrees with the account of it that I gave in a previous paper (Sewell, 1926, p. 90, fig. 18).

The atrial musculature agrees with the account given by Metcalf (1918, p. 107, fig. 100). The IInd dorsal sphincter muscle is in most cases independent and is not connected with any of the ventral sphincters, but in one specimen a branch of this muscle on one side of the body joined the IInd ventral sphincter muscle.

The very young aggregated zooids, while the stolon is still contained within the body of the solitary zooid, are arranged in pairs, with their ventral surfaces closely approximated (Text-fig. 6A), and closely resemble the condition found in the young *Pegea confederata* (*vide* Brooks, 1893, pl. iv, fig. 1). Both ends of the zooid are rounded and there is no trace of any anterior or posterior process. The endostyle appears to be relatively shorter than in the fully grown stage, and reaches back only to the level of the IIIrd body-muscle instead of to the anterior margin of the IVth. The "haft-organs" by which each zooid is attached to its neighbours have a character that is quite different from any that I have examined in other species (Text-fig. 6B and C); the anterior and posterior haft-organs arise from the ventral aspect close to the extremities of the body and pass forwards and backwards as a long slender cord which, opposite the middle of the ventral surface and just behind the posterior end of the endostyle, divides into three branches, each branch ending in a sucker-like "haft-organ" that is closely applied to the corresponding sucker of the "haft-organ" of the neighbouring individual. The haft-organs that spring from the middle of the ventral surface are of the usual type and end in a single sucker-like disc.

Each of these young aggregated zooids carries four developing ova in the usual situation on the right side of the body and about on a level with the Vth body-muscle. On the ventral side of the nucleus a mass of eleoblast is present.

Distribution.—This species is widely distributed throughout the warmer parts of the Pacific, Indian and Atlantic oceans. In the Atlantic Ocean it has been recorded from lat. 40° S. to Greenland and Iceland; and in the Pacific from the Strait of Magellan to lat. 56° N., off Alaska: it appears to be carried into these northerly areas by warm currents from the tropical regions.

Genus *Thetys* Tilesius.

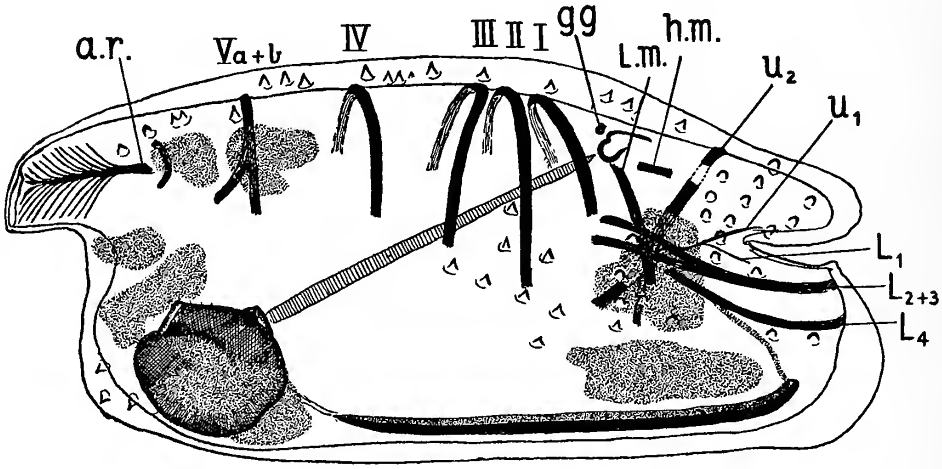
Thetys vagina Tilesius. (Text-fig. 7).

Thetys vagina Metcalf, 1918, p. 121, figs. 114–118; Sewell, 1926, p. 98, fig. 27*a*; Stiasny, 1927, p. 446, fig. H, pl. xx, figs. 10–12; Tokioka, 1937, p. 224, pl. xiii, fig. 3, pl. xiv, fig. 1.

Salpa (*Thetys*) *vagina* Harant and Vernières, 1938, p. 44, figs. 50, 58; Thompson, 1948, p. 136, pl. lii, figs. 3, 4, pl. liv, pl. lv, pl. lvi, figs. 1, 2; Berrill, 1950, p. 299, fig. 109.

Occurrence : Sta. 122, Zanzibar area, 732 m. : 9 examples of the aggregated zooid.

Remarks.—The body length of these individuals ranges from 50 to 74 mm. The test is thick, and scattered over the body are patches that present a finely granular appearance. The whole length of the dorsal aspect and the regions round the mouth and the nucleus are ornamented with scattered small pointed tubercles (Text-fig. 7). Herdman (1888) noted the presence of these spines in the solitary zooid and also in the form which he described as *Salpa sp.* and which has been shown to be the aggregated zooid ; he also described and figured certain tubular processes which projected from the surface and which he suggested might represent the attachment organs of the young zooid to the stolon. Apstein (1894, p. 16) in his account of the Salps of the Plankton Expedition has found the same structures in all the examples of the aggregated zooid and considers them to be the usual attachment organs. In the present examples I have not seen any tubular projections from the surface of the test, but in two specimens I was able to detect a canal that had a funnel-shaped depressed outer aperture and that opened on the interior by a round



Text-fig. 7.—*Thetys vagina* Tilesius. Aggregated zooid.

opening ; in one case this canal was situated not far from the mid-dorsal line near to the nerve-ganglion, and in the second example a similar canal penetrated the test on the left side in front of the muscle VI. Both of these appear to correspond as regards their position to the tubular projections recorded by Herdman and Apstein.

The oral musculature is as I have previously described (Sewell, 1926, p. 89, fig. 27*a*).

Tokioka (1937, p. 228, pl. xiii fig. 3) has, described the nursing apparatus in the aggregated zooid. Several specimens in the present collection bore a single developing embryo, and the structure of the apparatus agrees with Tokioka's description.

Distribution.—This species occurs in the warmer regions of all three great oceans, Pacific, Indian and Atlantic. In view of the fact that it has been recorded from Japanese waters (Tokioka) and from the Philippine Islands (Metcalf), it is somewhat surprising that it was not taken either by the " Siboga " in the Malay Archipelago or by the Great Barrier Reef Expedition. Thompson (1948) records it from the Tasmanian coast, and on one occasion it was taken by him off Wick on the north Scottish coast.

Genus *Thalia* Blumenbach.

Thalia democratica (Forskål). (Text-figs. 8, 9 and 10B.)

Salpa A and B, Huxley, 1851, p. 568, pls. xv, xvi.
Salpa democratica-mucronata Herdman, 1888, p. 79, pl. viii, figs. 1–10.
Salpa mucronata Apstein, 1906*a*, p. 171, figs. 27, 28 : Apstein, 1906*b*, p. 252, pl. xxviii, figs. 19, 20 ; Streiff, 1908, p. 38, pl. iii, fig. 28.
Salpa democratica Ihle, 1912, p. 51, figs. 57, 58.
Thalia democratica Metcalf, 1918, p. 109, figs. 104–112 ; Sewell, 1926, p. 92, figs. 20–26 ; Stiasny, 1927, p. 441, fig. G, pl. xxiii, figs. 37–42.
Salpa democratica Russell and Hastings, 1933, p. 638 : Russell and Colman, 1935, p. 210, figs. 104*c*, 105.
Thalia democratica, var. *orientalis* Tokioka, 1937, p. 226, fig. 1, pl. xiv, figs. 2–5.
Thalia democratica Thompson, 1948, p. 139, pl. lvi, fig. 3, pl. lvii, figs. 1, 2, pl. xviii, figs. 1–3, pl. lix, figs. 1–4.
Salpa (Thalia) democratica Berrill, 1950, p. 291, figs. 104*c*, and 105.
Salpa cabotti Agassiz, 1866, p. 17, figs. 1–5.

OCCURRENCE :

Sta. 61, northern area of Arabian Sea.

Day :—500–0 m. : 2700 solitary and 4100 aggregated zooids. 1000–0 m. : 2240 solitary and 5200 aggregated zooids. 1500–0 m. : 840 solitary and 12,000 aggregated zooids.

Night :—Surface. Small numbers of both solitary and aggregated zooids. 1000–0 m. : 3200 solitary and 3100 aggregated zooids. 1500–0 m. : 280 solitary and 1080 aggregated zooids. 2000–0 m. : 600 solitary and 160 aggregated zooids.

Sta. 76, Gulf of Oman, 200–0 m. : a few aggregated zooids.

Sta. 96, central part of Arabian Sea, 1–0 m. : numerous examples. 645–400 m. : 3 solitary zooids.

Sta. 131, Southern part of Arabian Sea, 500–0 m. : vertical, 5 solitary and 36 aggregated zooids.

Sta. 145, Maldive area, 100–0 m. : a few examples. 500–0 m. : 2 solitary zooids.

Sta. 172, central part of Arabian Sea, 200–0 m. : 2 solitary zooids. 400–0 m. : 3 solitary zooids. 1850–0 m. : 4 solitary zooids.

REMARKS.—*Solitary zooid :* The size of these examples exhibits a wide range, and both solitary and aggregated forms appear to fall into three groups, the body (without the postero-lateral processes) having the following average measurement :

	Solitary zooid (mm.).	Aggregated zooid (mm.).
Group I	0·82	0·96
Group II	3·35	2·65
Group III	6·03	6·18

The examples of Group I have only recently been born.

It is interesting to compare the relative sizes of examples that have been taken in different localities. Apstein (1901) has recorded examples that were taken between the Hebrides, Faroe Islands and Norway that had a total length of 25 mm. : although it is not so stated, it seems probable that this length includes the posterior processes. Agassiz (1866) gives the length of specimens of *Salpa cabotti* Desor from the region to the south of Cape Cod as being 1 inch (25 mm.) long in the solitary stage and five-eighths of an inch (15·5 mm.) in the aggregated form. Examples taken in the English channel near Plymouth measure 17 mm. in length without the posterior processes in the solitary stage and 12 mm in length in the aggregated form. In his account of the Salps of the German South-Polar Expedition Apstein (1906*a*) gives the length as being 24 mm. or without the posterior processes 16 mm. Herdman (1888) gives lengths of 13 mm. with the posterior processes of examples from the South Pacific Ocean in lat. 38° 7′ S., long. 94° 4′ E., and of 10 mm. without the processes of those from the South Atlantic. Bomford (1913) called attention to the relatively small size of specimens taken off the Burma coast, the largest that he measured being only 11 mm. long, and Stiasny has recorded examples from Java having a length of from 7–12 mm. Specimens from the tropical region of the Indian Ocean recorded by me (1926) ranged from 6·0 to 11·0 mm., and finally Berrill (1950) gives the length as " about 8 mm.," but does not specify any particular locality. In the present collection the largest examples measure about 8·0–10·0 mm. without the posterior processes.

In a previous paper (Sewell, 1926, pp. 93, 94) I have indicated that in examples taken in the Andaman Sea the length of the posterior processes of the solitary zooid varies with the size, and presumably with the age, of the individual; I then gave the average proportional lengths of these processes and of the body of the salp, as follows:

Body length (excluding processes) (mm.).	Proportional lengths of processes and body.
6.0	1 : 2·1
7·0	1 : 2·8
8·0	1 : 3·3
11·0	1 : 3·7

In the present collection I have measured a number of examples of different sizes, from small individuals that have just been set free from the parent aggregated zooid to those with a length of body of over 8·0 mm., and the results obtained are as follows:

Number of examples measured.	Average length of body (mm.).	Proportional lengths of processes and body.
54	0·74	No posterior processes.
5	2·10	1 : 4·19
4	2·50	1 : 3·75
5	2·95	1 : 1·61
7	3·85	1 : 1·97
15	5·78	1 : 2·47
17	7·03	1 : 2·73
1	8·67	1 : 2·89

It thus appears that there is a rapid growth in the length of these processes between the time of birth and of attaining a body-length of about 3·0 mm., after which the proportional length of these processes steadily diminishes. In certain rare instances these posterior processes appear to be longer than usual: at Sta. 131 (day). in the southern area of Arabian Sea, a few examples were taken in a vertical haul from 500–0 m. and one of these gave the following measurements:

Length of body (mm.).	Length of posterior processes (mm.).	Proportional lengths of processes and body.
5·5	4·62	1 : 1·18

In this instance the length of the posterior processes closely resembles the condition found in the nearly related species *Thalia longicauda* Quoy and Gaimard.

Stiasny (1927) has described and figured the various ridges that occur on the test, and in certain individuals these ridges are covered with small denticulations, at the base of each of which is a rounded cell, as described by Herdman (1888, p. 81, pl. viii, fig. 5). Tokioka (1937, p. 229) has also recorded the presence of these denticulations in some of the individuals captured by him in Japanese waters, and he terms these denticulated examples f. *echinata*. The degree to which this denticulation is developed varies very considerably: in every case the protuberances from the test, such as the postero-lateral processes, are denticulated and the lateral atrial palps present three rows of such denticulations, a row along each ridge of the thick lateral border and a third row down the thinner inner margin. The degree of denticulation of the test over the body also varies considerably: in many individuals it seems to be altogether absent, even on the lateral ridges, whereas in others these lateral ridges are strongly denticulated and denticulations are also scattered over the surface between the ridges. The margins of the oral aperture, both above and below, are also denticulated.

The body muscles: The number of fibres in the body-muscles has been used by Apstein (1906*b*) as a character to distinguish the aggregated zooid of *Thalia longicauda* Q. & G. from that of *Thalia democratica*, and Tokioka (1937) has used the same character to distinguish between the f. *typica* and f. *orientalis* of the solitary zooid of the present species. A study of the muscles in a series of examples in the present collection shows that the number of fibres in these body-muscles is by no means constant, and I give below the number of fibres in each of the body-muscles in examples of different lengths from different stations:

Solitary zooid, f. *typica*.

Total length of body (mm.).	Sta.	Depth (mm.).	Muscle bands. I.	II.	III.	IV*a*.	IV*b*.	Total.
2·6	61, day	500–0	5	6	5	7	4	27
2·9	,,	,,	7	8	7	7	5	34
3·0	,,	,,	5	6	6	6	5	28
	,,	,,	6	6	6	6	4	28
	,,	,,	7	7	6	5	3	28
3·1	,,	,,	7	8	6	7	4	32
3·2	,,	,,	5	5	5	6	3	24

Solitary zooid, f. *typica*—(continued).

Total length of body (mm.).	Sta.	Depth (mm.).	Muscle bands. I.	II.	III.	IV*a*.	IV*b*.	Total.
3·2	61, night	1000–0	8	8	8	8	4	36
4·1	,,	,,	8	7	8	8	6	37
	,,	,,	9	8	8	7	6	38
4·25	,,	,,	9	9	9	9	8	44
4·1	61, day	500–0	6	7	8	8	6	35
4·7	61, night	1000–0	8	7	9	8	5	37
5·0	61, day	500–0	6	5	5	6	6	28
	61, night	1000–0	8	7	8	8	7	38
5·2	,,	,,	8	7	10	9	5	39
5·33	,,	,,	7	9	7	7	3	33
5·4	61, day	500–0	7	8	8	8	5	36
	,,	,,	8	8	9–10	9	6	40–41
	61, night	1000–0	7	8	9	10	6	42
5·6	,,	,,	9	8	8	7	6	38
	61, day	500–0	6–7	7	8	7	6	35
6·0	61, night	1000–0	9	8	10	9	6	42
	,,	,,	8	8	9	8	3	36
	61, day	500–0	8	7	8	8	5	36
6·1	,,	,,	8	7	8	8	5	36
6·2	,,	,,	7	8	7	8	5	35
6·33	,,	,,	7	7	6	5	3	28
	61, night	1000–0	9	8	9	8	6	40
	172	400–0	8	12	12	12	8	52
6·6	61, day	500–0	8	8	8	8	5	37
6·7	,,	,,	8	8	8	7	5	36
	61, night	1000–0	8	8	9	9	4	38
6·8	61, day	500–0	8	8	7	8	5	36
	,,	,,	8	8	8	8	5	37
6·96	61, night	1000–0	8	7	8	10	6	39
7·0	61, day	500–0	8	8	8	8	5	37
7·7	172	400–0	9	12	9	11	9	50
7·8	172	850–0	9	12	9	9	6	45
7·3	61, night	1000–0	11	11	10	10	8	50
8·2	172	850–0	10	12	10	13	6	51

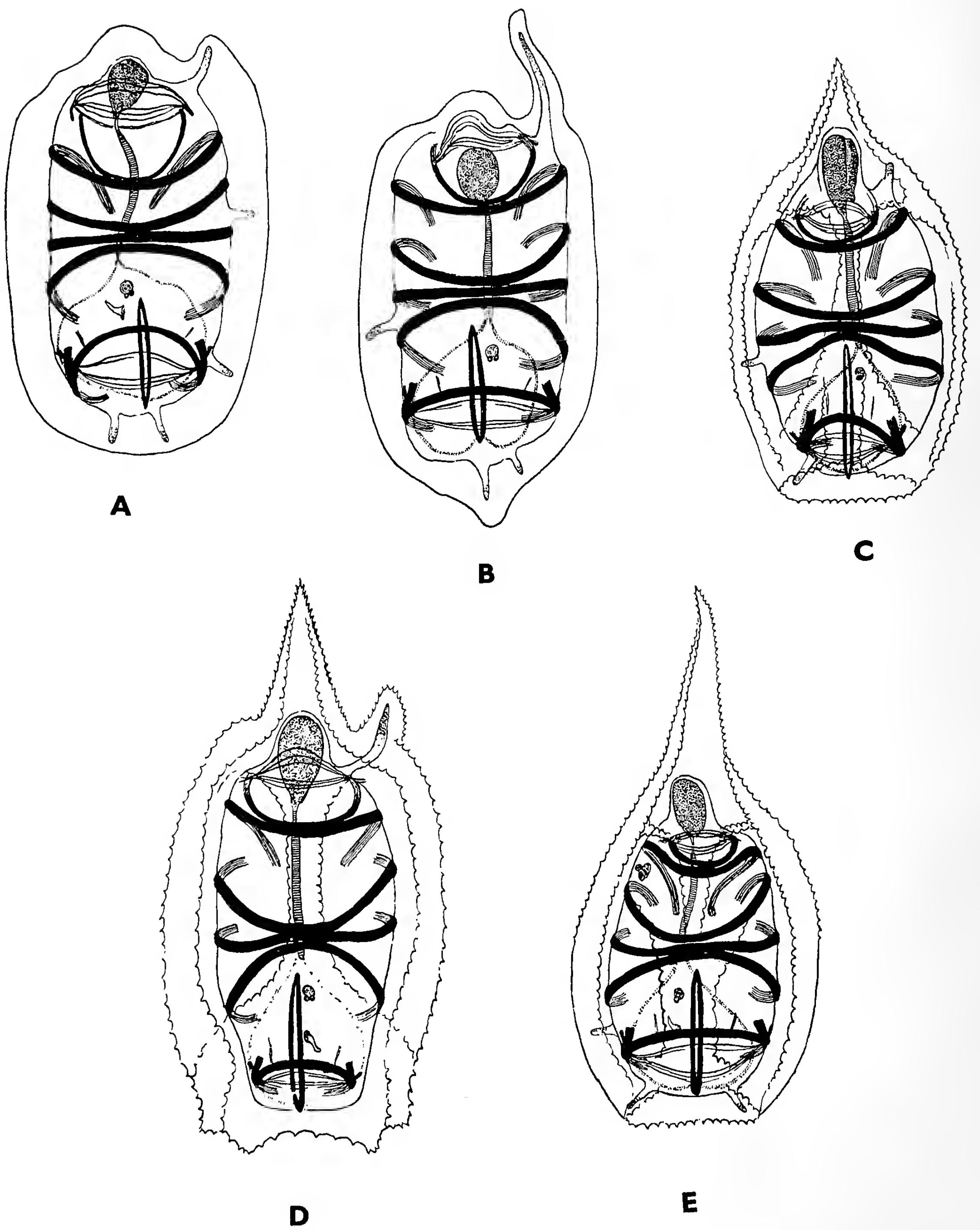
If now we divide the above series into size groups we get the following result :

Group.	Number of individuals examined.	Body length (mm.).	Average number of muscle bands in each muscle. I.	II.	III.	IV*a*.	IV*b*.	Average total.	Range.
I.	8	2·0–3·9	6·25	6·75	6·1	6·5	4·0	29·6	24–36
II.	14	4·0–5·9	7·6	7·5	8·2	7·9	5·8	37·0	33–44
III.	14	6·0–6·9	8·0	8·7	8·4	7·6	5·1	37·7	28–52
IV.	5	7·0–8·2	9·4	11·0	9·2	10·2	6·8	46·6	37–51

It thus seems clear that there is a distinct tendency for the number of muscle-fibres in each body-muscle to increase with an increase in size, and presumably therefore in age, of the individual.

Aggregated zooid: Several previous observers have commented on the differences that are to be found in the general shape of the aggregated zooids. In the account given by Huxley (1851, p. 569, pl. xv, figs. 2 and 4) the zooid is shown as having a truncated anterior end, where the mouth is situated, and the posterior end is somewhat produced in a pointed process that is about one-tenth to one-eighth the length of the main mass of the body; he remarks: "the body is sub-ovoid, smaller at the posterior extremity than at the anterior: the former ends in a point, the latter in a square facet." Herdman (1888, p. 81, and pl. viii, fig. 4) also shows the posterior end as being pointed, but he notes that there is considerable variation, and that the posterior end may be simply rounded, as described by Trausted (1885), or, as in three specimens from the Southern Ocean, may be bifid. Apstein (1894, p. 13) has recorded the occurrence of examples in which the posterior end may be produced in a tapering process that may equal the length of the body, while the anterior end is stated to be not rounded but produced in a point so that the form closely resembles *Salpa maxima*. In a previous paper (Sewell, 1926, p. 96, fig. 24) I also called attention to this last form. Tokioka (1937, p. 229, pl. xiv, fig. 5) has termed this form *echinata*, on account of the numerous small denticulations that he found to be present on the test. In the present collection there is very considerable variation in the form of the aggregated zooid. In some specimens the anterior end is somewhat truncated and the posterior end is rounded, and although there is a protrusion of the body wall on one side of the nucleus this is only sufficiently developed to cause a small bulging of the test: this form agrees with the condition that Metcalf (1918, p. 114, fig. 107B) states is the prevalent Atlantic form. In the next form both anterior and posterior ends are rounded, the posterior more sharply, and the protrusion of the body wall now causes a corresponding finger-like protrusion of the test (Text-fig. 8A). In the next stage the protrusion of the body-wall by the side of the nucleus has given rise to a long protrusion of the test, that thus appears to form a long tentacle which may be from one-sixth to one-fourth the length of the body (Text-fig. 8B) on one side of the posterior end. The most common form in the present collection is that in which the anterior end is truncated and the posterior end is produced in a sharply-pointed process that is about one-fourth to one-third the length of the body; in a large number of specimens this posterior process is seen to be quadrangular in cross-section, and each of the four ridges is provided with small denticulations that are continued along the four lateral ridges of the body-test (Text-fig. 8C). A further development may give rise to a small subsidiary process covering the protrusion of the body wall, similar to that seen in form A, but covered with small denticles (Text-fig. 9D). Finally a small number of individuals exhibit the form figured by Apstein (1906, pl. xxviii, fig. 20) and by Tokioka (1937, pl. xiv, fig. 5), and which the latter terms *S. democratica*, var. *orientalis* f. *echinata*. The posterior region is prolonged in a long process that is finely denticulated (Text-fig. 8E). These denticulations are for the most part arranged in four rows running along the corresponding ridges of the process and are then continued along the various ridges of the body-test.

Michael (1918, p. 245) remarks that "a fully-grown embryo is enormous in comparison to the Salpa which carries it," and quotes Leuckart (1854, p. 52), who remarks that at birth the embryo of *S. democratica* is fully two-fifths the size of the aggregate Salpa. He



Text-fig. 8.—*Thalia democratica* (Forskål). A–E, Variation in the general shape of the aggregated zooid.

also states that "before birth the stolon is completely developed in the embryo and has begun to be converted into aggregate salpæ of the succeeding generation." In the present collection the youngest liberated solitary zooid measures about 0·75 mm. in length, and below the posterior part of the body are two masses of tissue, the anterior being the placenta and the posterior a mass of eleoblast. As the average size of the adult aggregated zooid which was carrying an embryo was 3·3 mm. and the contained embryo was 0·73 mm., it seems clear that the embryo is far from being two-fifths the size of the parent salp and is usually only about one-fifth of its length when it is set free; furthermore, in none of the newly liberated embryos could a developing stolon be seen.

The body-muscles: Apstein (1906*b*, p. 254) has called attention to the number of muscle-fibres in the various muscle-bands of the body of this form, and gives the following figures for individuals of different sizes and from different localities:

Aggregated zooid.

Locality.	Length of body (mm.).	Number of fibres in the body-muscles. I.	II.	III.	IV*a*.	IV*b*.
Indian Ocean	1·5–3·0	5	3	3	3	2
Atlantic Ocean	6·0	5	3	3	3	2
Naples	7·0	5	3	3	3	2
Villa-franca	..	6	3	3	3	2
Mediterranean	13·0	5	3–4	3	3–4	2

and he remarks that it appears that the number of fibres in these bands is remarkably constant. In a later paper (1906*a*, p. 178) he gives the following figures:

mm.						
4·0	5	3	3	3	2	
	5	3	3	3	2	
5·0	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
6·0	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
	5	3	3	3	2	
9·0	5	3	3	3	2	on different sides of body.
	6	4	4	3	2	
11·0	5	3	3	3	2	
	5	3	4	3	2	

As in the solitary zooid, though to a much less marked degree, there is here a tendency for the number of muscle-fibres to increase with an increase in size of the body.

In the present series there is the same slight variation in the number of muscle-fibres in the various body-muscles :

Length of body (mm.).	Number of muscle-fibres in the body-muscles. I.	II.	III.	IV*a*.	IV*b*.	Total.
2·00	5	3	3	3	2	16
,,	5	3	3	3	2	16
2·25	5	3	3	3	2	16
2·42	5	3	3	3	2	16
,,	4	3	3	3	2	15
,,	5	3	3	3	2	16
2·50	4	3	3	3	2	15
2·58	4	3	3	3	2	15
,,	5	3	3	3	2	16
2·67	4	3	3	3	2	15
,,	5	3	3	3	2	16
2·83	5	3	3	3	2	16
3·00	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·08	4	3	3	3	2	15
,,	4	3	3	3	2	15
,,	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·17	4	3	3	3	2	15
,,	4	3	3	3	2	15
,,	5	3	3	3	2	16
3·25	5	3	3	3	2	16
,,	5	3	3	3	2	16
,,	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·33	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·42	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·50	5	3	3	3	2	16
3·58	5	3	3	3	2	16
,,	4	3	3	3	2	15
,,	4	3	3	3	2	15
3·67	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·83	5	3	3	3	2	16
,,	5	3	3	3	2	16
3·92	5	3	3	3	2	16
4·00	5	3	3	3	2	16
4·08	4	3	3	3	2	15

Length of body (mm.).		Number of muscle-fibres in the body-muscles. I.	II.	III.	IVa.	IVb.		Total.
4·17	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
4·25	.	5	3	3	3	2	.	16
4·33	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
4·50	.	5	3	3	3	2	.	16
4·67	.	5	3	3	3	2	.	16
4·75	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
4·83	.	5	3	3	3	2	.	16
4·97	.	5	3	3	3	2	.	16
5·00	.	5	3	3	3	2	.	16
,,	.	5	3	3	3	2	.	16
5·33	.	5	3	3	3	2	.	16
5·50	.	5	3	3	3	2	.	16
5·67	.	4–5	3	3	3	2	.	15 or 16
6·50	.	5	3	3	3	2	.	16
6·58	.	5	3	3	3	2	.	16

In the smaller examples, having a length measurement of less than 3·25 mm., the Ist body-muscle in 8 out of 21 examples that were measured and examined is composed of only 4 muscle-fibres, instead of the usual 5 ; in others having a length greater than 3·25 mm. but less than 4·25 mm. there were three such cases in 21 examples ; and in specimens having a length measurement greater than 4·25 mm., one example possessed 4 muscle-fibres on one side and 5 on the other in the Ist body-muscle, sixteen others possessed the usual five. Apstein has recorded the existence of a specimen in which the Ist body-muscle possessed 6 fibres, and a similar single example has been found in the present collection.

Forma *orientalis* Tokioka. (Text-fig. 8B.)

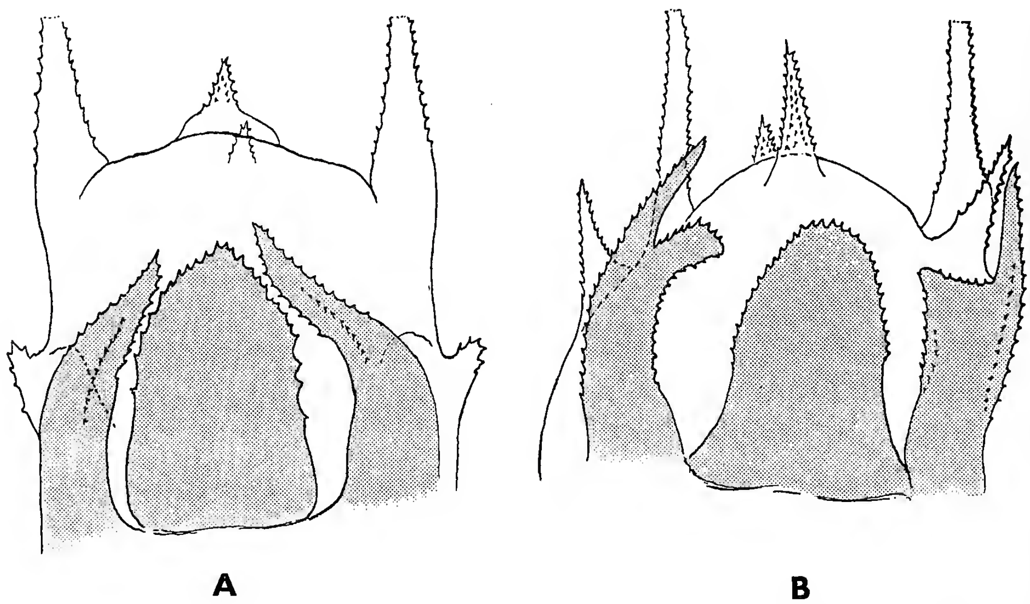
Thalia democratica, var. *orientalis* Tokioka, 1937, p. 226, fig. 1, pl. xiv, figs. 2, 3.

Solitary zooid: This variety was described by Tokioka from specimens taken in Japanese waters. Numerous examples of what appears to be the same variety occur in the " John Murray " collections, but these differ in some respects from Tokioka's description. The Japanese specimens have a length that ranges up to 10 mm., the majority of specimens falling between 6·0 and 8·0 mm. ; the present specimens range from 2·67 mm. to 10·7 mm.

A comparison of the frequency of occurrence of f. *typica* and f. *orientalis* at St. 61 in the different depths gives the following result :

Station No.	Depth of haul. (m.).	Number of examples of f. *typica*.	Number of examples of f. *orientalis*.
61, day	500–0	44	1
,,	1000–0	20	0
61, night	1000–0	26	10
	1500–0	15	14
	2000–0	14	13

Clearly the f. *orientalis* is more common in the catches taken in the deeper levels, and at these depths is as common as the f. *typica*. It is thus possible that they are a deep-dwelling form in the Arabian Sea region : but, if I am right in thinking that the presence of the large numbers of this species at these depths is due to their being in a moribund condition



TEXT-FIG. 9.—The posterior region of the body and the atrial palps of the solitary zooid. A, In *Thalia democratica* f. *typica* Forskål. B, In *Thalia democratica* f. *orientalis* Tokioka.

and to sinking down from the upper strata, then the number of examples in the greater depths suggests that either they are a seasonal form, occurring at the commencement of the breeding season and in consequence have had time to sink to the lower depths, or being on the average rather larger have tended to sink further.

The main character which distinguishes this form from f. *typica* is the bifid nature of the lateral atrial palps (*vide* Text-fig. 9A and B). Tokioka states that "the posterior protuberance may be as long as the body, but may be only $\frac{1}{4}$ of the body length." It is not clear to what structure he is referring by the name "protuberance": he may mean either the median posterior projection of the test behind the nucleus or the postero-lateral processes; if the former, I have never come across a specimen of the solitary zooid in which this protuberance is as long as the body, though it may be so, or nearly so, in the aggregated zooid. I assume that he is referring to the postero-lateral processes. I have failed to find any examples of the solitary zooid in which these processes are as long as the body; in the specimen with the longest processes the proportional lengths of the processes and of the body are as 1 : 1·18. Tokioka also states that in his examples of this form "the short lateral processes found in front of each posterior protuberance are missing in many specimens—nearly $\frac{1}{3}$ in the whole collection are lacking this process." In the present collection the condition is the exact opposite of this: in those specimens in which the atrial palps are bifurcate the lateral processes are well developed, whereas in those examples in which the atrial palps taper uniformly to a point, this process is very much shorter and may apparently be absent altogether. A further small difference that separates f. *orientalis* from the typical form is the extent to which the median dorsal process arising from the nucleus is developed: in what I take to be the typical form this process is relatively much shorter than in the f. *orientalis*, and usually measures only some 0·15 mm., whereas in f. *orientalis* the average length is about 0·97 mm.

Tokioka (*loc. cit.*, p. 228) has recorded that the number of muscle-fibres in the various body-muscles is considerably greater in f. *orientalis* then in the typical form and he gives the following data:

Number of fibres in each muscle	Body-muscle. I.	II.	III.	IV*a*.	IV*b*.
Maximum number	20	20	20	20	20

In the present series there is a considerable degree of variation, as is shown in the following table:

Total body length (mm.).	Sta.	Depth. (m.).	Number of fibres in each body-muscle. I.	II.	III.	IV*a*.	IV*b*.	Total.
2·67	61, day	500–0	15	13–14	15	14–15	8	65–67
3·67	61, night	1000–0	15	14	15	15	10	69
4·4	,,	,,	15	15	13	15	10	68
5·0	,,	,,	14	17	15	15	9	70
,,	,,	,,	14	14	16	14	10	68
5·3	,,	,,	16	17	18	15	11	77
5·5	,,	,,	10	13	12	13	6	54
5·9	,,	,,	12	13	13	13	14	65
6·3	61, day	500–0	14	17	16	15	12	74
6·75	61, night	1000–0	15	12	14	14	11	66
,,	,,	,,	15	17	17	17	10	76
7·0	,,	,,	11	10	13	11	9	54
7·2	,,	,,	16	23	20	20	14	93
7·25	,,	,,	10	11	11	9	7	48
7·3	,,	,,	15	15	13	13	9	65
,,	,,	,,	11	11	10	10	8	50
7·7	,,	,,	15	14	16	14	11	70
,,	,,	,,	17	17	18	18	12	82
7·8	,,	,,	16	15	18	18	14	81
8·2	,,	,,	11	15	16	16	12	70
8·1	,,	,,	11	13	11	12	8	55

Total body length (mm.).	Sta.	Depth. (m.).	Number of fibres in each body-muscle. I.	II.	III.	IV*a*.	IV*b*.	Total.
8·2	172	400–0	16	15	16	15	8	70
8·7	61, night	1000–0	18	14	18	17	10	74
9·5	,,	,,	16	17	18	15	12	78
9·6	,,	,,	13	14	18	17	10	72
10·7	,,	,,	13	17	17	16	13	76
	Average		14·0	15·15	15·27	14·66	10·2	

If we divide these individuals into groups according to their length measurement we get the following results :

Group.	Length (mm.).	Number	Average number of muscle-fibres in muscles. I.	II.	III.	IV*a*.	IV*b*.	Total.
I.	2·67– 4·9	3	15	14–14·3	14·3	14·7	9·33	67·3–68·0
II.	5·0 – 6·9	8	13·75	15	15·1	14·5	10·375	68·75
III.	7·0 – 8·9	12	13·97	14·4	14·9	14·25	10·2	72·66
IV.	9·0 –10·7	3	14·0	16·0	17·7	16·0	11·7	75·4

In this series there is very little evidence of any regular increase in the number of muscle-fibres in each muscle, such variation as is indicated suggests that the number of muscle-fibres may diminish with an increase in size in body-muscle I, and increase slightly in body-muscles II to IV*b*.

Aggregated zooid: In his account of what he believes to be the aggregated zooid of this variety, Tokioka (1937, p. 228, and pl. 14, fig. 5) remarks that " the posterior end of the body is bluntly pointed," but in the illustration that he gives he has figured the form of zooid in which the posterior end is produced in a long tapering process, that is usually stained a pale brown colour. Although this long-tailed form appears to be widespread, having been recorded by Apstein from the " Valdivia " Collection and by myself from the northern region of the Indian Ocean, it does not appear to be common, and I see no reason for associating it with the var. *orientalis* of the solitary zooid.

A large number of examples of this Salp, taken at Sta. 61, were found to be infected with *Trichophrya salparum* Entz ; this Acinetid was present much more frequently in examples of the aggregated zooid and was relatively scarce in the solitary zooid. A description of this parasite is given in an Appendix to this Report (*vide infra*, p. 86).

Distribution.—This species is the commonest of all Salps and has been taken in numerous hauls of the tow-net in the Pacific, Indian and Atlantic Oceans, and between Lats. 60° N. and 40° S. Apstein (1906*a*, p. 198) states that it is found all the year round in warm regions but is most common in July and August. He also points out that these planktonic organisms may be swept by such currents as the Gulf Stream and the North Atlantic Drift into regions far beyond their usual limits, thus causing the occurrence of large shoals around the Shetland Islands and the Hebrides, and off the Norwegian coast. Other northern records of swarms of this species have been given by Farran (1906) off the south-west coast of Ireland, and by Hornell (1901) in the English Channel. Apstein (1906*b*) has pointed out that most of the Salps are warm-water inhabitants, and that

Salpa democratica was taken in water of which the temperature lay between 17° C. and 28° C.: Michael (1918) has also called attention to the relationship between the occurrence of this Salp in the San Diego Region of the West coast of America and the temperature of the sea-water; in this area he obtained numerous examples when the water temperature was between 17·9° and 18·9° C.

It is interesting to compare the various records of the occurrence of large shoals of this species in different parts of the world, and in the accompanying table I have given the recorded occurrences of such shoals in different months of the year. In the North Temperate region such large shoals have been reported during the summer months from June to October, and in the South Temperate zone during the southern summer from September to March: but in the Tropical Belt the evidence seems to show that this species (and probably most other Salps also) exhibits two seasons, the first extending from August to October and the second from January to April. The record of a large shoal in the Gulf of Oman in November should probably be refered to October, for this catch consisted of dead examples that were sinking down towards the bottom of the sea. In a previous paper I have shown (Sewell, 1929) that in Indian waters the surface temperature of the sea exhibits two maxima in the year, a primary maximum in April and a secondary maximum in October or November. and the table seems to indicate that this species has its maximum concentration during those months in which the sea temperature is rising, and that the maximal temperatures in November and April cause a cessation of the reproductive process.

Apstein (1906*b*, p. 283) also states that differences in salinity have no influence on the distribution of Salps, except in such places as the Congo River estuary, where there is a large influx of fresh-water into the sea and Salps are absent. This complete or nearly complete absence of Salps at the surface may, however, be accompanied by their presence at a deeper level. I indicated (Sewell, 1926, p. 120 *et seq.*) that on the Burma coast a rise in the salinity of the surface water was accompanied by a marked rise in the number of individuals of both *Salpa democratica* and *S. cylindrica*, and that this phenomenon exhibited a periodic rhythm, which I attributed to a " Seiche " in the deeper water of the Andaman Sea, more saline water being brought up to the surface and so causing a rise in salinity from 30–32·8‰ up to about 33·4‰.

The majority of the Salps are found in the upper levels of the sea. Ihle (1912, p. 14) has pointed out that, as Salps are warm-water inhabitants, they are but rarely found at depths greater than 400 m., almost the only exception being *Salpa fusiformis*, f. *aspera*, that has been taken in the self-closing net between 1000 and 2000 m. Apstein (1913*b*, p. 280) points out that though examples were taken in tow-nettings from depths as great as 3070 m., there is no proof they were living at such a depth, and his largest catches came from depths between 0 and 100 m. In his account of the Salps of the Plankton Expedition (1893, p. 40) he has stated that *Thalia democratica* occurred in small numbers in the upper 50 m., but was more common between 50 and 100 m. In his account of the " Valdivia " collection he remarks that examples of this species occurred in fair numbers as far down as 200 m., but that by far the greater number were taken between 100 m. and the surface. Michael (1918), working in the San Diego region of the East Pacific, found that this species disappears completely below 100 m. depth. Russell and Colman (1935) found that off the Great Barrier Reef of Australia this species has its maximum abundance at about 10 m. depth and decreases rapidly in numbers below 15 m.; they note that the solitary forms " tend, if anything, to mass together at a slightly higher level than do the aggregate forms." In the present collection three solitary zooids were taken in a haul of the self-closing net at Sta. 98 between 645 and 400 m. depth, but at Sta. 61 in the entrance to the

Records of the Occurrence of Dense Shoals of Thalia democratica *in Different Regions and in Different Months of the Year.*

	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.
N. Temperate Zone:													
Hebrides	..	..	+	+	..	..	..	..	..	..	..	..	..
West Coast of Ireland	..	..	..	+	+	..	..	..	..	..	..	..	..
English Channel	..	..	..	+	..	..	..	..	..	..	..	..	..
Mediterranean Sea	..	..	+	+	..	..	..	..	..	..	..	..	..
Florida Current	..	..	..	+	..	..	..	..	..	..	..	..	..
Massachussetts Coast	..	..	+	+	+	+	..	..	..	..	..	..	..
Azores	..	..	..	..	..	+	..	..	..	..	..	..	..
San Diego California	..	+	+	..	..	..	..	..	..	..	..	..	..
Equatorial Zone:													
Mouth of Amazon River	..	..	..	..	..	+	..	..	..	..	..	..	..
Cape Verde Islands	..	..	..	+	..	..	..	..	..	..	..	..	..
Ascension Island	..	..	..	..	+	..	..	..	..	..	..	..	..
St. Helena	..	..	..	+	..	..	..	..	..	..	..	..	..
Aden	..	..	..	..	..	..	..	..	..	..	+	..	..
Gulf of Oman	..	..	..	..	..	..	+	..	..	..	..	..	..
Goa, India	..	..	..	+	+	..	..	..	..	..	..	..	..
Suvadiva Atoll	..	..	..	..	..	..	..	..	..	+	..	..	..
East Coast Madras	..	..	..	..	+	..	..	..	..	+	+	..	..
Nicobar Islands	..	..	..	..	..	..	..	..	..	+	+	..	..
South Burma Coast	..	..	..	..	..	..	..	..	+	+	+	..	..
Sumatra	..	..	..	..	..	..	..	..	+	+	..	..	..
Philippine Islands	..	..	..	..	..	..	..	..	..	+	+	+	..
S. Temperate Zone:													
South Atlantic	..	..	..	..	..	..	..	..	..	+	+	..	..
Cape of Good Hope	..	..	..	..	+	..	..	..	..	..	..	..	..
New Amsterdam	..	..	..	..	..	..	..	..	+	..	..	..	..
Bass Strait	..	..	..	..	..	..	..	..	..	..	..	+	..
S. E. Australian Coast	..	..	..	..	+	+	+	+	+	..	..	..	..

Gulf of Oman large numbers of both forms were taken at depths ranging from 500 to 2000 m. At this station nets were towed in series as nearly as possible at the depths stated for an hour and were then hauled to the surface ; they were thus fishing all the way up, but there can be little doubt that the bulk of the catch in each net came from the maximum depth at which the net was towed. In the following table I give the estimated numbers taken in the various nets in both day and night hauls :

Depth. (m.).	Day haul. Solitary.	Day haul. Aggregated.	Night haul. Solitary.	Night haul. Aggregated.
500–0	2700	4,100	. .	. .
1000–0	2240	5,200	3200	3100
1500–0	840	12,000	280	1080
2000–0	. .	. .	600	16

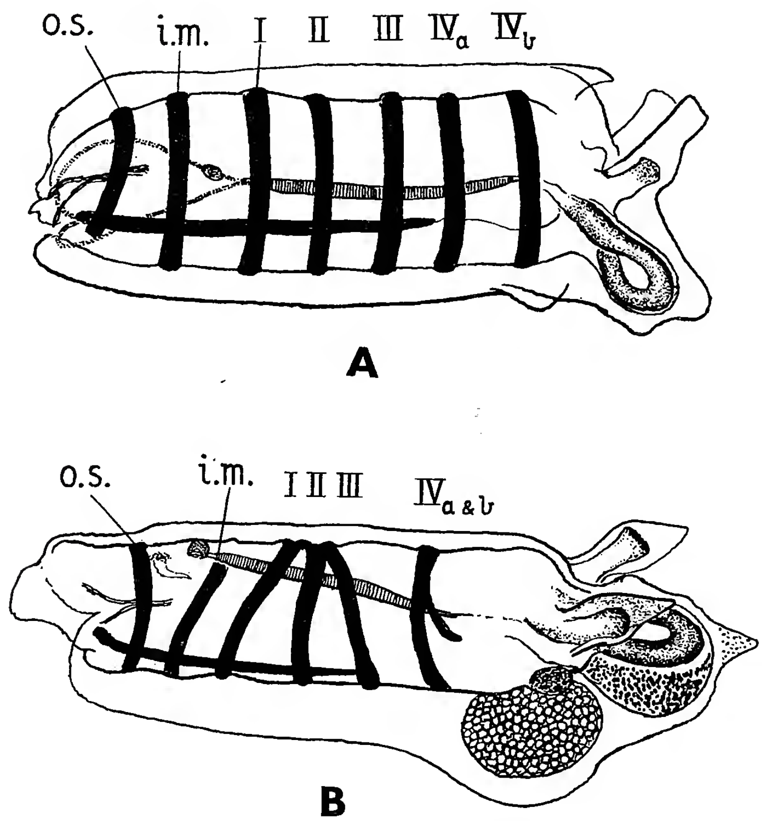
Only small numbers were taken at the surface. The solitary zooids appear to be most plentiful at a depth of 500 to 1000 m., and the aggregated zooids were most concentrated at a somewhat lower depth between 1000 and 1500 m.

It is noteworthy that all these specimens were in a poor state of preservation, and it seems probable that they were not actually living at these depths but were originally in the upper stratum, and had died off at some time previously and were now sinking down to the bottom. Gilson (1937, p. 48) has concluded from the figures obtained for the oxygen and nitrite/nitrate content of the water and from its transparency at this locality that " a period of considerable plankton production was just coming to an end, and that there were great quantities dying off in the discontinuity layer." Laevitt (1936) has shown that in the Atlantic Ocean there are two maxima of concentration of various species of Macroplankton at depths of about 800 and 1600 m. which agree closely with the present depths of concentration of these examples of *Salpa democratica*. Although Laevitt remarks that at one of his stations he found concentrations of Salps, he does not, unfortunately, give the name or names of the species, and he merely remarks that in some of his deep trawls fragments of *Iasis zonaria* were not infrequent. Seiwell and Seiwell (1938) have calculated the depths at which dead organisms will tend to accumulate, and they suggest that the greatest concentration will be found near the level of minimum oxygen-content, which they place in the North Atlantic at the depth where the water has a density of 27·232 ± 0·008 : in the table below I give the data for the different depths at Sts. 61 :

Depth (m.).	Temp. (° C.).	Salinity ‰.	Density *in situ*.	Oxygen contant (c.c./litre.
400	14·10	35·71	26·63	0·422
600	12·07	35·39	26·899	0·336
800	10·36	35·28	27·139	0·047
1000	9·00	35·14	27·258	0·086
1500	5·575	34·85	27·492	0·611
2000	3·18	34·59	27·648	1·43

Here the minimum-oxygen layer, 0·047 c.c. per litre, lies at a depth of 800 m. and the density of the water *in situ* at that depth is 27·139, while at 1000 m. depth the corresponding figures are 0·086 c.c./litre for the oxygen content and 27·258 for the density of the water *in situ*.

Thus the evidence points to the conclusion that the large numbers of this species at depths of from 500 to 2000 m. were dead and undergoing decomposition, and that the reduced oxygen content of the water at these depths is probably due in great part to bacterial action, as suggested by the Seiwells. The maximum concentration of the larger solitary zooids between 500 and 1000 m. and of the smaller aggregated zooids between 1000 and 1500 m. could be accounted for if the smaller aggregated zooids had died first and so had had a longer time in which to sink to greater depths, or were, as stated by Russell and Colman, already massed at a somewhat lower depth than the solitary zooids when death occurred.



TEXT-FIG. 10.—A young solitary zooid of A, *Thalia longicauda* (Quoy and Gaimard). B, *Thalia democratica* (Forskål). The body length of each specimen was about 1·4 mm.

Thalia longicauda (Quoy and Gaimard). (Text-fig. 10A.)

Salpa longicauda Quoy and Gaimard, 1824, p. 504, pl. 73, fig. 8.
Salpa democratica-mucronata, var. *flagellifera* Trausted, 1888, p. 369, pl. i, figs. 12, 13.
Salpa flagellifera Apstein, 1894, p. 13, fig. viii, 6, 7 ; Apstein, 1906*b*, pp. 253, 270, fig. 9 ; Apstein, 1906*a*, p. 171, fig. 29.
Salpa longicauda Ihle, 1912, p. 54, fig. 59.
Thalia longicauda Metcalf, 1918, p. 119, fig. 113, Thompson, 1948,p. 140, footnote.

OCCURRENCE :

Sta. 61, night, northern area of Arabian Sea, 1000–0 m. : a single young solitary zooid.

REMARKS.—This species has now been recorded from all three great oceans, Pacific, Indian and Atlantic ; but so far only from the southern hemisphere. Hardy and Gunther (1935) have recorded that this species occurred in a remarkably dense and well-defined patch, some 8 miles across, in lat. 30° 02′ 50″ S., long. 13° 06′ 30″ W., in the month of December, 1925. The present record increases its range in the Indian Ocean to the northern area of the Arabian Sea.

The present specimen is a young solitary zooid. It clearly exhibits the independent character of the body muscles, none of which is joined to other bands. The postero-lateral processes have only just begun to form and they possess a slightly different shape from those of *Thalia democratica* (Forskål) in the distal ends being truncated, instead of pointed. The endostyle also appears to be slightly longer than in *S. democratica*, as it here reaches back nearly to the IVth body-muscle, instead of only to the IIIrd.

Group Oligomyaria Streiff.

Genus *Pegea* Savigny. (Text-figs. 11 and 12.)

Pegea confœderata (Forskål).

Pegea confederata Metcalf, 1918, p. 127, figs. 119–132.

Pegea confœderata Sewell, 1926, p. 190, figs. 28–33 ; Stiasny, 1827, p. 448, fig. J, pl. xxiii, figs. 43–48 ; Tokiada, 1937, p. 230 ; Harant and Vernières, 1938, p. 44, fig. 54 ; Thompson, 1948, p. 143, pl. lx, figs. 1, 2, pl. lxi, figs. 1–4, pl. lxii, figs. 1–5.

Salpa (*Pegea*) *confederata* Berrill, 1950, p. 297, fig. 108.*

* Berrill in his fig. 108D gives a view of the dorsal aspect taken from Stiasny (1927, pl. xxiii, fig. 43) but has incorrectly named it " Dorsal view of aggregate form " : it is a view of the solitary zooid.

Occurrence :

Sta. 42, S. Arabian Coast, surface ; hand net. Aggregated zooid : 12 examples.

Sta. 43, S. Arabian Coast, 100–83 m. depth. Solitary zooid : 5 examples.

Sta. 55, off Cape Ras el-Had, surface ; hand net. Aggregated zooid : 6 examples. Solitary zooid : 100 specimens.

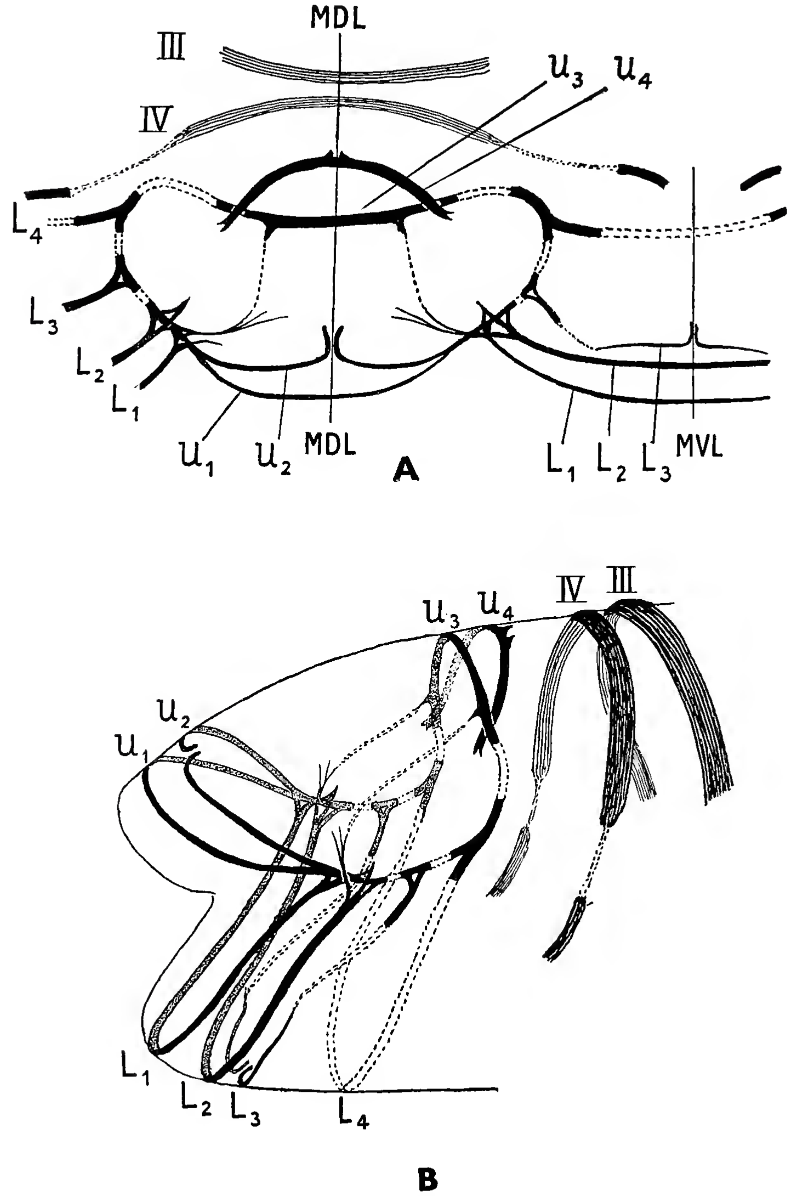
Sta. 61, night, North area of Arabian Sea, 1000–0 m. Solitary zooid : 4 specimens.

Sta. 70, at the head of the Gulf of Oman, surface : numerous examples.

Sta. 92, Central part of Arabian Sea, surface. Solitary zooid : 5 examples.

Sta. 95, Central part of Arabian Sea, 984–430 m. depth. Solitary zooid : 1 specimen, and 1 very young aggregated zooid.

Remarks.—Metcalf (1918, p. 137) has remarked that the " aggregated form of *Pegea confederata* is one of the most abundant of the Salpa group. . . . In all these collections there are, on the other hand, very few representatives of the solitary form of this species except numerous embryos from 5 mm. to 35 mm. long," and " this scarcity of the solitary form of *Pegea confederata* is a general condition in collections of Salpidæ . . . " He suggests that " it seems not unlikely that the solitary *Pegea confederata* lies generally in deep water the year round, a few wholly adult individuals coming to the surface only occasionally, the great majority probably never coming to the surface except more or less by accident." This salp was remarkably common in the surface water in the region of the Gulf of Aden, the South Arabian coast and in the Gulf of Oman, between 3rd September, 1933, and 25th November. Throughout this period enormous numbers of individuals of both forms were present : in my diary for 2nd–3rd October, 1933, I have noted that " all through these last few days there was a most amazing profusion of animal life in the surface water, perhaps the most common of the planktonic animals being the Salp *Pegea confœderata:* at times there were as many as 50 examples of the solitary zooid in a square metre at or near the surface. Most of these specimens possessed a well-developed stolon



TEXT-FIG. 11.—*Pegea confœderata* (Forskål). Solitary zooid. A, Atrial musculature. The atrium has been cut through laterally and the dorsal and ventral surfaces opened out. B, The atrial musculature from the side.

and numerous chains of the aggregated zooid, measuring as much as 3 feet in length were quite common." At this time the ship was working at the head of the Gulf of Aden. Again at Stas. 41 and 42, on 27th October, while working along the south Arabian Coast I have noted that " a number of long strings of the aggregated zooid of *Pegea confœderata*, some of them at least 3 feet in length, drifted by." During the first week of November, at Stas. 55 and 58, off Cape Ras el-Had, numerous chains of the aggregated zooid were seen, and at Sta. 55 numerous examples of the solitary zooid were present, about 100 being collected in the hand net. Finally at Sta. 70 at the head of the Gulf of Oman on 25th November, it was again noted that "the surface water was full of plankton, the most conspicuous objects being examples of *Pegea confœderata*."

The very large amount of plankton in this area at this time of the year is undoubtedly due to the upwelling of the deep-water resulting from the effect of the South-west Monsoon winds, and it seems probable that the solitary zooid phase of *Pegea confœderata* was brought to the surface by this upwelling: and that, conditions being favourable, breeding was going on and enormous numbers of the aggregate zooid were being produced.

The Solitary Zooid.—Size: At Sta. 43 the length of these zooids ranged from 43 mm. to 56 mm., the mean being 48·0 mm. Of the five examples taken at a depth of 83 m. only one showed a developing stolon with aggregated zooids. At Sta. 55 examples taken at the surface ranged in length from 28 mm. to 62 mm., with a mean of 44·1 mm. Of the 46 examples studied only 7 were without a developing stolon and these measured from 25 to 60 mm. in length, with a mean of 41·3 mm. The number of individuals in each chain of aggregated zooids ranged from 82 to 120 mm. At Sta. 61 the four examples taken in a haul from 1000–0 m. ranged in length from 10·8 to 12·33 mm. in length, with a mean of 11·37 mm.; and at Sta. 92 examples from the surface ranged from 30 to 36 mm. in length with a mean of 32 mm., and all possessed a relatively small stolon.

The oral musculature varies in different specimens, as I have indicated in a previous paper (Sewell, 1926, p. 101, fig. 28). In a young specimen taken at the surface on the South Arabian coast the arrangement of the muscle-bands agrees with the condition figured in my fig. 28c. The retractor consists of four separate bands, the dorsal three of which anastomose as they pass forward and finally divide into the Ist sphincter of the upper lip and the Ist and IInd sphincters of the lower lip. The IInd sphincter of the upper lip is a broad band that at the angle of the mouth divides into two branches, the anterior forming the IIIrd sphincter of the lower lip and the posterior turning backward to form a retractor muscle.

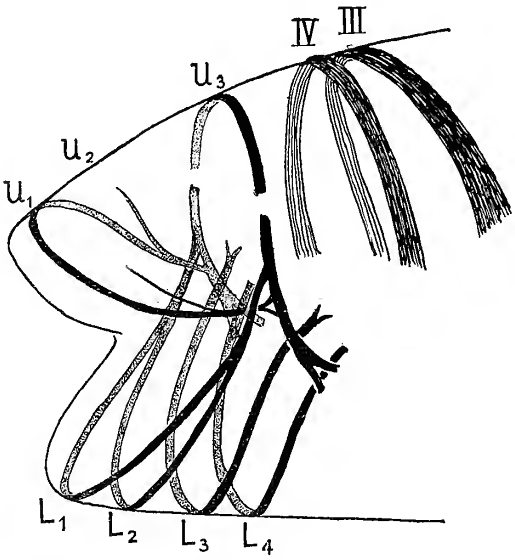
There is also a considerable degree of variation in the atrial musculature In the majority of examples this system agrees closely with the figure that I gave in my previous paper (Sewell, 1926, fig. 29b). Metcalf's figures (1918, figs. 121, 122) of this muscle system are somewhat confusing; he has completely omitted a band of muscle-fibres, frequently interrupted in the mid-dorsal line, that lies anterior to the IIIrd dorsal sphincter.

The aggregated zooid: At Sta. 42 the length of the examples varied between 40 mm. and 75 mm., with a mean of 64 mm. At Sta. 55 the length ranged from 43 mm. to 80 mm., with a mean of 55·2 mm. At Sta. 42 8 examples possessed an embryo, though most of these were small in size; but at Sta. 55 no example possessed an embryo, though a placenta was present.

In nearly all instances the surface of the test was smooth, but in one case it was provided with short stout denticles. A similar condition of the test has been recorded by Ritter and Byxbee (1905, p. 190) in certain examples from the Pacific Ocean.

The oral musculature is as in the solitary zooid.

A study of the atrial musculature in a young example necessitates a modification of Metcalf's interpretation (*vide* Metcalf, 1918, p. 133). The atrial retractor, which is bifid at its origin, passes upwards and backwards and gives off two branches; of these the lower, which has two roots, passes upwards and backwards and after a short course divides into two branches, of which the 1st, forming the 1st dorsal sphincter, is complete, while the second extends for only a short distance into the upper atrial lip. A little to the dorsal side of the origin of this dorsal sphincter muscle another branch arises and passes downwards and backwards, passing internal to the dorsal sphincter, and then divides into two muscle-bands, both of which are continuous around the aperture and form the Ist and IInd ventral sphincters. Arising slightly in front of the atrial retractor are two muscle-bands, the IIIrd and IVth atrial ventral sphincters ; these pass internal to the atrial retractor muscle and both are continuous around the ventral lip. Neither of these last two muscles in the young stage is in any way connected with the IVth body-muscle (Fig. 12).



TEXT-FIG. 12.—*Pegea confœderata* (Forskål). Aggregated zooid. The atrial musculature from the side.

Associated with examples of *Pegea confœderata* were three species of Copepoda. *Schmackeria serricaudata* (T. Scott) and *Corycæus* (*Onychocorycæus*) *agilis* Dana were found adhering to the exterior of the test, and both species were taken in the tow-net off the South Arabian coast. Their presence may thus be accidental, but since they are the only species out of 73 that were taken in the surface waters along this coast, that were found on the test, it seems possible that there may be a more intimate connection between the Copepod and the Salp. The third species is *Saphirina iris* Dana : a number of examples of this species were taken, some of them free in the surface water and some 37 specimens were associated with the Salp, and during life could clearly be seen swimming about in the atrial cavity of its host. Barnard (1937, p. 156) has noted that a few examples of the Amphipod, *Synopia ultramarina* Dana, taken in the surface water at night at Sta. 61, were found inside a Salp, probably *Pegea confœderata.*

DISTRIBUTION.—This species occurs throughout the tropical and subtropical zones of the Pacific, Indian and Atlantic Oceans. Apstein (1894) has noted the occurrence of swarms of this species in the region of the Atlantic to the north of Ascension Island in September and (1906*b*) in the region of the mouth of the English Channel and off the Bay of Biscay in August. Thompson (1948, p. 147) records that specimens were taken as far south as the Southern Tasmanian waters and off the south coast of Australia.

Metcalf (1918) in his list of specimens in the United States National Museum has given the numbers taken in various catches in the region of the Philippine Islands, and it seems clear that by far the greater numbers of the aggregated zooids were taken either in February (137) or in August (111). Russell and Colman (1935) found the species most abundant on the Great Barrier Reef in January and February and again in April to June with maxima in February and May; it was not taken in March. It thus appears probable that, like *Salpa* (*Thalia*) *democratica*, this species possesses two breeding seasons in tropical regions, the first occurring between January and June and the second in August to November.

Order *DOLIOLIDA* (= *CYCLOMMARIA*).

Family Doliolidæ.

In both the Doliolida and Pyrosomida I have encountered considerable difficulty in assigning certain individuals to a particular species. In both Orders there is a constant increase in the number of gill-slits as development progresses and in the Pyrosomida a similar increase is found in the number of gill-bars. This increase in the number of gill-slits as size and presumably growth progresses is clearly seen in four examples of *Doliolum* (*Dolioletta*) *gegenbauri* Uljanin, that were taken at Sta. 58, as is shown in the following table:

Specimen.	Total length (mm.).	Number of gill-slits.
I	1·43	14–15
II	2·30	16–20
III	2·80	23–25
IV	2·80	28–30

Ritter (1905, p. 86) has also pointed out that in *Doliolum tritonis* Herdman in the five examples of the gonozooid that he examined, with lengths ranging from 12 to 15 mm., the number of gill-slits was about 70 in the dorsal limb and 50 in the ventral limb, "but the number apparently varying with size and age." Garstang (1933) has called attention to the differences that have been found between different individuals of the same species or between so-called "species," and to the influence on growth of the gill-lamella or the testis that is exercised by the muscle-bands: he remarks, "Closely related species or varieties of sexual zooids may differ in little or nothing more than whether the series of gill slits begins dorsally or ends ventrally, at a particular muscle-band or its neighbour, or whether the testis extends forwards to the IVth, IIIrd or IInd."

The primitive number of gill-slits appears to be five. In two species of Doliolids, namely, *Doliolum* (*Doliolina*) *indicum* Neumann and *Doliolum* (*Dolioloides*) *rarum* Grobben, this number persists throughout life: the same number of gill-slits occurs in the first four ascidiozooids that develop from the cyathozooid of the Pyrosomida. The steady increase in the number of gill-slits as growth proceeds necessitates an increase in length of the branchial septum, that consequently must become more curved and so may reach further back. Similarly the length of the endostyle may vary with growth, and so may the length of the testis. In *Doliolum denticulatum* Garstang (1935, p. 247) notes that " below 3 mm. the endostyle is not completely in front of M_4, as it is in later stages of growth. At 1 mm. the posterior cæcum distinctly projects behind it; at 2 mm. it reaches the hinder edge of M_4, but does not overstep it; at 3 mm. it only reaches the front edge of M_4." As regards the forward extension of the testis in a number of species, Garstang (*loc. cit.*, p. 205) remarks: " the extension of the testis as a parietal organ involves its penetration between the pharyngeal wall and successive muscle-bands, and there is clear evidence that the muscle-bands or rather their connexions with the pharyngeal epithelium constitute definite ostacles to its advance, at least in the later stages of development."

In the present series of examples of *Doliolum* (*Dolioletta*) *gegenbauri* Uljanin with the increase in the number of gill-slits the testis is seen to extend further and further forward: in a specimen with about 15–18 gill-slits the testis extends only as far as mid-way between the IVth and Vth muscle-bands; in one with 23–25 gill-slits it reaches to just in front of the IVth muscle-band; and finally, in one with 28–30 gill-slits it reaches to well in front of the 3rd gill-slit in a line with the anterior end of the endostyle. Garstang attributes these differences to variation in the rate of development of the different organs in conditions of different environmental factors. He remarks (*loc. cit.*, p. 204): " There is thus a possibility—I put it no higher for the moment—that the ' specific ' differences in the limiting attachments of the gill-septum in such pairs of species as *nationalis* and *denticulatum, gegenbauri* and *tritonis, intermedium* and *resistibile, valdiviæ* and *mirabilis* (= *chuni*) are ultimately matters of differential growth-rates, and doubtless modifiable by nutrition, temperature and similar environmental factors."

Berrill (1950) treats *Doliolum tritonis* Herdman as a synonym of *D. gegenbauri* Uljanin and *Doliolum denticulatum* Quoy and Gaimard as a synonym of *D. nationalis* Borgert; but as regards this latter pair the specific name should be *denticulatum*, which was described in 1834, and *nationalis* Borgert, described in 1893, accepted as a synonym.

Genus *Doliolum* Quoy and Gaimard.
Subgenus *Doliolina* Borgert.

In this subgenus Neumann (1905, p. 227) included the following species: *rarum* Grobben, *indicum* Neumann, *intermedium* Neumann, *krohni* Herdman, *mülleri* Krohn, and *resistibile* Neumann. Unfortunately both Borgert and Neumann attributed to the species *krohni* Herdman examples that differed markedly from Herdman's species. Garstang (1934) has, however, managed to clear up a number of errors, and in his scheme of classification he has separated *Doliolum rarum* Grobben as the type of a new genus *Dolioloides*, and has named the form that Neumann took to be *krohni*, but which appears to be a different species altogether, as *Doliolina sigmoides* Garstang; and he has also pointed out that the various species probably fall into a number of pairs, as noted above.

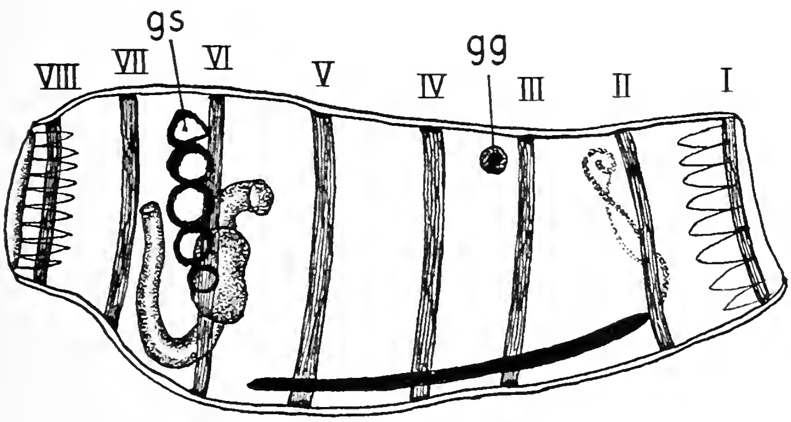
Doliolum (*Doliolina*) *indicum* Neumann. (Text-fig. 13.)

Doliolum indicum Neumann, 1905, p. 210, pl. xxiii, fig. 7, pl. xxiv, fig. 5, pl. xviii, fig. 6.
Doliolum (*Doliolina*) *indicum* Neumann, 1913, p. 13; Garstang, 1934, p. 211, fig. 4.

Occurrence:

Sta. 58, South coast of Arabia, surface: a single example, juv.

REMARKS.—*The gonozooid :* This specimen was very small, measuring only 0·97 mm. in total length and 0·47 mm. dorso-ventrally at its widest part. The mantle is very thin and delicate. The eight muscle-bands are relatively narrow. The gill lamella is situated for the most part behind the VIth muscle-band, commencing dorsally at about one-third the distance between the VIth and VIIth muscle-bands and terminating ventrally on a level with the VIth band ; it is perforated by 5 gill-clefts. The endostyle is long ; it commences immediately behind the IInd muscle-band and extends back to mid-way between the Vth and VIth muscle-bands. This is somewhat longer than in Neumann's specimen, in which it reached only to near the Vth muscle-band. The nerve ganglion is situated in the 3rd interspace, not far behind the IIIrd body-muscle. The alimentary canal, as Garstang has pointed out, forms in the sagittal plane an S-shaped rather than a U-shaped curve as the œsophagus passes at first backwards and then bends sharply towards the ventral side to enter the stomach. The œsophagus and the greater part of the stomach lie just in front of the VIth muscle-band, and the rectum and anus are situated



TEXT-FIG. 13.—*Doliolum (Dolioletta) indicum* Neumann. A young gonozooid.

between the VIth and VIIth muscle-bands, the anus opening near the VIIth band. I was unable to detect any trace of genital organs. Neumann (1905, p. 210) has stated that a consideration of the genital organs of a well-grown individual indicates that a considerable length of time in the life-history of this species is required before the genital organs attain maturity. It thus may be that the very small present specimen is a young sexual form, or on the other hand it may be a young phorozooid.

DISTRIBUTION.—*Doliolum indicum* has been recorded from the southern part of the Bay of Bengal, in the equatorial counter-current, and to the north of the Chagos Archipelago, in the Seychelles, in Zanzibar Channel and in the Gulf of Aden (Lohmann). The present record extends its distribution to the south coast of Arabia.

Subgenus *Dolioletta* Borgert.

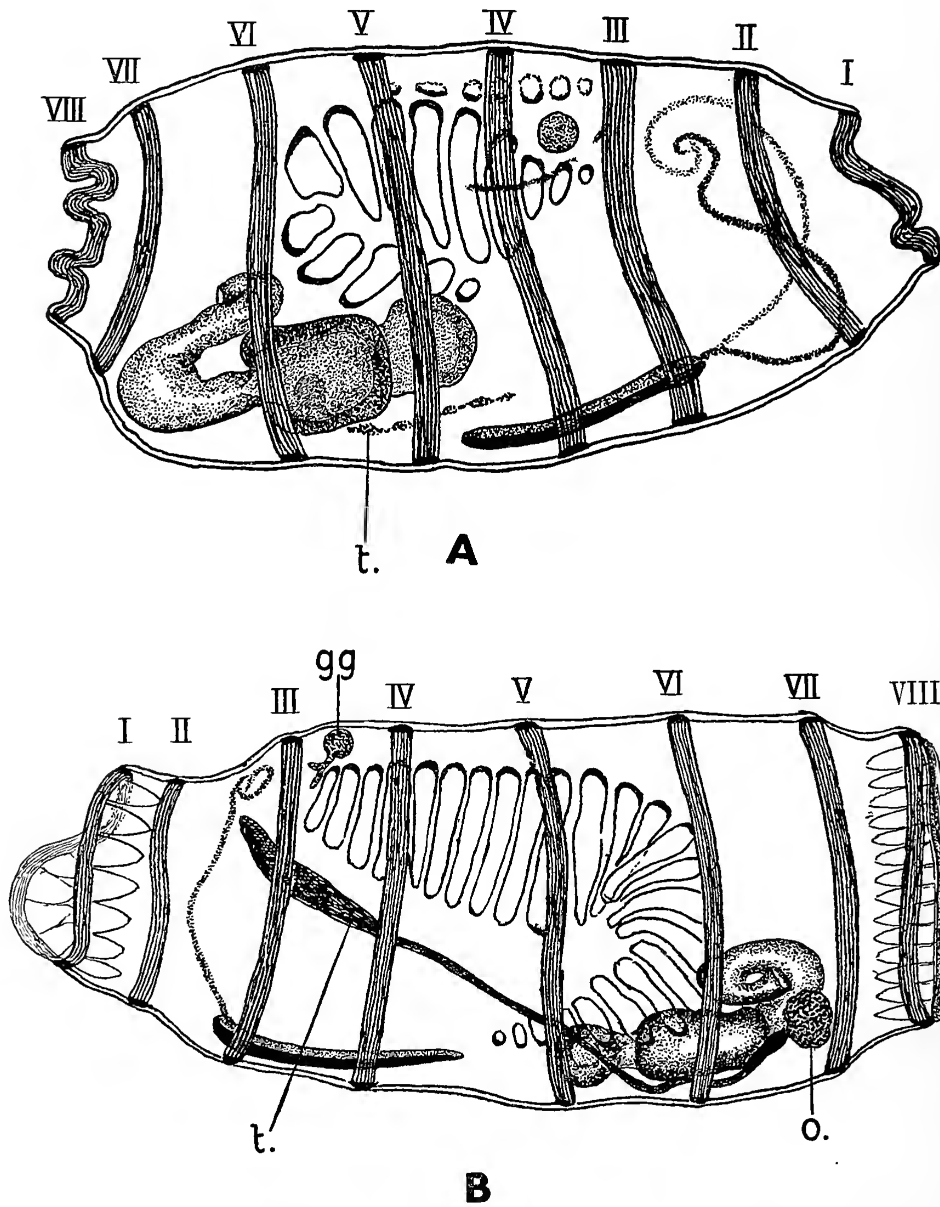
Doliolum (Dolioletta) gegenbauri Uljanin. (Text-fig. 14A and B.)

Doliolum gegenbauri Uljanin, 1884, p. 134, pl. vii, figs. 6, 8 ; Neumann, 1905, p. 216 ; Neumann, 1913, p. 15 ; Garstang, 1934, p. 216 ; Berrill, 1950, p. 285, figs. 100G, 101E, G and 103.
Doliolum (Dolioletta) gegenbauri Harant and Vernières, 1938, p. 49.
Dolioletta genegbauri Thompson, 1948, p. 94, pl. xxx, fig. 1, pl. xxxi, fig. 1.

Doliolum tritonis Herdman, 1888, p. 47, pl. iii, fig. 3; Fowler, 1905, p. 91; Ritter, 1905, p. 85, figs. 24–26; Borgert, 1894, p. 30; Ihle, 1910, p. 17; Neumann, 1913, p. 16; Garstang, 1934, p. 217.
Doliolum (*Dolioletta*) *tritonis* Harant and Vernières, 1938, p. 49.
Doliolum ehrenbergi Uljanin, 1884, p. 132, pl. x, figs. 1, 2, pl. xi, fig. 7.

OCCURRENCE:

Sta. 58, South coast of Arabia, surface: 4 examples.



TEXT-FIG. 14.—*Doliolum* (*Dolioletta*) *gegenbauri* Uljanin. A, A very small gonozooid, 1·43 mm. in length. B, A somewhat larger gonozooid, 2·80 mm. in length.

REMARKS.—These examples of the gonozooid appear to agree well with the description of *D. tritonis* Herdman, but the specimens are very small. Borgert (1894) gives the length of this species as up to 12 mm.; and Neumann (1913*a*, p. 219) gives lengths of 8·5 mm. for *D. gegenbauri* and up to 15 mm. for *D. tritonis*: but Fowler's examples of *D. tritonis* from the N.E. part of the Atlantic were all small, ranging from 2 to 5 mm. in length.

Specimen 1.—Total length, 1·43 mm. (Text-fig. 14A.)

In this example the endostyle extends from just in front of the IIIrd muscle-band to three-fourths the distance between muscle-bands IV and V. The nerve ganglion is situated close behind the IIIrd muscle-band. The number of gill-slits is only 14 or 15. The series commences immediately behind the IIIrd muscle-band on the dorsal side and the gill-lamella reaches as far back as just in front of the VIth muscle-band before it turns forwards again, to end ventrally in the middle of the 4th inter-muscular space. The œsophagus begins in the line of the Vth body-muscle and soon passes into the stomach which lies for the most part in the 5th inter-muscular space, reaching to the line of the VIth body-muscle ; the intestine passes backwards to the line of the VIIth muscle-band and then turns forwards on the right side, turns back again opposite the VIth body-muscle, and the anus opens in the 6th inter-muscular space. The ovary is small and undeveloped and lies just in front of the VIth muscle-band. The testis is represented by a moniliform band of tissue that passes forwards as far as the middle of the 4th interspace.

Specimen 2.—Total length, 2·30 mm.

The differences between this example and the smaller, and presumably younger, specimen 1 lie mainly in the number of gill-slits, which in this example are from 18 to 20 ; the testis still only extends forward to about midway between the IVth and Vth muscle-bands.

Specimen 3.—Total length, 2·80 mm.

The gill-lamella commences just behind the IIIrd muscle-band on a level with the nerve ganglion and passes back to the level of the VIth muscle, where it turns forward and ends about the middle of the 4th inter-muscular space : the number of gill-slits is now about 23–25. The œsophagus commences on a level with the Vth body-muscle ; the stomach lies in the VIth muscle line, and the intestine is coiled and opens just behind the VIth muscle-band. The ovary lies just in front of the VIIth body-muscle, and the testis now extends forward to just in front of the IVth body-muscle.

Specimen 4.—(Text-fig. 14B.)

This example is of the same size as example 3, but the development has proceeded somewhat further. The gill-lamella is attached anteriorly just behind the IIIrd body-muscle on either side of the nerve ganglion and extends backwards as far as the anterior margin of the VIth body-muscle, where it turns forwards and ends ventrally a little in front of the Vth body-muscle ; there are now, however, from 28–30 gill-slits. The endostyle commences just in front of the IIIrd body-muscle, but only extends back to about half the distance between the IVth and Vth body-muscles. The testis now extends considerably farther forward than in the other examples and reaches well in front of the IIIrd body-muscle. Ritter (1905, p. 86) in the description of his examples states that " the anterior end on the left side, usually in fully developed state slightly behind the second muscle-band, but the termination variable in position. Anterior end frequently, though not always, with pronounced hook."

The oozooid : Several examples of " Old Nurses " were taken at other stations. At Sta. 61, night, in the haul from 1500 m. depth, one specimen was taken having a length of

6·2 mm. Two other specimens were taken at Sta. 131, in the haul from 500–0 m., and four examples, having a length of 17–18 mm., were taken at Sta. 76 in the Gulf of Oman, in a haul from 645 to 400 m. All these examples fall into Garstang's category of—

(2) Eurymyonic :—Muscle-bands broader than half the interspaces.

Garstang has given data of the measurements of the IIIrd and IVth muscle-bands in *D. mülleri* and *D. gegenbauri*. In this latter species he gives, for examples that have a total length-measurement of 17–18 mm., the following measurements :

	Total length (mm.).	M_3 (mm.).	M_4 (mm.).
(Garstang)	17–18	3·02	2·78
Present examples	17–18	3·00	2·67

The otolith is situated in the 3rd interspace and the nerve ganolion in the 4th.

These two examples closely resemble the figure given by Ritter (1905, p. 92, fig. 28) of the oozooid of *D. ehrenbergi*, and Neumann (1913) considered that *D. ehrenbergi* of Uljanin (*non* Krohn) is a synonym of *D. gegenbauri*. Fowler (1905, p. 97) records the capture of a number of blastozooids, which he tentatively attributed to *D. tritonis*, and he gives measurements of the width of M_4 in examples of different sizes ranging from 3·0 to 8·0 mm. in length. Garstang (1934, p. 233, Table VI) has given the relative widths of the muscle-bands, as percentages of the total muscle mass, in the blastozooid of *D. gegenbauri* from three different localities, and in the table below I have combined Garstang's figures for the larger specimens from different localities and have also given the corresponding figures for the present examples :

		Muscle-widths as percentages of total muscle.									
Locality.	Size range (mm.).	M_1.	M_2.	M_3.	M_4.	M_5.	M_6.	M_7.	M_8.	M_9.	
Atlantic	17–18	2·5	10·7	20·5	18·9	15·1	14·2	10·7	4·7	2·6	Garstang
Pacific	7–9	2·2	11·1	17·1	18·00	16·5	14·1	11·6	7·0	2·3	,,
Indian 1	16	3·7	9·4	17·6	18·6	16·7	16·7	8·9	5·2	3·2	
,, 2	17	3·6	9·0	17·0	18·0	15·5	15·0	12·0	6·0	4·4	

It is clear that on the whole there is a fairly close correspondence between the examples from the Pacific Ocean and those from the Arabian Sea.

Distribution.—This species appears to be cosmopolitan throughout the tropical and temperate zones of all the great oceans. In the Atlantic it has been recorded from as far North as 60° between the Hebrides and Faeroes and in both the East and West Greenland Currents. In the Indian Ocean it has been taken from north of New Amsterdam, off Sumatra, in the North Equatorial Current, in the Bay of Bengal and off the East African coast, and the present records are from the Arabian Sea. In the Pacific Ocean it has been taken off the Northern part of New Zealand and in the region west of New Guinea ; Tokioka (1937) has recorded it as occurring somewhat irregularly in Japanese waters, and Ritter (1905) has recorded it from the San Diego region.

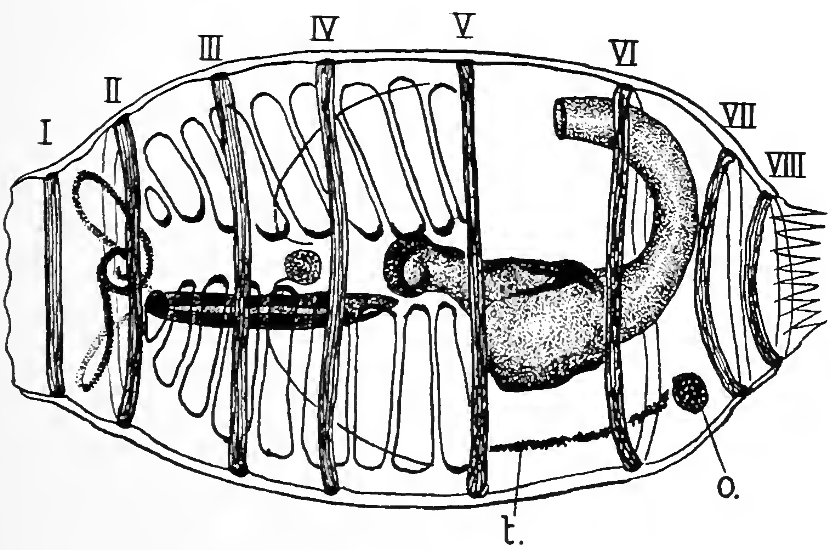
Doliolum (*Dolioletta*) *denticulatum* Quoy and Gaimard. (Text-fig. 15.)

Doliolum denticulatum Huxley, 1851, p. 600, pl. xviii, figs. 5 and 6 ; Neumann, 1905, p. 222, pl. xxiv, fig. 1 ; Neumann, 1913, p. 18 ; Ihle, 1910, p. 15.

Doliolum (*Dolioletta*) *denticulatum* Harant and Vernières, 1938, p. 49, fig. 63.
Dolioletta denticulatum Thompson, 1948, p. 96, pl. xxx. figs. 2, 3.
Doliolum nationalis Borgert, 1894, p. 21, pl. v, figs. 1–8; Neumann, 1905, p. 222; Garstang, 1934, p. 221, fig. 8; Berrill, 1950, p. 282, figs. 100D, H and 102A.
Doliolum (*Dolioletta*) *nationalis* Harant and Vernières, 1938, p. 49, fig. 63.
Doliolum challengeri Herdman, 1888, p. 48, pl. iii, fig. 4 (in part); Traustedt, 1893, p. 4, pl. i, figs. 12–14; Borgert, 1894, p. 31.

OCCURRENCE:

Sta. 58, South coast of Arabia: 1 gonozooid.
Sta. 76, Gulf of Oman, 0–200 m.: 4 "Old Nurses."
Sta. 96, Central part of Arabian Sea, 645–400 m.: 1 "Old Nurse."
Sta. 131, Southern area of Arabian Sea, 500–0 m.: 7 "Old Nurses."



TEXT-FIG. 15.—*Doliolum* (*Dolioletta*) *denticulatum* Quoy and Gaimard. A small specimen; total length 1·3 mm.

REMARKS.—*The gonozooid:* Total length, 1·3 mm.; dorso-ventral breadth, 0·73 mm. The gill-lamella begins at the IInd muscle-band and extends back to the level of the Vth muscle, where it turns forward and ends at about the junction of the anterior and middle thirds of the 3rd intra-muscular space. There are 13 gill-slits.

The nerve ganglion is situated a little in front of the IVth muscle-band. The endostyle commences immediately behind the IInd muscle and extends back to nearly one-half of the distance between the IVth and Vth muscle-bands. The alimentary canal begins in the œsophagus between the IVth and Vth muscle-bands and the stomach lies just behind the Vth muscle-band; the intestine forms a wide curve towards the right and opens about midway between the Vth and VIth muscle-bands. The ovary is small and lies a little in front of the VIIth muscle-band and the testis extends forwards on the left side as far as the Vth muscle-band. Ihle (1910, p. 15) has recorded that in the "Siboga" collections in some examples of *D. denticulatum* the gill-lamella extended forward on the ventral side to the middle of the 3rd inter-muscular space, as in the present specimen.

Neumann (1905, p. 223) has called attention to the existence of two forms, in one of which the testis is club-shaped and reaches forward to about the IVth muscle-band, the gill-slits number up to about 45, and the total length is up to 5 mm.; and in the other the testis is slender and rod-like and reaches up to the IInd muscle-band or even the 1st inter-muscular space, and from 80–85, or even up to 100, gill-slits are present and the total length is 8–9 mm. It is this latter form that Huxley described under the name *D. denticulatum* (1851). Neumann, however, does not consider that these differences justify the erection of a new species.

Garstang (1934, p. 205) has called attention to the gradual forward extension of the testis in *D. denticulatum*: he points out that in the smallest example of the gonozooid examined by him in the "Terra Nova" collections, which measured 1·0 mm. in length, the testis only extended forward as far as M_6; in somewhat larger, 2 mm., examples it extended as far as M_5 or M_4.

The oozooid: Several examples of the "Old Nurse" form were taken at Sta. 76, in the middle of the Gulf of Oman, in a haul from 200–0 m.; and again at Sta. 131, day, in the southern area of the Arabian Sea, in a vertical haul from 500–0 m. The total length of these examples ranged from 2·83 to 7·0 mm., as follows:

Sta. 76.		Sta. 131.	
4·17 mm.	1	2·83 mm.	1
4·5 ,,	2	3·08 ,,	1
6·33 ,,	1	3·67 ,,	1
		3·83 ,,	1
		4·0 ,,	1
		5·75 ,,	1
		7·0 ,,	1

They are characterized by an almost continuous sheet of muscle from end to end and thus fall into Garstang's category of

(3) Holomyonic :—Muscles 2–8 united into a continuous sheet.

According to Grobben (1882, p. 36 (236), pl. i, figs. 3, 4 and 5) in the young "Nurse" the muscle-bands are separated by inter-muscular spaces that are at least as wide as the muscle-bands, and only in later stages of growth do these interspaces become obliterated, so that the muscle-bundles finally form an almost complete covering (*vide* Grobben, *loc. cit.*, pl. ii, fig. 7), only the 1st and 9th sphincter muscles remaining separate round the oral and atrial apertures. He notes that small gaps in this muscular coat persist: between muscle-bands III and IV there is an opening for the otolith; between the IVth and Vth bands is a spindle-shaped opening for the brain; between the Vth and VIth there is a small gap on the ventral side for the stolon; and finally, between the VIth and VIIth and VIIth and VIIIth muscle-bands, are gaps where the VIIth and VIIIth muscles turn back to enter the dorsal process.

Garstang (1935, p. 198), however, considers that the earlier stages with separate muscle-bands, attributed by Grobben to the present species, should probably be referred to *D. gegenbauri*.

Distribution.—This species appears to be cosmopolitan throughout the warm-water regions of all three great oceans, Pacific, Indian and Atlantic; it has been recorded from as far south as Lat. 40° S. Tokioka (1937) records it as occurring throughout almost the whole year in Japanese waters.

Doliolum (*Dolioletta*) *mirabilis* (Korotneff). (Text-figs. 16 and 17.)

Dolchinia mirabilis Korotneff, 1891, p. 187, pl. 12, fig. 1.
D. (*Dolioletta*) *mirabilis* Garstang, 1934, p. 220, fig. 6; Neumann, 1913, p. 17.
D. (*Dolioletta*) *mirabile* Harant and Vernières, 1938, p. 49.
Doliolum chuni Neumann, 1906, p. 221, pl. 23, figs. 9, 10, pl. 24, fig. 3; Neumann, 1913*b*, p. 17.
D. (*Dioletta*) *chuni* Garstang, 1934, p. 219.
Doliolum valdiviæ Neumann, 1906, p. 219, pl. 21, fig. 2.
D. (*Dolioletta*) *valdiviæ* Neumann, 1913, p. 17; Garstang, 1934, p. 219, fig. 5.

Occurrence:

Sta. 58, South coast of Arabia, surface: 2 examples of the Gonozooid and 1 of the Phorozooid.

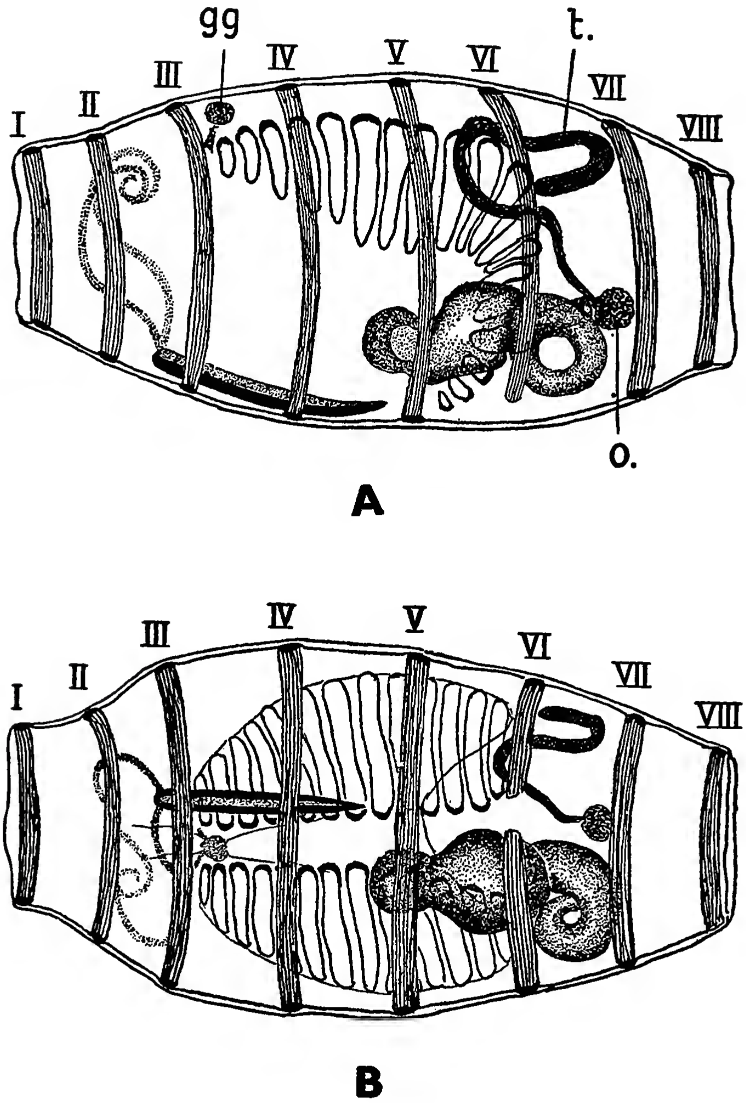
Remarks.—Fedele (1923) has united the two "species" *Doliolum mirabilis* and *D. chuni* into a single species under the name *D. mirabilis* (Korotneff), and Garstang has suggested that *D.* (*Dolioletta*) *valdiviæ* Neumann may be a third form of the same species.

The gonozooid: Both specimens were of about the same size, the total length being 1·9 and 2·1 mm. respectively.

The endostyle commences at about the middle of the 2nd inter-muscular space and extends backwards to the middle of the 4th inter-muscular space. The brain is situated close behind the IIIrd muscle-band, and on either side the hypophysis passes outwards and somewhat forwards immediately in front of the 1st gill-slit. The gill-lamella commences immediately behind the IIIrd muscle-band on a level with the brain and extends back as far as the VIth body-muscle, where it turns forwards and ends ventrally at the level of the Vth body-muscle. The number of gill-clefts is 19 or 20. The œsophagus lies immediately in line with the Vth body-muscle and opens immediately into the stomach, which lies in the 5th inter-muscular space. Opposite the VIth muscle the stomach passes into the intestine, and at this point in the mid-ventral line the VIth muscle is interrupted. The intestine forms a spiral loop, passing first backwards and to the right and then forwards as far the VIth muscle-band: it then curves round, and the terminal part lies just dorsal to the first part and opens at about three-fourths of the distance between the VIth and VIIth body-muscles. The ovary lies ventrally in contact with the VIIth body-muscle. In the smaller specimen the testis is closely attached to the ovary and passes at first forwards and somewhat to the left to a point a little in front of the VIth muscle, where it turns backwards and again crosses the VIth body-muscle not far from the mid-dorsal line: it continues backwards till near the VIIth body-muscle and then bends forwards again and ends touching the VIth muscle-band. In the larger example the testis is somewhat more convoluted; it passes forward and outwards to the VIth body-muscle, where it forms an 8-shaped twist and then runs back to the VIIth muscle-band, in front of which it runs inwards nearly to the mid-dorsal line.

These two examples appear to combine certain characters of both *D. valdiviæ* and *D. mirabilis*. In the length of the endostyle and the interrupted VIth body-muscle they conform to *D. mirabilis*, but the position and arrangement of the testis comes more nearly into line with the description of *D. valdiviæ* (*cf.* Neumann, 1906, pl. xxiii, fig. 8). The ending of the gill-lamella ventrally at the Vth muscle-band, agrees with *D. valdiviæ*, whereas in *D. mirabilis* it is continued forward to the level of the IVth body-muscle.

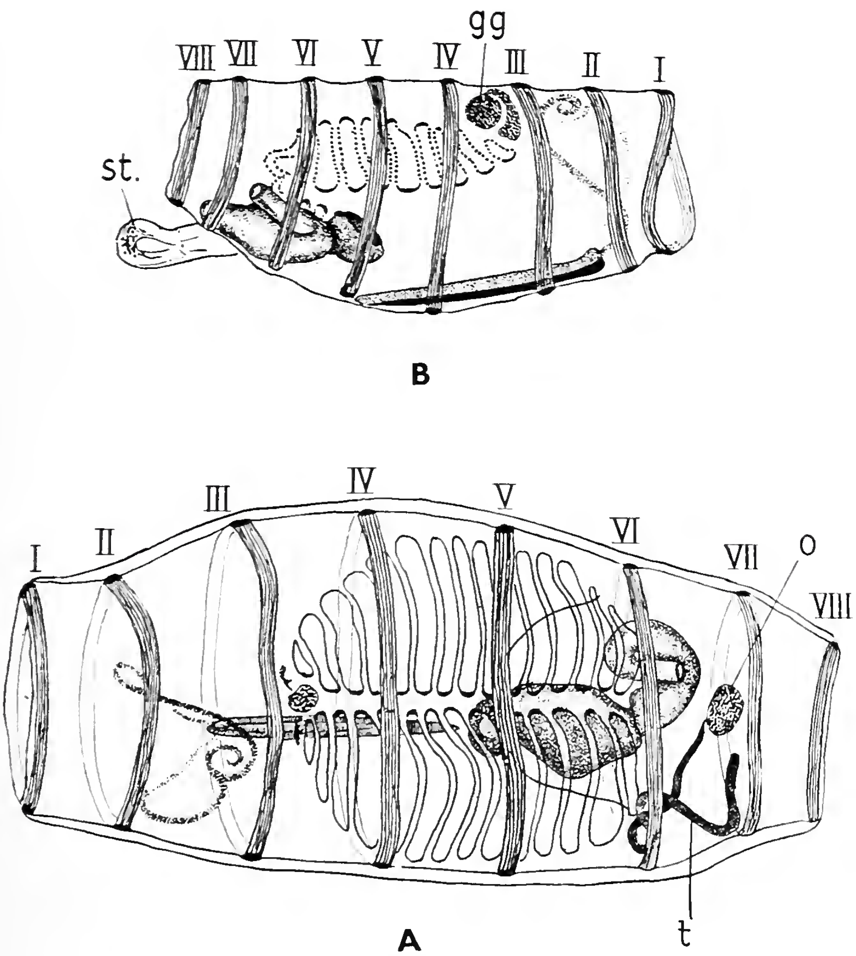
The phorozooid: The total length was only 1·05 mm. The general structure closely resembles that of the Gonozooid. The endostyle is, however, considerably longer than in *D. mirabilis* and closely resembles that of *D. valdiviæ* : it commences only a short distance posterior to the IInd body-muscle and terminates posteriorly close to the Vth body-muscle.



TEXT-FIG. 16.—*Doliolum* (*Dolioletta*) *mirabilis* (Korotneff). Gonozooid ; total length 1·9 mm. A, Lateral view. B, Ventral view.

There are only 12–13 gill-slits, and the gill-lamella ends ventrally at about the middle of the 5th inter-muscular space. The stalk is short and broad and arises from beneath the posterior half of the 6th inter-muscular space.

DISTRIBUTION.—If *D.* (*Dolioletta*) *mirabilis* (= *chuni*) and *D.* (*Dolioletta*) *valdiviæ* are, as seems probable, merely different forms of the same species, its distribution extends from the Mediterranean Sea, through the north and tropical Atlantic Ocean ; it has also been recorded in the southern part of the Benguela Current, off the Cape of Good Hope, in the northern part of the Indian Ocean and in the South-west Pacific Ocean off the northern point of New Zealand.



Text-fig. 17.—*Doliolum* (*Dolioletta*) *mirabilis* (Korotneff). A, A larger example of the gonozooid, from above. B. A Phorozooid, 1·05 mm. in length.

Order PYROSOMIDA.

Family Pyrosomatidæ.

Genus *Pyrosoma* Péron.

For many years past there has been a steady increase in the number of so-called "species" and subspecies in the genus *Pyrosoma*. The species of this genus have been divided into two groups :

Pyrosomata fixata :

Pyrosoma agassizi Ritter and Byxbee.
Pyrosoma spinosum Herdman.

Pyrosoma indicum Bonnier and Perez.
(= *P. spinosum* Herdman.)

PYROSOMATA AMBULATA :

Pyrosoma verticillatum Neumann.
Pyrosoma verticillatum cylindricum Metcalf and Hopkins.
Pyrosoma hybridum Metcalf and Hopkins.
Pyrosoma ellipticum Metcalf and Hopkins.
Pyrosoma operculatum Neumann.
Pyrosoma aherniosum Seeliger.
Pyrosoma ovatum Neumann.
Prosoma atlanticum (Péron).
(= *P. atlanticum atlanticum* (Péron) M. and H.).
Pyrosoma elegans Lesueur.
(= *Pyrosoma atlanticum elegans* Lsr., Neumann, M. and H.).
Pyrosoma triangulum Neumann.
(= *Pyrosoma atlanticum triangulum* Neumann, M. and H.).
Pyrosoma atlanticum echinatum Metcalf and Hopkins.
Pyrosoma atlanticum hawaiiense Metcalf and Hopkins.
Pyrosoma atlanticum paradoxum Metcalf and Hopkins.
Pyrosoma atlanticum var. *levatum* Seeliger.
Pyrosoma atlanticum var. *tuberculosum* Seeliger.
Dipleurosoma elliptica Brooks.
(= *Pyrosoma atlantica* f. *dipleurosoma* (Brooks), Metcalf and Hopkins.)
Pyrosoma atlanticum group *intermedium* M. & H.
Pyrosoma giganteum Lesueur.
(= *Pyrosoma atlanticum giganteum* Lesueur, Neumann.)

The characters upon which previous authors have relied for the determination of " species " are :

(1) The surface character of the test, and to a less extent the general shape of the colony, e.g., conical, cylindrical or flattened ;
(2) the general shape and proportions of the individual zooids, and
(3) The number of gill-clefts, gill-bars and dorsal languets present in the zooid.

All these characters, however, vary in a single colony.

Metcalf and Hopkins, who, as the above list demonstrates, are mainly responsible for the creation of most of these " species " and " subspecies," have remarked that " in the genus *Pyrosoma* . . . there is such intergradation that entirely confident demarcation of species and subspecies is not possible . . . The conditions among the Pyrosomas suggest hybridization as a factor co-operating with mutation to produce the results observed. . . . Among the Pyrosomata it (intercrossing) is altogether probable, cross-fertilization seeming to be universal, different forms being known to be present in the same water."

It seems much more probable that the majority of these different forms belong to a relatively few species and are merely growth stages, and that the differences between zooids in the same colony and the similarities of zooids in different colonies are attributable to changes in the relative growth and development of different parts of the individual, or of the colony, caused by corresponding differences in the environment, as Garstang (1933) suggested for the Doliolidæ.

Section Pyrosomata fixata.

This group is usually stated to include only two species, *Pyrosoma spinosum* Herdman (= *P. indicum* Bonnier and Perez) and *P. agassizi* Ritter and Byxbee. The characters that have been relied on for the separation of the species are as follows:

(1) *The Size of the Colony.*—According to Ritter and Bybee (1905, p. 201) the length of their colony was 12 cm. long by 1 cm. wide in the middle of its length. Metcalf and Hopkins had before them colonies that measured 8–11 cm. in length. Neumann records colonies ranging from 2½ to 17 cm. Kruger (1912) reported a colony from near the Azores of what he took to be *P. agassizi* as having a length of 111·5 cm.; but this estimate of the length is based on the assumption that the six fragments that he obtained were all from the same colony and the total length is reached by adding together the lengths of all the different fragments; but Metcalf and Hopkins are inclined to think that this last was in reality a colony of *P. spinosum* Herdman.

(2) *The Presence of Four Processes of the Test at the End of the Colonial Tube.*—The colony of *Pyrosoma agassizi* is stated to possess four quadrangular processes, which are of variable length, whereas *P. spinosum* presents no such processes; but Ritter and Byxbee (*loc. cit.*, p. 205) admit that in collections made by the "Albatross" in a cruise to the Hawaiian Islands in 1902 there were several colonies which they attribute to *P. agassizi*, but in which these processes were absent; and Kruger (*loc. cit.*) has noted that some of his smaller colonies of *P. agassizi* were similarly without these processes; and Farran has described a colony of *P. spinosum* from the coast of Ireland in which these processes were present. It seems clear that this character cannot be relied on to differentiate between the two forms.

(3) *The Shape of the Zooid.*—The zooid of *P. agassizi* is stated to be much higher than it is long, owing to the reduction in the lengths of both the oral and atrial chambers. Mature individuals of *P. spinosum* are much longer than high. Ritter and Byxbee (*loc. cit.*, p. 203) state that in *P. agassizi* "all the zooids, young and old, are much broader than long"; but as they admit that not a single zooid that they examined showed any trace of the genital organs, it seems very clear that none of their specimens could justifiably be termed "old." A study of a number of young zooids from a colony of *P. spinosum* in the present collection shows that in certain examples of the young zooid we may get characters that very closely resemble those said to be characteristic of *P. agassizi*: in Text-fig. 18 I have given the lateral views of four young zooids of *P. spinosum*, and it is clearly seen that in three out of the four the height of the zooid, taking the measurement at right angles to the line joining the oral and cloacal apertures, is much greater than the length, and may be in the proportion of 4 to 3.

(4) *The Angle of the Stigmata to the Horizontal.*—Metcalf and Hopkins (1919, p. 217) state that in *P. agassizi* the stigmata of the branchial basket run at an angle of 50° to 70° to the longitudinal axis of the zooid, whereas in *P. spinosum* this angle is considerably smaller, ranging from 5° to 20°. This, however, appears to be true only of the fully developed zooid. In a series of small developing zooids of *P. spinosum* in the present collection the angle of the stigmata to the longitudinal axis of the body, i.e., the axis from

mouth to atrial aperture, varies very considerably with growth and development, as also with the general shape of the individual. In the following table I give the dimensions of six zooids of different sizes, and the angle that the stigmata make to the longitudinal axis :

Size of zoood. Length (mm.).	Height (mm.).	Angle of stigmata to the longitudinal axis.
0·40	0·53	50°
0·63	0·45	30°
1·00	1·33	40°
1·30	1·50	20°
2·70	1·20	15°
4·7	2·0	10°

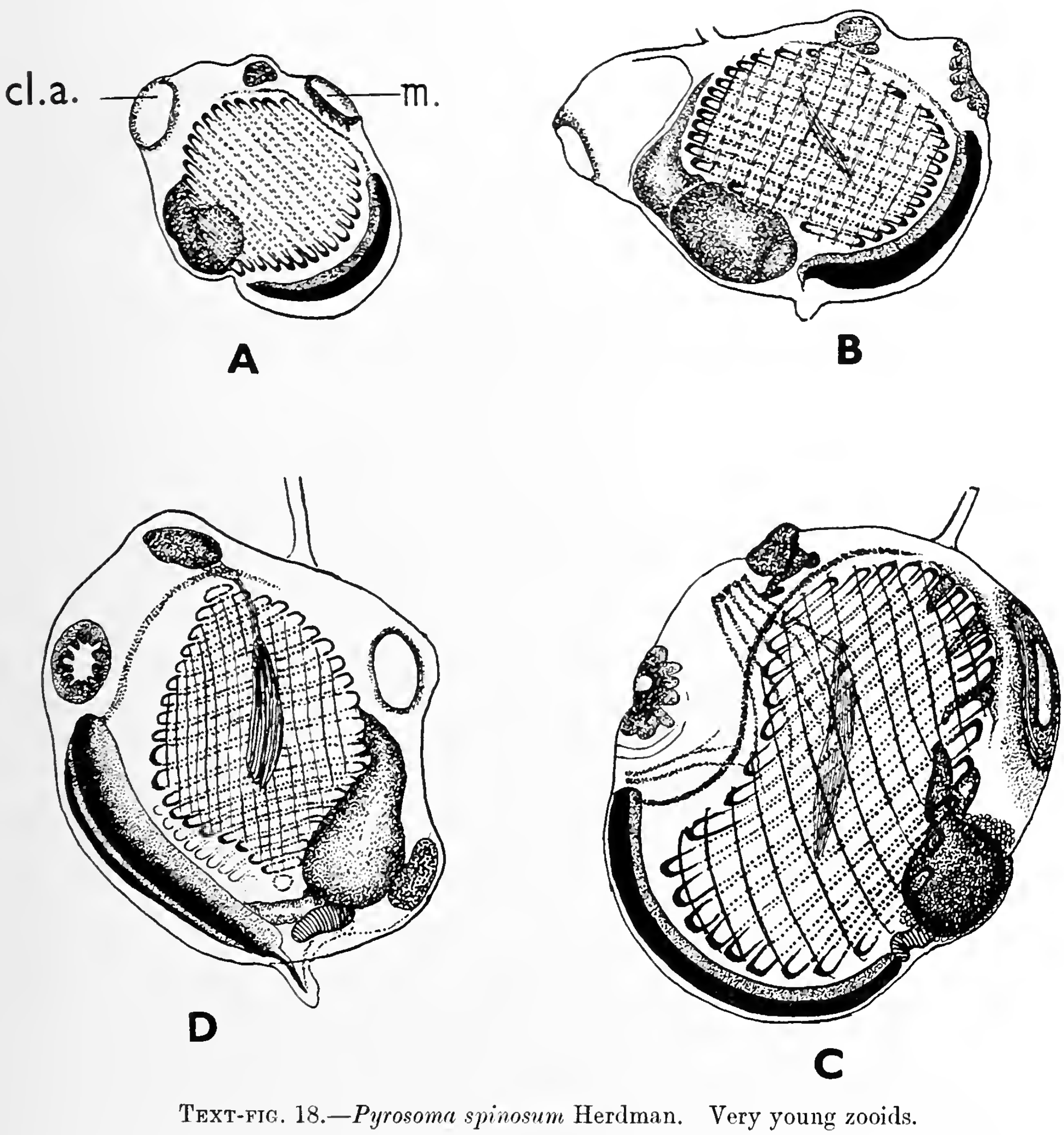
It seems clear that this angle decreases gradually with the increase in size of the zooid, and that it tends to be considerably wider in those examples in which the height of the body is greater than the length, so that in the smallest specimens both the shape of the zooid and the angle of the stigmata correspond closely with the condition present in *P. agassizi*.

(5) *The Number of Stigmata, Branchial Bars and Dorsal Languets.*—In *P. agassizi* the number of the branchial stigmata and the gill-bars are stated to be from 20 to 31, usually 26, of the former and 16 of the latter, with about 5 or 6 dorsal languets; whereas in *P. spinosum* the numbers are stated by Metcalf and Hopkins (1919) and Neumann (1913*a*) to be from 50 to 55 stigmata and 30 to 46 gill bars, with 9–10 (Metcalf and Hopkins) or as many as 22 (Neumann) dorsal languets. In the present series the number of these structures varies progressively with the size of the individual zooid, as is indicated below :

Size of zooid. Length (mm.).	Height (mm.).	Number of stigmata.	Number of branchial bars.	Number of dorsal languets.
0·40	0·53	15	13	–
1·0	1·33	17	14	3
2·7	1·2	20	19	5
4·7	2·0	29	21	5
6·9	2·5	40	29–30	6–8
8·3	2·9	45	33	(6–8)

Here again relatively small individuals of *P. spinosum* exhibit a considerable degree of resemblance to the zooid of *P. agassizi*. Metcalf and Hopkins in their examples of zooids of *P. spinosum*, that measured 8·0–10 mm. in length, found 9 or 10 languets, while Neumann in a specimen of 20·0 mm. length records as many as 22. *Pyrosoma agassizi* is stated to have only 5 or 6 dorsal languets in the largest zooids, which may reach a length of 2·5 to 3·2 mm. thus agreeing with the condition seen in young *P. spinosum* of a corresponding size.

This gradual increase in the number of stigmata, gill-bars and dorsal languets occurs in all the species of *Pyrosoma* as growth progresses. Huxley (1860, p. 218), in his account of the development of the budded individual of *Pyrosoma*, pointed out that in the species with which he was dealing, *P. giganteum*, "the languets do not appear till development has advanced a long way. . . . In buds 1/30th of an inch long one or two small tubercles are visible, projecting from the hypopharyngeal band. These gradually increase in number, elongate and assume their adult shape and size"; and in his description of the young developing ascidiozooid he stated that "9 or 10 branchial stigmata are discernable but there are as yet no branchial bars, and at a later stage there are 10 stigmata and 6



TEXT-FIG. 18.—*Pyrosoma spinosum* Herdman. Very young zooids.

	Length (mm.).	Height (mm.).	Number of gill-slits.	Angle of gill-slits to horizontal.
A	0·40	0·53	15	50°
B	0·63	0·45	15	30°
C	1·00	1·33	17	40°
D	1·30	1·50	20	20°

or 7 branchial bars," but only two languets have developed, whereas in the fully-grown zooid he found 8 languets (*vide* Huxley, *loc. cit.*, pl. xxx, fig. 1). It thus appears that most of the characters that have been used to separate the two species are merely evidences of immaturity in *P. agassizi*; this is supported by the fact that prior to the collections reported on by Metcalf and Hopkins no example of *P. agassizi* had ever been found to be sexually mature, and in their collection only a single colony showed individuals possessing what they considered to be the developing testis: they remark (1919, p. 22) that in *P. spinosum* "the gonads can be found in the zooids of comparatively large colonies only . . . and it is the testis that develops first: thus it appears that both *P. agassizi* and *P. spinosum* are protandrous." The smallest zooid in which I have seen what I take to be the commencing development of the testis is in a zooid that measured 1·30 mm. in length and 1·50 mm. in height (*vide* Text-fig. 18D). Neumann (1934) has pointed out the possibility that *P. agassizi* is merely a young form of *P. spinosum.*

Pyrosoma spinosum Herdman. (Text-figs. 18A–D, 19A and B and 20B.)

Pyrosoma spinosum Herdman, 1888, p. 29, pl. ii, figs. 9–15; Seeliger, 1895, p. 62; Farran, 1909, p. 221, pl. vi; Neumann, 1913*a*, p. 380, pl. xlii, fig. 1; Neumann, 1913*b*, p. 4; Neumann, 1913*c*, p. 28, fig. 19; Harant and Vernières, 1938, p. 51, fig. 66; Berrill, 1950, p. 275, figs. 97*c*, 99.
Pyrosoma indicum Bonnier and Perez, 1902, p. 1238.

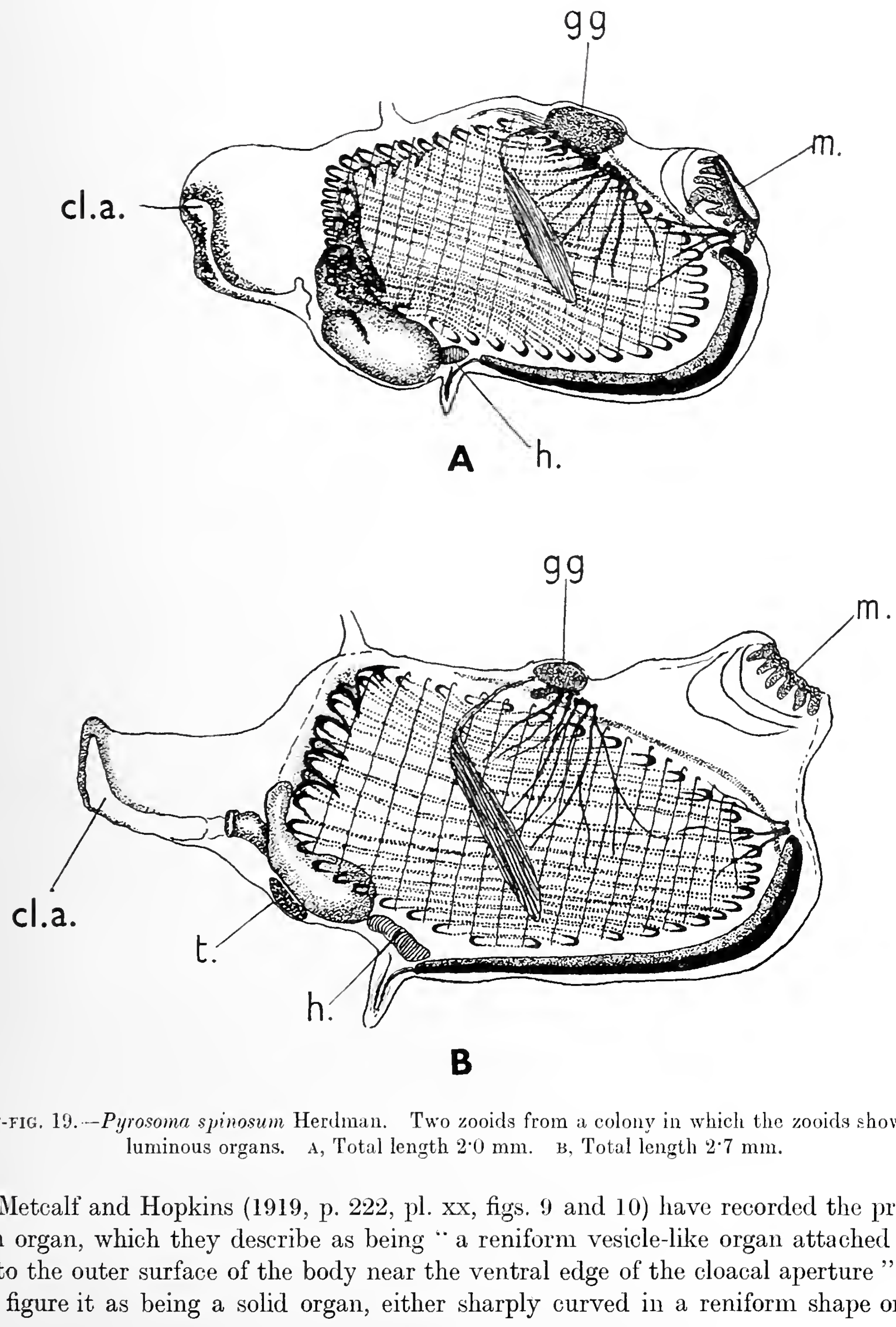
OCCURRENCE:

Sta. 43, South coast of Arabia, 100–83 m.: portions of a large colony.
Sta. 96, Central part of Arabian Sea, 645–400 m.: fragments of an enormous colony.
Sta. 133, Southern area of Arabian Sea: trawl in 3385 m. depth: fragments of a large colony.
Sta. 184, Gulf of Aden; trawl in 1270 m. depth: fragments of a large colony.

REMARKS.—I have already (*vide supra*, p. 57) discussed the characters that have been relied on to differentiate *P. spinosum* from *P. agassizi.* In the present specimens the atrial cavity of the zooids appears to increase steadily with the growth of the individual, and the cloacal lappet does not appear till growth has advanced to a body-length of about 2·7 mm., at which stage it forms a low rounded prominence immediately above the dorsal margin of the atrial aperture (Text-fig. 19A and B).

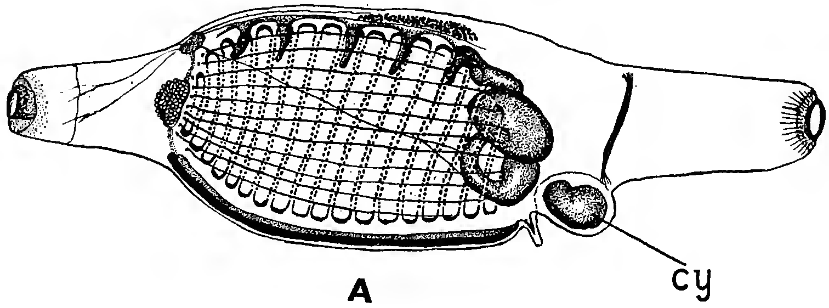
In the colonies captured at Stas. 43 and 133 I could find no trace of a luminous organ, either on the side of the buccal cavity or in the region of the atrium, in any individual at any stage of development. Seeliger (1893, p. 41) has called attention to the fact that Quoy and Gaimard recorded that their *Pyrosoma rufum* was non-luminous, and Panceri (1872) has also mentioned a non-luminous *Pyrosoma* that was taken in the Pacific Ocean by the Italian Frigate "Magenta" during her voyage round the world.

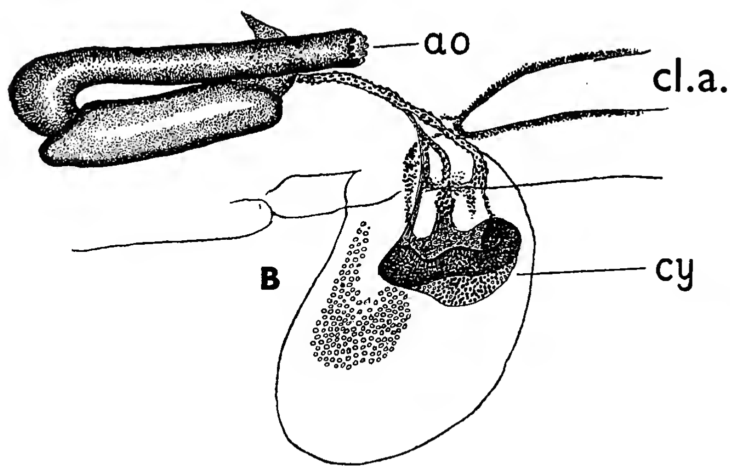
In some of the zooids a cyathozooid is present, lying, apparently, in the atrial cavity. Metcalf and Hopkins (1919, p. 211) have noted that "in our colonies we found embryos in which the atrium of the cyathozooid is completely overgrown by a layer of cellulose"; in the present examples the whole cyathozooid appears to be enclosed in a cellulose coat, and this mantle or test is ornamented in the region of the cloacal aperture by numerous small cells arranged in lines outlining pentagonal or hexagonal areas. A similar condition has been described and figured by Huxley (1860, p. 238, pl. xxxi, fig. 15) in *Pyrosoma* *giganteum*: he remarks that "the test appears at first to be a structureless excretion. Subsequently, cellular bodies, like connective-tissue corpuscles are discernable in its most superficial layer, and are disposed in such a manner as to form a very regular, hexagonal network, with large meshes."



Text-fig. 19.—*Pyrosoma spinosum* Herdman. Two zooids from a colony in which the zooids showed no luminous organs. A, Total length 2·0 mm. B, Total length 2·7 mm.

Metcalf and Hopkins (1919, p. 222, pl. xx, figs. 9 and 10) have recorded the presence of an organ, which they describe as being "a reniform vesicle-like organ attached by its end to the outer surface of the body near the ventral edge of the cloacal aperture": and they figure it as being a solid organ, either sharply curved in a reniform shape or more slightly curved in a crescent, lying in a hollow sac that is attached to the surface of the body near the anterior end of the ventral extension of the atrial aperture, but it must be remembered that in this species the atrial aperture, instead of being a more or less circular opening at the distal end of the atrial cavity as in other species, gradually changes its shape with growth of the zooid, and the ventral lip of the opening is carried forward so that the opening forms a long, slit-like aperture on the ventral side and its terminal point eventually comes to lie almost immediately below the anal opening of the intestine, in a





TEXT-FIG. 20.—A, A specimen of *Pyrosoma atlanticum* (Peron) with an early stage of development of a cyathozooid. B, A specimen of Metcalf and Hopkins' "renniform organ" in *Pyrosoma spinosum* Herdman, after staining with borax-carmine.

position close to where the genital organs lie, and where in other species, e.g., *Pyrosoma atlanticum* f. *giganteum*, the developing cyathozooid is situated (*vide* Text-fig. 20A). In the "John Murray" collection what I take to be this "reniform organ" is present in zooids from the large fragmentary colony taken at Sta. 184. The individual zooids are extremely long and measure, from the oral aperture to the base of the cloacal tentacle, 12·5–13·5 mm., the length of the atrial siphon being about 4·33 mm. The sac, in which the organ lies, varies in shape from almost spherical to an elongate cylinder, and the reniform mass also varies in its position within the sac, being usually at the proximal end, but in some cases at the distal end, or attached to the wall of the sac about the middle of its length.

Running from the organ is a well-developed strand of tissue that appears to be a blood-vessel; this passes upwards and forwards and is finally lost in the loop of the intestine. This I take to be the genital blood sinus. An examination of the solid organ, after staining with borax-carmine, shows it to consist of a hemispherical or cup-shaped mass of cells, enclosing a concavity (Text-fig. 20B). The margin of the cup-shaped mass is composed of columnar cells, which form a horse-shoe-shaped thickened rim, and in one specimen a small finger-shaped dense protuberance projected from the margin of the horse-shoe about its middle. Metcalf and Hopkins (1919, p. 222) suggest that this "reniform organ" "may possibly have something to do with reproduction," as they remark, "according to other descriptions, there have been no embryos found in Atlantic specimens of this species, though colonies of over one metre in length have been reported." A comparison of this organ in *Pyrosoma spinosum* with the condition seen in a specimen of *Pyrosoma atlanticum* f. *giganteum* (*vide* Text-fig. 20A), in which a cyathozooid has commenced to develop, shows that cyathozooid and the reniform organ occupy similar positions, namely, just below and behind the anal aperture and in the position where the ovary is normally situated. In none of the present specimens in which this organ is present is there any trace of the testis, and it seems to me that this organ is merely a stage in the early development of a cyathozooid.

Distribution.—This species has been recorded from all three great oceans, Pacific, Indian and Atlantic, in the tropical and temperate zones.

Neumann (1933, p. 228) states that the Pyrosomas are holoplanktonic and are found in the upper 200 metres and do not occur below a depth of 500 m.; but the records of the capture of large colonies of this species are almost all in hauls from considerable depths. Herdman (1888) records specimens in hauls from 4023 m. and 3475 m.; Kruger (1912) gives the depth at which the haul was made, when several fragments of a large *Pyrosoma* were taken, as from 3000 m.; Metcalf and Hopkins regard this example as probably a specimen of *P. spinosum*, and not *P. agassizi* as Kruger identified it. Neumann (1913*a*) records the capture of examples in hauls from 1134 and 1644 m. Metcalf and Hopkins (1919) give records of examples in hauls from 1367 m. and 1479 m. depth. In the present collection fragments of a large colony came from a depth of 100 m.; fragments of two other large colonies in trawls from 1270 and 3385 m. respectively, and, finally, fragments of an enormous colony were taken in the self-closing net from a haul between 645 and 400 m. The evidence thus seems to indicate that large colonies of this species are usually found in considerable depths; but this is not invariably the case, for at Sta. 183 in lat. 14° 40′ 06″ N.; long. 50° 53′ 36″ E., on 4th May, 1934, while carrying out a trawl in 1105 m., a large red *Pyrosoma* colony, looking remarkably like an inner tube of a motor tyre, drifted by on the surface: a boat was lowered to capture the specimen but unfortunately it could not be found. During the previous day, while we were steaming northwards, Captain Mackenzie had seen what must have been another specimen of the same animal, for he described it as looking like a motor tyre of a red colour, and on 5th May, while working Sta. 186, several of these large red *Pyrosoma* colonies were seen, and one that drifted by close to the ship was estimated by the officer on the bridge and myself as being about 5 feet in length with a width of some 9 inches; another one was seen about 4.0 p.m. on the same day, and yet another early the following morning. There can be little doubt that these large pyrosomas belonged to the same species as those taken by Bonnier and Perez in the Arabian Sea in March,1901, at a position only a little further east in lat. 16° 40′ N., long. 52° 30″ E., off Ras Merbat ; they describe their specimens as being of a vivid red colour, the colour being due to the ascidiozooids, whereas the test was colourless. Bonnier and Perez gave the size of their colonies as being from 2·5 to 4 m. in length. I have also seen, when on the "Investigator," an example of what I believe to have been an example of this species, having a length that was estimated at about 5 feet and a breadth of about 9 inches, on the surface in the middle of the Bay of Bengal. The colour of this colony was a pale pink.

Section Pyrosomata ambulata.

In the Group of *Pyrosomata ambulata* a number of species and subspecies or varieties have been founded by successive observers on characters that vary very considerably with the age of both the individual zooid, and, if size of a colony may be taken as an indication of its age, of the colony as well. The characters upon which most reliance has been placed for the separation of such species and varieties are :

(1) the surface characters of the test and to a less extent the general shape of the colony,
(2) the general shape and proportions of the individual zooids in the colony, and
(3) the number of gill-slits, gill-bars and dorsal languets present in the well-developed individual.

1. *The general character of the test and shape of the colony.*

Seeliger (1895), as one of the results of his investigations, came to the conclusion that the form of a colony may be modified in a number of different ways, and in consequence it is not possible to place any reliance as a specific character on such differences in shape as that one colony is conical and another cylindrical. Metcalf and Hopkins (1919), however, lay considerable stress on such slight differences, and also on such other differences as whether a colony is circular in cross-section or is flattened and elliptical ; and they argue that the shape of the cloacal aperture of a colony, circular or elliptical, is evidence that the colony was originally formed in that shape and that this condition is not the mechanical result of compression. In a series of individuals of *Pyrosoma atlanticum* Peron, taken together in a haul at Sta. 131, the smaller colonies are distinctly flattened, whereas the larger have much firmer tests and are circular in cross-section. Other differences that have been noted in the colonies of so-called species or subspecies and have been used as diagnostic characters are the presence or absence of processes of the test that project from the surface round some, though by no means all, of the oral apertures of individual zooids, and differences in the size and shape of such processes. Metcalf and Hopkins under the name *Pyrosoma atlanticum* Peron have grouped together a number of forms, some of which were previously described by earlier workers as distinct species ; most of these forms they regard as subspecies. Thus we have in this group the following :

	Length of colony (mm.).
Pyrosoma atlanticum Peron, f. *dipleurosoma* (Brooks) .	4·3–12·0
,, ,, *triangulum* Neumann	8·0– 9·0
,, ,, *paradoxum* M. and H. . .	8·6
,, ,, *atlanticum* Peron.	8·0–12·0
,, ,, *hawaiiense* M. and H. . .	11·0–17·0
,, ,, *echinatum* M. and H. . .	12·5
,, ,, *giganteum* Leseuer . . .	19·5–40·0

Seeliger (1895, p. 58) separated *Pyrosoma atlanticum* into two varieties, *levatum* and *tuberculosum*; in the former the test wall is stated to be flat and smooth without any very marked processes, and in the latter the test is provided with short, thorn-like processes that are situated dorsally to the mouth-opening of the zooid and are directed towards the posterior, or open, end of the colony. The length of his colonies ranged from 5·0 to 6·0 cm. Ritter (1905, p. 100) has noted that in a single colony he could find in the structure and arrangement of the test processes some that showed essential agreement with those said by Seeliger (1895) to be characteristic for *P. atlanticum* var. *tuberculosum* and others with those described and figured by various writers for *P. giganteum*.

If now we consider the type of these processes in the various colonies arranged according to their size we find that in the smallest group, that of *P. atlanticum atlanticum* f. *dipleurosoma* (Brooks), it is noted that " the test processes show various degrees of development. They may be quite absent, except for a few slight elevations, or they may be large and numerous. The processes are rarely long or tapering, but almost all show the characteristic truncation at their ends " (Metcalf and Hopkins, 1919, p. 299).

In *P. atlanticum triangulum*, with a colonial length of 8·0–9·0 cm. " the test processes are weakly developed, short, and for the most part sharply tipped " (Metcalf and Hopkins, 1919, p. 256).

In *P. atlanticum paradoxum*, with a length of 8·6 cm. the " test processes (are) fairly long and tapering, with oblique areas of truncation, which are a little denticulated on their edges " (Metcalf and Hopkins, 1919, p. 248).

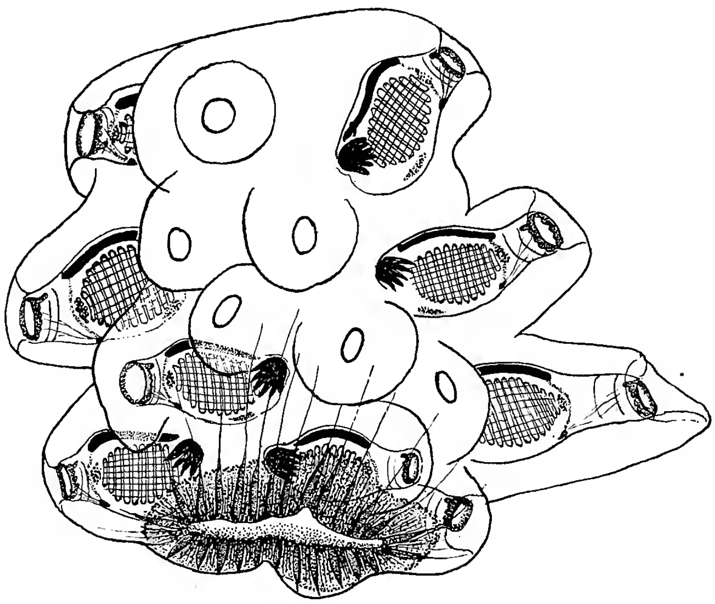
In *P. atlanticum atlanticum*, with a length of 8·0–12·0 cm., the test process " is a broad obliquely truncated cone, the truncated surface of which faces slightly toward the closed end of the colony," and, " appearing rather early, there is a characteristic denticulation along the lateral edges of the truncated process and at its dorsal tip " (M. and H., 1919, p. 240).

In *P. atlanticum hawaiiense*, with a length of 11·0 to 17·0 cm. " the test processes are low rounded protuberances with extremely blunt ends; over the entire outer surface of the colony there are minute rounded elevations, which are visible only under magnification, thus giving to the test a granular opaqueness " (M. and H., 1919, p. 246).

In *P. atlanticum echinatum*, with a length of 12·5 cm., " nearly all the test processes are long and finger-like and bend in the direction of the colonial aperture. At their ends they are not sharply pointed but are narrow and in edge view for the most part emarginate, being narrowed on the outward side " (Metcalf and Hopkins, 1919, p. 257). So far as I understand this description it would seem that these processes are very similar to those that Herdman (1888, p. 18, fig. 2, and p. 20, fig. 4) described for *P. giganteum*.

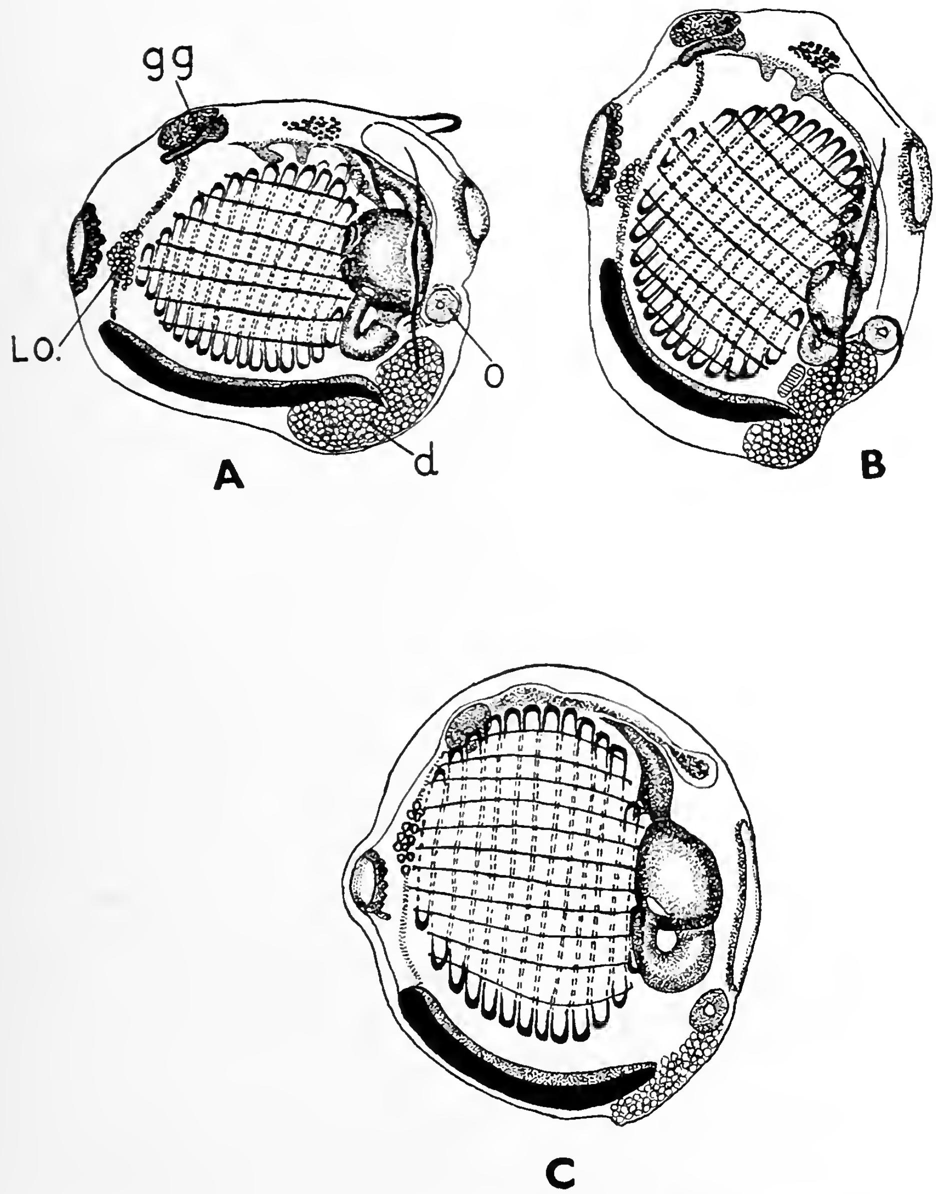
Finally, in *P. atlanticum giganteum*, the largest of all, with a colonial length running to 19·5–40·0 cm., " the test processes for the most part are thick rounded papillae, while scattered here and there are long finger-like tentacles. . . . which are sharply pointed and flattened at their tips, as a result of the extremely oblique truncation " (Metcalf and Hopkins, 1919, p. 253).

Similar long processes are to be found, if we may judge from the photographs of the colonies given by these authors (Metcalf and Hopkins, 1919, pls. 34, 35), in *P. atlanticum* f. *dipleurosoma* and *P. atlanticum echinatum*. In certain colonies that I attribute to the form *P. atlanticum* f. *giganteum* one can trace a gradual development of these test processes. In the smallest colonies at the closed end there are no processes, and the zooids have their oral apertures situated at the bottom of a crater-like depressed area, but as the colonial opening is approached many of the zooids are situated on a slightly raised area, which is obliquely truncated, so that the rim is much more marked on the side towards the aperture, i.e., towards the dorsal side of the zooid, and this raised rim is covered with small rounded denticulations. In larger colonies some of these raised areas become more elongated so as to form a definite tentacular projection. Metcalf and Hopkins (1919, p. 238) admit that in colonies of the same type but of different ages there may be considerable differences in the character of the processes ; in young zooids of the *atlanticum* form they note that the truncated area around the oral orifice may be depressed, forming more or less of a funnel leading to the mouth, while in older colonies test processes sometimes develop to a great length, so that they give to the colony a bristling spiny appearance " : in other colonies these test processes are rather late in making their appearance, as, for



TEXT-FIG. 21.—A young colony of *Pyrosoma* (?) *atlanticum* (Peron) showing a rapid change in the character of the Test-processes. Size of colony 7 mm. long by 8 mm. wide. from Sta. 131A.

instance, in the young colonies of *P. atlanticum*, which are smooth and thus resemble the species *verticillatum*, *hybridum*, *ellipticum* and *operculatum*. These changes in the character of the test processes may occur very rapidly in the course of development of a young colony, as is shown in Text-fig. 21 : this is a sketch of a young colony of what I believe to be *Pyrosoma atlanticum* with only four rows of individuals. In the topmost row at the closed end the mouths of the zooids are situated on a slightly raised papilla, of which the dorsal lip on the side towards the colonial aperture is in the case of the individual on the right side somewhat longer than on the ventral side ; in the second row the mouth opens on a short stout pillar that terminates in a circular depressed area ; the process stands out perpendicularly to the surface of the colony and the terminal depression faces directly outwards, thus agreeing with the description of these processes given by Metcalf and Hopkins (1919, p. 234) for the species *P. aherniosum*. In the third row one individual on the right side now opens at the apex of a relatively long column, the apex of which is obliquely truncated and thus resembles the type of process that is seen in *P. atlanticum*, and in a more extreme form in *P. ovatum*. In each succeeding row the length of the oral siphon increases. It thus appears extremely doubtful if any reliance can be placed on these differences of shape of a colony or the character of the test processes as specific characters.



TEXT-FIG. 22.—Three young zooids from a colony of *Pyrosoma atlanticum giganteum*. Dimensions: A, Length, 0·45 mm.; height, 0·38 mm. B, Length, 0·35 mm.; height, 0·48 mm. C, Length, 0·65 mm.; height, 0·70 mm.

2. *The shape and proportions of the zooid.*

Another character that has been used for the determination of species is the shape and proportions of the zooid itself. Neumann (1909) created a new species *P. triangulum* on the triangular character of the branchial basket; Metcalf and Hopkins (1919) reduced this form to the level of a subspecies. I have found that a careful examination of a number of zooids in different colonies may reveal the presence of zooids having this triangular shape in forms that are clearly of different species. Ritter (1905, p. 100) in his account of *P. giganteum*, remarked that " in the same colony I find old zooids with long siphons, but others again certainly equally old as judged by the position in the colony and development of the gonads, with the siphons decidedly short and wide. . . . So far as concerns the branchial sac, the testes and the musculature, upon which some reliance is placed by various writers for separating the two species (*giganteum* and *atlanticum*,) I am of the opinion that individual variation is so great here that the value of differences can be determined only by extensive quantitative studies, careful regard being had to the age of the zooids." A study of individual zooids in a single colony reveals that the general shape and proportions of a zooid may change very considerably as growth and development proceeds. In the very young zooid of many so-called species the zooid, when viewed from the side, presents an outline that approximates to a circle ; in some the longer axis is dorso-ventral, while in others it is antero-posterior. In Text-fig. 22 I have given three young zooids from the same colony of *P. atlanticum giganteum*, in one of which (Text-fig. 22C) the form is nearly circular, in another (Text-fig. 22A) the greater diameter is antero-posterior, while in the third (Text-fig. 22B) it is dorso-ventral. At a somewhat later stage of development individual zooids in the same colony may also exhibit considerable differences. Neumann (1913*a*, p. 390), in his account of *P. verticillatum*, gives as one of the characteristics of the species that the body of the zooid is round or elliptical, in this latter form the major diameter being dorso-ventral, and the pharyngeal siphon is absent. In Text-fig. 24A and B I give two zooids in much the same stage of development from the same colony, which I attribute to this species : in one (A) the pharyngeal siphon is very short, but in the other (B) it is long, about two-thirds the length of the branchial basket, and closely resembles the form that is given as one of the characteristics of *P. aherniosum* Seeliger. In two other zooids (Text-fig. 24C and D) in a later stage of development the branchial basket shows a great difference in shape ; in the more mature example (D) it is approximately circular in outline, as Neumann states, but in the other (C) it is much deeper from above downwards near the anterior end and narrows considerably posteriorly, so that it closely resembles the shape that Neumann gave as characteristic of *P. triangulum* Neumann.

The number of gill-slits, gill-bars and dorsal languets.

Differences in the number of gill-slits, gill-bars and dorsal languets are characters that have been used to differentiate between so-called species of the group Ambulata. I have already (*vide supra*, p. 58) called attention to the manner in which the number of these organs changes in *P. spinosum* Herdman with increase in the size and, presumably, age of a colony. Metcalf and Hopkins (1919) have given details of these structures in various so-called species and subspecies in this group and I quote these in the following table :

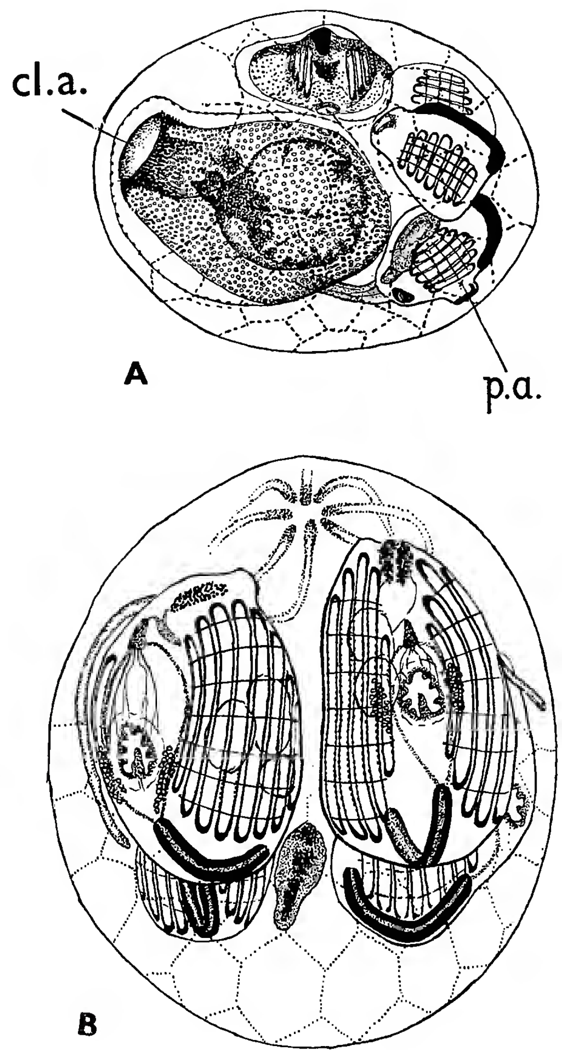
Species.	Maximum length of colony (cm.).	Number of gill-slits.	Number of gill-bars.	Number of dorsal languets.
P. verticillatum	3·0	21	11	4–5
P. aherniosum	3·0	24	14	7
P. verticillatum cylindricum	3·4	27–28	14	7

Species.	Maximum length of colony (cm.)	Number of gill-slits.	Number of gill-bars.	Number of dorsal languets.
P. hybridum	4·2	27–30	14–15	5–7
P. ellipticum	4·5	27–28	15–16	6–7
P. ovatum	5·5	28–40	18	9–12
P. operculatum	5·5	40–45	18–20	16
P. atlanticum				
triangulum	8–9	25–27	13–14	6–8
paradoxum	8·6	33–37	15–17	9
atlanticum	8–12	30–36	14–16	6–10
hawaiiense	11–17	30–32	15–17	8–9
echinatum	12·5	30–36	16–17	8–9
giganteum	19·5–40	*c.* 36	15–20	9

Here again it seems clear that there is a quite definite increase in the numbers of these structures in zooids from colonies of increasing size in both the so-called species and in the various subspecies of *P. atlanticum* Peron. An exactly similar increase in the number of these structures occurs in individual zooids of differing degrees of development in the same colony. Huxley (1860, p. 237) has pointed out that in the very young zooids of *P. giganteum* there are at first 9 or 10 branchial stigmata but no gill-bars or dorsal languets, while a little later there are 10 stigmata and 6–7 gill-bars, while at a still later stage two dorsal languets make their appearance as short rounded protuberances. In very young zooids in a developing cyathozooid of *P. atlanticum* (Peron) the number of gill-slits appears to be five, and in a slightly older cyathozooid it was seven. In slightly older zooids of a tetrazooidal colony of *P. atlanticum* that I have examined (Text-fig. 23A and B), the number of gill-slits is 7–8 and there were seven gill-bars but only one dorsal languet could be detected. In a slightly older colony with three rows of zooids, in the smallest zooids, measuring 0·50–0·55 mm. in length, there were 10–11 gill-slits and 8–9 gill-bars. In a series of developing zooids of this species from a colony measuring 2·0 cm. in length I found the following differences :

Example.	Number of gill-slits.	Number of gill-bars.	Number of dorsal languets.
1	8	7	1 (? 2)
2	13	7	3
3	14	9	4
4	17–18	10	4
5	19–20	11	5

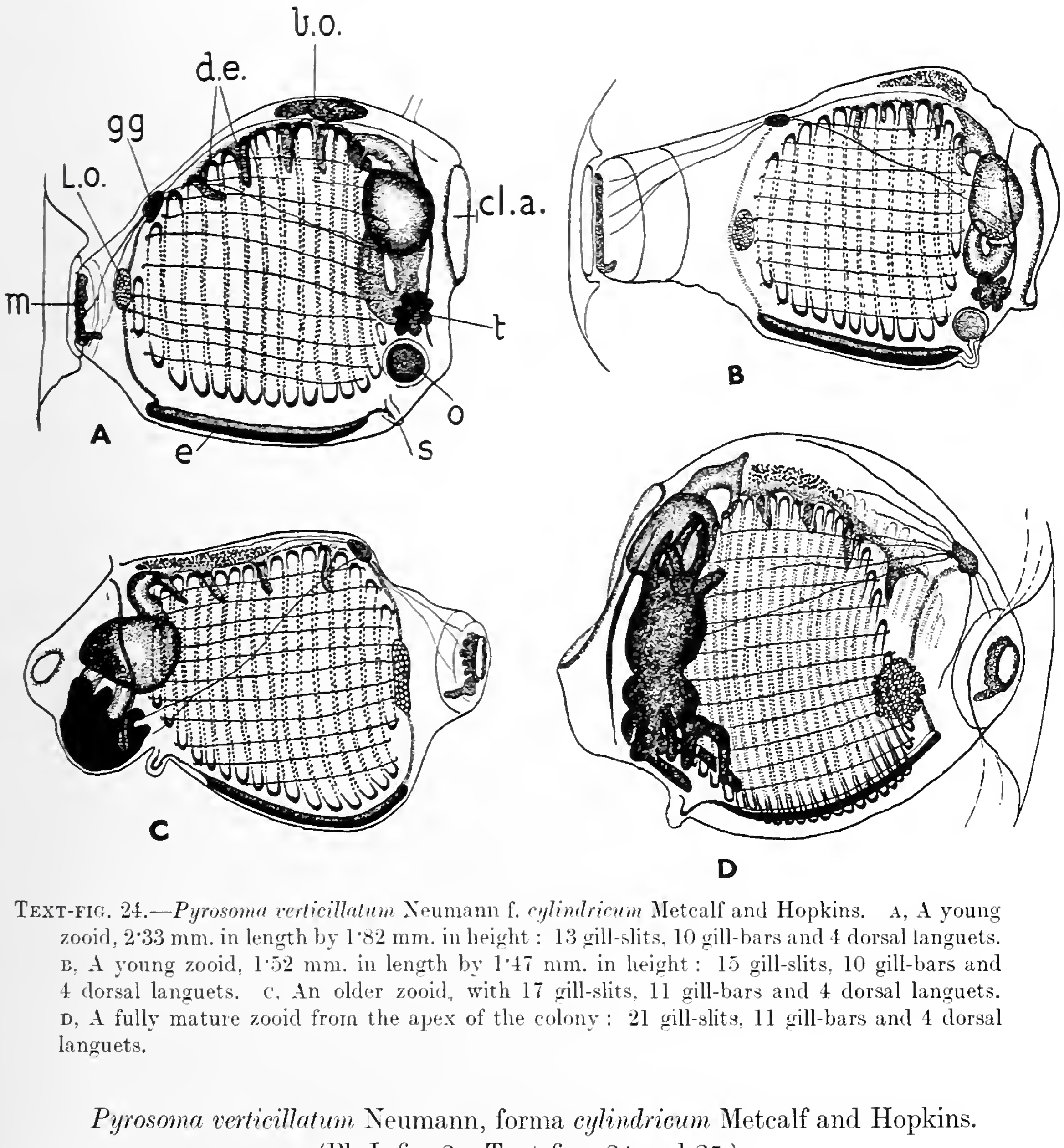
Ritter (1905, p. 98) found that in his colonies, that ranged from 19·0 to 60·0 cm. in length, which he referred to *P. giganteum*, but which Metcalf and Hopkins consider to have been *P. atlanticum atlanticum*, the number of gill-slits was 32, of the branchial bars 15, and of the dorsal languets 6 to 8. Metcalf and Hopkins (1919, p. 254), when discussing the differences between two of their subspecies of *P. atlanticum*, namely *atlanticum* and *giganteum*, give for *atlanticum* the colonies of which measured from 3·1 to 10·0 cm. in length that " in each wall of the branchial basket there are 14 to 15, occasionally 16 longitudinal bars; 30–36 stigmatal rows. Dorsal languets vary from 6 to 10 in mature zooids; in small colonies (1·5 cm.) the normal number is 4 to 5." In *P. atlanticum giganteum* the colonies of which ranged from 19·5 to 40·0 cm. in length, they state that " in each branchial lamella there are about 36 stigmatal rows and 17–18 longitudinal bars, occasionally only 16 or as many as 20," and they show 9 dorsal languets in their figure of the zooid (*vide* Metcalf and Hopkins, 1919, pl. xxx, fig. 37). They remark: " These numerical distinctions,



TEXT-FIG. 23.—*Pyrosoma atlanticum* (Peron). A, A cyathozooid from the central cavity of the colony. B, A tetrazooidal colony from the central cavity of the colony.

according to our experience, serve better than any others in demarcating this form (*giganteum*) from *P. atlanticum atlanticum*, for in none of the Pacific specimens of *P. atlanticum* which we have examined could we find more than 16 longitudinal bars in each gill lamella."

In view of the marked changes that take place with increasing age and growth of both the individual zooids and the colonies, as I have indicated above, it seems to me that such slight differences are useless as criteria on which to differentiate between species or subspecies. Harant and Vernières (1938) have reached the conclusion that all forms taken in French waters should be united in the one species, *Pyrosoma atlanticum* Peron. Thompson (1948) has also stated that in specimens taken in Australian waters he found that not one of the distinctions between the subspecies *atlanticum* and *giganteum* was valid: there was wide variation in the shape of the colony, in the number of longitudinal gill-bars, the lowest numbers always being found in the smaller colonies, and such differences were still more marked in the number of gill-slits: the length of the pharyngeal chamber varied from 0·41 to 2·5 mm., this latter length being reminiscent of the condition figured by Metcalf and Hopkins for *P. operculatum*.



TEXT-FIG. 24.—*Pyrosoma verticillatum* Neumann f. *cylindricum* Metcalf and Hopkins. A, A young zooid, 2·33 mm. in length by 1·82 mm. in height: 13 gill-slits, 10 gill-bars and 4 dorsal languets. B, A young zooid, 1·52 mm. in length by 1·47 mm. in height: 15 gill-slits, 10 gill-bars and 4 dorsal languets. C, An older zooid, with 17 gill-slits, 11 gill-bars and 4 dorsal languets. D, A fully mature zooid from the apex of the colony: 21 gill-slits, 11 gill-bars and 4 dorsal languets.

Pyrosoma verticillatum Neumann, forma *cylindricum* Metcalf and Hopkins.
(Pl. I, fig. 2; Text-figs. 24 and 25.)

Pyrosoma verticillatum Neumann, 1913*a*, p. 390, pl. xli, fig. 1, pl. xliv, figs. 1, 3 and 4.; Neumann, 1913*b*, p. 6; Neumann, 1913*c*, p. 31; Metcalf and Hopkins, 1919, p. 225, pl. xxi, fig. 12, pl. xxii, fig. 13.
Pyrosoma verticillatum cylindricum Metcalf and Hopkins, 1919, p. 227, pl. xxii, figs. 14, 15, pl. xxxiii, fig. 43.
Dipleurosoma elliptica Brooks, 1906.

Occurrence :

Sta. 131a, Southern area of Arabian Sea, 800–0 m., vertical haul : one colony.
Sta. 131d, 500–0 m., vertical haul : one small colony, 7 mm. by 8 mm.

Remarks.—The larger colony (Pl. I, fig. 2) measures 20·0 mm. in length by 11·0 mm. in width : it is an elongate oval in shape when viewed from the side as it lies in a dish, but is markedly flattened. The test is colourless and the surface smooth. The colonial aperture is produced in a conical funnel ; Metcalf and Hopkins (1919) make no mention of such a feature in their account of this form but it is clearly seen in the photograph of one of their colonies, which measured 1·9 cm. in length (*vide* their pl. xxxiii, fig. 43). The zooids are arranged in transverse rows and there are nine rows in all, but the regularity of these rows is obscured in the region of the colony near the apperture by the interpolation of young zooids between the older individuals. The surface of the test is smooth and there are no processes. The oral aperture of each zooid is situated in a shallow sunk pit on the surface of the colony (*vide* Text-fig. 24a and d), but occasionally a zooid may show a slight elevation of the test surrounding the mouth. In the uppermost row at the closed end of the colony there are only two zooids, that have a length-measurement of about 2·5 mm. The size of the zooids diminishes as the open end of the colony is approached, and the smaller specimens near the aperture measure only 1·67 mm. in length.

Neumann (1913*a*, p. 390) states that in the typical form the body of the zooid is round or elliptical, in this latter form the height being greater than the length. Metcalf and Hopkins (1919, p. 227) state that in their specimens of *cylindricum* " all the larger zooids appear quite globular and short. The atrium is very short and broad, the oral chamber, i.e., the portion of the pharynx in front of the stigmata, is almost lacking." In the present example the general shape of the zooids varies very considerably : in some the branchial basket is widest in front and narrows considerably towards the posterior end, but in others the condition is the exact opposite of this, the zooid being narrow in front and widening out considerably behind. In one zooid in the colony the pharynx in front of the branchial basket is greatly elongated, being nearly two-thirds as long as the branchial basket, and very closely resembles the condition that is supposed to be characteristic of *Pyrosoma aherniosum* Seeliger (*vide* Text-fig. 24b). The branchial basket, according to Neumann, possesses 21 gill-slits, 11 gill-bars and 4 or 5 dorsal languets. Metcalf and Hopkins in their subspecies *cylindricum* found 27–28 gill-slits, 14 gill-bars and 5 dorsal languets. In the present colony the smallest individuals possess only 13 gill-slits, 7 gill-bars and 3 dorsal languets, but in the largest example there are 24 gill-slits, 11 gill-bars and 4 dorsal languets, thus agreeing closely with Neumann's original account of the species. The cloacal cavity is short : Metcalf and Hopkins (*loc. cit.*, p. 228) state that in their specimens the opening into the colonial cavity was very wide, but this is by no means always the case in the present colony : in the oldest individual it is very wide, but in others, not quite so mature though the testis is well developed, it may be quite narrow (*cf.* Text-fig. 24c and d). The cloacal muscle is long and narrow. The intestine forms a curve forwards and there is a well-marked space between the two limbs of the curve. The testis forms only a relatively slight protuberance on the surface ; when fully developed it is composed of ten elongated processes and in the oldest zooid is divided into two lobes, each bearing five lobules (fig. 24d). In zooids from the middle of the colony the development of the male and female genital organs appears to be more or less synchronous (Fig. 24a and b).

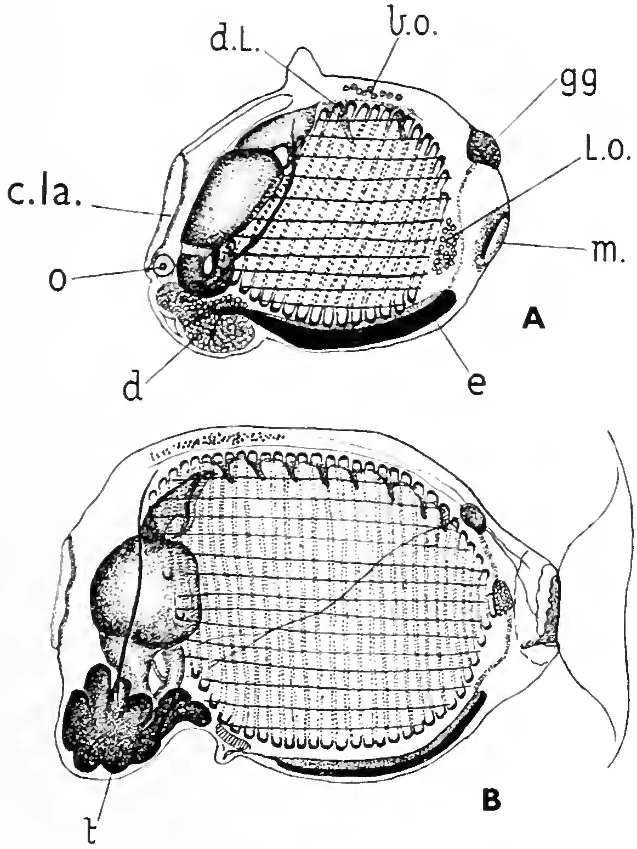
Pyrosoma verticillatum Neumann, forma *hybridum* Metcalf and Hopkins.
(Pl. I, fig. 3 ; Text-fig. 25A and B.)

Pyrosoma hybridum Metcalf and Hopkins, 1919, p. 229, pl. 23, figs. 16, 17, pl. 36, figs. 54, 55.

OCCURRENCE :

Sta. 131A, Southern area of Arabian Sea, 600–0 m. : one colony.

REMARKS.—This colony agrees extremely well with the description and figures given by Metcalf and Hopkins (*loc. cit.*, pl. 36, figs. 54, 55) : it is oval in shape, when viewed from the side and is markedly flattened. The dimensions are 2·2 cm. in length by 1·6 cm.



TEXT-FIG. 25.—*Pyrosoma verticillatum* Neumann f. *hybridum* Metcalf and Hopkins. A, A young zooid with 15 gill-slits, 11 gill-bars and 2 dorsal languets. B, A mature zooid with 31 gill-slits, 14 gill-bars and 8 dorsal languets. Dimensions : 3·25 mm. long and 2·17 mm. high.

in width, which agrees remarkably well with the dimensions given by Metcalf and Hopkins for an average colony, namely 2·4 cm. by 1·7 cm. The test is colourless and the surface is quite smooth. The opening of the colony is a long narrow slit.

Each zooid opens at the bottom of a shallow saucer-like depression. The primary arrangement of the zooids in the colony is in parallel rows, the zooids in one row alternating with those above and below : this arrangement is best seen in the lower part of the colony, i.e., the part towards the colonial aperture ; here the arrangement is so regular that the zooids form oblique rows running diagonally across the surface of the colony ; a similar arrangement of the zooids is clearly seen in Metcalf and Hopkins's photograph of one of their colonies (*loc. cit.*, pl. 36, fig. 54), and is also to be seen in their photograph of a specimen of *P. ellipticum* Metcalf and Hopkins (*loc. cit.*, pl. 33, fig. 44).

The shape and size of the individual zooids differs in different parts of the colony. In the young zooids near the colonial aperture the shape of the individual when viewed from the side is nearly spherical, but at a later stage the length becomes greater than the height (Text-figs. 25A, B) ; at the same time there is an increase in the number of gill-slits, gill-bars and dorsal languets, as shown in the following table :

Dimensions of zooid.				
Length (mm.).	Height (mm.).	Number of gill-slits.	Number of gill-bars.	Number of dorsal languets.
0·53	0·52	16	10	2 (very short)
0·75	0·58	16	11	2 (long)
2·50	1·67	29	13–14	6
3·25	2·17	31	14	8

The testis forms a well-marked hernia on the postero-ventral region of the body-wall and has about 10 blunt lobes.

Metcalf and Hopkins (*loc. cit.*, p. 229) state that " all the zooids, and to some extent the test, are darkly stained bluish-gray, never yellow." In the present specimen the test is colourless and the individual zooids are a pale fawn colour.

Metcalf and Hopkins (1919, p. 229) in their account of this form remark : " It is not likely that it is a hybrid form, for there have been collected a considerable number of specimens, 16 in all, from four localities": in view of this it seems a pity that they should have named the so-called species *Pyrosoma hybridum.*

In the following table I have given the chief characters of the three so-called species, *Pyrosoma verticillatum* Neumann, *P. hybridum* Metcalf and Hopkins and *P. ellipticum* Metcalf and Hopkins. From this it can be seen that the main diagnostic characters on which Metcalf and Hopkins rely for the determination of their " species " are for the most part exactly those characters, such as the shape of the individual, and the number of gill-slits, gill-bars and dorsal languets, that I have already shown (*vide supra*, pp. 67–69) to vary very considerably with the size, which depends largely on age-growth of the individual. Other characters are :—

(1) The shape of the colonial aperture, which is oval in *P. verticillatum* but slit-like in *P. hybridum* and *ellipticum.* Such a difference is undoubtedly associated with the flattened form of the colony in the last two " species," if not actually due to it.

(2) The size of the cloacal aperture, which is stated to be wide in *P. verticillatum* but relatively narrow in *hybridum* and *ellipticum.* But as *verticillatum* is protogynous in the older individuals this aperture must of necessity be large in order to allow of the passage of the cyathozooid into the colonial cavity.

(3) The degree to which the testis forms a bulge on the postero-ventral wall of the body. This is easily accounted for by the progressive growth and development of the testis.

I cannot but conclude that there is little justification for the creation of these different so-called " species," and I believe that they are merely growth-stages of a single species, *P. verticillatum* Neumann.

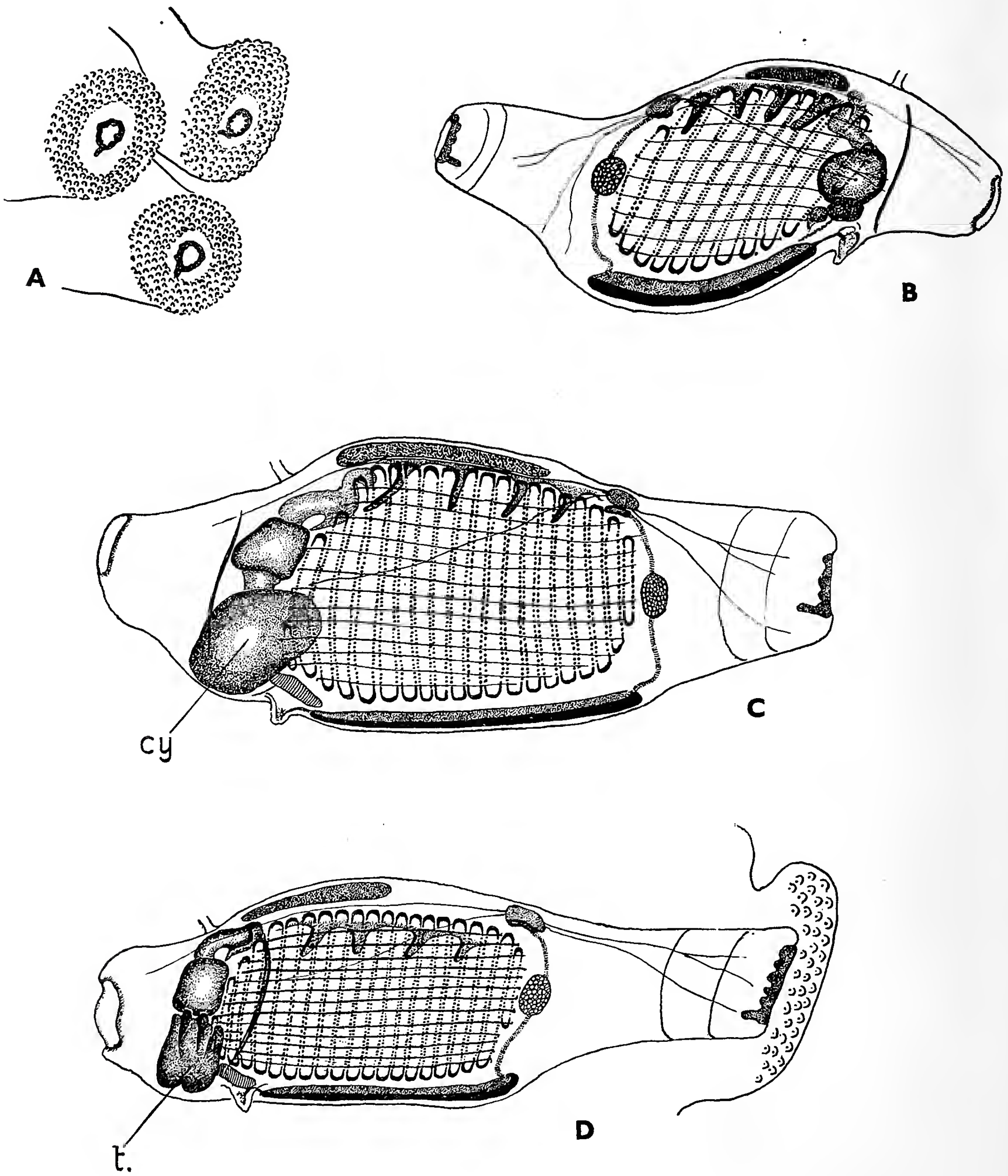
Character.	*P. verticillatum.*	*P. hybridum.*	*P. ellipticum.*
Size of colony	2·5 to 3·0 cm. long 1·2 cm. wide	2·4–4·2 cm. long 1·7 cm. wide	4·5 cm. long; 2·0 cm. wide.
Shape of colony	Egg-shaped	Laterally flattened: oval when viewed from the side	Laterally flattened; oblong with rounded corners.
Colonial aperture	Oval; Funnel-shaped	A long slit	Slit-like.
Surface of colony	Smooth; no processes	Similar	Similar.
Arrangement of zooids	In transverse parallel rows; number of rows, 8	Transverse parallel rows at closed end; oblique rows near open end; number of rows, 19	Transverse parallel rows not clearly marked at closed end; oblique rows towards open end; number of rows, 22 or more.
Size of zooid	2·5 to 2·7 mm. long; 2·7 to 3·0 mm. high	3·0 mm. long; 2·5 mm. high	3·2–4·0 mm. long; 2·0–2·6 mm. high.
Situation of mouth	At the bottom of a funnel-shaped depression	Slightly sunken	Flush with surface of colony.
Oral siphon	Lacking	Short; sometimes lacking	Rather short; never entirely lacking.
Branchial basket	21 stigmata; 11 longitudinal gill-bars	27–30 stigmata; 14–15 (rarely 16) gill-bars	27–28 stigmata; 15–16 gill-bars.
Number of dorsal languets	4–5	5–7 or 8	6–7.
Endostyle	Short; evenly curved	Shorter than branchial basket; rather strongly and evenly curved	Shorter than branchial basket; curved.
Intestine	Sharply bent on itself	Less sharply bent on itself	Less sharply bent on itself.
Cloacal chamber	Short; atrial aperture very wide (in some examples)	Short; atrial aperture of moderate size	Elongated somewhat and narrowing posteriorly to the aperture, which is small.
Testis	Scarcely bulges the body wall; 10–15 lobes	Forms a well-marked evagination of body-wall; about 10–15 lobes directed upwards and slightly forwards	Protrudes strongly: 18 finger-like lobes directed upwards and slightly forwards.
Development	Individuals near closed end of colony protandrous, younger individuals protogynous	Protogynous	Protogynous.

Distribution.—This species was first recorded from the Indian Ocean in a belt stretching from west of Ceylon to the Amirantes, west of the Seychelles. Metcalf and Hopkins (1919) described their subspecies *cylindricum* from the west Pacific Ocean in Philippine waters, and from the same region recorded the occurrence of their two new species, *hybridum* and *ellipticum*. The present examples of f. *cylindricum* and f. *hybridum* were taken at the same Station 131, lat. 1° 39′ 06″ S., long. 61° 13′ 48″ E. Thus in Indian waters this species is at present known only from the zone of the North Equatorial Current, and between the Seychelles and the Amirantes from that branch of it that bends southwards to join the Equatorial Counter-current.

Pyrosoma aherniosum Seeliger. (Pl. I, fig. 4; Text-figs. 26A–D, 27.)

Pyrosoma aherniosum Seeliger, 1895, p. 64, pl. iv, figs. 6–11; Neumann, 1913*a*, p. 396, pl. xliv, fig. 2*; Neumann, 1913*b*, p. 8; Neumann, 1913*c*, p. 31; Kruger, 1912, p. 10, pl. ii, fig. 5; Metcalf and Hopkins, 1919, p. 234, pl. xxiv, figs. 24, 25.

Pyrosoma elegans Herdman, 1888, p. 34, pl. ii, fig. 8.



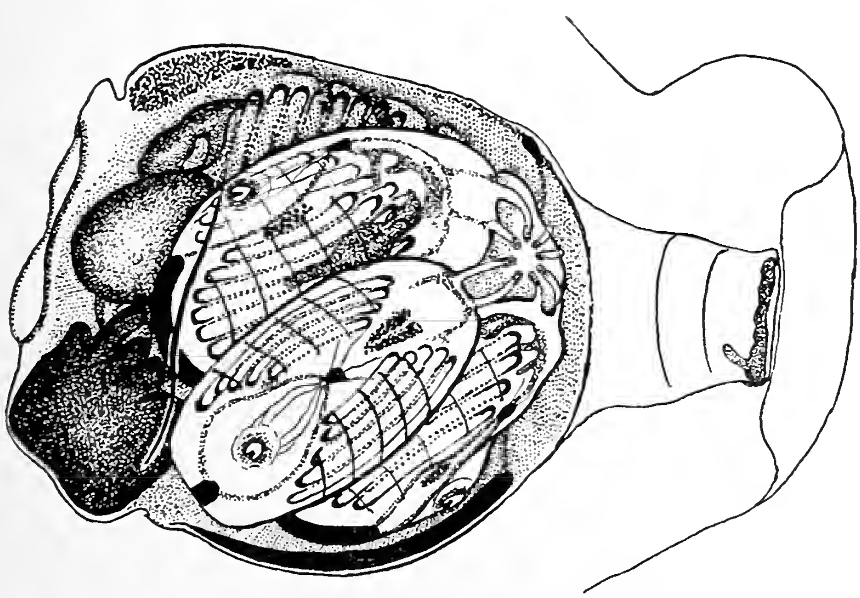
TEXT-FIG. 26.—*Pyrosoma aherniosum* Seeliger. A, Test processes. B, A young zooid, with 11 gill-slits, 9 gill-bars and 4 dorsal languets. The ovary and testis are still in a rudimentary state. C, An older zooid with 20 gill-slits and 12 gill-bars, containing a cyathozooid. D, A still older zooid with 21 gill-slits and 13 gill-bars, with a well-developed testis.

* In the text Neumann refers to this figure, giving the plate reference as *P. aherniosum*, and at the head of pl. xliv he gives the names of the species referred to in the plate as " *P. verticillatum, aherniosum* and *giganteum* "; but the explanation of fig. 2 gives the names as *P. agassizi*. I presume that this is merely a " *lapsus calami*."

Occurrence :

Sta. 131A, Southern area of Arabian Sea, 500–0 m., vertical haul: one well developed colony.

Remarks.—The colony is conico-cylindrical in shape with the colonial aperture at the broader end. The dimensions of this colony are 2·3 cm. long by 1·2 cm. wide. The test is produced in short thick-walled tubes, which surround the oral siphons of the zooids, and the mouth of the zooid is situated, as described by Metcalf and Hopkins (1919, p. 234), at the bottom of a shallow pit that is surrounded by a raised ring-like margin, having a diameter of about 2·0 mm., that is often swollen and undercut on the side towards the



Text-fig. 27.—*Pyrosoma aherniosum* Seeliger. With a tetra-zooidal colony occupying the whole of the right peribranchial space and possessing a well-developed testis.

colonial aperture. These crater-like rings are covered with numerous small rounded papillæ, each one showing a test cell in the middle (Text-fig. 26A and D). As in Seeliger's examples there are only three zooids at the closed end of the colony. As in other species, there is a considerable range in the size and shape of the individual zooids, but in a typical specimen there is a well-developed oral siphon, which appears to increase somewhat in length with the gradual development of the zooid; the branchial basket is oval in shape, being considerably longer than high. The endostyle is nearly straight and is almost as long as the branchial basket. The atrial chamber is somewhat shorter than the oral siphon and is about half the length of the branchial basket. A fully grown zooid measures about 3·7 to 4·0 mm. in length. The number of gill-slits and gill-bars, as in other species, increases with the age of the zooid. In a small zooid, having a length of 1·4 mm. (Text-fig. 26B) there are 10 or 11 gill-slits and 9 or 10 gill-bars, but already there are 4 dorsal languets: in larger zooids, having a length of 3·7 to 4·0 mm., there are 20 or 21 gill-slits and 13 gill-bars, but the number of dorsal languets is still 4, though Neumann gives for his examples, having a length of 5·0 mm., 24 gill-slits, 14 gill-bars and 5 languets.

The zooids are protogynous and the cyathozooid usually undergoes its development in the posterior end of the right peribranchial sac immediately to the right of the stomach and intestine, but in one individual the development of the cyathozooid had proceeded so far that a tetrazooidal colony was found to be lying in the peribranchial space and completely filling it (Text-fig. 27). The testis develops after the cyathozooid, and is composed of about 12 lobes when fully developed: it is of a yellowish-red colour and projects hardly at all on the ventral surface.

Distribution.—This species appears to be distributed throughout all three great oceans.

Pyrosoma atlanticum (Peron). (Pl. I, fig. 5; Text-figs. 22A–C, 23A and B, 28A and B, 29A–C, 30A–C, and 31A and B.)

Pyrosoma atlanticum Huxley, 1851, p. 580, pl. xvii; Herdman, 1888, p. 25, pl. i, figs. 1–3; Seeliger, 1895, p. 58, pl. iii, figs. 1–13, pl. iv, fig. 5; Neumann, 1913*a*, p. 397, pls. xxxvi, xxxvii, figs. 3–11, xxxviii, xxxix, figs. 1–21, xlii, figs. 4–6, xliii, figs. 4, 8; Neumann, 1913*b*, p. 32; Metcalf and Hopkins, 1919, p. 237, pls. xv, xxvi, xxvii, xxviii, fig. 33, xxix, xxx, xxxii, xxxiv, xxxv, xxxvi, figs. 50–53; Harant and Vernières, 1938, p. 51, fig. 65; Berrill, 1950, p. 273, figs. 97D, 98.
Pyrosoma atlanticum atlanticum Thompson, 1948, p. 86, pls. xxviii, xxix, figs. 1–3.
Pyrosoma giganteum Huxley, 1860, p. 193, pls. xxx, xxxi; Joliet, 1888, pp. 1–96, pls. i–iv; Herdman, 1888, p. 26, pl. i, figs. 4–21; Ritter, 1905, p. 98, figs. 30, 31; Ihle, 1910, p. 11; Kruger, 1912, p. 5.
Pyrosoma triangulum Neumann, 1913*a*, p. 406, pl. xliii, fig. 2.
? *Dipleurosoma ellipticum*, Brooks, 1906.

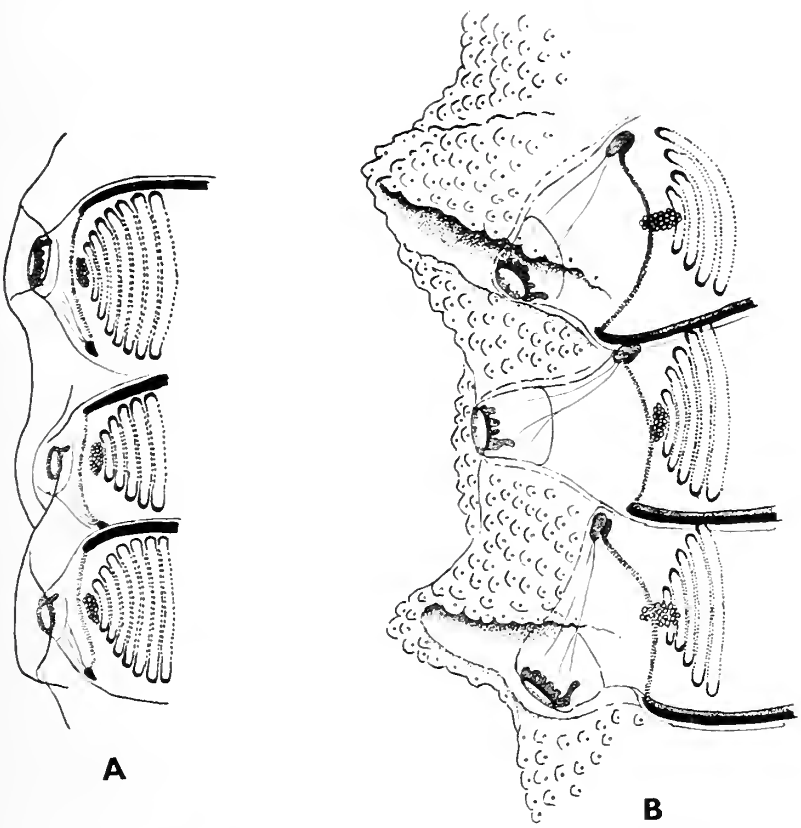
Occurrence:

Sta. 131A, Southern area of Arabian Sea, 600–0 m., vertical haul: 7 specimens, and two very small colonies probably of this species.

Remarks.—The size of the 7 colonies ranged from 2·9 cm. to 6·4 cm. in length, and the proportions of length to breadth are as follows:

Length (mm.).	Diameter at closed end (mm.).	Diameter at open end (mm.).
29	7	9
35	7	9
39	9	14
44	11	15
55	14	17
56	11	17
64	14	18

Thus all were conico-cylindrical in shape. In the smaller colonies the colonial opening was oval or slit-like. but in the larger examples it was more nearly circular. The smaller colonies were distinctly flattened, whereas the larger colonies were more circular in cross-section. Metcalf and Hopkins (1919, p. 239) conclude "that this flattening is not entirely due to artificial causes (shrinking or compression from poor preservation) is evident, for if the diaphragm at the opening of the colony is examined it will be found to be adapted to the form of the slit-like opening." This, however, does not exclude the possibility that in the younger and smaller colonies the slit-like aperture may be due to natural causes, and that as the colony grows and the test wall becomes thicker and firmer, as is seen in the present specimens, the colonial aperture may be remodelled, for a study of the examples of the various species clearly shows that considerable changes in the test can be effected, as is indicated by the changes in the test processes. In the smaller examples the test was



TEXT-FIG. 28.—*Pyrosoma atlanticum* (Peron). A, The oral apertures of three zooids near the closed end of a colony 35 mm. long. B, The test processes and oral apertures from zooids near the open end of the same colony.

much thinner and more delicate than in the larger specimens. Brooks (1906) founded his new genus *Dipleurosoma* on this flattening of the colony, but as Metcalf and Hopkins remark (1919, p. 249), "except for the one feature so prominent, namely the flattening of the colony, it would be rather impracticable to draw any lines of distinction between this form (f. *dipleurosoma*) and the typical *P. atlanticum atlanticum*, which also sometimes shows more or less flattening of its colonies, especially near the open end."

When freshly caught these colonies were of a pale coral-pink colour (Ridgway, 1912, pl. xiii). The colour appears to be variable, for Ritter described his colonies as ranging from colourless to a vivid pink, and Metcalf and Hopkins describe their examples as being "ordinarily colorless and transparent but varies through pale yellowish to a distinct flesh-color."

As soon as the catch was on board these *Pyrosoma* colonies were taken down into the Laboratory and were tested for luminescence: the moment that one of the colonies was touched by a finger it broke out in a pale greenish light that at first was quite bright; the intensity of the light decreased at each repeated application of the stimulus until at last there was no response; but after a few minutes' rest the power to produce the light returned again and there was but little diminution in the intensity of the light produced.

In the smaller colonies of a length of 29 to 35 mm. the outer surface of the test near the closed end is smooth and entirely devoid of any processes, the zooids opening at the bottom of shallow crater-like depressions at the summit of a slight dome-like rise (Text-fig. 28A), but towards the open end round the mouth of some of the zooids the test is produced in a sharply rounded point, which is excavated on its ventral side to form a shallow gutter into which the mouth of the zooid opens, and the outer surface of these processes is ornamented by numerous small rounded papillae, each of which has a small test-cell at its base (Text-fig. 28B). In the larger colonies these processes become longer and more marked, and are present over the greater part of the colony, while the whole surface of the test may be ornamented with the small papillæ.

Individual zooids may exhibit a considerable range of shape. In the very young zooids the shape may range from an almost exact circle when viewed from the side (Text-fig. 22C), or may be either longer than high or higher than long (Text-fig. 22A and B). In zooids from older colonies the different parts of the body exhibit a wide range of variation. In some the branchial basket may have an almost circular outline (Text-fig. 30A); in others it presents a triangular form, such as Neumann described in his *Pyrosoma triangulum*, the greater height being situated at the anterior end and the basket tapering to the poster part, (Text-fig. 29B and 30B), or it is the posterior part that possesses the greater height; in others again it may exhibit an elongate oval shape (Text-fig. 30C). The oral and atrial cavities may also vary greatly in length; in many individuals both these cavities are relatively short, and this seems to be particularly the case in zooids that open on the smooth surface of the test, whereas in specimens that open at the apex of one of the test processes the oral cavity may be much increased in length. In the table below I give a series of measurements of individuals from colonies of different lengths:

	Length of oral cavity (mm.).	Length of branchial basket (mm.).	Length of atrial cavity (mm.).
From a 35 mm. colony	0·25	0·92	0·33
	0·28	1·25	0·37
	0·33	1·12	0·45
From a 55 mm. colony	0·28	1·25	0·97
	0·30	1·42	0·92
	0·33	1·33	0·95
	0·42	1·17	1·00
	0·43	1·42	1·08
From a 64 mm. colony	0·17	1·67	0·38
	0·20	1·59	0·58
	0·28	0·53	0·25
	0·30	1·38	0·42
	0·70	2·33	1·58

If now we calculate in parts per 100 of the total body-length the proportional lengths of these three regions of the body of the zooid, we get the following result:

	Average proportional lengths of—		
	Oral cavity.	Branchial basket.	Atrial cavity.
In 35 mm. colony	16·3	62·0	21·7
,, 55 ,,	19·4	40·3	40·3
,, 64 ,,	14·4	61·7	23·9

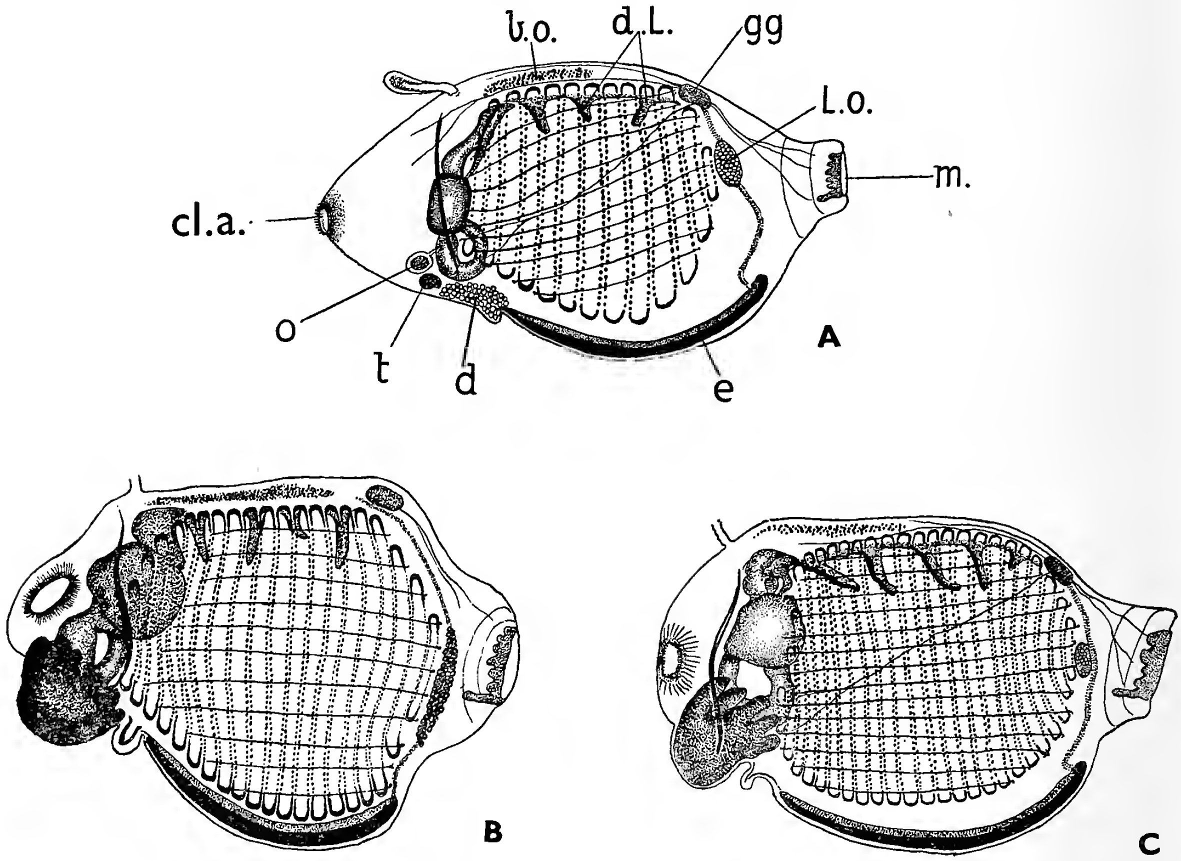
The majority of the zooids in the 55 mm. group were bearing cyathozooids. It seems clear that the great elongation of the atrial cavity in this colony is associated with this development of the cyathozooid, and that at a later stage, when the cyathozooid has been ejected, the atrial cavity tends to return once again to its former proportional length. Another change that results from the birth of the cyathozooid is the very great dilatation of the atrial aperture: in the 35 mm. colony the average circumference of this aperture was 227μ; in the 55 mm. colony it was 415μ in the short-bodied zooids and 222μ in the long-bodied zooids, many of whom were bearing cyathozooids: but in the 64 mm. colony the circumference was as great as 1028μ. This great increase in the circumference of the atrial aperture I attribute to changes induced by the birth of the cyathozooid and its extrusion into the central cavity of the colony.

The individual zooids exhibit a considerable range of variation as growth proceeds: in the table below I give the dimensions of some zooids from three of the colonies and the number of gill-slits, gill-bars and dorsal languets present:

	Size of zooid.				
	Length (mm.).	Height (mm.).	Number of gill-slits.	Number of gill-bars.	Number of dorsal languets.
From a colony 35 mm. in length	0·33	0·49	15	9	2
	0·45	0·38	16	7–9	2
	0·75	0·62	13	11	–
	1·12	0·68	13	10	3
	1·60	1·25	20	11	4
	2·67	1·97	24	14	5
From a colony 55 mm. in length	1·13	0·68	13	8	3
	1·83	1·30	18	10	4
	1·88	1·42	17	11	4
	3·50	1·05	18	11	5
	4·08	2·30	27	14	6
From a colony 64 mm. in length	3·25	0·90	22	11	5
	3·25	1·08	24	12	5
	4·58	1·67	26–27	14	8

In the smaller 35 mm. colony the shape of the stomach of young zooids is a cylinder with rounded ends (Text-fig. 29A), thus resembling the condition which Metcalf and Hopkins (1919, p. 248) gives as a character of their subspecies *paradoxum*, and the wall is relatively thin ; in some examples of a more advanced stage, as indicated by the increased number of branchial-bars, this organ is more nearly quadrilateral, as Metcalf and Hopkins (1919, p. 247) have described in their subspecies *hawaiiense* (Text-fig. 29 B and C).

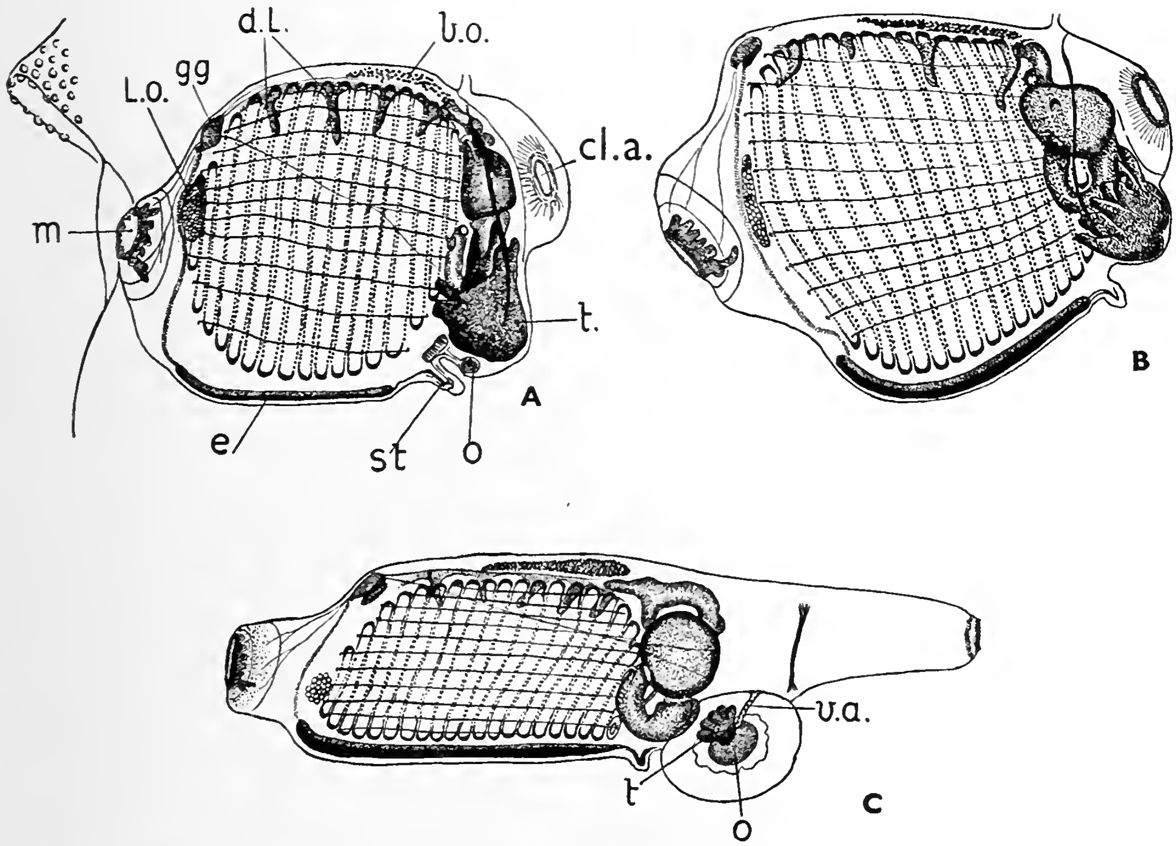
In the 35 mm. colony budding was in full swing and the colony was crowded with young zooids, filling every available space between the larger parent zooids, which were arranged in somewhat irregular rows. In the young zooids with only 13 gill-slits and 10 gill-bars both testis and ovary are immature and lie close together behind and below the stomach (Text-fig. 29A) ; but at a somewhat later stage with 20 to 24 gill-slits and 11 to



TEXT-FIG. 29.—*Pyrosoma atlanticum* (Peron). Three zooids from a colony with a length measurement of 35 mm. A, A zooid with 3 dorsal languets, 13 gill-slits and 10 gill-bars. The zooid is of an elongate shape with a long atrial cavity. B, A zooid with 4 dorsal languets, 20 gill-slits and 11 gill-bars. The shape of the zooid approximates to that on which Neumann based his species *P. triangulum*. C, A zooid with 5 dorsal languets, 24 gill-slits and 14 gill-bars.

14 gill-bars the testis has rapidly developed and consists of about eight leaf-like or short finger-like lobes, the main mass forming a marked protrusion on the ventral aspect (Text-fig. 29B and C). This is in agreement with the view put forward by Neumann and confirmed by Metcalf and Hopkins (1919, p. 243) that the rapid development of the buds in a growing colony retards the development of the genital organs and that the testis develops earlier than the ovary, so that the individuals are protandrous ; and also agrees with what Metcalf and Hopkins (1919, p. 258) found in their examples of the form *dipleurosoma*, regarding which they state that " in the majority of zooids the egg appears to mature after the testis has developed."

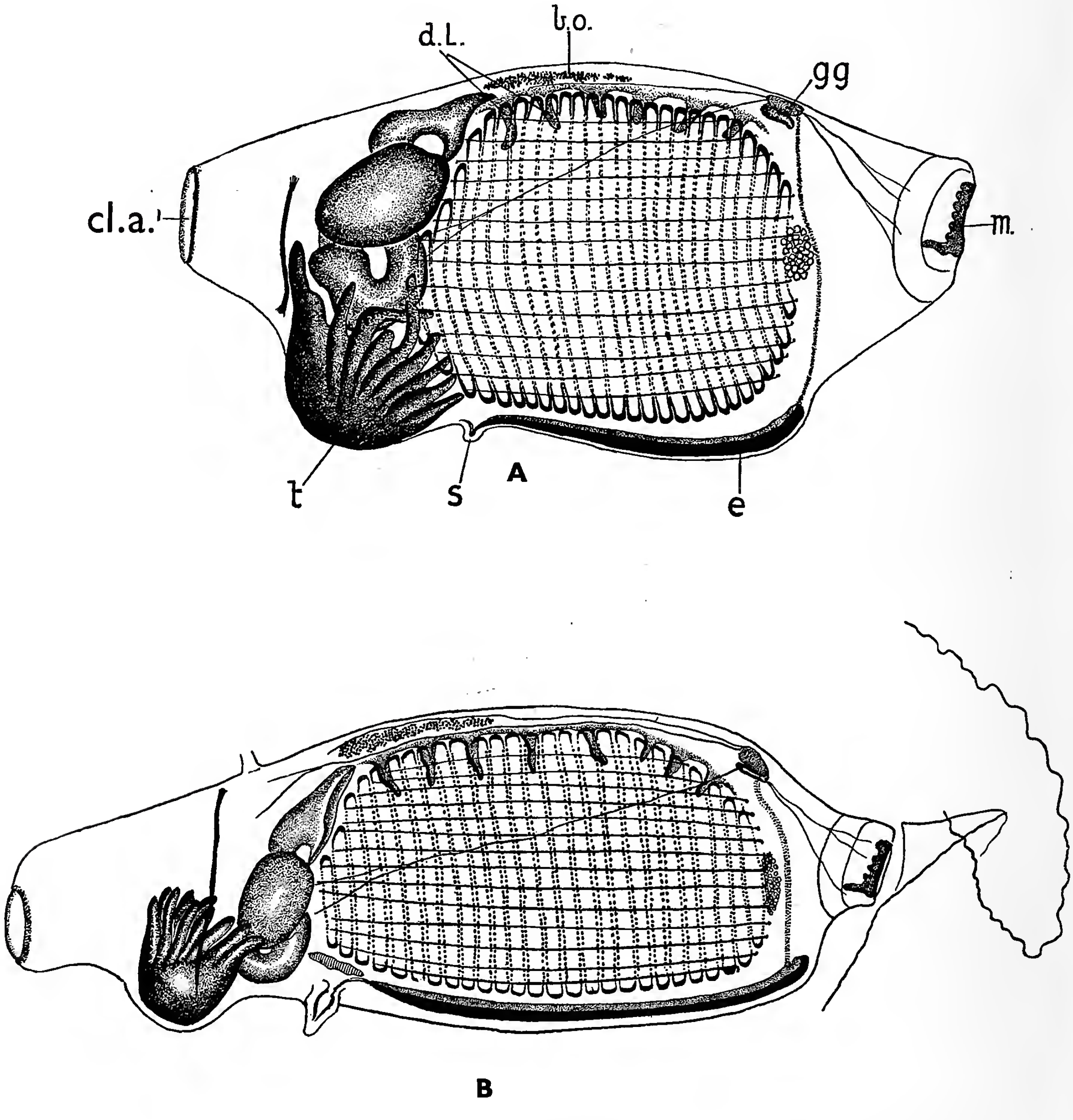
In the 55 mm. colony in a number of individual zooids the testis was well developed (Text-fig. 30A and B) and this is particularly the case in zooids that exhibit only a relatively few gill-slits and gill-bars; others in a more advanced stage of development show an immature testis and ovary lying close together in a large ovarian cavity (Text-fig. 30C). The production of Cyathozooids was in full swing, and contained within the colonial cavity were a number of zooids that exhibited varying degrees of development ranging from young cyathozooids with a straight stolon, bearing the usual four zooids, to free tetra-zooidal colonies (Text-fig. 23A and B).



TEXT-FIG. 30.—*Pyrosoma atlanticum* (Peron). Three zooids from a colony with a length of 55 mm. A, A zooid with 17 gill-slits, 10 gill-bars and 4 dorsal languets. B, A zooid with 17 gill-slits, 11 gill-bars and 4 dorsal languets, showing a tendency to a triangular shape. C, A zooid with 21 gill-slits, 11 gill-bars and 5 dorsal languets. The zooid is now bearing a cyathozooid and possesses a markedly elongate shape, affecting the atrial cavity in particular. This is the type that Metcalf and Hopkins named *P. atlanticum* subspecies *hawaiiense*.

In the largest colony with a length of 64 mm. the zooids at the closed end of the colony possessed a fully developed testis that caused a well-marked protrusion of the ventral body-wall (Text-fig. 31B); in other parts of the colony the production of cyathozooids was still in full swing and the central colonial cavity contained numerous examples in varying stages of development. As soon as the developing cyathozooid has been set free the testis appears to develop rapidly and completely fills the cavity previously occupied by the ovum, forming a large protrusion on the ventral aspect; this stage seems to be reached in zooids that now possess 26 to 27 gill-slits and 14 gill-bars.

The developing cyathozooid and its modification into a tetra-zooidal colony follows exactly the line shown to occur by Huxley (1860, pl. xxxi) and by Julian (1912) in *Pyrosoma giganteum.*



Text-fig. 31.—*Pyrosoma atlanticum* (Peron). Two zooids in an advanced stage of development. A, From a colony having a length measurement of 55 mm. The zooid possesses 27 gill-slits, 14 gill-bars and 6 dorsal languets. The proportions of length to height are as 100 : 56·4. B, From a colony having a length of 64 mm. The zooid possesses 26 gill-slits, 14 gill-bars and 8 dorsal languets. The proportions of length to height are as 100 : 36·5, due largely to the increased length of the atrial cavity.

The youngest cyathozooid, in which the four buds were well developed, measured 1·01 mm. in length by 0·75 mm. in width and the individual zooids possessed the following characters :

Size.						
Length (mm.).	Breadth (mm.).		Number of gill-stigmata.		Number of gill-bars.
0·33	0·25	.	6	.	4
0·63	0·45	.	6–7	.	4–5

Huxley (1852, p. 238) records that in the test of the cyathozooid of *P. giganteum* "cellular bodies, like connective-tissue corpuscles, are discernible in its most superficial layer, and are disposed in such a manner as to form a very regular hexagonal network, with large meshes." He has figured this condition in pl. xxxi, fig. 14. Panceri (1872) has also shown this hexagonal network in the surface of the test throughout the development of the cyathozooid of the same species, *P. atlanticum, f. giganteum*, from the early stage of four embryonic buds on the stolon up to the young tetrazooid colony. In the present examples of this species I have been able to examine different stages of development, and here too the hexagonal network, formed on the surface by somewhat elongated tissue cells, can be traced in all the early stages up to the tetrazooid colony (*vide* fig. 23A, B.).

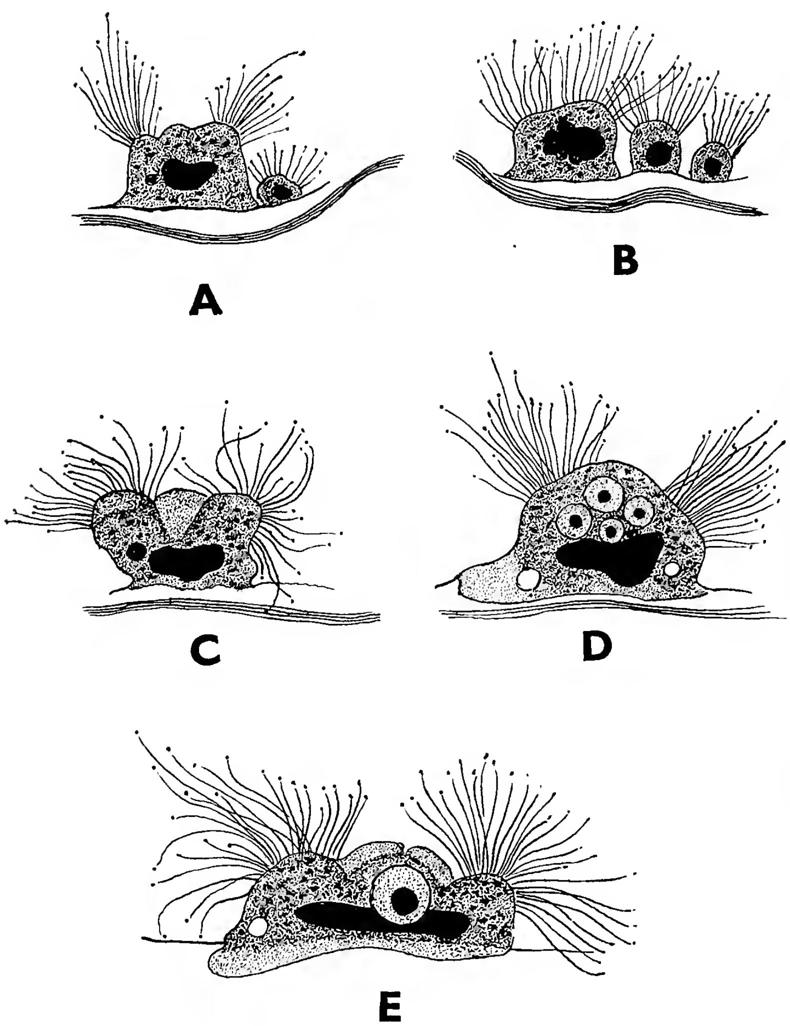
Within the colonial cavity of the larger specimens taken at Sta. 131 were several examples of the Copepodid stages of a species of *Sapphirina*. No adults were found, so that the identity of the species could not be absolutely determined, but the structure of these young stages, especially of the 1st and 2nd antennæ and the furcal rami, seemed to correspond most nearly with these appendages in *Sapphirina sali* Farran (1929, p. 287, fig. 34) or *Sapphirina iris* Giesbrecht (1892).

Distribution.—Metcalf and Hopkins (1919, p. 237) admit that the species *Pyrosoma atlanticum* (Peron) *sensu lato* includes "a large group of closely related forms which we are including in this species classing as subspecies a number of forms previously described as species and also several new types in our collection." They state that they "have been led to believe that no valid distinctions can be made among Atlantic forms of *Pyrosoma*, which would show the existence of the two nearly allied subspecies *atlanticum* and *giganteum*, generally described." They found in the Pacific Ocean numerous examples that they consider belong to the *atlanticum* group, and they conclude that the large examples described from the Atlantic Ocean should be regarded as specimens of *giganteum*. They also found in the Atlantic Ocean "less specialized forms of *Pyrosoma* than the typical *giganteum* which appear to be intermediate between the Pacific type, *P. atlanticum atlanticum*, and the genuine *P. atlanticum giganteum*. They refer to these intermediate forms as *P. atlanticum*, group *intermedium*.

Whatever the true status of these various forms may be, the species *atlanticum sensu lato* occurs throughout all the three great oceans, Pacific, Indian and Atlantic.

If, as I believe, all the various subspecies and varieties that Hopkins and Metcalf have created in this species are really only different forms of one species, resulting from different local conditions in which development and growth are taking place, then the distribution of the species is worldwide in waters that exhibit a temperature range from 7° C. to 30° C. It seems to be most common at some depth below the surface rather than at the surface. Thompson (1948) gives the number of individuals captured at different depths in the South-east Australian region as follows :

Depth of haul (m.).	Number of examples taken.
50–0	62
100–0	83
250–0	22+
500–0	663



TEXT-FIG. 32.—Examples of *Trichophrya salparum* Entz from *Thalia democratica* (Forskål).

APPENDIX.

Trichophrya salparum Entz. (Text-fig. 32.)

Trichophrya salparum Entz, 1884, p. 297; Calkins, 1901, p. 466, fig. 69; Collins, 1911, p. 380, fig. xcix; Hamburger and von Buddenbruck, 1913, p. 183, fig. 38.

This Acinetid was first recorded and described by Entz (1884) in specimens of the Salp, *Salpa* (*Thalia*) *democratica* Forskål, taken off Naples, and Entz states that the parasite was present in every example of the salp that he examined. The present examples were taken in specimens of the same salp that were captured at Sta. 61, in the middle of the entrance to the Gulf of Oman, at depths ranging from 500 to 1500 m. They were not as common as Entz found them, occurring in about 50% of the aggregated zooids, but being relatively rare in the solitary zooids. Entz found his specimens in the wide gill-cavity of the salp, but in only one example on the gill-bar itself: in the present collection examples were most commonly situated in the groove that is caused by the infolding of the lower lip, but not infrequently they were found on the peripharyngeal ciliated bands. Entz noted that the parasites tend to occur in groups, in which the specimens are of different sizes, and these groups he regards as representing families. Similar groups occurred in the present series, and in each group the individuals are arranged in order of size (*vide* Text-fig. 32B). The size of individuals varies very considerably: the smallest specimen noted had a transverse diameter of 14μ and a dorso-ventral of 9μ, and the largest examples ranged from 42 to 54μ transversely by 20 to 29μ dorso-ventrally. The base of attachment was flat and in many individuals equals the width of the cell, but in some the body of the cell tapers to a relatively narrow pedicle. The number of tentacles appears to increase with growth: in the small specimens there are some 10 to 12 tentacles arising close together from the distal margin with no trace of any division into two bundles; but as growth proceeds the number appears to increase and they become separated into two fasciculi, which are situated respectively on a rounded prominence at each end of the distal margin of the cell. In one or two large examples these two rounded prominences are separated by the median bulge of the distal margin, at the apex of which there appears to be a birth-pore. The nucleus in small examples is spherical, but as growth proceeds it may become pear-shaped or rod-like. There are one or two vacuoles present. Collin (1911, fig. xcix *e* and *f*) shows as many as nine or ten embryos in a single parent, but in the present collection the greatest number that I could detect was four, and in several there was only a single one: it may be that the lower reproduction rate in the present examples is correlated with the death and decay of the host salp which has caused a reduced standard of living for the *Trichophrya*.

This species has also been reported from a number of sessile Ascidians: Lachman (1859) recorded it from a species of *Polyclinum*, Calkins (1902) recorded it from *Molgula mahattensis* (de Kay), and Collin states that he has taken it at Cette in abundance on *Ciona intestinalis* (Linn.) and on *Ascidiella aspera* (Müller) and *A. scabra* (Müller) as well as on Botryllids, but never found it on a Salp in this area.

The present examples are colourless, as recorded by Entz, and thus differ from Collin's specimens from certain sessile Ascidians; in these hosts the parasite was coloured yellow or golden.

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EXPLANATION OF LETTERING USED IN TEXT-FIGURES.

I, II, III, IV, etc., body muscles.

a.r., atrial retractor muscle.
a.s., atrial sphincter muscle.

b.o., blood-forming organ.

cl.a., cloacal aperture.
cy., cyathozooid.

d.l., dorsal languets.

e., endostyle.
el., eleoblast.

gg., ganglion.
gs., gill-slit.

h., heart.
h.m., dorsal horizontal muscle.

i.m., intermediate muscle.

l.o., luminous organ.
L_1, L_2, L_3, L_4, sphincter muscles of lower lip of mouth or atrial aperture.

m., mouth.
m.d.l., mid-dorsal line.
m.v.l., mid-ventral line.

o., ovary.
o.r., oral retractor muscle.
o.s., oral sphincter muscle.

p.a., primary ascidiozooid.

s., stolon.
st., stalk of phorozooid.

t., testis.

U_1, U_2 U_3, U_4, sphincter muscles of upper lip of mouth or atrial aperture.

v.d., vas deferens.

xx, brown muscle of oral siphon in *Iasis zonaria.*

EXPLANATION OF PLATE.

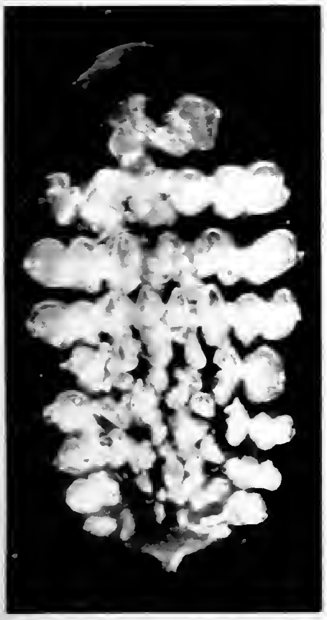
FIG. 1.—*Metcalfina hexagona* (Quoy and Gaimard). A solitary zooid with fully developed stolon.

FIG. 2.—*Pyrosoma verticillatum* Neumann, forma *cylindricum* Metcalf and Hopkins. Size of colony 20·0 mm. in length by 11·0 mm. in width.

FIG. 3.—*Pyrosoma verticillatum* Neumann, forma *hybridum* Metcalf and Hopkins. Size of colony 22 mm. in length by 17 mm. in width.

FIG. 4.—*Pyrosoma aherniosum* Seeliger. Size of colony 23 mm. in length by 12 mm. in width.

FIG. 5.—*Pyrosoma atlanticum* (Peron). Three colonies, of different sizes and presumably of different ages, showing the gradual development of the processes of the test. Sizes of the colonies: 35 mm., 55 mm. and 64 mm. in length.



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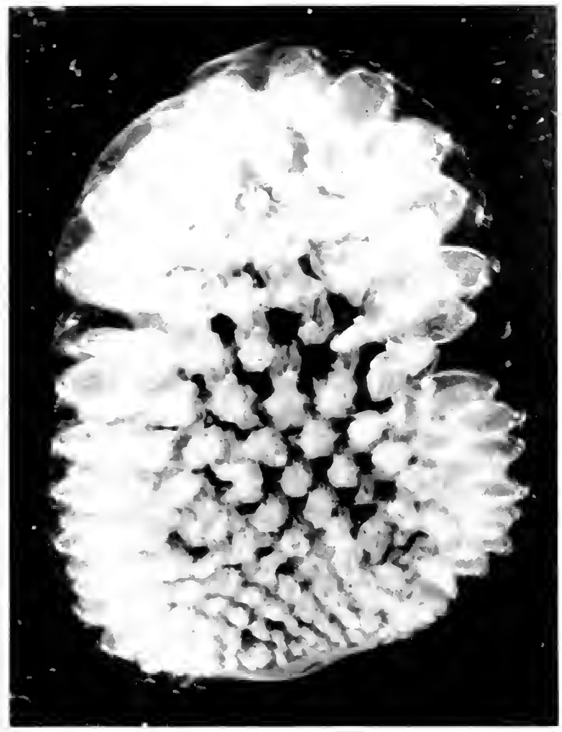

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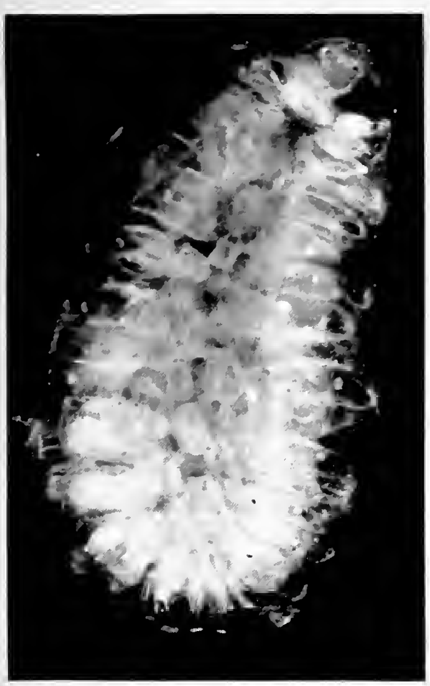

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BRITISH MUSEUM (NATURAL HISTORY)

THE
JOHN MURRAY EXPEDITION
1933–34
SCIENTIFIC REPORTS

VOLUME X, No. 2

SCAPHOPODA

BY
N. H. LUDBROOK, M.A., Ph.D., F.G.S.

WITH ONE PLATE

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INTRODUCTION

THE Scaphopoda recovered by the Expedition represent thirty-six species, of which eight [*Dentalium* (*D.*) *adenense*, *D.* (*Fissidentalium*) *perinvolutum*, *D.* (*Episiphon*) *sewelli*, *D.* (*Episiphon*) *minutissimum*, *Entalina inæquisculpta*, *Entalina adenensis*, *Cadulus* (*Gadila*) *reesi*, *C.* (*Gadila*) *subcolubridens*] are described as new. Eight of the species [*Dentalium* (*D.*) *octangulatum*, *D.* (*D.*) *pseudosexagonum*, *D.* (*Tesseracme*) *quadrapicale*, *D.* (*Lævidentalium*) *longitrorsum*, *D.* (*Pseudantalis*) *rubescens*, *D.* (*Episiphon*) *subrectum*, *D.* (*Gadilina*) *insolitum*, *Cadulus* (*Dischides*) *prionotus*] are familiar species, widely distributed in the Indo-Pacific region. Of six species [*D.* (*Fissidentalium*) *martensi*, *D.* (*Lævidentalium*) *banale*, *D.* (*Gadilina*) *stapes*, *D.* (*Fissidentalium*) *perinvolutum*, *Cadulus* (*Dischides*) *ovalis* and *C.* (*Polyschides*) *hexaschistus*], described or recorded from the Netherlands East Indies by the " Siboga " Expedition, the range has been extended to the westward. Six species, [*D.* (*Antalis*) *usitatum*, *D.* (*Graptacme*) *elpis*, *Entalina mirifica*, *Cadulus* (*C.*) *campylus*, *C.* (*Gadila*) *anguidens* and *C.* (*G.*) *euloides*] were previously known only from dredgings in the Bay of Bengal and off the Indian coast; of three species, [*D.* (*Lævidentalium*) *curvotracheatum*, *Cadulus* (*C.*) *cyathoides*, and *D.* (*Compressidens*) *comprimatum*], described from the Tiefsee Expedition, the first two are widely distributed and the last restricted to the Zanzibar area. Four species [*D.* (*Fissidentalium*) *ægeum*, *D.* (*Lævidentalium*) *leptosceles*, *D.* (*Graptacme*) *acutissimum*, *Cadulus* (*Dischides*) *prionotus*] were recovered by the " Challenger " Expedition, but of these the two deepwater species are only very doubtfully identical with the John Murray specimens. Two species *D.* (*Dentalium*) *reevei* and *D.* (*Fissidentalium*) *shoplandi*, previously reported from Aden and the Arabian coast, are confirmed, and the range still appears to be restricted.

The greater part of this material, including the holotypes, is in the British Museum (Natural History), registered under the numbers referred to in the report. A proportion will be deposited in the Fuad I Institute, Cairo.

Additionally, there are some twenty species recorded from the area which were not dredged by the " Mabahiss." Among them are three species dredged in deep water by the R.I.M.S. " Investigator " and previously not specifically identified. Through the courtesy of the Director, Zoological Survey of India, these specimens have been kindly made available on loan. They were recorded and are identified as follows :—

Lloyd, R. E., 1907, Records Indian Museum, I (1), 1, p. 7, " Investigator " Sta. 362, 878 metres, 13° 50′ N., 48° 18′ E. :

" Several empty shells of *Dentalium.*"

These are eight dry specimens of *Dentalium* (*Fissidentalium*) *magnificum* Smith. Reg. No. $\frac{\text{M6215}}{1}$ Zool. Survey India.

Lloyd, R. E., 1907, Rec. Ind. Mus. I (3), 20, p. 259. " Investigator " Sta. 375. Off Dondra Head, Ceylon, 1107 metres :

" A small species of *Dentalium.*"

Two species are here represented :

Dentalium (*Gadilina*) *insolitum* Smith.

Three specimens in spirit.

Dentalium (*Antalis*) *usitatum* Smith.

Three specimens in spirit.

Lloyd, 1907, Rec. Ind. Mus. I (1), 1, p. 3, also recorded from " Investigator " Sta. 357, 1016 metres, 16° 51′ N., 48° 18′ E. :

" Several large *Dentalia*, probably *D. magnificum.*"

No trace can at present be found of these shells, which are presumed to have been correctly identified.

Other Scaphopoda recorded from the area but not dredged by the " Mabahiss " are as follows :

Dentalium (*Dentalium*) *mannarense* Winckworth.

Dentalium mannarense Winckworth, 1927, Proc. Malac. Soc. XVII, (4), p. 167, pl. 14, figs. 1, 2, text-fig. 1.

DISTRIBUTION.—6 metres, sand, west side of Mannār Island, Ceylon, inside reef.

Dentalium (*Dentalium*) *javanum* Sowerby.

Dentalium javanum Sowerby, 1860, Thes. Conch. III, p. 102, pl. 223, fig. 12 ; Winckworth, 1927, Proc. Malac. Soc. XVII (4), p. 169.

DISTRIBUTION.—Shallow water, Cape York, North Australia ; Java ; Malacca ; Ennūr near Madras.

Dentalium (*Dentalium*) *bisexangulatum* Sowerby.

Dentalium bisexangulatum Sowerby, 1860, Thes. Conch. III, p. 102, pl. 223, fig. 8.

DISTRIBUTION.—14–55 metres, Java, Singapore, Japan, Gulf of Suez, Torres Strait, Querimba Is., Mozambique.

Dentalium (*Dentalium*) *conspicuum* Melvill.

Dentalium conspicuum Melvill, 1897, Mem. and Proc. Manchester Lit. and Phil. Soc. XLI (3), 1896–7, p. 21, pl. 7, fig. 28.

DISTRIBUTION.—Karachi.

Dentalium (*Dentalium*) *cookei* Sharp & Pilsbry.

Dentalium acus Cooke, 1885, Ann. Mag. Nat. Hist. ser. 5, XVI, . 274 (*non D. acus* Eichwald).
Dentalium cookei Sharp & Pilsbry, 1897, Man. Conch. XVII, p. 29 (*nom. mut.*).

DISTRIBUTION.—Gulf of Suez.

Dentalium (*Dentalium*) *laugieri* Jousseaume.

Dentalium laugieri Jousseaume, 1894, Bull. Soc. Philom. Paris, ser. 8, VI (2), p. 103.

Distribution.—Aden, Suez.

Dentalium (*Dentalium*) *tomlini* Melvill.

Dentalium tomlini Melvill, 1918, Ann. Mag. Nat. Hist. ser. 9, I, p. 155, pl. 5, fig. 31.

Distribution.—Karachi.

Dentalium (*Dentalium*) *zanzibarense* Plate.

Dentalium (*Dentalium*) *zanzibarense* Plate, 1908. Tiefsee Exped. IX (3), p. 348, pl. 30, figs. 35, 36.

Distribution.—463 metres, Zanzibar Channel.

Dentalium (*Antalis*) *serrulatum* Smith.

Dentalium serrulatum Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 249.

Distribution.—55 metres, Andaman Islands.

Dentalium (*Antalis*) *subcurvatum* Smith.

Dentalium subcurvatum Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 251.

Distribution.—1337–1411 metres, S.W. of Cape Comorin.

Dentalium (*Antalis*) *gardineri* Melvill.

Dentalium gardineri Melvill, 1909, Trans. Linn. Soc. Lond. XIII, p. 120, pl. 5, fig. 9.

Distribution.—293–382 metres, Amirante Is.

Dentalium (*Fissidentalium*) *magnificum* Smith.

Dentalium magnificum Smith, 1897, Ann. Mag. Nat. Hist. ser. VI, XVIII, p. 371; 1906, ser. 7, XVIII, p. 248.

Distribution.—412–1464 metres, Travancore to Bay of Bengal west of Burma; Arabian Sea.

Dentalium (*Fissidentalium*) *profundorum* Smith.

Dentalium profundorum Smith, 1894, Ann. Mag. Nat. Hist. ser. 6, XIV, p. 167, pl. 4, fig. 18; 1906, ser. 7, XVIII, p. 249.

Distribution.—1041–1987 metres, Ceylon and Andaman Is.

Dentalium (*Fissidentalium*) *cornu-bovis* Smith.

Dentalium cornu-bovis Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 249.

Distribution.—410–520 metres, 2111 metres, Indian Ocean.

Dentalium (*Fissidentalium*) *chuni* Plate.

Dentalium (*Fissidentalium*) *chuni* Plate, 1908, Tiefsee Exped. IX (3), p. 341, pl. 30, figs. 1–9.

Distribution.—694–1134 metres, East African coast; Padang I.

Dentalium (*Fissidentalium*) *ceras* Watson.

Dentalium ceras Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 510.
Dentalium keras Watson, Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 248.

Distribution.—Mid-Pacific, E. of Japan, 3751 metres, W. of Valparaiso, 3953 metres; S. of Ceylon, 2745 metres.

Dentalium (*Lævidentalium*) *lacteum* Deshayes.

Dentalium lacteum Deshayes, 1825, Mem. Soc. Hist. nat. Paris, II, p. 362, pl. 16, fig. 27; Winckworth, 1927, Proc. Malac. Soc. XVII (4), p. 169, pl. 14, fig. 5.

Dentalium (*Lævidentalium*) *subtorquatum* Fischer.

Dentalium subtorquatum Fischer, 1871, Journ. de Conch. XIX, pp. 212, 218.

Distribution.—Suez.

Dentalium (*Gadilina*) *truncatum* Boissevain.

Dentalium (*Gadilina*) *truncatum* Boissevain, 1906, Siboga Exped. LIV (32), p. 51, pl. 6, fig. 33.

Distribution.—281 metres, Celebes Sea; 397 metres, Arafura Sea; Zanzibar Channel; Miocene of Timor.

Dentalium (*Rhabdus*) *eburneum* Linné.

Dentalium eburneum Linné, 1767, Syst. nat. ed. 12, p. 1264; Winckworth, 1927, Proc. Malac. Soc. XVII (4), p. 169.

Distribution.—Manapad, South India; Singapore; Mergui Archipelago; Siam; Philippine Is.

Two records from the area are regarded as doubtful or unlikely occurrences:
Dentalium elephantinum Linné. Issel, 1869, Mal. Mar. Rosso, p. 235.
Dentalium lubricatum Sowerby. Smith, 1906, Ann. Mag. Nat. Hist., ser. 7, XVIII, p. 250.

The known scaphopod fauna of the area dredged by the "Mabahiss" may be summarized:

A. Shallow Water Species:

Dentalium (*Dentalium*) *octangulatum* Donovan.
D. (*D.*) *pseudosexagonum* Deshayes.
D. (*D.*) *reevei* Fischer.
D. (*D.*) *mannarense* Winckworth.
D. (*D.*) *javanum* Sowerby.
D. (*D.*) *bisexangulatum* Sowerby.
D. (*D.*) *conspicuum* Melvill.
D. (*D.*) *cookei* Sharp & Pilsbry.
D. (*D.*) ? *elephantinum* Linné.
D. (*D.*) *laugieri* Jousseaume.
D. (*D.*) *tomlini* Melvill.
D. (*Antalis*) *gardineri* Melvill.
D. (*Fissidentalium*) *ægeum* (?) Watson.
D. (*Tesseracme*) *quadrapicale* Sowerby.
D. (*Lævidentalium*) *longitrorsum* Reeve.
D. (*L.*) *lacteum* Deshayes.
D. (*L.*) *subtorquatum* Fischer.

D. (*L.*) ? *lubricatum* Sowerby.
D. (*Pseudantalis*) *rubescens* Deshayes.
D. (*P.*) *rubescens* var. *tenuifissum* Monterosato.
D. (*Episiphon*) *sewelli* sp. nov.
D. (*E.*) *minutissimum* sp. nov.
D. (*E.*) *subrectum* Jeffreys.
D. (*Graptacme*) *elpis* Winckworth.
Cadulus (*Cadulus*) *campylus* Melvill.
C. (*Dischides*) *prionotus* Watson.
C. (*D.*) *ovalis* Boissevain.
C. (*D.*) *dichelus* Watson.

b. Deep Water Species :

Dentalium (*Dentalium*) *adenense* sp. nov.
D. (*D.*) *zanzibarense* Plate.
Dentalium (*Antalis*) *usitatum* Smith
D. (*A.*) *subcurvatum* Smith.
Dentalium (*Fissidentalium*) *shoplandi* Jousseaume.
D. (*F.*) *martensi* Boissevain
D. (*F.*) *perinvolutum* sp. nov.
D. (*F.*) *magnificum* Smith
D. (*F.*) *profundorum* Smith.
D. (*F.*) *cornu-bovis* Smith.
D. (*F.*) *chuni* Plate.
D. (*F.*) *ceras* Watson.
Dentalium (*Lævidentalium*) *curvotracheatum* Plate.
D. (*L.*) ? *leptosceles* Watson.
D. (*L.*) ? *banale* Boissevain.
D. (*Compressidens*) *comprimatum* Plate.
D. (*Gadilina*) *insolitum* Smith.
D. (*G.*) *stapes* Boissevain.
D. (*Graptacme*) *acutissimum* Watson.
Entalina mirifica Smith.
E. inæquisculpta sp. nov.
E. adenensis sp. nov.
Cadulus (*Cadulus*) *cyathoides* Jaeckel.
C. (*Gadila*) *anguidens* Melvell & Standen.
C. (*G.*) *euloides* Melvill & Standen.
C. (*G.*) *reesi* sp. nov.
C. (*G.*) *subcolubridens* sp. nov.
C. (*Polyschides*) *hexaschistus* Boissevain.

Subgenera which are predominantly or wholly represented in shallow water only are : *Dentalium, Tesseracme, Pseudantalis, Episiphon, Dischides* ; those which are almost restricted to deep water in the area are : *Fissidentalium, Gadilina, Entalina, Gadila, Polyschides. Antalis* and *Lævidentalium* are almost evenly distributed.

SYSTEMATIC DESCRIPTIONS.

Class *SCAPHOPODA*.

Family DENTALIIDÆ.

Genus *Dentalium* Linné, 1758.

Dentalium Linné, 1758, Syst. nat. ed. 10, p. 785.

Type species (subsequent designation Montfort, 1810) *Dentalium elephantinum* Linné.

Subgenus *Dentalium* s.str.

(= *Paradentalium* Cotton & Godfrey, 1933).

Dentalium (*Dentalium*) *octangulatum* Donovan. (Fig. 1.)

Dentalium octangulatum Donovan, 1802, Nat. Hist. Brit. Shells, V, pl. 162 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 16, pl. 2, figs. 16, 17, 18, 22 ; Boissevain, 1906, Siboga Exped. LIV (32), p. 17, pl. 1, fig. 8, pl. 4, figs. 8, 9 ; Dautzenberg & Fischer, 1907, Journ. de Conch. LIV, p. 249 ; Winckworth, 1927, Proc. Malac. Soc. XVII (4), p. 167, pl. 14, fig. 4 ; Nomura, 1938, Venus, VIII (3/4), p. 155.

Dentalium octogonum Lamarck, 1818, Anim, s. Vert. V, p. 344, Deshayes, 1825, Mém. Soc. Hist. nat. Paris, II, p. 352, pl. 16, figs. 5, 6 ; Delessert, 1841, Rec. de Coq., pl. 1, figs, 1*a*, *b* ; Chenu, 1842, Illust. Conch. I, p. 5, pl. 1, figs. 21–23 ; Reeve, 1842, Conch. Syst. II, pl. 130, fig. 8 ; Sowerby, 1860, Thes. Conch. III, p. 102, pl. 1 (Thes. 223), fig. 9 ; Lischke, 1871, Jap. Meeres-Conch. II, p. 103 ; Sowerby, 1872, in Conch. Icon. XVIII, pl. 2, fig. 12 ; Martens, 1874, Vorderasiat. Conch. p. 102 ; Lischke, 1874, Jap. Meeres Conch. III, p. 75, pl. 5, figs. 1–3 ; Brazier, 1877, Proc. Linn. Soc. N.S.W. II, p. 55 ; Dunker, 1882, Ind. Moll. Mar. Jap. p. 153 ; Hall & Standen, 1907, Journ. Conch. Leeds, XII, p. 65; Yokoyama, 1920, Journ. Coll. Sci. Tokyo, Imp. Univ. XXXIX (6), p. 103; 1922, *id.* XLIV (1), p. 118.

Dentalium octagonum Yokoyama, 1929, Imp. Geol. Surv. Japan, Rep. 101, pp. 68, 115.

Dentalium striatulum Turton, 1819, Conch. Dict. Brit. Is., p. 38 (in part).

Dentalium aprinum Mawe, 1823, Linn. Syst. Conch. p. 192, pl. 33, fig. 1 (*non D. aprinum* Linné).

Sta. 80. South-east Arabian Coast, 22° 13′ 30″ N., 59° 48′ 48″ E., 16–22 metres ; coarse sand and shells. " Salpa " Dredge, width 4 feet ; 1 specimen. 1952.3.25.130.

Sta. 119. Zanzibar area, 6° 29′ 24″ S., 39° 49′ 54″ E. to 6° 32′ 00″ S., 39° 53′ 30″ E., 1207–1463 metres. Agassiz Trawl ; 1 specimen. 1952.3.25.227.

DISTRIBUTION.—Widely distributed in shallow waters of the Indo-Pacific from Southern Arabia to Japan, including Northern Australia. The single dead shell from Station 119 is anomalous and may have been swept into deep water by currents.

DESCRIPTION.—Shell of moderate size, moderately curved especially towards the apex, white, generally opaque, sculptured with 8 (rarely 9) strong, rounded longitudinal ribs extending from apex to aperture. Ribs separated by wide, deep, concave interspaces which are smooth in the early stages but generally develop longitudinal striæ or small, frequent riblets towards the aperture. Growth striæ variable, but slight in specimens with conspicuous intercostal riblets. Apex small, simple, fairly thick, round within, octagonal without ; aperture slightly oblique, octagonal, thin, crenulated by the ribs and intercostal riblets.

DIMENSIONS.—Length 50, diameter at aperture 5, diameter at apex 1 mm.

TYPE LOCALITY.—Japan.

NEOTYPE.—British Museum No. 1952.2.23.1.

OBSERVATIONS.—As no holotype can be found, a neotype has been selected from contemporary material (B.M. 1952.2.23.1–12) in the British Museum (Mus. Cracherode) agreeing very closely with one of Donovan's original figures.

Dentalium (*Dentalium*) *adenense* sp. nov. (Fig. 2.)

Sta. 28. Gulf of Aden, 12° 00′ 00″ N., 50° 38′ 42″ E., 201 metres; coarse grey sand, mud and shells. Petersen Grab; 57 specimens. 1952.3.25.124 & 252–261.

Sta. 103. Zanzibar area, 5° 39′ 30″ S., 39° 11′ 30″ E., 101 metres; coarse sand and shells. Petersen Grab; 1 specimen. 1952.3.25.251.

Sta. 179B. Gulf of Aden, 12° 02′ 06″ N., 50° 40′ 12″ E., 275 metres; green mud and sand. Petersen Grab; 10 specimens. 1952.3.25.263–272.

Sta. 180. Gulf of Aden, 12° 03′ 24″ N., 50° 40′ 12″ E., 397 metres; green mud and sand. Petersen Grab; 1 specimen. 1952.3.25.262

Sta. 185. Gulf of Aden, 13° 48′ 06″ N., 49° 16′ 48″ E., to 13° 48′ 36″ N., 49° 16′ 24″ E., 2000 metres; green mud. Agassiz Trawl; 7 specimens. 1952.3.25.46–52.

DISTRIBUTION.—Gulf of Aden, 201 to 2000 metres; Zanzibar area, 101 metres.

DESCRIPTION.—Shell small, slender, very gradually tapering, solid, opaque, cream or greyish white; curvature very slight. Entire surface of the shell sculptured with seven strong, sharp, raised longitudinal ribs, triangular in section with wide concave interspaces. Interspaces smooth posteriorly but at about one-third length of shell developing by intercalation at least one intercostal riblet in each interspace. Apex heptagonal, with a plug and very small pipe which in the holotype is broken at the plug; aperture oblique, octagonal owing to the greater development of one of the secondary riblets; ribs and intercostal riblets triangularly nodulating the margin.

DIMENSIONS.—Length 20, diameter at apex 1, diameter at aperture 2 mm., arc 1 mm.

TYPE LOCALITY.—Sta. 28, Gulf of Aden, 201 metres.

HOLOTYPE.—British Museum No. 1952.3.25.124.

OBSERVATIONS.—This is a very small slender *Dentalium* typically seven-ribbed, but in some individuals there may be eight or, rarely, six ribs. The species most closely resembles the juvenile stages of *D. javanum* Sowerby which has no intercostal riblets, these being variable in number in the present species but nearly always present to some extent. The species appears to occur at depths of about 200 to 2000 metres. *D. intercostatum* Boissevain is a somewhat similarly sculptured shell with more numerous intercostal threads.

Dentalium (*Dentalium*) *pseudosexagonum* Deshayes. (Fig. 3.)

Dentalium pseudosexagonum Deshayes, 1825, Mém. Soc. d'Hist. nat. Paris, II, p. 358, pl. 16. figs. 14–16; Sowerby, 1860, Thes. Conch. III, p. 103, pl. 2 (Thes. 224), fig. 34; Sowerby, 1872, in Reeve, Conch. Icon. XVIII, pl. 4, fig. 23; Brazier, 1877, Proc. Linn. Soc. N.S.W. II, p. 56; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 23, pl. 4, figs. 47, 48; Boissevain, 1906, Siboga Exped. LIV (32), p. 14, pl. 1, fig. 10; Melvill, 1909, Trans. Linn. Soc. London, ser. 2, XIII (1), p. 120.

Sta. 180. Gulf of Aden, 12° 03′ 24″ N., 50° 40′ 12″ E., 397 metres; green mud and sand. Petersen Grab; 1 specimen. 1952.3.25.228.

Sta. 191. Gulf of Aden, 13° 46′ 30″ N., 47° 48′ 54″ E., 274 metres ; green sand and mud. Petersen Grab ; 2 specimens. 1952.3.25.128–129.

Distribution.—Philippines ; North Australia, 20–55 metres ; Gulf of Aden, 366–499 metres ; Saya de Malha Banks ; Cargados Carajos, 55 metres ; Amirantes, 62 metres.

Description.—Shell rather small, gradually tapering, moderately curved, particularly towards the apex, white or greyish white, somewhat transparent. Sculptured near the apex with six elevated sharp primary ribs between which numerous longitudinal threadlike riblets arise by intercalation, gradually covering the shell and replacing the primary ribs, which disappear towards the aperture. Apex markedly hexagonal, aperture slightly oblique, subcircular.

Dimensions.—(Sta. 191.) Length 38, diameter at apex 0·8, diameter at aperture 3, arc 2 mm.

Type Locality.—Not recorded.

Syntypes.—École de Mines, Paris.

Dentalium (*Dentalium*) *reevei* Fischer.

Dentalium reevei Fischer, 1871, Journ. de Conch. XIX (ser. 3, XI), p. 212.

Dentalium aratorum Cooke, 1885, Ann. Mag. Nat. Hist. ser. 5, XVI, pp. 273–4 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 10.

Dentalium lineolatum Cooke, 1885, *tom. cit.* p. 274 ; Pilsbry & Sharp, 1897, *tom. cit.* p. 11.

Dentalium clavus Cooke, 1885, *tom. cit.* p. 275.

Dentalium macandrewi Boissevain, 1906, Siboga Exped. LIV (32), p. 25, pl. 5, figs. 25, 26, 28–34, ? fig. 27.

Sta. 45. Hadramaut Coast, 18° 03′ 30″ N., 57° 02′ 30″ E., 38 metres ; lithothamnion. Triangular Dredge 4 ; 1 specimen. 1952.3.25.53.

Sta. 53. Hadramaut Coast, 19° 22′ 36″ N., 57° 53′ 00″ E., 13·5 metres. Triangular Dredge 4 ; 2 specimens, 1952.3.25.54–55.

Distribution.—Suez, Aden, South Arabian Coast, shallow water to 38 metres.

Description.—Shell rather short, solid, pale amber coloured or white, acuminated in young, strongly truncated in adults. Sculptured with 9 to 12 strong equidistant ribs which are generally bisected by a longitudinal groove. Interstices at least twice as wide as ribs, sculptured with three or more slightly raised riblets and decussated by frequent minute transverse striæ. Apex polygonal, generally truncated, slightly notched on the convex side, broadly plugged and having a short supplementary tube. Aperture polygonal, not oblique.

Dimensions.—(Specimen Sta. 53.) Length 29, diameter at apex 2·8, diameter at aperture 5 mm.

Type Locality.—Suez.

Holotype.—Not located.

Observations.—Although *D. laugeri* Jousseaume has been included in the synonymy of this species by Pilsbry & Sharp (1897, p. 12) and by Boissevain (1906, p. 27), Jousseaume's description of a species with rounded smooth ribs and wide interspaces with 3 to 5 delicate striæ suggests the species recorded from Farsan Is. (Cox, 1931, p. 9) as *D. aratorum.* This is distinct from the present species ; it is a much longer shell with smooth ribs and wide, nearly smooth interspaces infrequently finely striated.

Subgenus *Antalis* Herrmannsen, 1846.

Antalis Herrmannsen, 1846, Ind. Gen. Malac. I, p.63.

Type species (subsequent designation Pilsbry & Sharp, 1897). *Dentalium entalis* Linné (= *Entalis* Gray 1847, Proc. Zool. Soc., p. 158, *non* Sowerby, 1839) (= *Entaliopsis* Newton & Harris, 1894, Proc. Malac. Soc, I (2), p. 66).

Dentalium (*Antalis*) *usitatum* Smith. (Fig. 4.)

Dentalium usitatum Smith ,1894, Ann. Mag. Nat. Hist. ser. 6, XIV, p. 168 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 29, pl. 10, figs. 68, 69 ; Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 280.

Sta. 23. Gulf of Aden. 12° 00′ 00″ N., 50° 38′ 42″ E., 201 metres ; coarse grey sand, mud and shells. Petersen Grab : 1 specimen. 1952.3.25.212.

Sta. 139. Maldive area. 2° 13′ 30″ N., 73° 09′ 00″ E., 57 metres : coral sand. Petersen Grab : 1 specimen. 1952.3.25.213.

Sta. 143. Maldive area. 5° 15′ 48″ N., 73° 22′ 48″ E. to 5° 13′ 42″ N., 73° 23′ 36″ E., 797 metres ; green sand. Agassiz Trawl : 6 specimens. 1952.3.25.214–219.

Sta. 158. Maldive area. 4° 42′ 30″ N., 72° 42′ 30″ E., to 4° 36′ 48″ N., 72° 48′ 54″ E., 786–1170 metres ; Agassiz Trawl : 2 specimens. 1952.3.25.126–7.

Distribution.—Off Colombo, 1234 metres ; Bay of Bengal, 1092 metres ; Gulf of Aden, 183 metres ; Maldive Islands, 56–787 metres ; west of Burma, 1542 metres.

Description.—Shell fairly small, slender, white or greyish-white : sculptured with from 20 to 25 fine, longitudinal liræ which are stronger near the apex and become obsolete toward the aperture. Growth lines oblique, stronger near the aperture. Apex small, thick, circular, with a short, broad, V-shaped notch. Aperture oblique, well arched ventrally, slightly broadened and flattened dorsally.

Dimensions.—(Specimen Sta. 158.) Length 39, diameter at apex 0·5, diameter at aperture 3, arc 1 mm.

Type Locality.—Off Colombo, 1235 metres.

Holotype.—Indian Museum.

Paratype.—British Museum No. 1894.9.11.8.

Observations.—The " Siboga " species recorded by Boissevain (1906, p. 44) as *Dentalium* (*Graptacme*) *usitatum* Smith is distinct from *usitatum*, and is described below as *D.* (*F.*) *perinvolutum*. It is, as stated by Boissevain, represented in the British Museum by a fairly large, strongly-curved *Fissidentalium* erroneously, in my opinion, identified by Smith as *usitatum*. *D.* (*A.*) *usitatum* is scarcely curved, and has the notched aperture of *Antalis*. Three of the four " Siboga " specimens have, according to Boissevain (1906, p. 45), a long apical slit.

Subgenus *Fissidentalium* Fischer, 1885.

Fissidentalium Fischer, 1885, Man. de Conch., p. 894.

Type species (monotypy) *Dentalium ergasticum* Fischer (= *Schizodentalium* Sowerby, 1894, Proc. Malac. Soc. I, p. 158).

Dentalium (*Fissidentalium*) *shoplandi* Jousseaume.

Dentalium shoplandi Jousseaume, 1894, Bull. Soc. Philom. Paris, ser. 8, VI (2), p. 102 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 28, pl. 12, fig. 100 ; Boissevain, 1906, Siboga Exped. LIV (32), p. 31, pl. 1, fig. 12.

Sta. 34. Gulf of Aden, 13° 05′ 36″ N., 46° 24′ 42″ E., 1022 metres ; green mud. Agassiz Trawl ; 19 specimens, 16 fragments. 1952.3.25.56–61, 172–181.

Sta. 176. Gulf of Aden, 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres ; green mud and sand. Agassiz Trawl ; 35 specimens, 46 fragments. 1952.3.25.182–191.

Sta. 184. Gulf of Aden, 14° 36′ 06″ N., 51° 00′ 18″ E., to 14° 38′ 42″ N., 50° 57′ 42″ E., 1270 metres ; green mud. Agassiz Trawl ; 4 specimens, 6 fragments. 1952.3.25.152–156.

Sta. 188. Gulf of Aden, 13° 43′ 18″ N., 47° 56′ 54″ E., to 13° 46′ 00″ N., 47° 50′ 42″ E., 528 metres ; green mud. Agassiz Trawl ; 5 specimens, 2 fragments. 1952.3.25.167–171.

Sta. 193. Gulf of Aden, 13° 06′ 12″ N., 46° 24′ 30″ E. to 13° 03′ 00″ N., 46° 21′ 42″ E., 1061–1080 metres ; green mud. Agassiz Trawl ; 13 specimens (1 live), 15 fragments. 1952.3.25.62, 157–166.

Distribution.—Gulf of Aden, 528–1350 metres.

Description.—Shell large, slightly curved in the early stages but nearly straight in the adult, solid, slowly tapering, chalky, creamy-white to greyish. Sculpture near the apex generally of about 17 but sometimes from 16 to 21 subequal, narrow, unequally spaced, sharply defined riblets about half the width of the interspaces and increasing in size towards the aperture ; riblets increasing in number by intercalation to about 25 at the aperture. Whole surface densely and conspicuously transversely striated by unequal striæ crossing riblets and interspaces and slightly crenulating the riblets. Apex where preserved small, narrow, with a long slit on the convex side ; aperture slightly oblique, subcircular.

Dimensions.—(Holotype.) Length 75, diameter 11 mm. (Adult specimen, Sta. 193.) Length 111, diameter 12 mm.

Type Locality.—50 miles from Aden, 1240 metres.

Holotype.—Museum d'Histoire naturelle, Paris.

Observations.—The record of this species from the Antarctic (Melvill & Standen, 1908, p. 143) has been omitted from the synonymy in view of the unlikelihood that the Antarctic specimen is conspecific with *D. shoplandi*. The species was dredged in some numbers by the John Murray Expedition including fully grown adults attaining a length of over 110 mm. Previously the species has been classified in *Dentalium* s. str. and the apex described as simple (Pilsbry & Sharp, 1897, p. 28). Where the apex is fully preserved in the young stages, the presence of the long slit typical of *Fissidentalium* is revealed.

Dentalium (*Fissidentalium*) *martensi* Boissevain.

Dentalium martensi Boissevain, 1906, Siboga Exped. LIV (32), p. 34, pl. 5, figs. 1–3.

Sta. 50. Hadramaut Coast, 18° 38′ 00″ N., 58° 05′ 00″ E., 1536–1939 metres ; brown mud. Triangular Dredge 4 ; 1 specimen. 1952.3.25.63.

Sta. 119. Zanzibar area, 6° 29′ 24″ S., 39° 49′ 54″ E. to 6° 32′ 00″ S., 39° 53′ 30″ E., 1207–1463 metres. Agassiz Trawl ; 2 fragments. 1952.3.25.234.

Distribution.—Macassar Strait, 1301 metres ; Banda Sea, 4391 metres ; Hadramaut Coast, 1536–1939 metres ; Zanzibar area 1207–1463 metres.

Description.—Shell of moderate size, nearly straight, very gradually tapering.

slightly dorso-ventrally compressed near the apex, more rounded toward the aperture. Longitudinally sculptured with 16 sharp, fine ribs near the apex separated by wide flatly concave interspaces. Secondary and, towards the aperture, finer tertiary riblets rise in the interspaces by intercalation, those on the concave side generally soon equalling the the primary ribs in size, those on the convex generally remain smaller than the primary ribs. Ribs crossed at frequent intervals by deep, transverse striæ which divide them into small irregular rounded teeth. Interspaces transversely striated but not conspicuously so. Apex dorso-ventrally compressed, entire, oval in section with a fairly long rather wide slit on the convex side. Anterior aperture subcircular, slightly dorso-ventrally compressed.

Dimensions.—(Holotype.) Length 56, diameter of apex 1·7, diameter of aperture 6·3 × 6 mm.

Type Locality.—" Siboga " Sta. 88, Macassar Strait, 1301 metres.

Holotype.—Amsterdam.

Dentalium (*Fissidentalium*) *œgeum* (?) Watson.

Dentalium œgeum Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 509; Watson, 1886, Chall. Rep. Zool. XV, p. 2, pl. 1, fig. 2. Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 69, pl. 20, fig. 27.

Dentalium (*Fissidentalium*) *œgeum* Watson. Plate, 1908, Tiefsee Exped. IX (3), p. 343, pl. 30, figs. 10, 11, 52.

Sta. 120. Zanzibar area, 5° 49′ 12″ S., 41° 28′ 12″ E., to 5° 52′ 24″ S., 41° 40′ 12″ E., 2926 metres; brown mud over grey globigerina ooze. Agassiz Trawl; 1 specimen. 1952.3.25.64.

Distribution.—Kerguelen Island 201 metres, 88 metres; Zanzibar area 2926 metres.

Description.—Shell of moderate size, fairly long and rapidly increasing, moderately curved, finely tapering, thin, white, opaque, shining, strongly inclined to decortication at the apex. Sculptured with about 16 fine, longitudinal riblets at the apex, increasing by intercalation to from 30 to 35 at the aperture. Riblets high posteriorly, narrow, rounded, about equal to the interspaces, but broadening and flattening towards the aperture, where the ridges are indicated only by the faint striæ of the furrows. Whole surface transversely crossed by growth striæ and very faintly microscopically longitudinally striated. Aperture circular, slightly oblique, peristome thin, nearly smooth.

Dimensions.—Length 62, diameter at apex 1·5, diameter at aperture 7·5, arc 5 mm.

Type Locality.—Off London River, Kerguelen Island, 201 metres.

Holotype.—British Museum No. 1887.2.9.8.

Observations.—The identification of the species from deep water off Zanzibar is doubtful. One specimen only was taken alive. It is smaller than the holotype of *œgeum*, but appears to be a juvenile of that species. It is similarly sculptured and has the posterior portion intact and not decorticated as in the holotype of *œgeum*.

Dentalium (*Fissidentalium*) *perinvolutum* sp. nov. (Fig. 7.)

Dentalium (*Graptacme*) *usitatum* Smith. Boissevain, 1906, Siboga Exped. LIV (32), p. 44, pl. 5, figs. 6, 7, 8.

Sta. 185. Gulf of Aden, 13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E., 2000 metres; green mud. Agassiz Trawl; 1 specimen. 1952.3.25.65.

DISTRIBUTION.—West of Burma, 1542 metres; Celebes Sea 1301 metres; Banda Sea, 1158 metres; Timor Sea, 918 metres; Gulf of Aden, 2000 metres.

DESCRIPTION.—Shell thin but solid, small for the subgenus, very strongly curved, white, translucent, gradually tapering. Sculpture of about 20 fine, sharply rounded riblets at the apex, separated by wide, flat, shallow interspaces which are microscopically longitudinally and transversely striated. Sculpture becoming obsolete at a little more than the posterior one-third, where the shell becomes smooth except for microscopic longitudinal striæ and oblique growth-lines. Apex circular with a long linear slit; aperture oblique, circular, peristome thin.

DIMENSIONS.—(Holotype.) Length 68, diameter of apex 1, diameter of aperture 7, arc 8, length of slit 3 mm.

TYPE LOCALITY.—Sta. 185, Gulf of Aden, 2000 metres.

HOLOTYPE.—British Museum No. 1952.3.25.65.

OBSERVATIONS.—This is a handsome and very puzzling species. In the early stages it is very like *D.* (*Antalis*) *usitatum* Smith, with which it has been identified by Smith (specimen 1906.10.12.3 in the British Museum from West of Burma) and Boissevain. The not inconsiderable number of examples of *usitatum* in the John Murray material, all agreeing in size, sculpture and apical characters with the paratype of *usitatum* in the British Museum, leads me to the conclusion that they cannot all be young or broken examples of the large species described above as *perinvolutum*. Both the John Murray specimen and the large specimen 1906.10.12.3 of *perinvolutum* are more strongly curved than *usitatum*; in both the apex has the well-developed slit of *Fissidentalium*. Almost all examples of *usitatum* have either a simple apex or one with a short triangular notch. All the specimens figured by Boissevain belong to *perinvolutum*. Of the 11 specimens recorded from "Siboga" Expedition as *usitatum*, 4, according to Boissevain, have the long slit. Whether all the specimens are *perinvolutum* it is impossible to say without examination of the material. The species combines the early features of *Fissidentalium* with the shape, general appearance, and later smooth sculpture of *Lævidentalium*.

Subgenus *Tesseracme* Pilsbry & Sharp, 1898.

Tesseracme Pilsbry & Sharp, 1898, Man. Conch. XVII, p. 249.

Type species (original designation), *Dentalium quadrapicale* Sowerby.

Dentalium (*Tesseracme*) *quadrapicale* Sowerby. (Fig. 5.)

Dentalium quadrapicale Sowerby *ex* Hanley MS, 1869, Thes. Conch. III, p. 103, pl. 3 (Thes. 225), fig. 61; Sowerby, 1872, in Reeve, Conch. Icon. pl. 7, fig. 46; Clessin, 1896, Conch. Cab. p. 13, pl. 3, fig. 6; Pilsbry & Sharp, 1897, Man. Conch. XVII, pp. 34, 249, pl. 4, fig. 50; Smith, 1897, Ann. Mag. Nat. Hist. ser. 6, XVIII, p. 371; Boissevain, 1906, Siboga Exped. LIV, (32), p. 42, pl. 1, fig. 13.

Dentalium (*Tesseracme*) *quadrapicale* (Hanl.). Plate, 1908, Tiefsee Exped. IX (3), p. 350, pl. 30, fig. 53.

Dentalium quadriapicale (*lapsus calami* for *quadrapicale* Sowb.) Melvill & Standen, 1901, Proc. Zool. Soc. Lond. p. 459.

Sta. 72. Gulf of Oman, 25° 38′ 18″ N., 56° 26′ 36″ E., 73 metres; coarse sand and shells. Agassiz Trawl; 2 specimens. 1952.3.25.133–134.

DISTRIBUTION.—Malabar; Cochin; Travancore, 743 metres; Gulf of Oman, Maskat, 9–27 metres, 73 metres; Mekran Coast, generally distributed; Madura Bay and southern part of Molo Strait, West Sumatra, 614 metres.

Description.—Shell of moderate size, solid, white, shining, strongly curved in the apical one-third, slightly arcuate posteriorly. Sculptured with four prominent ribs at the quadrate apex with finer secondary riblets rising between them by intercalation near the apex, developing an octangular section. At the anterior one-third further riblets develop by intercalation with shallow intervals, covering the whole shell, which becomes rounded with about 36 subequal riblets at the aperture. Apex strongly four-angled, aperture oblique, subcircular.

Dimensions.—(Holotype.) Length 33, diameter at apex 1, diameter at aperture 4, arc 2 mm.

Type Locality.—Cochin, India.

Holotype.—British Museum No. 1907.10.28.147.

Subgenus *Lævidentalium* Cossmann, 1888.

Lævidentalium Cossman, 1888, Ann. Soc. roy. Malac. Belg. XXIII, p. 9.

Type species (original designation), *Dentalium incertum* Deshayes.

Dentalium (*Lævidentalium*) *curvotracheatum* Plate. (Fig. 8.)

Dentalium (*Plagioglypta*) *curvotracheatum* Plate, 1908, Tiefsee Exped. IX (3), p. 358, pl. 30, fig. 47.

Sta. 109. Zanzibar area, 5° 10′ 36″ S., 39° 33′ 48″ E., 640 metres ; light grey mud. Agassiz Trawl ; 1 specimen. 1952.3.25.231.

Sta. 143. Maldive area, 5° 15′ 48″ S., 73° 22′ 48″ E. to 5° 13′ 42″ S., 73° 23′ 36″ E., 797 metres ; green sand. Agassiz Trawl ; 4 specimens. 1952.3.25.66–69.

Sta. 145E. Maldive area, 4° 58′ 42″ S., 73° 16′ 24″ E., 494 metres ; green mud and sand. Agassiz Trawl ; 29 specimens, 36 fragments. 1952.3.25.202–211.

Sta. 176. Gulf of Aden, 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres ; green mud and sand. Agassiz Trawl ; 44 specimens, 13 fragments. 1952.3.25.192–201.

Distribution.—Zanzibar area ; Maldive Islands ; Gulf of Aden ; range 463–732 metres.

Description.—Shell fairly large, solid, moderately thick, creamy-white, opaque, gradually and evenly tapering, strongly curved, smooth except for conspicuously oblique growth striae. Apex small, circular, with a broad V-shaped notch on the ventral side and a small supplementary pipe. Aperture oblique, slightly oval, dorso-ventrally compressed.

Dimensions.—(Specimen Sta. 176.) Length 61, diameter at apex 1, diameter at aperture 4·5, arc 5 mm.

Type Locality.—" Valdivia " Sta. 245, Zanzibar Channel, 463 metres.

Holotype.—Berlin Museum.

Observations.—Although the growth-lines on this and related species are conspicuously striate and oblique, they should, in my opinion, be regarded rather as more precisely defined than usual in *Lævidentalium* and other subgenera of *Dentalium* and not as the typical undulating rather corded striæ of the Palæozoic and early Mesozoic *Plagioglypta*.

Dentalium (*Lævidentalium*) *longitrorsum* Reeve.

Dentalium longitrorsum Reeve, 1842, Conch. Syst. II, p. 6, pl. 130, fig. 6; Reeve, 1842, Proc. Zool. Soc. p. 197; Sowerby, 1860, Thes. Conch. III, p. 98, pl. 3 (Thes. 225), figs. 59, 60; Sowerby, 1872, in Reeve, Conch. Icon. XVIII, pl. 2, figs. 9*a*, *b*; Brazier, 1877, Proc. Linn. Soc. N.S.W. II, p. 59; Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 515; Watson, 1886, Chall. Rep. Zool. XV, p. 9; Cooke, 1885, Ann. Mag. Nat. Hist. ser. 5, XVI, p. 273; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 111; Smith, 1903, Proc. Malac. Soc. V, p. 393; Boissevain, 1906, Siboga Exped. LIV (32), p. 52, pl. 2, figs. 33, 33*a*.
Dentalium lamarckii Chenu, 1843, Ill. Conchyl. p. 5, pl. 6, figs. 15, 15*a*.
Dentalium longirostrum Paetel, 1869, Moll. Syst. Cat. p. 64.

Sta. A. Red Sea, 29° 17′ 00″ N., 32° 43′ 00″ E., 65–68 metres; soft grey mud. Otter Trawl; 1 specimen. 1952.3.25.70.

Distribution.—Philippines; China; Darnley Island, Torres Strait; West of Cape York and South-west of Papua, 46 metres; Bombay; Gulf of Suez; Red Sea; Zanzibar; Durban.

Description.—Shell very long, strongly curved, slender, smooth, shining, thin, solid, white or amber coloured. Sculpture absent, except for slightly oblique growth lines. Apex circular, simple, or with a slight notch on the convex side. Aperture circular, slightly oblique, thin.

Dimensions.—(Holotype.) Length 114, diameter at apex 1, diameter at aperture 5, arc 17 mm.

Type Locality.—Zanzibar.

Holotype.—British Museum No. 1952.3.24.1 (Cuming Collection).

Dentalium (*Lævidentalium*) *leptosceles* (?) Watson. (Fig. 6.)

Dentalium leptosceles Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 513; Watson 1886, Chall. Rep. Zool. XV, p. 7, pl. 1, fig. 6; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 110, pl. 3, figs. 44–46.

Sta. 184. Gulf of Aden, 14° 36′ 06″ N., 51° 00′ 18″ E. to 14° 38′ 42″ N., 50° 57′ 42″ E., 1270 metres; green mud. Agassiz Trawl; 1 specimen. 1952.3.25.132.

Distribution.—South of Australia, 4758 metres; ? Gulf of Aden, 1270 metres.

Description.—Shell very gradually tapering, thin, shining nearly straight, with a slight curvature near the apex, irregularly flecked with white, otherwise translucent to opaque. There is an irregular flexuous longitudinal texture in the shell substance affecting the reflection from the surface. Growth-lines somewhat oblique, crowded, rather irregular. Slightly dorso-ventrally compressed at the apex, subcircular and oblique at the aperture.

Animal yellow, with a large dark patch in the region of the liver. A close little bunch of captacula round the mantle opening.

Dimensions.—Length 38, diameter at apex 0·8, diameter at aperture 3 mm.

Type Locality.—South of Australia, 42° 42′ S., 134° 10′ E. 4758 metres.

Holotype.—British Museum No. 1887.2.9.21.

Observations.—It is almost certain that the John Murray specimen does not belong to this species, although it is doubtfully referred to it for want of more definite information. The one specimen obtained closely resembles in size, almost complete absence of curvature, very gradual tapering and texture the holotype of *D.* (*L.*) *leptosceles*.

Dentalium (*Lævidentalium*) *banale* (?) Boissevain.

Dentalium (Lævidentalium) banale Boissevain, 1906, Siboga Exped. LIV (32), p. 55, pl. 6, fig. 30.

Sta. 184. Gulf of Aden, 14° 36′ 06″ N., 51° 00′ 18″ E. to 14° 38′ 42″ N., 50° 57′ 42″ E., 1270 metres ; green mud. Agassiz Trawl ; 1 specimen, 1952.3.25.71.

DISTRIBUTION.—Timor Sea, 918 metres ; Gulf of Aden, 1270 metres.

DESCRIPTION.—Shell attenuated, evenly and very slightly curved, thin but strong, very gradually tapering. Sculpture absent except for close irregular growth striæ with here and there a deeper incised line. Colour mostly white or bluish-white stained with brown ; shell transparent except for many white opaque patches. Apex simple, without slit or notch, circular, with thick walls. Aperture circular, thin, strong, slightly oblique.

DIMENSIONS.—Length 39, diameter at apex 1, diameter at aperture 2·9 mm.

TYPE LOCALITY.—" Siboga " Sta. 300, Timor Sea, 918 metres.

HOLOTYPE.—Amsterdam.

OBSERVATIONS.—The single specimen from Sta. 184 is somewhat doubtfully referred to this species. The " Siboga " specimens apparently lacked the early part of the shell, which is present in the John Murray specimen. The latter, however, if conspecific, is a young example of the species with the following dimensions : length 37, diameter at apex 0·5, diameter at aperture 1·5 mm. In curvature and other features it conforms to Boissevain's description of the holotype.

Subgenus *Pseudantalis* Monterosato, 1884.

Pseudantalis Monterosato, 1884, Nom. Gen. Spec. alc. Conch. Medit. p. 32.

Type species (subsequent designation Sacco, 1897), *Dentalium rubescens* Deshayes.

Dentalium (*Pseudantalis*) *rubescens* Deshayes.

Dentalium rubescens Deshayes, 1825, Mon. Dentale, p. 363, pl. 16, figs. 23, 24 ; Philippi, 1836, Enum. Moll. Sicil. I, p. 244 ; Philippi, 1844, *id.* II, p. 206 ; d'Orbigny, 1854, Shells Canaries, p. 28 ; Sowerby, 1860, Thes. Conch. III, p. 98, pl. 2 (Thes. 244), fig. 39 ; Aradas, 1870, Conch. Mar. Sicil. p. 117 ; Jeffreys, 1882, Proc. Zool. Soc. p. 660 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 105, pl. 19, fig. 2.

Dentalium rufescens Deshayes. Weinkauff, 1868, Conch. Mittelm. II, p. 420 ; Clessin, 1896, Conch. Cab. p. 8, pl. 3, fig. 7.

Dentalium splendens Costa, 1829, Cat. rag. Test. Sic. p. 125.

Pseudantalis rubescens Deshayes. Monterosato, 1884, Nom. Gen. Spec. Conch. Medit. p. 32.

Sta. 103. Zanzibar area, 5° 39′ 30″ S., 39° 11′ 30″ E., 101 metres ; coarse sand and shells. Petersen Grab ; 2 specimens. 1952.3.25.229–230.

DISTRIBUTION.—Mediterranean Sea, 4–73 metres ; Canary Is. ; Indian Ocean, 101 metres.

DESCRIPTION.—Shell slender, gradually tapering, rather thin, generally semi-transparent, moderately arcuate, more strongly curved in the posterior one-third. Colour generally white, anteriorly shading to deep flesh-colour posteriorly. Surface smooth, shining, with only faintly indicated growth-lines. Aperture circular, moderately oblique, peristome thin and acute ; apex circular, small ; on the convex side of the shell in the typical form there is a long internal groove ending in a slight apical notch. The groove is not always present, and it may be partially open. The form in which the groove is completely open is distinguished below under the varietal name *tenuifissum.*

Type Locality.—Mediterranean Sea.

Syntypes.—École de Mines, Paris.

Observations.—Indian Ocean specimens seem specifically identical with those from the Mediterranean. The long internal groove, which shows clearly through the transparency of the shell and which is completely open in the form of a long groove in the variety *tenuifissum,* distinguishes this species from species of the subgenus *Lævidentalium,* in which it is sometimes placed. The grooved, slit, and unslit varieties almost always occur together and appear to intergrade.

Dentalium (*Pseudantalis*) *rubescens* Deshayes var. *tenuifissum* (Monterosato). (Fig. 9.)

Dentalium fissura Philippi, 1836, Enum Moll. Sicil. I, p. 244 (*non* Lamarck).
Pseudantalis tenuifissa Monterosato, 1884, Nom. Gen. Spec. Conch. Medit. p. 33.
Dentalium rubescens Deshayes var. ? *tenuifissum* Monterosato. Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 106, pl. 19, figs. 16, 17.
Dentalium tenuifissum Monterosato. Boissevain, 1906, Siboga Exped. LIV (32), p. 59, pl. 6, figs. 18, 19.

Sta. 73. Gulf of Oman, 25° 28′ 48″ N., 56° 35′ 54″ E., 91 metres ; green mud, sand and shells. Petersen Grab ; 2 specimens. 1952.3.25.135–136.

Sta. 103. Zanzibar area, 5° 39′ 30″ S., 39° 11′ 30″ E., 101 metres ; coarse sand and shells. Petersen Grab ; 2 specimens. 1952.3.25.232–233.

Distribution.—Mediterranean Sea ; Gulf of Oman, 45 metres ; Zanzibar area, 101 metres ; Madura Bay and Molo Strait, East Indies, 69–91 metres.

Description.—As for *rubescens,* but with a long, linear apical slit on the convex side.

Type Locality.—Mediterranean Sea.

Observations.—Both the variety and the typical form of the species appear to be widely distributed from the Mediterranean to the East Indies.

Subgenus *Compressidens.*

Compressidens Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 123.

Type species (original designation) *D. pressum* Pilsbry & Sharp.

Dentalium (*Compressidens*) *comprimatum* Plate.

Dentalium (*Compressidens*) *comprimatum* Plate, 1908. Tiefsee Exped. IX (3), p. 349, pl. 30, figs. 26–34.

Sta. 105B. Zanzibar area, 5° 34′ 24″ S., 39° 14′ 06″ E. to 5° 37′ 00″ S., 39° 14′ 36″ E., 238–293 metres ; green mud. Agassiz Trawl ; 2 specimens. 1952.3.25.72 & 235.

Distribution.—Zanzibar area, 238–463 metres.

Description.—Shell short, fairly rapidly tapering, moderately curved, apex narrow, fairly thick, solid, white, opaque. Dorso-ventrally compressed, the ventral face flatly convex, flattened in the middle, dorsal face subangulate in the middle, roundly convex. Dorsal and ventral faces meeting at a fairly low angle. Whole surface of shell sculptured with numerous fine, longitudinal riblets which are wider than the interspaces. Particularly near the apex, the longitudinal sculpture is crossed and faintly reticulated by microscopic fine growth striæ. Apex flatly angularly ovate. aperture subovate, oblique, peristome thin.

Dimensions.—(Specimen Sta. 105.) Length 21·5. diameter at apex lateral 1. dorso-ventral 0·8. diameter at aperture lateral 3. dorso-ventral 2·5. arc 1·8 mm.

Type Locality.—" Valdivia " Sta. 245, Zanzibar Channel, 463 metres.

Holotype.—Berlin Museum.

Observations.—The two specimens appear to be more angulate laterally than those described by Plate, but they otherwise conform to the original description.

Subgenus *Episiphon* Pilsbry & Sharp, 1897.

Episiphon Pilsbry & Sharp. 1897, Man. Conch. XVII. p. 117.

Type species (subsequent designation Suter. 1913). *Dentalium sowerbyi* Guilding.

Dentalium (*Episiphon*) *sewelli* sp. nov. (Fig. 10.)

Dentalium subrectum Linné. Boissevain, 1906, Siboga Exped. LIV (32), p. 47. pl. 6. figs. 46–50.

Sta. 75. Gulf of Oman. 25° 10′ 48″ N., 56° 47′ 30″ E. to 25° 09′ 48″ N., 56° 47′ 30″ E., 201 metres ; green mud. Petersen Grab ; 7 specimens. 1952.3.25.125 & 244–250.

Sta. 103. Zanzibar area, 5° 39′ 30″ S., 39° 11′ 30″ E., 101 metres ; coarse sand and shells. Petersen Grab ; 1 specimen. 1952.3.25.243.

Sta. 188. Gulf of Aden, 13° 43′ 18″ N., 47° 56′ 54″ E. to 13° 46′ 00″ N., 47° 50′ 42″ E., 528 metres ; green mud. Agassiz Trawl ; 5 specimens. 1952.3.25.236–242.

Sta. M.B. II (c). Hadramaut Coast. 17° 33′ 30″ N., 56° 01′ 30″ E., 29 metres ; coarse sand. Rectangular Dredge ; 1 specimen. 1952.3.25.73.

Distribution.—Gulf of Oman, 201 metres, 285 metres (Winckworth Collection, from the dredgings made by F. W. Townsend) ; Zanzibar area, 101 metres ; Gulf of Aden, 528 metres ; South Arabian Coast, 29 metres ; Persian Gulf (F. W. Townsend Collection) ; Suez (B.M. 1914.1.8.181–200).

Description.—Shell thin, transparent. acicular, narrow, moderately curved, attenuated towards the apex, increasing to a moderate diameter at the aperture. Colour white to a very delicate salmon tint. Apex very small, circular, with a broad V-shaped notch and supplementary pipe ; aperture circular.

Dimensions.—(Holotype.) Length 24, diameter at apex 0·5, diameter at aperture 2·1 mm.

Type Locality.—Sta. 75. Gulf of Oman, 201 metres.

Holotype.—British Museum No. 1952.3.25.125.

Observations.—This is a more strongly curved and considerably more finely tapering shell than *D. subrectum* Jeffreys, which is probably the shell known also as *D. attenuatum* Sowerby (*non* Say). It appears from the description and figures to be identical with the " Siboga " Expedition species identified as *D. subrectum* Linné (? *err. pro* Jeffreys). The curvature is slightly variable, but the shell is never so nearly straight or so slightly tapering as *D. subrectum*. It is named in honour of the leader of the Expedition, Lieutenant-Colonel R. B. Seymour Sewell, C.I.E., F.R.S.

Dentalium (*Episiphon*) *minutissimum* sp. nov. (Fig. 11.)

Sta. 147. Maldive area, 4° 53′ 12″ N., 72° 54′ 30″ E., 27 metres ; soft cream mud. Petersen Grab ; 17 specimens, 2 fragments. 1952.3.25.113–123.

Distribution.—Maldive Island, 27 metres.

Description.—Shell minute, fragile, white, smooth, transparent, with a moderate curvature. Apex very small, circular ; aperture circular.

Dimensions.—Length 6·7, diameter at apex 0·2, diameter at aperture 0·6 mm.

Type Locality.—Sta. 147, Maldive area, 27 metres.

Holotype.—British Museum No. 1952.3.25.123.

Observations.—These are very small acicular shells which do not appear to be juveniles of either *subrectum* or the deeper water *sewelli*. The size of the 17 examples from shallow water is uniform.

Dentalium (*Episiphon*) *subrectum* Jeffreys.

Dentalium subrectum Jeffreys, 1882, Proc. Zool. Soc. p. 661 ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 119, pl. 18, fig. 5.

Sta. 67. Gulf of Oman, 23° 41′ 48″ N., 58° 36′ 00″ E., 274 metres ; soft green mud and stones. Triangular Dredge 4 ; 5 specimens, 3 fragments. 1952.3.25.78–82.

Sta. M.B. II (c). Hadramaut Coast, 17° 33′ 30″ N., 56° 01′ 30″ E., 29 metres ; coarse sand. Rectangular Dredge ; 4 specimens. 1952.3.25.74–77.

Distribution.—Philippines ; Hadramaut Coast, 29 metres ; Gulf of Oman, 291 metres.

Description.—Shell acicular or needle-shaped, thin, extremely slender, tapering almost to a point, nearly straight, translucent whitish, with a very faint reddish tint from the middle to the apex. Surface smooth, glossy, with faint growth striæ only. Apex minute, circular, with thin, entire adge ; aperture circular, not oblique.

Dimensions.—Length 16, diameter of aperture 1 mm.

Type Locality.—Philippines.

Holotype.—U.S. National Museum.

Subgenus *Gadilina* Foresti, 1895.

Gadilina Foresti, 1895, Bull. Soc. Malac. Ital. XIX, p. 259.

Type species (monotypy). *Dentalium triquetrum* Brocchi.

Dentalium (*Gadilina*) *insolitum* Smith.

Dentalium insolitum Smith, 1894, Ann. Mag. Nat. Hist. ser. 6, XIV, p. 168, pl. 4, figs. 17, 17*a* ; Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 109, pl. 22. figs. 56, 57 ; Smith, 1906, Ann. Mag. Nat. Hist. ser. 7, XVIII, p. 250.

Dentalium (*Gadilina*) *insolitum* Smith. Boissevain, 1906, Siboga Exped. LIV (32), p. 49, pl. 5, fig. 15, pl. 6, figs. 80, 82, 84; Plate, 1908, Tiefsee Exped., IX (3), p. 353, pl. 30, figs. 50, 51 ; Jaeckel, 1932, Tiefsee Exped. XXI (2), p. 306.

Sta. 34. Gulf of Aden. 13° 05′ 36″ N., 46° 24′ 42″ E., 1022 metres ; green mud. Agassiz Trawl ; 11 specimens, 1952.3.25.83–93.

Sta. 143. Maldive area. 5° 15′ 48″ N., 73° 22′ 48″ E. to 5° 13′ 42″ N., 73° 23′ 36″ E., 797 metres ; green sand. Agassiz Trawl ; 1 specimen. 1952.3.25.220.

Sta. 184. Gulf of Aden. 14° 36′ 06″ N., 51° 00′ 18″ E. to 14° 38′ 42″ N., 50° 57′ 42″ E., 1270 metres; green mud. Agassiz Trawl: 5 specimens, 2 fragments. 1952.3.25.94–98 and 221.

DISTRIBUTION.—Bay of Bengal, 1092 metres; North of Ceylon, 911–1328 metres; Flores Sea, 794 metres; E. Sumba Sea, 959 metres; E. African Coast N. of Equador, 1134 metres; Maldive area, 797 metres; Gulf of Aden, 1022–1270 metres.

DESCRIPTION.—Shell smooth, rather small, slender, rather strongly curved, finely tapering towards the apex, subtrigonal in section. Shell flattened on the dorsal or concave curve, laterally compressed and fairly steeply arched on the ventral or convex curve. Concave side defined by lateral angles, rather sharp near the apex but becoming more rounded toward the aperture. Shell transparent in the live state, white and porcellaneous when dead. Apex with a wide shallow notch and generally a supplementary tube; section at apex shows shell-wall to be thickened on the concave margin; ventral wall thin. Aperture subtrigonal, corners rounded.

DIMENSIONS.—Length 36, diameter at apex 0·5 diameter at aperture 2·5 mm.

TYPE LOCALITY.—Bay of Bengal, 1092 metres.

HOLOTYPE.—British Museum No. 1894.9.11.9.

Dentalium (*Gadilina*) *stapes* Boissevain.

Dentalium (*Gadilina*) *stapes* Boissevain, 1906, Siboga Exped. LIV (32), p. 50, pl. 5, figs. 16–20, pl. 6, figs. 79, 81, 83.

Sta. 108. Zanzibar area, 5° 18′ 06″ S., 39° 24′ 12″ E. to 5° 14′ 30″ S., 39° 25′ 36″ E., 786 metres; grey mud. Agassiz Trawl: 1 specimen. 1952.3.25.99.

DISTRIBUTION.—Banda Sea, 462 metres; Zanzibar area, 786 metres.

DESCRIPTION.—Shell rather large, smooth except for growth striæ, rather strongly curved, finely tapering, subtriangular in section, sharply arched and laterally compressed on the ventral or convex side, flattened on the concave side. Lateral walls on the convex side flat, wall on the concave side faintly convex in section. Concave side defined by sharp lateral angles which become rounded towards the aperture. Apex very attenuated, slightly notched, sometimes with a supplementary tube; aperture roundly trigonal, the concave side being indicated by the flatly convex base of the triangle.

DIMENSIONS.—Length 50, diameter at apex 0·5, lateral diameter at aperture 3 mm.

TYPE LOCALITY.—Banda Sea, 462 metres.

SYNTYPES.—Amsterdam.

Subgenus *Graptacme* Pilsbry & Sharp, 1897.

Graptacme Pilsbry & Sharp, 1897, Man. Conch. XVII, p. 85.

Type species (subsequent designation, Woodring, 1925) *Dentalium eboreum* Conrad.

Dentalium (*Graptacme*) *acutissimum* Watson.

Dentalium acutissimum Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 514; Watson, 1886, Chall. Rep. Zool. XV, p. 8, pl. 1, fig. 8; Pilsbry & Sharp, 1897, Man. Conch. XVII, 94, pl. 20, fig. 26; Boissevain, 1906, "Siboga" Exped. LIV (32), p. 45, pl. 2, fig. 39, pl. 5, figs. 9–12.

Dentalium (*Graptacme*) *acutissimum* Watson. Plate, 1908, Tiefsee-Exped. IX, (3), p. 351.

Sta. 119. Zanzibar area, 6° 29′ 24″ S., 39° 49′ 54″ E. to 6° 32′ 00″ S., 39° 53′ 30″ E., 1207–1463 metres. Agassiz Trawl; 12 specimens. 1952.3.25.100–111.

DISTRIBUTION.—N. of Papua, 1958 metres; mid-Pacific E. of Japan, 3749 metres; Celebes Sea, 1301 metres; Banda Sea, 1158 metres; Timor Sea, 918 metres; off Kenya Coast, 1668 metres; Zanzibar area, 1207–1463 metres.

DESCRIPTION.—Shell of moderate size, slender, slowly tapering, gently and gradually curved, thin, glossy, white, transparent in the live shell to opaque in the dead shell. Surface sculptured near the apex with frequent fine longitudinal striæ which disappear about 15 mm. from the apex and are obsolete over the rest of the shell. Surface also transversely very finely striated by oblique growth lines. Apex small, circular, with a deep broad slit; aperture round, oblique, margin thin.

DIMENSIONS.—(Holotype.) Length 38, diameter at apex 0·7, diameter at aperture 3, arc 1·5 mm.

TYPE LOCALITY.—N. of Papua, 1959 metres.

HOLOTYPE.—British Museum No. 1887.2.9.31.

Dentalium (*Graptacme*) *elpis* Winckworth.

Dentalium elpis Winckworth, 1927, Proc. Malac. Soc. XVII (4), p. 168, pl. 14, figs. 6, 7.

Sta. 53. Hadramaut Coast. 19° 22′ 36″ N., 57° 53′ 00″ E., 13·5 metres; rock, shingle, shells, lithothamnion. Triangular Dredge 4; 1 specimen. 1952.3.25.112.

? Sta. 142B. Maldive area, 5° 23′ 12″ N., 73° 37′ 06″ E., 37 metres; cream mud. Petersen Grab; 3 juveniles doubtfully belonging to the species. 1952.3.25.222–225.

? Sta. 149. Maldive area. 4° 49′ 30″ N., 72° 51′ 06″ E., 238 metres; coral rock, lithothamnion. Petersen Grab; 1 juvenile doubtfully belonging to the species. 1952.3.25.226.

DISTRIBUTION.—Mannar Island, Ceylon, 5·5 metres; Hadramaut Coast, 13·5 metres; ? Maldive area, 37 metres, 238 metres.

DESCRIPTION.—Shell small, moderately slender, thin, rather blunt at the apex, very gently curved, white except for reddish-brown stain at apex, opaque to translucent posteriorly, transparent anteriorly. Sculptured in posterior half with about 20 very fine, equal, raised and rounded riblets separated by narrow interspaces; anterior half smooth, shining, microscopically sculptured with faint growth striæ. Apex truncated somewhat, circular, with a short triangular notch on the convex side and supplementary pipe. Aperture circular, slightly oblique, peristome thin.

DIMENSIONS.—(Holotype.) Length 26, diameter at apex 0·8, diameter at aperture 2, arc 2 mm.

TYPE LOCALITY.—West side of Mannar Island, Ceylon, 5·5 metres; inside reef.

HOLOTYPE.—British Museum No. 1952.3.21.13.

Family SIPHONODENTALIIDÆ.

Genus *Entalina* Monterosato, 1872.

Entalina Monterosato, 1872, Not. int. Conch. Foss. Pell. Fic. p. 27.

Type species (original designation) *Dentalium quinquangulare* Forbes. (= *Eudentalium* Cotton & Godfrey, 1933, S. Aust. Nat. XIV (4), p. 140).

Entalina mirifica (Smith). (Fig. 15.)

Dentalium mirificum Smith. 1895. Ann. Mag. Nat. Hist. ser. 6. XVI. p. 9. pl. 2. fig. 1.
Entalina mirifica Smith. Pilsbry & Sharp, 1897, Tryon's Man. Conch. XVII. p. 134, pl. 20. fig. 29; Boissevain, 1906, Siboga Exped. LIV (32), p. 62, pl. 2, fig. 37.

Sta. 109. Zanzibar area. 5° 10′ 36″ S., 39° 33′ 48″ E., 640 metres; light grey mud. Agassiz Trawl; 2 specimens. 1952.3.25.3–4.

Sta. 119. Zanzibar area. 6° 29′ 24″ S., 39° 49′ 54″ E. to 6° 32′ 00″ S., 39° 53′ 30″ E., 1207–1463 metres; globigerina ooze. Agassiz Trawl; 2 specimens. 1952.3.25.1–2.

Sta. 176. Gulf of Aden. 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres; green mud and sand. Agassiz Trawl; 31 specimens. 1952.3.25.322–331.

Sta. 180. Gulf of Aden, 12° 03′ 24″ N., 50° 40′ 12″ E., 397 metres; green mud and sand. Petersen Grab; 34 specimens. 1952.3.25.332–341.

Sta. 184. Gulf of Aden, 14° 36′ 06″ N., 51° 00′ 18″ E. to 14° 38′ 42″ N., 50° 57′ 42″ E., 1270 metres; green mud. Agassiz Trawl; 1 eroded specimen. 1952.3.25.321.

Sta. 188. Gulf of Aden. 13° 43′ 18″ N., 47° 56′ 54″ E. to 13° 46′ 00″ N., 47° 50′ 42″ E., 528 metres; green mud. Agassiz Trawl; 10 specimens. 1952.3.25.309–318.

Sta. 191. Gulf of Aden. 13° 46′ 30″ N., 47° 48′ 54″ E., 274 metres; green sand and mud. Petersen Grab; 43 specimens and fragments. 1952.3.25.299–308.

Sta. 204. Red Sea. 13° 41′ 24″ N., 42° 31′ 30″ E. to 13° 42′ 30″ N., 42° 31′ 12″ E., 110 metres; green mud and rock. Petersen Grab; 2 specimens. 1952.3.25.319–320.

Distribution. Off Trincomalee, Ceylon. 183–640 metres; Red Sea, 110 metres; Gulf of Aden, 274–1270 metres; Zanzibar area, 640–1463 metres.

Description.—Shell fairly large for the genus, solid, quadrate-tubular, rapidly tapering in the posterior one-third, very strongly curved towards the apex; angles becoming obsolete toward the aperture. Dorsal or inner face wider than ventral and lateral faces; ventral face convex, dorsal and lateral faces concave between the angles. Shell sculptured all over with fine longitudinal riblets, about 10 on each face between the angles. Medial riblet on the dorsal face conspicuously raised toward the apex where it produces a secondary fifth angulation. Apex pentagonal in section; section at aperture ⌂-shaped, arched ventrally, with a broad, almost flat base on the dorsal face.

Dimensions.—Specimen Sta. 176. Length 17, diameter at apex 0·5, diameter at aperture 2, arc 3 mm.

Type Locality.—Off Trincomalee, Ceylon, 183–640 metres.

Holotype.—British Museum No. 1895.7.2.26.

Entalina inaequisculpta sp. nov. (Fig. 16.)

? *Entalina platamodes* Watson. Boissevain, 1906, Siboga Exped. LIV (32), p. 61, pl. 6, figs. 76–78.

Sta. 185. Gulf of Aden, 13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E., 2000 metres; green mud. Agassiz Trawl; 15 specimens. 1952.3.25.5–19.

Distribution.—Sta. 185, Gulf of Aden, 2000 metres; ? Celebes Sea, 1301 metres; ? Ceram Sea, 835 metres; ? Banda Sea, 1158–2198 metres.

Description.—Shell white, translucent, shining, thin, but solid, strongly curved, fairly regularly tapering, pentagonal near the apex, quadrangular towards the aperture, strongly keeled at the angles. Ventral and lateral faces narrow, flat to concave, relatively smooth, dorsal face wide, longitudinally conspicuously ribbed. On each keel there are

3 narrow riblets; the ventral and lateral faces are unsculptured except for very fine, transverse growth striæ; on the dorsal face the sculpture is similar to and continuous with that on the dorso-lateral keels, and consists of about 12 primary and several secondary riblets which rise by intercalation. On the posterior part of the dorsal face there is a secondary median keel which gives a pentagonal section near the apex; keel becomes obsolete anteriorly where the fifth angle disappears. Apex simple, roundly pentagonal, aperture oblique, quadrangular, with the section of the primary and secondary ribs sculpturing the margin.

Dimensions.—(Holotype.) Length 21, diameter at apex 0·3, lateral diameter at aperture 2·2, dorso-ventral diameter at aperture 2 mm.

Type Locality.—Sta. 185, Gulf of Aden, 2000 metres.

Holotype.—British Museum No. 1952.3.25.5.

Observations.—This species is very close to *E. quadrangularis* Boissevain, which is a wider shell towards the aperture, sculptured on all sides with fine longitudinal ribs. The relative absence of sculpture on the ventral and lateral faces is striking in *E. inæquisculpta*. It also appears to be less concave on the lateral faces than does *E. quadrangularis*. The shell identified by Boissevain as *E. platamodes* Watson from the West Indies is probably this species. It has some points of resemblance to *E. platamodes*, which is a smaller, more solid, and less regular shell lacking the characteristic sculpture on the angles and on the concave face.

Entalina adenensis sp. nov. (Fig. 17.)

Sta. 185. Gulf of Aden, 13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E., 2000 metres; green mud. Agassiz Trawl; 2 specimens. 1952.3.25.20–21.

Distribution.—Gulf of Aden, 2000 metres.

Description.—Shell fairly large, markedly polygonal, strongly curved, thin but solid, white, glossy, smooth, fairly regularly tapering. Hexagonal, strongly keeled at the angles. Ventral or convex side with two relatively narrow concave faces; lateral faces concave and moderately broad, dorsal or concave side with two broad concave faces. Faces smooth and glossy, crossed by fine, frequent growth striæ. Longitudinal sculpture absent. The angle in the middle of the concave face is much more produced and downwardly curved anteriorly, giving to the aperture a very characteristic shape.

Dimensions.—(Holotype.) Length 15, diameter at apex 0·5, diameter at aperture dorso-ventral 2, lateral 1·5 mm.

Type Locality.—Gulf of Aden, 2000 metres.

Holotype.—British Museum No. 1952.3.25.20.

Genus *Cadulus* Philippi, 1844.

Cadulus Philippi, 1844, Enum. Moll. Sicil. II, p. 209.

Type species (monotypy), *Dentalium ovulum* Philippi.

Subgenus *Cadulus* s. str.

Cadulus (*Cadulus*) *cyathoides* Jaeckel. (Fig. 12.)

Cadulus cyathoides Jaeckel, 1932, Tiefsee Exped. XXI (2), p. 308, text fig. 5.

Sta. 176. Gulf of Aden, 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres; green mud and sand. Agassiz Trawl; 8 specimens, 1952.3.25.289–297.

Sta. 188. Gulf of Aden, 13° 43′ 18″ N., 47° 56′ 54″ E. to 13° 46′ 00″ N., 47° 50′ 42″ E., 528 metres; green mud. Agassiz Trawl; 6 specimens. 1952.3.25.283–288.

Sta. 191. Gulf of Aden, 13° 46′ 30″ N., 47° 48′ 54″ E., 274 metres: green sand and mud. Petersen Grab; 90 specimens. 1952.3.25.273–282.

Sta. 204. Red Sea, 13° 41′ 24″ N., 42° 31′ 30″ E. to 13° 42′ 30″ N., 42° 31′ 12″ E., 110 metres; green mud and rock. Petersen Grab: 1 specimen. 1952.3.25.367.

Sta. 206. Red Sea, 13° 57′ 30″ N., 42° 35′ 24″ E., 256 metres; green brown sand, mud and rock. Petersen Grab; 1 specimen. 1952.3.25.137.

Distribution.—Sumatra, 750 metres; Red Sea, 110-256 metres; Gulf of Aden, 274–732 metres.

Description.—Shell small, thin, smooth, milk-white or creamy white, moderately obese; greatest circumference at about the middle. Ventral side evenly arcuate with convexity slightly towards the apex; dorsal side abruptly arcuate slightly to the anterior, flattening out at the apex and aperture. Apex oval in section, oblique, with a callous ring within; aperture larger, oblique, oval in section.

Dimensions.—(Specimen Sta. 206.) Length 2·87, greatest diameter 1·4, diameter at apex 0·63, diameter at aperture 0·7 mm.

Type Locality.—"Valdivia" Sta. 191, Sumatra, 750 metres.

Holotype.—Berlin Museum.

Cadulus (*Cadulus*) *campylus* Melvill. (Fig. 13.)

Cadulus campylus Melvill, 1906, Proc. Malac. Soc. VII, p. 80, pl. 8, fig. 32.

Sta. 164. Maldive area, 8° 15′ 24″ N., 73° 01′ 30″ E., 183 metres; green sand. Petersen Grab; 1 specimen. 1952.3.25.145.

Distribution.—Gulf of Oman, 285 metres; Maldive Island, 183 metres.

Description.—Shell small, smooth, glossy, transparent, yellowish-white, slightly curved, elongate cask-shaped. Greatest diameter near the middle of the shell, which appears slightly obtuse-angled on the dorsal face. Ventral curve almost uninterrupted, dorsal curve bulging medially. Apex small, oval, thickened within; aperture large, oval, oblique, dorso-ventrally compressed.

Dimensions.—(Specimen Sta. 164.) Length 2·94, diameter at apex 0·2, diameter at aperture 0·56, greatest diameter 0·84 mm.

Type Locality.—Gulf of Oman, 285 metres.

Holotype.—British Museum No. 1906.10.23.76.

Subgenus *Gadila* Gray, 1847.

Gadila Gray, 1847, Proc. Zool. Soc. p. 159.

Type species (original designation) *Dentalium gadus* Montagu (= *Gadus* Rang, 1829, *non* Linné; *Helonyx* Stimpson, 1865; *Loxoporus* Jeffreys, 1883)

Cadulus (*Gadila*) *anguidens* Melvill & Standen. (Fig. 18.)

Cadulus anguidens Melvill & Standen, 1898, Journ. Conch. IX, p. 32, pl. 1, fig. 6; Pilsbry & Sharp, 1898, Tryon's Man. Conch. XVII, p. 253, pl. 39, fig. 4; Boissevain, 1906, Siboga Exped. LIV (32), p. 74, pl. 3, fig. 50.

Sta. 28. Gulf of Aden, 12° 00′ 00″ N., 50° 38′ 42″ E., 201 metres; coarse green sand, mud, shells. Petersen Grab; 1 specimen. 1952.3.25.344.

Sta. 176. Gulf of Aden, 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres; green mud and sand. Agassiz Trawl; 11 specimens. 1952.3.25.149, 368–377.

Sta. 179B. Gulf of Aden, 12° 02′ 06″ N., 50° 40′ 12″ E., 275 metres; green mud and sand. Petersen Grab; 1 specimen. 1952.3.25.345.

Sta. 180. Gulf of Aden. 12° 03′ 24″ N., 50° 40′ 12″ E., 397 metres; green mud and sand. Petersen Grab; 14 specimens. 1952.3.25.346–355.

Sta. 189. Gulf of Aden, 13° 51′ 30″ N., 47° 49′ 12″ E., 91 metres; green sand and mud. Petersen Grab; 1 specimen. 1952.3.25.378.

Sta. 191. Gulf of Aden, 13° 46′ 30″ N., 47° 48′ 54″ E., 274 metres; green sand and mud. Petersen Grab; 12 specimens. 1952.3.25.356–365.

Sta. 204. Red Sea, 13° 41′ 24″ N., 42° 31′ 30″ E. to 13° 42′ 30″ N., 42° 31′ 12″ E., 110 metres; green mud and rock. Petersen Grab; 1 specimen. 1952.3.25.379.

Distribution.—Red Sea, 110 metres; Gulf of Aden, 91–732 metres; Madras; East Indies (Winckworth Collection).

Description.—Shell small, white, transparent or translucent, smooth, shining, very slender in the posterior half, where it gradually tapers towards the apex. Swollen at the anterior one-third and gradually tapering to the anterior aperture. Ventral edge evenly and gently arcuate, dorsal edge slightly sinuate in conformity with the increase in diameter at the anterior one-third. Apex circular in section, aperture oval, laterally compressed, oblique.

Dimensions.—Length 9, greatest diameter 1·75, diameter at apex 0·49, diameter at aperture 1·19 mm.

Type Locality.—Madras.

Holotype.—Manchester Museum.

Cadulus (*Gadila*) *euloides* Melvill & Standen. (Fig. 19.)

Cadulus euloides Melvill & Standen, 1901, Proc. Zool. Soc. p. 459, pl. 24, fig. 24; Boissevain, 1906, Siboga Exped. LIV (32), p. 70, pl. 3, fig. 52; Jaeckel, 1932, Tiefsee Exped. XXI, (2), p. 310.

Sta. 66. Gulf of Oman, 23° 44′ 24″ N., 58° 40′ 00″ E., 609 metres; soft brown green mud. Triangular Dredge 4; 12 specimens. 1952.3.25.22–31.

Sta. 75. Gulf of Oman, 25° 10′ 48″ N., 56° 47′ 30″ E. to 25° 09′ 48″ N., 56° 47′ 30″ E., 201 metres; green mud. Petersen Grab; 1 specimen. 1952.3.25.148.

Sta. 149. Maldive area, 4° 49′ 30″ N., 72° 51′ 06″ E., 238 metres; coral rock, lithothamnion. Petersen Grab; 6 specimens. 1952.3.25.380–384.

Sta. 190. Gulf of Aden, 13° 49′ 00″ N., 47° 49′ 12″ E., 183 metres; green sand and mud. Petersen Grab; 1 specimen. 1952.3.25.366.

Distribution.—Karachi; Gulf of Oman, 201–609 metres, also 631 metres (F. W. Townsend Collection), 285 metres (Winckworth Collection, from dredgings made by F. W. Townsend); Maldive Island, 238 metres; Gulf of Aden, 183 metres.

Description.—Shell white, glossy, smooth, transparent, thin, gently arcuate, posteriorly attenuated, increasing gradually in diameter to the anterior one-fifth, then slightly tapering to the aperture. Apex circular in section, aperture circular, oblique, margin thin and sharp.

Dimensions.—(Specimen Sta. 75.) Length 11, diameter at apex 0·5, diameter at aperture 1·4, greatest diameter 1·75 mm.

Type Locality.—Karachi.

Holotype.—British Museum No. 1901.12.9.12.

Observations.—As Jaeckel (*l.c.*) has observed, some examples of this species are smaller than typical *euloides*. Except for a smaller apex in certain specimens there appear to be no characters other than that of size to separate them specifically from *euloides* Both small and large examples occur together at 156 fathoms in the Gulf of Oman (Winckworth Collection), and small examples from Sta. 149 have the typical apex.

Cadulus (*Gadila*) *reesi* sp. nov. (Fig. 20.)

Sta. 105B. Zanzibar area. 5° 34′ 24″ S., 39° 14′ 06″ E. to 5° 37′ 00″ S., 39° 14′ 36″ E., 238–293 metres; green mud. Agassiz Trawl; 1 specimen and 5 fragments. 1952.3.25.150 & 390–394.

Sta. 176. Gulf of Aden. 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres; green mud and sand. Agassiz Trawl, 3 specimens. 1952.3.25.385–388.

Sta. 179B. Gulf of Aden. 12° 02′ 06″ N., 50° 40′ 12″ E., 275 metres; green mud and sand. Petersen Grab: 1 specimen. 1952.3.25.389.

Sta. 191. Gulf of Aden. 13° 46′ 30″ N., 47° 48′ 54″ E., 274 metres; green sand and mud. Petersen Grab; 7 specimens. 1952.3.25.395–401.

Distribution.—Zanzibar area, 238–293 metres; Gulf of Aden, 274–732 metres.

Description.—Shell small, short, white, solid, smooth, shining, dorso-ventrally compressed, maximum diameter in the middle, only slightly tapering to the apex, contracting more sharply from the anterior one-quarter to the aperture. Ventral curve uninterrupted though more arcuate anteriorly than posteriorly: dorsal margin almost straight, with a very slight medial bulge. Apex wide, simple, oval, dorso-ventrally compressed; aperture moderate, oval, dorso-ventrally compressed, oblique.

Dimensions.—(Holotype.) Length 6·75, greatest diameter 2·1, diameter at apex 1·4, diameter at aperture, 1·4 mm.

Type Locality.—Sta. 105B. Zanzibar area, 238–293 metres.

Holotype.—British Museum No. 1952.3.25.150.

Observations.—The species here described is most nearly related to *C. platei* Jaeckel from South Africa. It is distinguishable by its shape and greater width at the apex and by the oval section at both apex and aperture. It is named in honour of Dr. W. J. Rees of the British Museum (Natural History).

Cadulus (*Gadila*) *subcolubridens* sp. nov. (Fig. 21.)

Cadulus colubridens Watson. Boissevain, 1906, Siboga Exped., LIV (32), p. 71, pl. 6, fig. 66.

Sta. 185. Gulf of Aden, 13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E., 2000 metres; green mud. Agassiz Trawl; 13 specimens. 1952.3.25.32–44.

Distribution.—Banda Sea, 1886 and 1158 metres; Gulf of Aden, 2000 metres.

Description.—Shell large, semi-opaque, white, solid, smooth, shining, long, slender, fairly strongly curved, dorso-ventrally compressed. Angularly swollen and the anterior one-fourth, thence contracting flatly on the convex side to the aperture and tapering gradually toward the apex. Dorsal curve rather straight in the anterior fourth, ventral curve strong, angulate at the anterior fourth, then flattened to the aperture. Apex small, almost circular, margin thin and easily chipped, so that it is difficult to tell whether the species rightly belongs to *Gadila*; aperture oval, dorso-ventrally compressed, flattened on the ventral face, very oblique.

DIMENSIONS.—(Holotype.) Length 21, greatest diameter 3, diameter at apex 0·8, diameter at aperture lateral 3, dorso-ventral 2 mm.

TYPE LOCALITY.—Sta. 185, Gulf of Aden, 2000 metres.

HOLOTYPE.—British Museum No. 1952.3.25.32.

OBSERVATIONS.—This is apparently the shell identified by Boissevain as *C. colubridens* Watson from the north-east point of New Zealand. Although the resemblance between the two species is very strong, particularly in the position of the greatest diameter, the present species is very much larger, more strongly curved and more gradually tapering in the posterior half. The aperture is more oblique in *subcolubridens*. An immature specimen from Sta. 185 comparable in size with the holotype of *C. colubridens* clearly demonstrates that *colubridens* is not a juvenile of the present species.

Subgenus *Dischides* Jeffreys, 1867.

Dischides Jeffreys, 1867, Ann. Mag. Nat. Hist. ser. 3, XX, p. 251.

Types species (original designation), *Ditrupa polita* S. V. Wood.

Cadulus (*Dischides*) *prionotus* (Watson). (Fig. 24.)

Siphodentalium prionotum Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 522; Watson 1886, Chall. Rep. Zool. XV, p. 16, pl. 2, fig. 9.

Cadulus prionotus Watson. Pilsbry & Sharp, 1898, Man. Conch. XVII, p. 146, pl. 26, fig. 74; Boissevain, 1906, Siboga Exped. LIV (32), p. 66, pl. 3, fig. 47.

Sta. 28. Gulf of Aden, 12° 00′ 00″ N., 50° 38′ 42″ E., 201 metres; coarse grey sand, mud and shells. Petersen Grab; 2 specimens. 1952.3.25.146–147.

DISTRIBUTION.—North-east Australia, 284 metres; Port Blair (Winckworth Collection); Gulf of Aden, 201 metres; Misamis, I of Mindanao.

DESCRIPTION.—Shell small, white, smooth, shining, pellucid, gently curved, with maximum curvature in the posterior half. Very gradually tapering from apex to about 1 mm. above the aperture and then slightly tapering to the aperture. Apex circular, cut into two lobes by two narrow lateral slits; aperture oval, dorso-ventrally compressed, oblique.

DIMENSIONS.—(Specimen Sta. 28.) Length 6·3, greatest diameter 1, diameter at apex 0·4, diameter at aperture 0·8 mm.

TYPE LOCALITY.—Raine Island, Cape York, N.E. Australia, 284 metres.

HOLOTYPE.—British Museum No. 1887.2.9.67.

OBSERVATIONS.—This species is very close to *C. viperidens* Melvill & Standen, from which it differs in being narrower posteriorly. The Deshayes manuscript name *acuminatum* (*non Cadulus acuminatus* Tate) applies to this species, represented in the Cuming Collection (British Museum) by 5 specimens from Mindanao.

Cadulus (*Dischides*) *ovalis* Boissevain. (Fig. 23.)

Cadulus ovalis Boissevain, 1906, Siboga Exped. LIV (32), p. 66, pl. 6, fig. 52.

Sta. 103. Zanzibar area, 5° 39′ 30″ S., 39° 11′ 30″ E., 101 metres ; coarse sand and shells. Petersen Grab ; 2 specimens. 1952.3.25.140–142.

DISTRIBUTION.—Madura Bay, 69–91 metres ; Zanzibar area, 101 metres.

DESCRIPTION.—Shell thin, transparent, glossy, smooth, moderately curved, increasing gradually in diameter from the apex to the anterior one-fourth, then slightly contracting to the aperture. Ventral curve uninterrupted, dorsal curve with a slight bulge at the anterior one-fourth. Apex small, slightly dorso-ventrally compressed ; aperture ovate, dorso-ventrally compressed, oblique.

DIMENSIONS.—Length 9 mm., dorso-ventral diameter of aperture 0·8 mm.

TYPE LOCALITY.—" Siboga " Sta. 51, Madura Bay, East Indies, 69–91 metres.

HOLOTYPE.—Amsterdam.

Cadulus (*Dischides*) *dichelus* (Watson). (Fig. 22.)

Siphodentalium dichelum Watson, 1879, Journ. Linn. Soc. Lond. XIV, p. 521 : Watson 1886, Chall. Rep., Zool. XV, p. 15, pl. 2, fig. 7.

Cadulus dichelus (Watson) Pilsbry & Sharp, 1898, Man. Conch. XVII, p. 145, pl. 26, fig. 73 ; Boissevain, 1906, Siboga Exped. LIV (32), p. 65, pl. 3, fig. 48, pl. 6, fig. 51.

Sta. 33. Gulf of Aden, 13° 41′ 00″ N., 48° 17′ 00″ E. to 13° 40′ 00″ N., 48° 19′ 00″ E., 1295 metres ; green mud. Agassiz Trawl ; 1 specimen. 1952.3.25.298.

Sta. 43. Hadramaut Coast, 17° 29′ 00″ N., 55° 47′ 00″ E., 83–100 metres. Otter Trawl ; 1 specimen. 1952.3.25.45.

Sta. 105B. Zanzibar area, 5° 34′ 24″ S., 39° 14′ 06″ E. to 5° 37′ 00″ S., 39° 14′ 36″ E., 238–293 metres ; green mud. Agassiz Trawl ; 2 specimens. 1952.3.25.143–144.

DISTRIBUTION.—Levuka, Fiji, 22 metres ; Samau Strait ; Zanzibar 238–293 metres ; Gulf of Aden, 1295 metres ; Hadramaut Coast, 83–100 metres.

DESCRIPTION.—Shell fairly long, of moderate size, very gently curved, narrowly tapering posteriorly, swollen in the anterior three-fifths with maximum diameter at about the anterior one-third, then slightly narrowing to the aperture. Ventral curve uninterrupted, although curvature slightly greater near to the aperture ; dorsal curve gently bulging in the anterior three-fifths. Apex narrow, oval, with two deep narrow lateral slits, aperture oval, oblique.

DIMENSIONS.—Length 8·5, greatest diameter 1·54, diameter at apex 0·5, diameter at aperture 0·7 mm.

TYPE LOCALITY.—Levuka, Fiji, 22 metres.

HOLOTYPE.—British Museum No. 1887.2.9.65.

Subgenus *Polyschides* Pilsbry & Sharp, 1897.

Polyschides Pilsbry & Sharp, 1897, Man. Conch. XVII, pp. 142, 146.

Type species (original designation) *Cadulus tetraschistus* Watson.

Cadulus (*Polyschides*) *hexaschistus* Boissevain. (Fig. 14.)

Cadulus (*Polyschides*) *hexaschistus* Boissevain, 1906, Siboga Exped. LIV (32), p. 67, pl. 6, fig. 53.

Sta. 176. Gulf of Aden, 12° 04′ 06″ N., 50° 38′ 36″ E., 655–732 metres; green mud and sand. Agassiz Trawl; 2 specimens. 1952.3.25.342–343.

Sta. 188. Gulf of Aden, 13° 46′ 00″ N., 47° 50′ 42″ E., 528 metres; green mud. Agassiz Trawl; 2 specimens. 1952.3.25.138–139.

DISTRIBUTION.—Ceram Sea, 835 metres; Gulf of Aden, 528–732 metres.

DESCRIPTION.—Shell large, white, solid, slender, very gradually tapering, smooth, shining, translucent, moderately curved. Maximum diameter at about the anterior one-fourth, whence it very gradually tapers posteriorly and narrows slightly anteriorly towards the aperture, where it is slightly flattened on the convex curve. Tumidity scarcely visible on the concave curve, stronger on the convex curve. Apex slightly dorso-ventrally compressed, with three pairs of slits, two on each side of the ventral or convex curve and one on the side of the concave curve, dividing the apex into six lobes, of which the one on the concave face is largest and short. Aperture slightly oblique, subovate.

DIMENSIONS.—Length 22, diameter of apex lateral 1, dorso-ventral 0·8, diameter of aperture lateral 2·6, dorso-ventral 2·2 mm.

TYPE LOCALITY.—Ceram Sea, 835 metres.

HOLOTYPE.—Amsterdam.

OBSERVATIONS.—All four specimens from the Gulf of Aden are broken at the apex, so that confirmation of the species is not completely possible. In shape, size and general characters they agree with Boissevain's description and figure.

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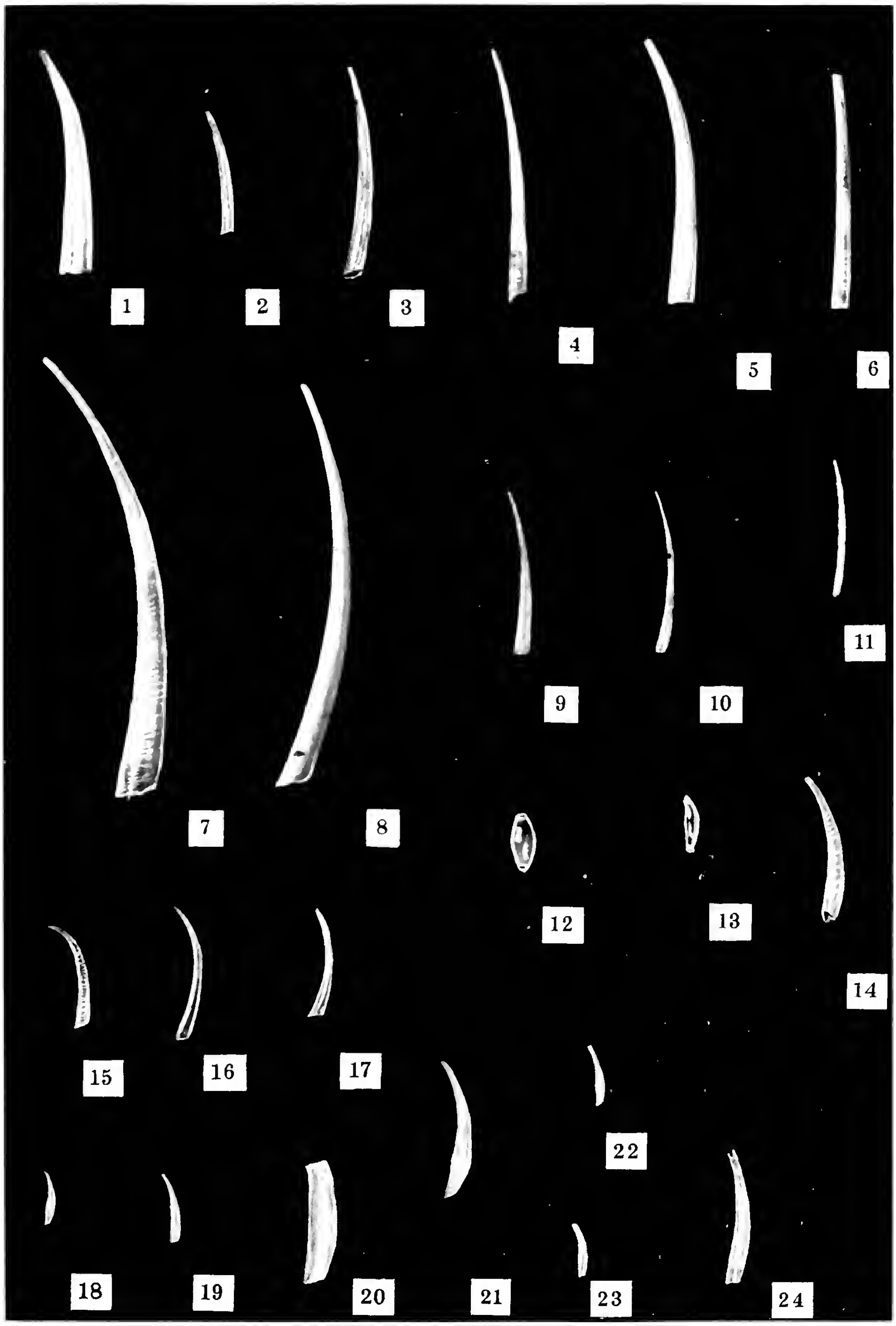
EXPLANATION OF PLATE.

FIG. 1.—*Dentalium* (*Dentalium*) *octangulatum* Donovan, Sta. 80. × 1.
FIG. 2.—*Dentalium* (*Dentalium*) *adenense* sp. nov., holotype, Sta. 28. × 2.
FIG. 3.—*Dentalium* (*Dentalium*) *pseudosexagonum* Deshayes, Sta. 191. × 1.
FIG. 4.—*Dentalium* (*Antalis*) *usitatum* Smith, Sta. 158. × 1.
FIG. 5.—*Dentalium* (*Tesseracme*) *quadrapicale* Sowerby, Sta. 72. × 1.
FIG. 6.—*Dentalium* (*Lævidentalium*) *leptosceles* (?) Watson, Sta. 184. × 1.
FIG. 7.—*Dentalium* (*Fissidentalium*) *perinvolutum* sp. nov., holotype, Sta. 185. × 1.
FIG. 8.—*Dentalium* (*Lævidentalium*) *curvotracheatum* Plate, Sta. 176. × 1.
FIG. 9.—*Dentalium* (*Pseudantalis*) *rubescens* var. *tenuifissum* Monterosato, Sta. 73. × 1.
FIG. 10.—*Dentalium* (*Episiphon*) *sewelli* sp. nov., holotype, Sta. 75. × 1.
FIG. 11.—*Dentalium* (*Episiphon*) *minutissimum* sp. nov., holotype, Sta. 147. × 3.
FIG. 12.—*Cadulus* (*Cadulus*) *cyathoides* Jaeckel, Sta. 206. × 3.
FIG. 13.—*Cadulus* (*Cadulus*) *campylus* Melvill, Sta. 164. × 3.
FIG. 14.—*Cadulus* (*Polyschides*) *hexaschistus* Boissevain, Sta. 188. × 1.
FIG. 15.—*Entalina mirifica* Smith, Sta. 176. × 1.
FIG. 16.—*Entalina inæquisculpta* sp. nov., holotype, Sta. 185. × 1.
FIG. 17.—*Entalina adenensis* sp. nov., holotype, Sta. 185. × 1.
FIG. 18.—*Cadulus* (*Gadila*) *anguidens* Melvill & Standen, Sta. 176. × 1.
FIG. 19.—*Cadulus* (*Gadila*) *euloides* Melvill & Standen, Sta. 75. × 1.
FIG. 20.—*Cadulus* (*Gadila*) *reesi* sp. nov., holotype, Sta. 105. × 3.
FIG. 21.—*Cadulus* (*Gadila*) *subcolubridens* sp. nov., holotype, Stat. 185. × 1.
FIG. 22.—*Cadulus* (*Dischides*) *dichelus* Watson, Sta. 105. × 1.
FIG. 23.—*Cadulus* (*Dischides*) *ovalis* Boissevain, Sta. 103. × 1.
FIG. 24.—*Cadulus* (*Dischides*) *prionotus* Watson, Sta. 28. × 3.



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THE JOHN MURRAY EXPEDITION 1933–34

SCIENTIFIC REPORTS

VOLUME X, No. 3

CEPHALOCHORDATA

BY

J. E. WEBB, D.Sc., Ph.D.(Lond.)

WITH ONE TABLE AND TWO TEXT-FIGURES

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(*Department of Zoology, University College, Ibadan.*)

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INTRODUCTION.

THE Cephalochordata taken by the "John Murray" Expedition consist of specimens of *Branchiostoma* from two localities in the Arabian Sea near Ras al Hadd at the entrance to the Gulf of Oman. The paucity of this collection, however, may not be due to rarity of animals of this group in the Arabian Sea and Indian Ocean, but rather to the comparatively few localities with shallow water and a sandy bottom dredged with suitable apparatus. It is to be expected that extremely local aggregations of *Branchiostoma* would be found in the shallow coastal waters fringing these seas wherever the deposits consist of sufficiently coarse sand undisturbed by water movement. Moreover the absence of lancelets from samples taken from such areas is not necessarily an indication that they do not occur as these animals are small and very active and frequently evade capture when disturbed by the dredge.

The lancelets taken from the Arabian Sea are the first recorded from that area and include sixty specimens of a new species of *Branchiostoma* related to *B. belcheri* Gray (1847) and to *B. bazarutense* Gilchrist (1923), one specimen of *B. lanceolatum* (Pallas) (1774) from the same locality and one specimen (damaged and unidentifiable) from a different locality. A sample of the new Arabian species has been compared statistically with a new sample of *B. belcheri* from Amoy on the coast of China, but a similar comparison with *B. bazarutense* was not possible as this species is known only from the three specimens described by Gilchrist (1923) from the Bazaruto Islands off the coast of Portuguese East Africa. The occurrence of the single specimen of *B. lanceolatum* is of particular interest, first as it confirms that this species has spread from the Mediterranean to the Arabian Sea and, second, as *B. lanceolatum* may now be considered sympatric with the Arabian species, both forms having been taken in the same haul. Specimens held by Prenant (1928) to be *B. lanceolatum* have already been recorded from Madagascar while others from the Morrumbene Estuary, Portuguese East Africa, have also been referred to that species (Webb, 1957).

The author is grateful to the Trustees of the British Museum (Natural History) for permission to examine the " John Murray " collection and also to Professor David Barker of the University of Hongkong who obtained the sample of the Amoy lancelet.

SYSTEMATIC ACCOUNT

Family Branchiostomidae.

Branchiostoma arabiae sp. n.

Text-fig. 1.

Type Specimens.—Holotype (B.M. reg. no. 1955.12.13.1) 52 mm. ; small gonads are present. This specimen has been fixed in bouin and is preserved in 70% alcohol. Paratypes comprise 4 specimens fixed in bouin and preserved in 70% alcohol (B.M. reg. nos. 1955.12.13.2–4) and 20 specimens preserved in 70% alcohol (B.M. reg. nos. 1955.12.13.5–15). Four of the paratypes only possess gonads. The holotype and the paratypes are deposited in the British Museum (Natural History).

Other Material.—The collection included the damaged remains of 35 other specimens (5 fixed in bouin and preserved in 70% alcohol, B.M. reg. nos. 1955.12.13.16–20 and 30 preserved in 70% alcohol of which 20 are retained in the British Museum, reg. nos. 1955.12.13.21–40) believed to be the same species but in a condition too poor to permit positive diagnosis.

Type Locality.—Sta. 80, 22° 13′ 30″ N., 59° 48′ 48″ E., near Ras al Hadd on the Arabian coast near the entrance to the Gulf of Oman. Specimens were taken with a 4 ft. Salpa Dredge in 16–22 metres of water from coarse sand with shells on 30th November 1933 between 16.54–17.26 hours. No indication of temperature or salinity of the water is given. (See also comments on the locality and the nature of the deposit in Sewell (1935), Farquharson (1936) and Stubbings (1939)). At Sta. 79, 22° 12′ 48″ N., 59° 49′ 42″ E. the surface temperature was 26·5 degrees Centigrade and the salinity 36·58 parts per thousand.

Diagnosis.—In the following diagnosis counts and measurements have been made on 25 specimens and examined statistically.

(1) Dorsal fin chambers number 297–366 : Mean 333·2 : Standard Deviation 18·22: S.D. = 5·47% of the Mean.

(2) Preanal fin chambers number 65–87 : Mean 74·0 : Standard Deviation 5·92: S.D. = 8·0% of the Mean.

(3) Tallest of dorsal fin chambers 2·0–3·2 times as high as broad : Mean 2·35 : Standard Deviation 0·35 : S.D. = 14·89% of the Mean.

(4) Height of dorsal fin contained 10–13 times in the depth of the body in the mid-atrial region : Mean 11·52 : Standard Deviation 0·92 : S.D. = 7·99% of the Mean.

(5) Postatrioporal region 0·33–0·43 the length of the preatrioporal region : Mean 0·37 : Standard Deviation 0·035 : S.D. = 9·46% of the Mean.

(6) Myotomes from anterior end to atriopore 36–41 : Mean 38·96 : Standard Deviation 1·49 : S.D. = 3·8% of the Mean.

(7) Myotomes from atriopore to anus 16–18: Mean 16·4: Standard Deviation 0·65: S.D. = 3·9% of the Mean.

(8) Myotomes posterior to anus 8–11: Mean 9·44: Standard Deviation 0·71: S.D. = 7·55% of the Mean.

(9) Total myotomes 61–67: Mean 64·8: Standard Deviation 1·56: S.D. = 2·4% of the Mean.

(10) Maximum length in sample examined 61 mm.; minimum length 34 mm.

The following characters not suitable for numerical evaluation assist in the recognition of this species and are illustrated in Text-fig. 1 which has been prepared from *camera lucida* drawings of the holotype. The dorsal fin is approximately the same height throughout its length and is not separated from the rostrum by a post-rostral notch. The caudal fin runs smoothly into the preanal fin with very little indication of the point of termination of the lower lobe. The extent of this lobe is variable and the position of the anus, usually behind the centre, may be in advance of the centre of the lobe in individuals where the fin is short. The preanal fin is narrow and the fin chambers in the anterior region extend the full width of the fin. Seen ventrally, the chambers are broad and cover almost the entire width of the body, but do not divide to give rise to a double preanal fin even at the anterior extremity of the fin as Gilchrist (1923) has indicated to be the case in *B. bazarutense*.

From this diagnosis it is evident that the Arabian lancelet belongs to the Indo-Pacific Group (Webb, 1955) and is near *B. bazarutense* and *B. belcheri*. Characters in which these three are similar include the relatively high number of dorsal fin chambers, the very high number of preanal fin chambers, a dorsal fin of similar height and proportions and certain aspects of the myotome formula. Unfortunately the types of *B. bazarutense* appear to have been lost and are not, as might be expected, with the types of *B. capense* (also described by Gilchrist) in the South African Museum, Cape Town. From Gilchrist's description of *B. bazarutense*, however, it seems that the chief differences between this form and the Arabian lancelet lie in the relatively shorter postatrioporal region in the latter and in the double preanal fin of *B. bazarutense* mentioned earlier. Without more data on *B. bazarutense* it is impossible to carry the comparison further.

The case is different with regard to a comparison with *B. belcheri* as an adequate sample of this species has been obtained from Amoy and, from counts on 25 specimens (B.M. reg. nos. 1955.12.13.43–60), a more complete diagnosis has been prepared than has hitherto been published. The figures obtained have been analysed statistically for comparison with those for the Arabian lancelet.

Diagnosis of *Branchiostoma belcheri* Gray (Amoy sample).

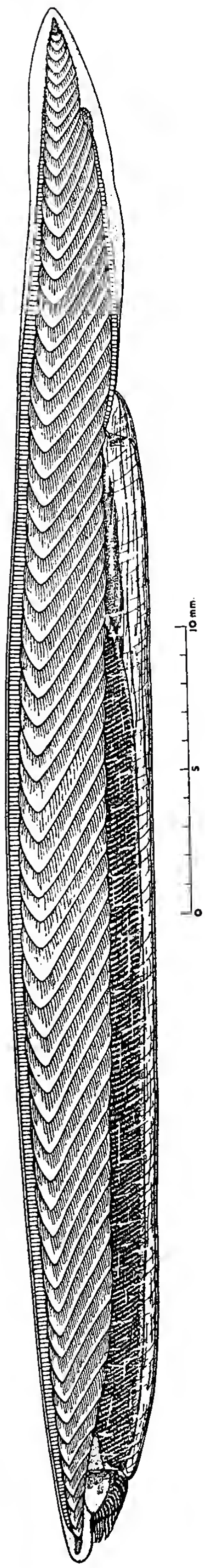
(1) Dorsal fin chambers number 250–340: Mean 305: Standard Deviation 23·64: S.D. = 7·8% of the Mean.

(2) Preanal fin chambers number 67–90: Mean 78·1: Standard Deviation 5·26: S.D. = 6·74% of the Mean.

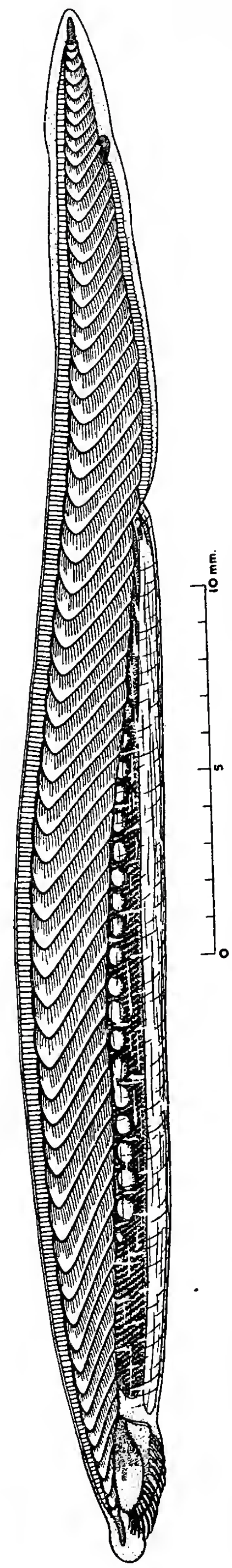
(3) Tallest of dorsal fin chambers 2·5–3·5 times as high as broad: Mean 2·96: Standard Deviation 0·31: S.D. = 10·5% of the Mean.

(4) Height of dorsal fin contained 7–11 times in the depth of the body in the mid-atrial region: Mean 9·08: Standard Deviation 0·96: S.D. = 10·55% of the Mean.

(5) Postatrioporal region 0·42–0·54 the length of the preatrioporal region: Mean 0·50: Standard Deviation 0·024: S.D. = 4·8% of the Mean.



Text-fig. 1.—*Branchiostoma arabiae* sp. n. Holotype.



Text-fig. 2.—*Branchiostoma belcheri* Gray. Specimen from Amoy.

(6) Myotomes from anterior end to atriopore 35–38: Mean 36·5: Standard Deviation 0·82: S.D. = 2.25% of the Mean.

(7) Myotomes from atriopore to anus 15–18: Mean 17·0: Standard Deviation 0·76: S.D. = 4·47% of the Mean.

(8) Myotomes posterior to anus 9–11: Mean 10·0: Standard Deviation 0·54: S.D. = 5·38% of the Mean.

(9) Total myotomes 62–65: Mean 63·56: Standard Deviation 1·0: S.D. = 1·64% of the Mean.

(10) Maximum length in sample examined 46 mm.: minimum length 20 mm.

The following characters not suitable for numerical evaluation assist in the recognition of this species and are illustrated in Text-fig. 2 which has been prepared from *camera lucida* drawings of specimen B.M. reg. no. 1955.12.13.61. The dorsal fin tends to be higher in the posterior than in the anterior region and is separated from the rostrum by a shallow post-rostral notch. The caudal fin runs smoothly into the preanal fin with little or no indication of the point of termination of the lower lobe. As far as can be judged the anus lies in advance of the centre of the lower lobe. The preanal fin is narrow and the fin chambers extend beyond half the width of the fin, but, except at the extreme anterior end, do not traverse the full width of the fin. The fin chambers are broad, covering the greater part of the ventral surface of the body, but are not divided in the mid-line to form a double preanal fin.

Comparison of *B. arabiae* and *B. belcheri*.

In general appearance, *B. arabiae* and *B. belcheri* are very similar except that the former is a more robust species, deeper in the body, without a post-rostral notch, with a relatively short oral region and with differences in the preanal fin. A comparison of the myotome and fin ray chamber counts and the proportions of the body and fins, however, reveal clear differences separating the two forms. The extent of these differences is shown in Table I where, for each of the characters numbered 1–9 in the diagnoses for both *B. arabiae* and *B. belcheri*, the Mean and the Standard Deviation is given and from these "*t*"

TABLE I.

Character No.	*B. arabiae.* Mean.	*B. arabiae.* S.D.	*B. belcheri.* Mean.	*B. belcheri.* S.D.	"*t.*"	"*P.*"
1	333·2	18·22	305·0	23·64	4·629	<0·001
2	74·0	5·92	78·1	5·26	2·537	0·02
3	2·35	0·35	2·96	0·31	6·390	<0·001
4	11·52	0·92	9·08	0·96	8·990	<0·001
5	0·37	0·035	0·50	0·024	15·007	<0·001
6	38·96	1·49	36·5	0·82	7·086	<0·001
7	16·4	0·65	17·0	0·76	2·947	0·01
8	9·44	0·71	10·0	0·54	3·279	0·001
9	64·8	1·56	63·56	1·0	3·282	0·001

A statistical analysis showing to what extent the differences between the samples of *B. arabiae* and *B. belcheri* may be held to characterize the populations from which the samples were taken.

and hence " *P* ", the degree of probability that such a difference could occur between random samples of one population, have been calculated.

In this comparison, assuming " *P* " = 0·05 to be the limit of significance, the high values for " *t* " and the correspondingly low values for " *P* " in the majority of characters considered give a measure of the dissimilarity of the two forms. In particular the height of the dorsal fin relative to the depth of the body (character 4), the comparatively short postatrioporal region (character 5) and the higher number of myotomes before the atriopore (character 6) are features of *B. arabiae* which serve to distinguish it from *B. belcheri*. On the other hand a character which these species share with *B. bazarutense* but differ from all other known lancelets is the very high number of preanal fin chambers (character 2). There is, therefore, good reason to regard *B. arabiae* as a species separate from but related to *B. belcheri* and *B. bazarutense* and these three as a distinct group.

N.B. Since the diagnosis for the Amoy sample of *B. belcheri* was prepared and the comparison with *B. arabiae* made, a new series of 9 specimens of *B. belcheri* from Lingalinga in Portuguese East Africa has been examined (Webb, 1957). This series confirms an observation that *B. belcheri* occurs on the East Coast of Africa made by Franz (1922) from specimens taken at a locality near Zanzibar. In view of the close proximity of Portuguese East Africa to the Arabian coast compared with Amoy, it is desirable to show that the differences demonstrated between *B. arabiae* and the Amoy sample of *B. belcheri* also obtain with the Portuguese East African form of that species. A comparison of the Amoy sample with that from Portuguese East Africa has been made and shows that the two series are very similar and differ with high significance only with respect to the relative length of the postatrioporal region of the body (character 5). These two samples, in fact, show a greater measure of agreement than is to be found between samples of *B. lanceolatum* from the Mediterranean, the English Channel and the Kattegat (Webb, 1956). When *B. arabiae* is compared with the Portuguese East African sample of *B. belcheri* the significance of the differences between them is of the same order as or is greater than that already shown with the Amoy sample except in the case of the total number of myotomes (character 9) which, in this instance, is closely similar. It is clear, therefore, that *B. arabiae* cannot be regarded as an extreme form of *B. belcheri*.

Branchiostoma lanceolatum (Pallas).

Limax lanceolatus Pallas (1774).
Branchiostoma lubricus Costa (1834).
Amphioxus lanceolatus Yarrell (1836).
Branchiostoma lanceolatum Gray (1851).

Occurrence.—Sta. 80, 22° 13′ 30″ N., 59° 48′ 48″ E. near Ras al Hadd on the Arabian coast near the entrance to the Gulf of Oman. A single specimen (B.M. reg. no. 1955.12.13. 41) was taken together with the collection of *Branchiostoma arabiae* in the same haul details of which have already been given with reference to that species.

Distribution.—Norwegian coast, North Sea, Kattegat, Heligoland, English Channel, Irish Sea, Mediterranean Sea, Suez Canal, Arabian Sea, Madagascar, Portuguese East Africa.

REMARKS.—This record of *B. lanceolatum* from the Arabian Sea is yet another east of the Suez Canal. Prenant's (1928) lancelets from Madagascar were held to be this species and there is a further record of its occurrence in the Morrumbene Estuary in Portuguese East Africa (Webb, 1957). It is also of importance as a clear instance where two species of lancelet may be considered sympatric. For these reasons the following description of the specimen is given. The total range of difference in each character for *B. lanceolatum* from regions other than the Arabian Sea and Indian Ocean is given in parenthesis for comparison after the figures for the Arabian specimen.

(1) Dorsal fin chambers number 264. (200–270.)
(2) Preanal fin chambers number 47. (29–48.)
(3) Tallest of dorsal fin chambers 1·6 times as high as broad. (1·4–2·7.)
(4) Height of dorsal fin contained 12 times in the depth of the body in the mid-atrial region. (8–16.)
(5) Postatrioporal region 0·52 the length of the preatrioporal region. (0·38–0·51.)
(6) Myotomes from anterior end to atriopore 37. (33–38.)
(7) Myotomes from atriopore to anus 13. (12–16.)
(8) Myotomes posterior to anus 14. (10–14.)
(9) Total myotomes 64. (58–65.)
(10) Length 36·5 mm. (Maximum length recorded elsewhere 61 mm.)

In the shape of the fins the Arabian specimen resembles *B. lanceolatum* from the Mediterranean region, but differs from this form in that the counts of the fin chambers and myotomes are rather higher and the postatrioporal region slightly longer relative to the region before the atriopore. Nevertheless, with the exception of this last feature, the figures for every diagnostic character fall within the total range recorded for the species as a whole. The specimen is clearly very different from *B. arabiae*, *B. belcheri* and *B. bazarutense* previously considered and the only other species with which it might be confused is *B. haeckelii* Franz (1922) from Ceylon, a form which was once referred to *B. lanceolatum* by Tattersall (1903). Here there are differences in the height of the dorsal fin relative to the depth of the body, in the relative length of the postatrioporal region, in the number of myotomes in the tail and in the form of the rostrum and the caudal fin which suggest that the Arabian specimen is not *B. haeckelii*.

Branchiostoma sp.

OCCURRENCE.—Sta. 58, 22° 22′ 12″ N., 59° 57′ 30″ E., near Ras al Hadd on the Arabian coast near the entrance to the Gulf of Oman. One specimen (B.M. reg. no. 1955.12.13.42) was taken with a 4 ft. Salpa Dredge in 1189–1354 metres of water on the 5th November 1933 between 14.11–15.02 hours. The bottom deposit was green mud. At the surface the temperature was 26·7 degrees Centigrade and the salinity 36·55 parts per thousand. At 1240 metres the temperature was 6·95 degrees Centigrade and the salinity 35·14 parts per thousand. (See also comments on the locality and nature of the deposit in Sewell (1935), Farquharson (1936) and Stubbings (1939).)

REMARKS.—This specimen was too badly damaged to permit specific identification. The occurrence of *Branchiostoma* in so unlikely a locality as Station 58, however, is worth recording although the specimen is probably a straggler from shallow water and it is very doubtful if a population could ever become established in the green mud deposit.

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THE SESSILE TUNICATA

BY

PATRICIA KOTT

WITH SEVENTEEN TEXT-FIGURES

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SUMMARY

Twenty-four species of sessile Ascidians are recorded from the Red Sea, Gulf of Aden and Southern Arabia. These include three species which are new to science. The Ascidian fauna of this area is more closely related to that of the East Indies-Northern Australian region than to other adjacent areas.

INTRODUCTION

The following report deals with twenty-four species of sessile Tunicates (Class Ascidiacea) from the Red Sea and Indian Ocean area.

LIST OF SPECIES IN THE COLLECTION

I. Enterogona

Podoclavella detorta Sluiter.
Stomozoa murrayi, n. sp.
Archidistoma murrayi, n. sp.
Archidistoma parva (Sluiter) ?
Didemnum moseleyi (Herdman).
Didemnum psammotodes Sluiter.
Didemnum candidum Savigny.
Trididemnum lüderitzi Michaelsen.
Trididemnum aspiculatum, n. sp.
Lissoclinum capense (Hartmeyer).

Diplosoma spongiforme (Giard).
Synoicum hypurgon (Michaelsen) var. *arenosum* nov.
Aplidium violaceum Hartmeyer.
Aplidium savignyi Michaelsen, var. *translucidum* nov.
Ascidia melanostoma Sluiter.
Ascidia malaca Traustedt.

II. Pleurogona

Styela canopus Savigny.
Polycarpa thelypanes (Sluiter).
Polycarpa aurita (Sluiter).
Polycarpa cryptocarpa (Sluiter).
Alleocarpa similis (Sluiter).
Botrylloides nigrum Herdman.
Hexacrobylus sp. ?.
Herdmania momus (Savigny) var. *kyamanensis* Michaelsen.

Of these, three species are new to science, one of them being referred to a monotypic genus, Stomozoa, in a new Subfamily, Stomozoinae, of the family Clavelinidae. Sessile Tunicates were taken only at stations in the Red Sea, Gulf of Aden and around the south coast of Arabia; none were taken from the central Indian Ocean, nor from stations on the west coast of India and the Maldive Archipelago, nor on the east coast of Africa.

The collection is of particular interest in that it shows the very wide range of distribution of the species present in the area. Only three species, *Styela canopus*, *Stomozoa murrayi* and *Herdmania momus* var. *kyamanensis* are limited to the Red Sea area. Most other species have a wide range into the Malayan, East Indies, North Australian area and *Polycarpa cryptocarpa* and *Didemnum moseleyi* have also been recorded from Japan. Of the fauna taken previously off south east Africa only *Lissoclinum capensis*, *Didemnum psammatodes*, *Aplidium violaceum* and *Diplosoma spongiforme* were taken in the Red Sea and adjacent areas; *Trididemnum lüderitzi* has been recorded from South West Africa and north west Australia.

The collection is housed in the British Museum (Natural History).

I. Order ENTEROGONA.

Sub-Order KRIKOBRANCHIA Seeliger.

Family Clavelinidae Forbes & Hanley.

Subfamily Clavelininae Seeliger.

Podoclavella detorta Sluiter.

(Text-fig. 1.)

Sluiter, 1905.

Collection.—Sta. 53, 19° 22′ N., 57° 53′ E., south east Arabia; Triangular dredge, 13·5 m., 2.xi.33.

Previous Records.—7° 55′ S., 114° 26′ E., East Indies.

Colony.—A large number of individuals 2–3 cm. long, completely separate from one another except where the test is joined basally.

Test : Is hard and gelatinous except where it covers the thorax where it is soft and thin. Due to the delicate nature of the test around the thorax this part of the animal is very often lost in these colonies. The test enclosing the zooid is about 2–3 cm. long.

Zooid (Text-fig. 1) : The zooid is about 1·5 cm. long and does not occupy the whole length of the test. Thorax is only 2–3 mm. long ; the length of the zooid is mainly occupied by the long neck containing narrow oesophagus and rectum. There is a slight expansion posteriorly for the smooth stomach and loop of the intestine.

Apertures : On the thorax there are muscles radiating out from the apertures which are both smooth rimmed and sessile and both on the side of the zooid (Text-fig. 1). The atrial opening is most anterior and the branchial opening posterior to it, so that the zooid is more or less upside down.

Thorax : There are 20 branchial tentacles. There are 4 rows of stigmata arranged parallel to the long axis of the zooid, with about 30 stigmata in each row. The dorsal lamina consists of 3 languets ; the endostyle extends half way around the branchial sac on its posterior and lateral aspect, and the oesophagus, leaving the branchial sac antero-laterally runs down the side of the branchial sac inside the rectum.

Abdomen : The stomach is smooth walled. The rectum curves around the anterior end of the zooid and opens just above the atrial opening. The anus is very extended in these specimens and the six lobes described by Sluiter are not apparent. Gonads were not observed.

Discussion.—The thorax in these specimens is smaller than that described by Sluiter. The orientation of the branchial sac and the relative positions of the apertures are, however, distinctive and the species are undoubtedly identical. This disposition of the apertures is reminiscent of the situation in *Pyura pachydermatina* Herdman and related species (Kott, 1952) which are simple, stalked forms where the branchial aperture is posterior to the atrial aperture in relation to other parts of the animal.

In Sluiter's species the endostyle is much shorter and the oesophagus opens from the ventral aspect of the branchial sac. The two records of this species are from widely separated regions and it is therefore possible that the species has a general distribution in the Indian Ocean–East Indies area.

Subfamily Stomozoinae, nov. subfam.

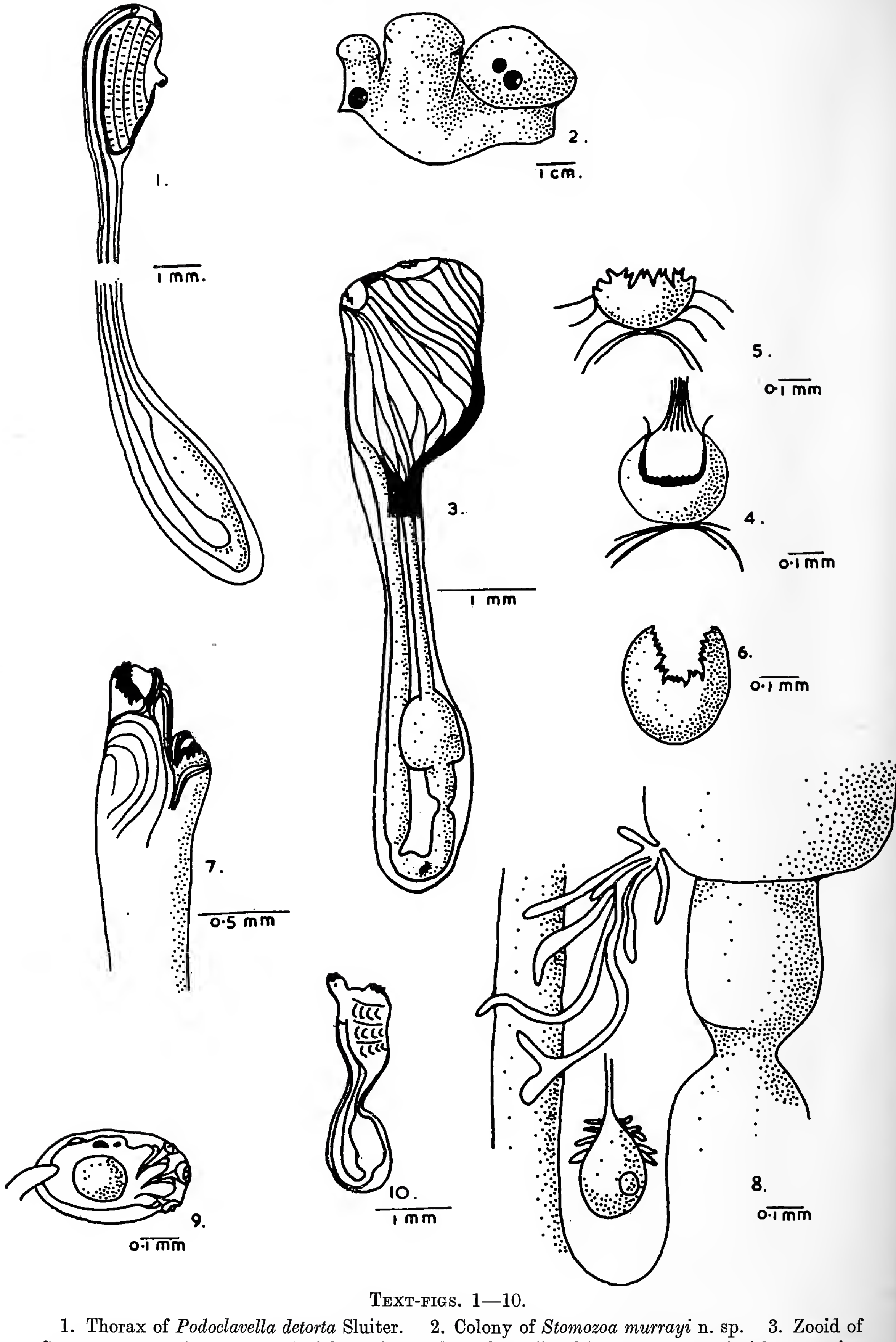
Stomozoa murrayi, nov. gen., n. sp.

(Text-figs. 2–8.)

Collection.—Motor boat station 1, 13° 39′ 30″ N., 42° 43′ E., Bay between Great Hanish and Suyul Hanish Islands, Red Sea ; dredge, 13 fathoms, 17.ix.33.

Colonies (Text-fig. 2.).—Two colonies are available, composed of 3–4 club-shaped rounded lobes, 0·5 cm.–2·5 cm. in diameter and joined basally.

Test hard and gelatinous in preserved specimens, with a slightly purple colour, the pigment especially accumulated at the ends of the blood vessels which ramify through the test. The smooth surface of the colony is sometimes interrupted by the openings of large canals which traverse the test and into which smaller canals ramifying through the



TEXT-FIGS. 1—10.

1. Thorax of *Podoclavella detorta* Sluiter. 2. Colony of *Stomozoa murrayi* n. sp. 3. Zooid of *Stomozoa murrayi* n. sp. 4. Atrial opening to show closed lip of *Stomozoa murrayi* with protective pouch removed. 5. Pouch of atrial opening of *Stomozoa murrayi* n. sp. 6. Pouch of Branchial opening of *Stomozoa murrayi* n. sp. 7. Extended thorax of *Stomozoa murrayi* n. sp. to show apertures open. 8. Gastric gland and gonads of *Stomozoa murrayi* n. sp. 9. Larva of *Archidistoma murrayi* n. sp. 10. Zooid of *Archidistoma parva* (Sluiter).

test discharge. At other times, the smaller canals open either on the surface or in small rounded fossae on the surface. This system of canals presumably provides for a circulation of water through the rigid test in which zooids are only sparsely distributed. There are only 4–8 zooids in each lobe, more or less vertically placed and opening around the upper surface of the lobe. Throughout the test, however, there are isolated abdominal portions of zooids, which have been "budded off" the abdomen for the vegetative multiplication of zooids (Berrill, 1950, p. 48).

From the posterior end of the zooids there is a blood vessel which ramifies through the test. Zooids open on the surface of the test with the two apertures very close together. The openings are very small, but the test conforms more or less with the structure of the mantle around the apertures as described below.

Zooids (Text-fig. 3) : These are found away from the surface of the colony and careful dissection must be made to expose them. They are about 1 cm. long, of which the abdomen is 0·6 mm. and the thorax 0·4 mm., and are about 0·2 mm. in mean thickness.

Apertures : The branchial and atrial apertures are sessile, and terminal and antero-dorsal respectively. The lips of the apertures provide the principal distinguishing character of the species. Each aperture consists of a flap-like lip with the free border indented to form about 8 small rounded lobes. The lip is ventral on the atrial siphon and dorsal on the branchial siphon. In a contracted zooid, this lip closes against the smooth rimmed lower or dorsal border of the opening for the atrial aperture and against the ventral border of the opening for the branchial aperture. (Text-fig. 4). The apertures when closed, therefore, are transverse but are covered by a pouch-like flap of tissue (Text-figs. 5, 6) with deeply lobed borders, and attached to an area around the apertures on the side opposite to the lips already described. The area for the attachment of the pouch on the atrial siphon is semicircular and the resultant flap is half a circle (Text-fig. 5), whereas the area for the attachment of the branchial pouch extends dorsally around the sides of the aperture and the resultant pouch is crescent shaped (Text-fig. 6). The apertures in the extended state are shown in Text-fig. 7.

Muscles : The part of the mantle forming the "pouches" protecting the apertures is not very muscular but there are strong muscles around the base of the pouch where it is attached to the rest of the body : there is also a strong band of muscle into the base of the "lips" of the apertures and transversely across the base of the lip (Text-fig. 7).

The thorax has about 14 muscle bands on each side (Text-fig. 3) which run obliquely towards the dorsal aspect and join, on each side of the abdomen, into a wide muscle band running the length of the abdomen and practically completely enclosing it.

Branchial sac : Branchial tentacles are simple and of varying sizes. There are 26 rows of oval stigmata and about 60 stigmata in a row, on each side of the body ; wide transverse vessels are present between the stigmata.

Abdomen : The oesophagus is fairly long and opens into a rounded smooth-walled stomach about half-way down the abdomen. There is a duodenal constriction and another constriction separating the mid-intestine from the rectum. The gastric gland is very well developed, composed of branching tubules which wind across the ascending rectum (Text-fig. 8).

Gonads (Text-fig. 8) are present superficially on the right side of the abdomen just posterior to the stomach ; the testes are deep to the one egg ovary and consist of many short tubules. The gonoducts run anteriorly through the superficial connective tissue surrounding the abdomen ; they are very delicate and only with difficulty separated from the connective tissue and muscles.

Discussion.—This species has been placed in a new subfamily of the Clavelinidae, of equal status with the subfamilies Polycitorinae and Clavelininae, on account of the very great specialization of the apertures, the superficial situation of the gonads and the great development of the gastric gland. The two latter characters may be secondary and not of any phylogenetic importance and it is interesting to observe that *Rhodosoma* (Kott, 1952), a simple form of the sub-order Dictyobranchia which has also a highly specialized and muscular organization in the apertures, possesses a well-developed gastric gland too.

The subfamily has probably been derived from the Clavelininae by an elaboration of the apertures ; in the Polycitorinae, also derived from the Clavelininae, the zooids have much less modification of the apertures, tend to be grouped together in the test to form systems, and have, except in rare cases, reduced numbers of rows of stigmata.

Polycitor torensis (Michaelsen, 1921) also from the Red Sea, has similar body musculature and a similar disposition of the gonads. There are, however, only 9 rows of stigmata and many less stigmata in each row, the stomach is folded, the branchial and atrial openings are not modified and the test differs.

Subfamily Polycitorinae Michaelsen.

Archidistoma murrayi n. sp.

(Text-fig. 9.)

Collection.—Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 40 metres, 29.x.33.

Colonies.—Many colonies consisting of numbers of long lobes 2·5 cm. long and 5 mm. thick arising from a common base. Each lobe contains about 6 zooids in separate compartments and the free ends of the lobes are occupied by rounded protuberances from these compartments, and support the openings of the zooids.

Test : This is completely filled and brittle, with sand throughout.

Zooids are 2·5–3·00 mm. long and the abdomen is about one and a half times the length of the thorax. A brood pouch is present on the right side of the branchial sac, consisting of an expansion of the distal end of the oviduct and containing 6–7 embryos in two rows.

Apertures : Both the branchial and atrial siphons are 6-lobed and open separately to the surface. They are both fairly short. The branchial siphon is terminal and the atrial siphon is antero-dorsal.

Muscles : There are strong transverse and longitudinal muscles in the walls of the thorax, but longitudinal muscles only on the abdomen, in two bands on its ventral aspect.

Thorax : There are 3 rows of stigmata with about 16 in each half row and wide horizontal membranes are present between them. In the middle of the anterior row the stigmata are particularly long, but are very much reduced in length towards the ventral and dorsal surfaces.

Abdomen : The oesophagus is very long and wrinkled anteriorly, due to contraction. The stomach is two-thirds of the way down the abdomen and is round and smooth. There is no posterior stomach and the intestine enters the very much wider rectum in the pole of the loop.

The rectum is also coiled and folded anteriorly, like the oesophagus. The testes lobes are many and pear-shaped ; they are situated in and around the alimentary loop posterior to the stomach and particularly on the left side of the loop. The ovary is to the right of the testes in the gut loop. The vas deferens and oviduct is wrinkled like the oesophagus and intestine.

Larvae (Text-fig. 9) : The fully formed embryo is about 0·5 mm. in length. There are four paired ampullae on the ridges on either side of the three suckers, which are arranged in the median line.

Discussion.—Externally this species is very similar to colonies of *Archidistoma aggregatum* Garstang (Berrill, 1950), particularly in respect of the sand-filled test separating the zooids, the separate openings of the apertures to the exterior and the absence of common cloacal apertures or systems of any sort. The most anterior portions of the zooids, however, are not so markedly separated from one another as is the case in *A. aggregatum*. This, however, is merely a matter of degree and *A. murrayi* may be considered as intermediate between *Archidistoma aggregatum* and the species of *Eudistoma* embedded in a common test. The larvae, the alimentary canal, body-wall musculature and gonads are similar in the two species although the colony, zooid and larvae are smaller in *Archidistoma aggregatum*. Berrill (1950) and Kott (1952*a*) have suggested that *Archidistoma* and *Eudistoma* are separated on only very slender grounds. Therefore, in this paper the generic name *Archidistoma* is adopted for a species of the subfamily Polycitorinae with both apertures six-lobed, a smooth stomach and three rows of stigmata. The zooids of *Eudistoma miniaceus* (Sluiter) (Sluiter, 1909) have a similar alimentary canal, branchial sac and gonads to the present species and both apertures open separately to the exterior ; the form of the anterior row of stigmata and the nature of the test, however, differ. Millar (1953) has described a sand-covered species, *Eudistoma ramosum*, from West Africa, which is also similar in many respects, but the lobes of the colony are longer. *Archidistoma murrayi*, therefore, is most closely related to *Archidistoma aggregatum* found in the English Channel and on the coast of North Carolina, U.S.A.

Archidistoma (*Eudistoma*) *parva* (Sluiter) ?

(Text-fig. 10.)

Sluiter, 1900.

Collection.—Sta. 24, 11° 53′ 42″ N., 51° 13′ 12″ E., off Cape Guardafui, Somaliland, Conical dredge, 73–200 metres, 9.x.33.

Previous Records.—Laysan, Hawaiian Islands.

Colony.—One colony only is available. It is cylindrical, 2 cm. high and 5 mm. in diameter. The test is semitransparent, soft and fleshy throughout. The head of the colony is naked but the basal half is coated with sand. There are numerous zooids in the colony, arranged radially over the surface and sides of the head, but no systems are obvious.

Zooids (Text-fig. 10) are 2–3 mm. long. The thorax and abdomen are more or less equal.

Apertures : The branchial aperture is on a short siphon and six-lobed ; the atrial aperture is on a long siphon from the antero-dorsal corner of the thorax and is also six-lobed.

Muscles : There are strong longitudinal muscles on the thorax but musculature on the abdomen is weak.

Thorax : There are three rows of long rectangular stigmata, with about 6–8 stigmata in each half-row.

Abdomen : This is sometimes folded back on the thorax but this condition may be due to preservation. The alimentary loop is short ; the stomach is large, smooth and rectangular and occupies the posterior half of the abdomen. The intestine and rectum are not differentiated from one another. The gonads are present alongside and posterior to the gut loop. There are many testes lobes.

DISCUSSION : This species is distinguished from others described from this and adjacent areas by the short alimentary loop, the large stomach and the long atrial siphon. It agrees very well in all aspects with Sluiter's description of *A. parva* but the identification can only be regarded as provisional as only one small colony is available for examination. It seems unlikely that a species which appears to be uncommon would occur in two areas so remote from one another.

Family DIDEMNIDAE Giard.

Didemnum moseleyi (Herdman).

(Text-figs. 11, 12.)

For literature and synonymy see Tokioka, 1953.

COLLECTION.—Sta. 53, 19° 22′ 36″ N., 57° 53′ 00″ E., south-east Arabia. Triangular dredge 13·5 m. 2.xi.33 ; Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 38 m., 29.x.33.

PREVIOUS RECORDS.—Phillipines, East Indies, Japan.

COLONY.—Thin, white, investing colonies.

Test : All layers throughout are filled with spicules. Branchial apertures regularly spaced over the surface and conspicuous by the spicules over their lobes. Common cloacal openings are present. The common cloacal cavity is extensive and traversed by the entire thoracic part of the zooids,which are enclosed in a thin layer of test with fewer spicules than are present elsewhere. This common cloacal cavity therefore divides the test into two layers, an upper, thin, layer level with the branchial siphons of the zooids and a lower, thicker, layer enclosing the abdomen and larvae of the zooids. In the colony from Sta. 53, even the abdomen of the zooids is present above the basal layer of test.

Spicules (Text-fig. 11) are stellate, 20μ to 30μ in diameter with six, ten or twelve arms in optical section. The smaller spicules with a greater number of arms are most plentiful and larger spicules with a smaller number of arms are rare. In the colony from Sta. 45 there are occasional very large spicules of 50μ diameter, with six very pointed rays, in the surface of the basal layer of the test, *i.e.* in the floor of the common cloacal cavity.

Zooids : The branchial siphon is distinctly six-lobed; the atrial aperture is huge, exposing most of the dorsal surface of the thorax to the common cloacal cavity. There are about six stigmata in each of the four rows. No thoracic organ is evident. The testis is a single lens-shaped organ surrounded by five to six coils of the vas deferens. The thorax and abdomen are of equal size.

Larvae (Text-fig. 12) are present in the basal layer of the test, are 0·3 mm. long and have four pairs of ampullae in a line on each side of the suckers, arising from an outgrowth ventral to the developing zooid.

Discussion.—This specimen generally conforms with descriptions given for the species and Sluiter (1905) has remarked on the similarity of this species to *D. bistratum* (Sluiter) which has been recorded from the head of the Gulf of Aden (Sluiter, 1905). The spicules in the latter species are completely different from those of *D. moseleyi* and this seems to be one of the few characters separating the adults of the two species. Tokioka (1953) has described the larvae of *D. moseleyi* from Japanese waters and the fully developed larvae, although slightly larger, are similar to those of the present specimens. These specimens must, therefore, be referred to *D. moseleyi*, despite the fact that this species has not previously been reported from any area west of the East Indies.

Didemnum psammatodes Sluiter var. *ianthinum* Sluiter.

(Text-figs. 13, 14.)

For literature and synonymy see Michaelsen, 1921.

Collection.—Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 40 m., 29.x.33.

Previous Record.—Mozambique.

Colony.—Thin investing colonies or thicker lobed colonies. The common cloacal cavity is extensive at the level of the thoraces of the zooids and, particularly in the thicker colonies, there are infra-abdominal lacunae in the basal layer of the test. Branchial openings are distinctly six-lobed and evenly spaced over the surface. Some common cloacal openings are present. Over the surface, particularly of the thick colonies, the test is raised into spicule-filled pointed papillae ; in other colonies these papillae are present on small parts of the surface only.

Spicules (Text-fig. 13) : These are plentiful just below the surface in the upper layer of the test. They are more sparse in the test surrounding the abdomen and are practically absent from the basal layer of test. They are variable in form, but seldom of greater diameter than 25μ. The most plentiful types are of the usual stellate form with 7–10 conical rays in optical section. Sometimes the points of the rays are rounded and occasionally the rays are very fine and needle-like ; very rarely there are cylindrical spicules with about four conical rays on either end.

Zooids : The thorax and abdomen are both about 0·42 mm. There are four rows of stigmata with about five stigmata in each row. The two posterior rows are shorter than the anterior ones. The testis is a single, lens-shaped, lobe surrounded by 6–8 coils of the vas deferens.

Larvae (Text-fig. 14) 0·4 mm. long and of particularly sturdy form. There are six pairs of ampullae arranged along the ridges on either side of the suckers and two pointed processes in the median line alternating with the suckers.

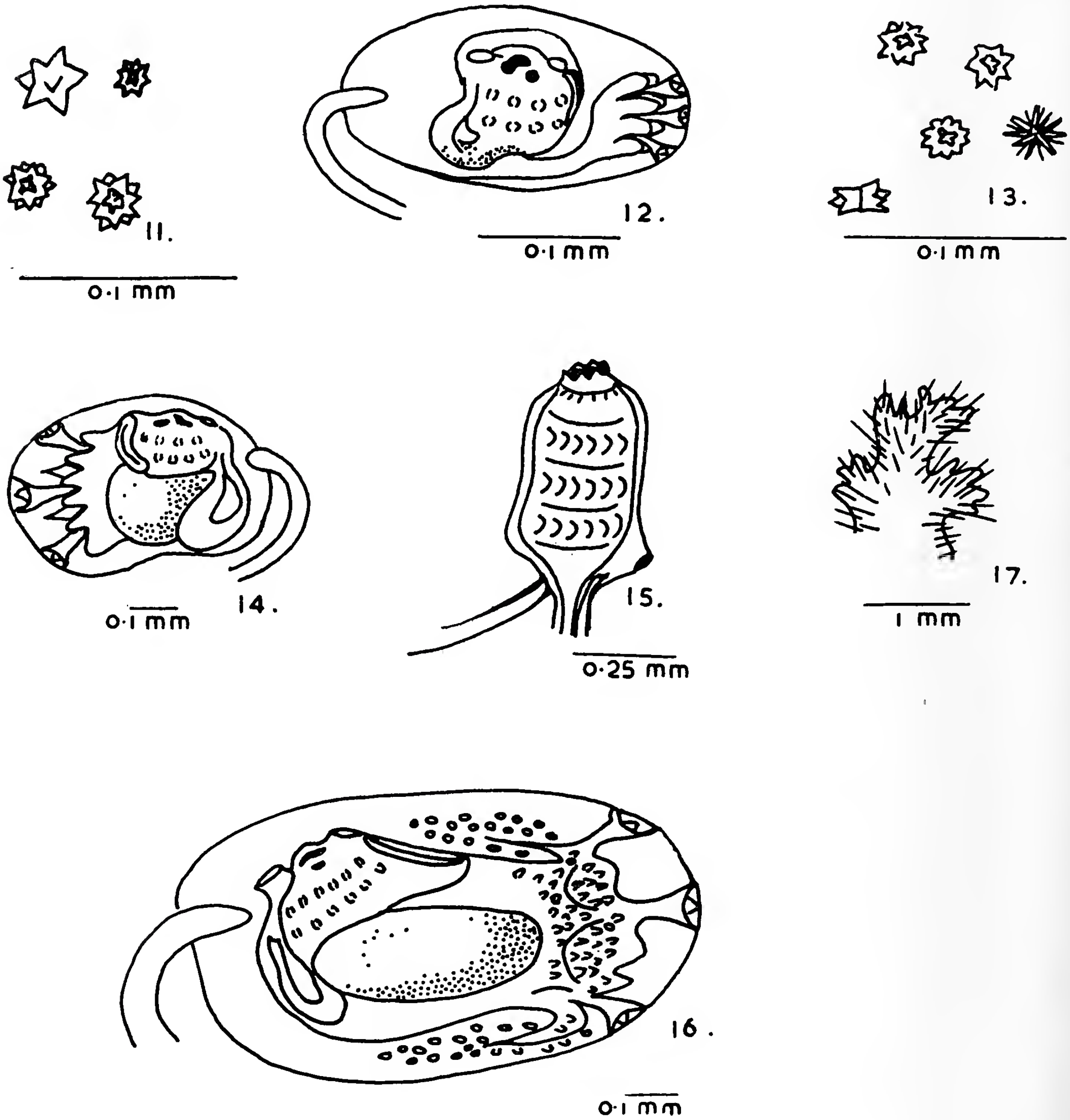
Discussion.—Both the spicules, the common cloacal cavity and the zooids agree with descriptions of *D. psammatodes* var. *ianthinum*. Although var. *skeati* (Michaelsen, 1920) has been taken previously from this area, the present specimens do not contain faecal pellets in the test, as is the case with this and other varieties of this species. Unless, therefore, the varieties have been transported artificially from one area to the other, it seems unlikely that the " varieties " of this species are geographical subspecies.

Didemnum candidum Savigny.

For literature and synonymy see Van Name, 1945.

Collection.—Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E. off southern Arabia. Triangular dredge, 40 m., 29.x.33.

Previous Records.—Red Sea, Indian Ocean, Malaya, West Indies, Bermudas, Brazil.



Text-figs. 11—17.

11. Spicules of *Didemnum moseleyi* (Herdman). 12. Larva of *Didemnum moseleyi* (Herdman). 13. Spicules of *Didemnum psammatodes* v. *ianthinum* Sluiter. 14. Larva of *Didemnum psammatodes* v. *ianthinum* Sluiter. 15.—Thorax of *Trididemnum aspiculatum* n. sp. 16. Larva of *Aplidium violaceum* Hartmeyer. 17. Lobe from around branchial aperture of *Hexacrobylus* sp. ?

COLONY.—White and brittle with closely packed spicules. Common cloacal cavities obscured.

Spicules almost rounded, 50µ in diameter with only traces of rays.

Zooid : Thorax twice the size of the abdomen. The abdomens of the zooids lie almost horizontally with the thoraces. About eight stigmata in each row. There are two testis lobes and five to six coils of the vas deferens.

DISCUSSION.—The tightly packed spicules, obscured common cloaca and two testis lobes are distinctive.

Trididemnum lüderitzi Michaelsen.

For literature and synonymy see Michaelsen, 1930.

COLLECTION.—Sta. 45. 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 40 m., 29.x.33.

PREVIOUS RECORDS.—Shark's Bay, Western Australia ; Lüderitz-Bucht, S.W. Africa ; Ambrizette, Angola.

COLONY.—Thick and rounded, up to 1 cm. thick. Branchial apertures regularly scattered over the surface, six-lobed. Common cloacal cavities are present at the level of the abdomen of the zooids and at the level of the neck joining the thorax and abdomen. No obvious systems are present.

Spicules are present throughout the test. They are 40–50µ, stellate with about eight rays in optical section.

Zooids : Thorax 0·85 mm. long and twice the size of the abdomen. The branchial aperture is on a fairly short siphon with six lobes. The atrial aperture is on a long, sometimes trumpet-shaped siphon, rising from the middle of the dorsal surface of the thorax, and directed posteriorly. There are areas devoid of stigmata anterior and posterior to the three rows of stigmata in the branchial sac, of which there are about ten in each row.

The alimentary canal has a large rectangular stomach, mid-intestinal constriction and rectum, and is covered almost completely on one side by the large lens-shaped testis with six coils of the vas deferens.

DISCUSSION.—This species is closely related to *T. natalense* Michaelsen, from the Barrier Reef and Natal and to *T. opacum* from California. It is distinguished from the latter by its extensive cloacal system, and from the former by the arrangement and form of the spicules.

Trididemnum aspiculatum n. sp.

(Text-fig. 15.)

COLLECTION.—Sta. 43, 17° 29′ N., 55° 47′ E., Kuria Thuria Is., off southern Arabia, Otter Trawl, 83–100 m., 28.x.33.

COLONY.—A small free lobe 1 × 1·5 cm. The test is transparent without spicules. Basally there are sand grains and shell particles embedded in the test. The zooids are closely packed throughout. The colony has a central common cloaca with one aperture terminally. Strands of the test form connectives across this common cloacal cavity and are filled with what appear to be eggs, although no developing embryos were found. Common cloacal canals ramify through the test and open into the central cloacal cavity.

Zooids (Text-fig. 15) are minute and measure only about 0·7 mm. in all. The branchial siphon is of moderate size with six very well defined lobes. The atrial siphon, opposite the last row of stigmata, is a short, posteriorly directed, tube with a smooth margin. The branchial sac has three rows of 8–10 long, rectangular, stigmata. The alimentary canal is of the usual form with an almost spherical smooth stomach ; the loop of the gut is almost horizontal and cradles a large, one-egg, ovary and a small single-lobed testis with seven coils of the vas deferens.

Discussion.—The small zooids, transparent test without spicules and central common cloacal cavity are distinctive for the species. The form of the colony is very similar to *Didemnum sycon* Michaelsen (1920).

Lissoclinum capense (Hartmeyer).

Hartmeyer, 1912.

Collection.—Sta. 53, 19° 22′ 36″ N., 57° 53′ 0″ E., off southern Arabia. Triangular dredge, 13·5 m., 2.xi.33.

Previous Record.—Cape of Good Hope.

Colony.—Irregular investing layer, about 4 mm. thick. There is a large circular common cloacal canal running just inside the margin of the colony. The zooids are especially plentiful around this canal and others are scattered less densely over the rest of the surface of the colony. Black pigment is present scattered through the test and particularly in the vicinity of the common cloacal canal.

Spicules are very plentiful in the surface layers but not in the deeper parts of the test. They are stellate with short conical arms and are 30–50μ in diameter.

Zooids : There is a fairly long branchial siphon with six lobes ; the atrial siphon rises from the mid-dorsal aspect of the thorax and is long and trumpet-shaped, directed laterally or posteriorly. There are four rows of stigmata, with ten in each row. The abdomen is of the usual form ; the vas deferens is straight and there are two testis lobes.

Discussion.—The "Leptoclinides" form of the atrial siphon and testis with its duct are similar to those Hartmeyer has described. The common cloacal cavities of Hartmeyer's specimens are, however, extensive whereas that in the present colony is well-developed only in the margins of the colony. Hartmeyer's specimens also contain spicules having a greater size range than those in this collection. Despite these differences, however, the species, if not identical, are obviously closely related and there is insufficient evidence, on variations of the cloacal cavity and spicules, to place the present single colony in a different species.

Diplosoma spongiforme (Giard).

For literature and synonymy see Michaelsen, 1920.

Collection.—Sta. 10, 13° 31′ 00″ N., 42° 31′ 00″ E., southern Red Sea, Otter trawl, 55 m., 17.ix.33.

Previous Records.—Seychelles, Zanzibar Channel.

Colony.—One very small, regularly oval colony, 5 mm. long. The test is spongy with large common cloacal spaces throughout.

Zooids are very small and measure only about 1 mm. The thorax and abdomen are of equal size about 0·34 mm. The branchial siphon is six-lobed ; the atrial aperture is wide and there is no siphon. There are four rows of stigmata with six in each row.

There are two testis lobes and a straight vas deferens. No ovary is evident and the testis lobes are very small and discernible only with difficulty.

Discussion.—Although this is a very young specimen, the form of the cloacal system, the size of the zooids, the branchial sac, atrial aperture and gonads all place it unmistakably as a specimen of *D. spongiforme*. Michaelsen (1920) describes both dioecious and hermaphrodite colonies and the absence of any apparent ovary in this colony may be because it is a male colony, rather than merely due to its youth.

Family Polyclinidae Verrill.

Subfamily Polyclininae Adams.

Synoicum hypurgon (Michaelsen) var. *arenosum* nov. var.

For literature and synonymy see Michaelsen, 1930.

Collection.—Sta. 45. 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia, Triangular dredge 38 m. 29.x.33.

Previous Records.—*f. typicum*: North Is., New Zealand; *f. galei*: Fremantle, Western Australia.

Colony.—Sandy, investing colonies about 2–3 mm. thick. The test is filled with sand throughout. No systems are obvious.

Zooids: The zooid is 4·5 mm. long, of which the thorax is 1·5 mm., the abdomen 0·5 mm. and the post-abdomen 2·5 mm. The branchial aperture is six-lobed and the atrial aperture antero-dorsal with a large stout atrial languet. There are sixteen rows of stigmata with about eight in each row.

There are about ten thin, well spaced bands of muscle down either side of the thorax continuing along the abdomen without very much concentration into broader muscle bands. These thin bands of muscle therefore practically completely encase the abdomen. The stomach is smooth although, when relaxed, there are apparent folds which are merely artifacts of the collapsed stomach.

Discussion.—The zooids of these colonies are very similar to those of previously described forms of *S. hypurgon*. The very sandy nature of the test is, however, distinctive and characteristic. *S. hypurgon* is apparently a widely distributed species with many distinctive varieties.

Aplidium violaceum Hartmeyer.

(Text-fig. 16.)

Hartmeyer, 1912.

Collection.—Sta. 53, 19° 22′ 36″ N., 57° 53′ 00″ E., off southern Arabia. Triangular dredge, 13·5 m., 2.xi.33.

Previous Records.—Dar-es-Salaam, Zanzibar.

Colony.—Flattened, but rounded masses. The surface of the colony is smooth but there is sand investing the basal part and sand particles are scattered through the rest of the test. The test is soft and semi-transparent and the surface layer is spongy with canals and lacunae. Numerous common cloacal openings are present on the surface, but no systems were distinguished.

Zooids are small and only sparsely distributed in the test. The branchial aperture is six-lobed and the atrial aperture antero-dorsal with a small slightly bifid lip. There are fifteen rows of stigmata with 12–14 in each row. Larvae are present in a brood pouch at the side of the branchial sac. The stomach has 8–10 folds which, on the dorsal side against the ascending rectum, are broken up into 2–3 sections.

Larvae (Text-fig. 16) are large, 0·9 mm. long. There are three suckers, with a single median ampulla between the dorsal and middle suckers and two median ampullae between between the middle and ventral suckers. There are numerous epidermal vesicles budding off from the anterior part of the larva in the region of the suckers and ampullae and extending posteriorly in the mid-dorsal and mid-ventral regions. The larvae are most reminiscent of *Aplidium proliferum* (Milne Edwards) (Kott, 1952*a*) from the English Channel. The epidermal vesicles are exceedingly numerous and it is interesting to note that species of this genus from Antarctic waters have very few of them.

Discussion.—Although the colony of *A. violaceum* described by Hartmeyer does not contain the sand scattered throughout the test, and the present specimens have lost any pigmentation, the zooids are similar in all features. The colonies and zooids are similar to *A. glabrum* Verrill and *A. californicum* (Ritter and Forsyth) and these species are undoubtedly closely related to the present colonies.

Aplidium savignyi Michaelsen *var. translucidum* nov. var.

Michaelsen, 1919.

Collection.—Sta. 43, 17° 29′ 00″ N., 55° 47′ 00″ E., Kuria Muria Islands, off southern Arabia. Otter trawl, 83–100 m., 28.x.33.

Previous Records.—Gulf of Suez (var. *typicum*).

Colony.—Rounded glassy lobes, 2 cm. high and 2 cm. in diameter. They are attached to the substrate by a narrow base. The test is completely transparent and soft and the zooids are clearly seen through it. Zooids are plentiful, opening radially around the surface of the lobe and extending into the base. No systems are evident.

Zooids are about 6 mm. long in the expanded state. The postabdomen is half of the body length and the thorax and abdomen are equal. The branchial aperture is on a short siphon and is six-lobed ; the atrial aperture is antero-dorsal and on a short siphon below a long undivided languet. There are 10–11 rows of stigmata on each side of the body, with about 20 in each row. The alimentary canal is long and it sometimes may be twisted as in *Polyclinum*. The stomach has 10–12 longitudinal folds.

Discussion.—These specimens are very closely related to *A. glabrum* Verrill from Arctic regions and *A. californicum* Ritter & Forsyth from California, and although the zooids are identical with those described for *A. savignyi* Michaelsen from the Red Sea, the test is different. The test in the present colonies is very like the transparent test in some species of *Polyclinum*, and it is interesting that some of the zooids in the present colonies have the intestine twisted so that the rectum crosses the oesophagus, also a characteristic of *Polyclinum*.

Despite the differences from *A. savignyi* noted above it does not seem advisable to separate the present specimens from it as specifically distinct ; the geographical area is the same and a separation of species on the basis of the nature of the test alone is unjustified ; moreover the species of this genus are very variable. It also seems unlikely that species from the Californian coast and from the Arctic region would occur off southern Arabia.

Sub-Order PHLEBOBRANCHIATA Lahille.

Family Ascidiidae Adams.

Subfamily Ascidiinae Herdman.

Ascidia melanostoma Sluiter.

Sluiter, 1886; Sluiter, 1904; Kott, 1952.

Collection.—Sta. A, 29° 17′ 00″ N., 32° 43′ 00″ E., Red Sea, Otter trawl, 65 m., 6.ix.33.

Previous Records.—East Indies; S.W. Australia.

External Characters.—The specimen is 9 cm. long and 5 cm. wide; the test is firm and black; the branchial aperture is terminal and the atrial aperture arises from the dorsal surface about $\frac{1}{3}$ of the distance from the anterior end.

Internal Characters.—The mantle musculature especially on the right side of the branchial sac is strong; the prebranchial area is very short and the stigmata of the branchial sac commence almost immediately posterior to the branchial tentacles. Although the prebranchial area is so short, it is covered with minute papillae. The dorsal tubercle is a simple U-shaped slit, placed well down in the peritubercular area; there are about 60 simple tentacles of varying sizes. The branchial sac is very long; the dorsal lamina is a toothed membrane, ribbed on the left-hand side, and the oesophagus opens half-way down the branchial sac. The branchial sac itself has papillae at the intersection of longitudinal and transverse vessels but there are no intermediate papillae; there are six stigmata in each mesh. The alimentary canal forms a double loop.

Discussion.—*Ascidia melanostoma* has not been taken previously in this area, although there is another, externally similar form, *Ascidia nigra* (Sav.) which has been recorded from the Red Sea and the Gulf of Aden. There is no question, however, of these two being synonyms, since *A. nigra* has the very distinctive character of separate openings of the dorsal tubercle into the branchial sac. Both forms occur in the same areas elsewhere and in those areas appear to behave as distinct species.

Ascidia malaca Traustedt.

For literature and synonymy see Michaelsen and Hartmeyer, 1928.

Collection.—Sta. 24, 11° 53′ 42″ N., 51° 13′ 12″ E., off Cape Guardafui. Conical dredge, 73–200 m., 9.x.33.

Previous Records.—Mediterranean; Fremantle, Western Australia.

External Characters.—This specimen is 7 cm. long and only 2 cm. wide. The test is whitish, semi-transparent, firm and gelatinous. The branchial aperture is terminal, fairly long and directed posteriorly; the atrial aperture is also terminal but is directed anteriorly.

Internal Characters.—There are fine longitudinal muscle bands in the mantle and an accumulation of circular muscles around the siphons. The dorsal tubercle, a simple U with outwardly directed horns, is present at the base of the atrial siphon, which arises a short distance down the branchial sac ; the stigmata of the branchial sac extend well up into the posteriorly directed part of the branchial siphon so that the prebranchial area is actually short and papillated. Therefore, although the branchial siphon externally appears long, it is in fact very short. There are about twenty-four branchial tentacles. The dorsal lamina is a double membrane in the anterior quarter of its length, but joins into a single membrane posterior to this ; it is ribbed on the right-hand side and has small pointed languets on the edge of the membrane at the end of each rib. There are occasional intermediate papillae in the branchial sac ; there are 6–7 stigmata in each mesh, but some of the stigmata are irregular and extend over more than one mesh. The oesophageal opening is terminal at the posterior end of the branchial sac. The alimentary canal is confined to the posterior quarter of the branchial sac and forms a double loop ; the stomach is long and spindle-shaped, with internal folds. The anus opens just anterior to the pole of the intestinal loop and has a lobed margin.

Discussion.—The posteriorly directed branchial siphon is characteristic of many species of this genus, particularly those with a rather thick, rigid, gelatinous test and especially of the *Phallusia*-type species with the separate openings of the dorsal tubercle into the branchial sac. Although this specimen is smaller than any previously referred to *A. malaca*, and the branchial siphon is not quite so long, the condition of the branchial siphon, the similarity of the branchial sac and alimentary canal and the situation of the atrial siphon are diagnostic of the species which appears to have a continuous distribution from the Mediterranean, through the Red Sea to the west coast of Australia.

II. Order PLEUROGONA (Huus).

Sub-Order STOLIDOBRANCHIATA (Lahille).

Family Styelidae Sluiter.

Styela canopus Savigny.

For literature and synonymy see Michaelsen, 1918*a*.

Collection.—Sta. A, 19° 17′ 00″ N., 32° 43′ 00″ E., Red Sea. Otter trawl, 65 m., 6.ix.33.

Previous Records.—Red Sea, Gulf of Suez.

Discussion.—One specimen only is present in the collection and this conforms with other descriptions previously given for the species. Although there are closely related forms present over a wide area, this particular species has very constant characters and exists, as far as present records show, in the very limited area of the Red Sea and the Gulf of Aden.

Polycarpa thelypanes (Sluiter).

Sluiter, 1904 ; Kott, 1952.

Collection.—Sta. 27, 11° 57′ 12″ N., 50° 35′ 00″ E., north of Cape Guardafui. Otter trawl, 37–91 m., 12.x.33.

Previous Records.—Sulu Archipelago ; Albany, Western Australia.

External Characters.—The present specimen is very damaged. The test is brittle with sand. The body is more or less oval and the two apertures on fairly long siphons are placed at either end of the upper surface. Both of these apertures are inclined slightly posteriorly.

INTERNAL CHARACTERS.—The mantle is very thin and with only weakly developed musculature. The branchial sac has four folds but the condition of the specimen did not enable the number of vessels on the folds to be counted : there are six longitudinal vessels between the folds and about four stigmata in each mesh ; these stigmata are fairly long and seem to be more regular than those previously described for this species. The alimentary canal describes a single wide loop which is confined to the posterior part of the body ; the stomach is elongate with longitudinal folds. Elongate polycarps are present in two rows around the ventral part of the body.

DISCUSSION.—There are differences in the branchial sac and the external appearance of this specimen compared with other specimens described and assigned to *P. thelypanes*. Sluiter's specimen had rudimentary folds ; the specimen from Western Australia has rounded, but well developed folds ; the present specimen appears to have well developed folds, which may in some way be an artefact of the flattened and damaged branchial sac ; this character, therefore, may be a variable one. Externally the specimen is very similar to *P. manaarensis* Herd. (Herdman, 1906) but internally is entirely different. Therefore, since the external appearance of many species is known to be affected by the environment, this also must be considered as probably variable within the species. The specimen is, however, identical with *P. thelypanes* in respect of its alimentary canal and gonads.

Polycarpa aurita (Sluiter).

For literature and synonymy see Kott, 1952.

COLLECTION.—Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 38 m., 29.x.33.

PREVIOUS RECORDS.—Malaya ; Cape Jaubert, Western Australia ; Barrier Reef, N.E. Australia.

DESCRIPTION AND DISCUSSION.—The only character in which the present specimen differs from previous descriptions of *P. aurita* is in having a dorsal tubercle with simple longitudinal slit. The elaborate dorsal tubercle described previously for the species, is however merely an elaboration of this single form, and the connective from the stomach to the intestine is distinctive. Cylindrical endocarps are present in the loop of the gut.

Polycarpa cryptocarpa (Sluiter).

Sluiter, 1885 ; Hartmeyer, 1906.

COLLECTION.—Sta. 53, 19° 22′ 36″ N., 57° 53′ 00″ E., off southern Arabia. Triangular dredge, 13·5 m., 2.xi.33. Sta. 45, 18° 03′ 30″ N., 57° 02′ 30″ E., off southern Arabia. Triangular dredge, 40 m., 29.x.33.

PREVIOUS RECORDS.—East Indies and Japan.

EXTERNAL CHARACTERS.—A large number of specimens are present from the above stations in large clumps of individuals ; some have a short stalk posteriorly but others are completely sessile. The test is leathery and smooth. The branchial and atrial apertures are both anterior and sessile. A living specimen matched in sunlight against a Ridgway colour chart was " Ochraceous Orange ".

INTERNAL CHARACTERS.—The mantle musculature is strong and the mantle strongly adherent to the test in the preserved animal. The branchial tentacles are long and slender, of varying lengths ; the dorsal tubercle is a large cushion with many apertures. The branchial sac has the following arrangement of longitudinal vessels : E2(8), 3(10), 3(9), 3(3), 1 DL, and there are 8–9 stigmata in the meshes between the folds. The alimentary canal encloses a circular endocarp and the anus is fringed by many small lobes. There are about 25 polycarps scattered over the body wall on the left and about twenty on the right.

DISCUSSION.—These specimens are very similar to *Polycarpa pedunculata* Heller (Kott, 1952) and belong to the " pedunculata " group of this genus, all with large endocarp enclosed by the loop of the alimentary canal. *Polycarpa mytiligera* (Sav.) (Michaelsen, 1918) is the species of this group previously reported from the Red Sea area, but it has, however, about 20 stigmata in the meshes between folds and has longer siphons. Therefore, although in *P. mytiligera* the dorsal tubercle has the same multiplicity of apertures as the *P. cryptocarpa*, the two are regarded as distinct.

Alleocarpa similis (Sluiter) ?

Sluiter, 1904.

COLLECTION.—Sta. 53, 19° 22′ 36″ N., 57° 53′ 00″ E. off southern Arabia. Triangular dredge, 13·5 m., 2.xi.33.

PREVIOUS RECORDS.—East Indies.

EXTERNAL CHARACTERS.—The zooids are 1–2 mm. long, dorso-ventrally flattened and enclosed in a colourless test investing the stalks of *Podoclavella detorta*. The test is very tough. Sometimes the zooids are very close together, but at other times they are well separated and there is a large extent of test with ramifying blood vessels between. The colony is very similar to those of species of *Chorizocarpa* (Herdman) (Herdman, 1899). The apertures are both on the upper surface of the zooid and are sessile.

INTERNAL CHARACTERS.—The branchial sac has four longitudinal vessels and no folds. There are about four stigmata between each longitudinal vessel and nine rows of long rectangular stigmata. The alimentary canal occupies the posterior half of the left side of the zooid and, due to dorso-ventral flattening, is ventrally situated ; it forms a double loop. The stomach is rounded with 12 well developed longitudinal folds and a large and curved coecum posteriorly No gonads are developed.

DISCUSSION.—As the zooids of this colony are smaller than those previously described for related species, and since there are no gonads present, the colonies are presumably very young and their identification is not certain. Despite similarities to *Chorizocarpa* spp. (Herdman) in respect of the branchial sac and the form of the colony, the gland of the alimentary canal differs ; instead of being branched and ramifying over the intestine, it is here a simple curved coecum. In this latter character it agrees with *Alleocarpa similis* (Sluiter) and this resemblance with similarities of the colony, gut and branchial sac seem to relate it more closely to this species than to any other.

Botrylloides nigrum Herdman.

For literature and synonymy see Kott, 1952.

COLLECTION.—Sta. 27, 11° 57′ 12″ N., 50° 35′ 00″ E., north of Cape Guardafui. Otter trawl, 37–91 m., 12.x.33.

Previous Records.—Red Sea, Mediterranean, Malaya, South Africa, Australia, north west Europe and North Atlantic.

Family Pyuridae Hartmeyer.

Herdmania momus (Sav.) var. *kyamanensis* Michaelsen.

For literature and synonymy see Michaelsen, 1918*a*.

Collection.—Sta. 27, 11° 57′ 12″ N., 50° 35′ 00″ E., north of Cape Guardafui. Otter trawl, 37–91 m., 12.x.33.

Previous Records.—Red Sea.

Discussion.—This form of a widely distributed species shares with *Styela canopus* Savigny the distinction of being one of the few species in this collection whose recorded distribution is limited to the Red Sea area. Unlike *S. canopus*, however, other varieties of the species with a wider distribution are also present in the area: *H. momus* var. *curvata* Kott (Kott. 1952) from north east Australia is synonymous with *H. momus* var. *typica* (Sav.) previously recorded only from the Red Sea area; and *H. momus* var. *pallida* (Heller) is present in the Gulf of Aden, Malaya, South Africa and the West Indies.

Sub-Order ASPIRICULATA Seeliger.

Family Hexacrobylidae. Seeliger.

Hexacrobylus sp.?

(Text-fig. 17.)

Collection.—Sta. 54, 21° 50′ 00″ N., 59° 52′ 00″ E., off southern Arabia. Agassiz dredge, 952 m., 3.xi.33. Sta. 185, off southern Arabia. Agassiz dredge, 2000 m., 5.v.34.

External Characters.—There are several individuals from the two stations. They are 0·5–1 cm. in diameter, and laterally flattened. The test is thin and transparent, but tough: posteriorly there is a thick mass of fine hair-like extensions of the test, tangled with some sand. The apertures are at opposite ends of the upper surface. The branchial aperture is surrounded by a thickened area of the test, about 3 mm. in diameter, and limited by six hollow extensions of the test (Text-fig. 17) into which muscular expansions of the mantle protrude. These extensions are as wide as they are long, have about three primary lobes and are secondarily indented many times and covered by thin hair-like processes. In the contracted condition, these lobes exactly fit together to cover the branchial aperture.

Internal Characters.—The zooids inside the test are hardened and indistinguishable. A small portion of the branchial sac, however, shows the large wide open meshes present in species described from deep water.

Discussion.—Due to the hardened and indistinguishable condition of the body of the zooid inside the test, these animals cannot be assigned with certainty to any previously described form. The branchial projections from the test are, however, distinctive and have been described only for this rare genus. This with the wide rectangular meshes of the branchial sac suggest that it may be a species of *Hexacrobylus*, of which there are records from Malaya (Sluiter, 1905) and Ceylon (Oka, 1913).

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BY

MAURICE BURTON, D.Sc.

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DEFINITION OF THE INDIAN OCEAN AREA

For the purposes of this report the Indian Ocean is arbitrarily delimited as follows. The Tropic of Capricorn is accepted as the southern boundary. To the east, the boundary starts at the junction of this Tropic with the coast of Africa, thence runs north to include the African coast, Red Sea (excluding the Suez Canal), Persian Gulf and the southern seaboard of Asia to the southern tip of the Malay Peninsula. Sumatra is also included and from the tip of Malaya southwards the western boundary follows the line of latitude 105° west to its junction with the Tropic of Capricorn.

Such an area does not represent a true zoogeographical area, and its use must be qualified by the knowledge that some species, typical of the Indian Ocean proper, may be found further south or east, along the coast of South Africa, in the Southern Ocean and east into the East Indian Archipelago. In addition, species proper to these adjoining areas will in some cases overlap with the Indian Ocean Area as here defined.

LIST OF SPECIES RECORDED FROM THE INDIAN OCEAN AREA, INCLUDING THOSE NEW WITH THIS REPORT

Order HEXACTINELLIDA.

(The list of species in this order is arranged according to the scheme given in Ijima, 1927, pp. 364–377.)

Sub-order Amphidiscophora.

Family Pheronematidæ.

Genus *Pheronema* Leidy.

P. raphanus Schulze.
P. carpenteri (Thomson).
P. giganteum Schulze.

Genus *Semperella* Gray.

S. cucumis Schulze.

Genus *Platylistrum* Schulze.

P. platessa Schulze.

Family Monorhaphidæ.

Genus *Monorhaphis* Schulze.

M. chuni Schulze.
M. dives Schulze.

Family Hyalonematidæ.

Genus *Hyalonema* Gray.

H. proximum Schulze.
H. aculeatum Schulze.
H. heideri Schulze.
H. lamella Schulze.
H. indicum Schulze.
H. indicum laccadivense Schulze.
H. indicum andamense Schulze.
H. heymousi Schulze.
**H. affine* Brandt.
H. pirum Schulze.
H. tulipa Schulze.
H. nicobaricum Schulze.
H. nicobaricum nicobaricum Schulze.
H. nicobaricum somalicum Schulze.
H. molle Schulze.
H. coniforme Schulze.
H. simile Schulze.
H. valdiviæ Schulze.
H. rapa Schulze.
H. globiferum Schulze.
H. martabanense Schulze.
H. alcocki Schulze.
H. investigatoris Schulze.
H. urna Schulze.
H. solutum Schulze.
H. validum Schulze.
H. masoni Schulze.
H. weltneri Schulze.

Genus *Compsocalyx* Schulze.

C. gibberosa Schulze.

Genus *Lophophysema* Schulze.

L. inflatum Schulze.

Sub-order Hexasterophora.

Tribe Hexactinosa.

Sub-tribe Clavularia.

*This is called *H. apertum* by Ijima (1927) who, throughout a long discourse on the species does not mention *H. affine* Brandt, nor do Brandt's works figure in Ijima's list of literature referred to.

Family FARREIDÆ.

Genus *Farrea* Bowerbank.

F. occa occa Bowerbank.
F. occa erecta Ijima.
F. spirifera Ijima.

Genus *Sarostegia* Topsent.

S. oculata Topsent.

Sub-tribe SCOPULARIA.

Family EURETIDÆ.

Genus *Pleurochorium* Schrammen.

P. annandalei (Kirkpatrick).

Genus *Myliusia* Gray.

M. verrucosa Ijima.

Family AULOCALYCIDÆ Ijima.

Genus *Aulocalyx* Schulze.

A. serialis Dendy.

Genus *Rhabdodictyum* Schmidt.

R. delicatum Schmidt.

Family APHROCALLISTIDÆ Gray.

Genus *Aphrocallistes* Gray.

A. beatrix Gray.
(*A. bocagei* Wright and *A. ramosus* Schulze are treated as synonyms of *A. beatrix* in this present report.)

Tribe LYCHNISCOSA.

Family AULOCYSTIDÆ.

Genus *Aulocystis* Schulze.

A. zitteli zitteli Marshall and Meyer.
A. grayi grayi (Bowerbank).
A. grayi polæ (Ijima).

Tribe LYSSACINOSA.

Family LEUCOPSACASIDÆ.

Genus *Placoplegma* Schulze.

P. solutum Schulze.

Genus *Chaunangium* Schulze.

C. crater Schulze.

Family EUPLECTELLIDÆ.

Genus *Euplectella* Owen.

E. aspergillum Owen.
E. regalis Schulze.
E. simplex Schulze.
?*E. aspera* Schulze.
?*E. cucumer* Owen.
?*E. suberea* Thomson.

Genus *Holascus* Schulze.

H. fibulatus Schulze.
H. robustus Schulze.
H. tener Schulze.

Genus *Regadrella Schmidt.*

R. decora Schulze.
R. phœnix Schmidt.

Genus *Dictyaulus Schulze.*

D. elegans Schulze.

Genus *Saccocalyx* Schulze.

S. pedunculata Schulze.

Family CAULOPHACIDÆ.

Genus *Sympagella* Schmidt.

S. johnstoni (Schulze).

Family ROSSELLIDÆ.

Genus *Lophocalyx* Schulze.

L. spinosa Schulze.

Genus *Bathydorus* Schulze.

B. lævis Schulze.

Order CALCAREA

(The list of species in this order is arranged according to the scheme given by Dendy and Row, 1913.)

Family HOMOCŒLIDÆ.

Genus *Leucosolenia* Bowerbank.

L. canariensis (Michlucho-Maclay).
L. coriacea (Montagu).
L. darwinii Haeckel.
L. gardineri Dendy.
L. irregularis Jenkin.
L. tenuipilosa Dendy.

Genus *Dendya* Bidder.

D. prolifera Dendy.

Family LEUCASCIDÆ.

Genus *Leucetta* Haeckel.

L. chagosensis Dendy.
L. primigenia Haeckel.
L. pyriformis Dendy.

Genus *Pericharax* Poléjaeff.

P. heteroraphis (Poléjaeff).

Family LEUCALTIDÆ.

Genus *Leucaltis* Haeckel.

L. clathria Haeckel.

Family MINCHINELLIDÆ.

Genus *Plectroninia* Hinde.

P. deansii Kirkpatrick.

Family MURRAYONIDÆ.

Genus *Murrayona* Kirkpatrick.

M. phanolepis Kirkpatrick.

Family SYCETTIDÆ Dendy.

Genus *Sycetta* Haeckel.

S. sagittifera Haeckel.

Genus *Sycon* Risso.

S. proboscideum (Haeckel).
S. raphanus Schmidt.
S. tabulatum (Schuffner).
S. munitum Jenkin.

Family HETEROPIIDÆ.

Genus *Grantessa* Lendenfeld.

G. glabra Row.
G. hastifera (Row).
G. simplex Jenkin.
G. stauridia (Haeckel).
G. sycilloides (Schuffner).

Genus *Heteropia* Carter.

H. glomerosa (Bowerbank).

Genus *Grantilla* Row.

G. quadriradiata Row.

Family Grantiidæ.

Genus *Grantia* Fleming.

G. indica Dendy.

Genus *Leuconia* Grant.

L. anguinea (Ridley).
L. bathybia (Haeckel).
L. claviformis (Schuffner).
L. donnani (Dendy).
L. echinata (Schuffner).
L. falcigera (Schuffner).
L. infesta Row.
L. innominata Row.
L. pulvinar (Haeckel).
L. wasinensis (Jenkin).

Genus *Aphroceras* Gray.

A. alcicornis Gray.

Genus *Paraleucilla* Dendy.

P. cucumis (Haeckel).

Family Amphoriscidæ.

Genus *Leucilla* Haeckel.

L. proteus Dendy.

Family Lelapiidæ.

Genus *Kebira* Row.

K. uteoides Row.

Order TETRAXONIDA.

Sub-order Homosclerophora.

Family Plakinidæ.

Genus *Acanthoplakina* **gen. n.**

A. spinosa (Kirkpatrick).

Genus *Astroplakina* Dendy and Burton.

A. stelligera Dendy and Burton.

Genus *Dercitopsis* Dendy.

D. ceylonica Dendy.
D. clathrata (Kirkpatrick).

Genus *Plakortis* Schulze.

P. simplex Schulze.

Genus *Thrombus* Sollas.

T. ornatus Schulze.

Sub-order STREPTASTROSCLEROPHORA.

Family PACHASTRELLIDÆ.

Genus *Yodomia* Lebwohl.

Y. perfecta Dendy.

Genus *Pachastrella* Schmidt.

P. monilifera Schmidt.

Genus *Pœcillastra* Sollas.

P. eccentrica Dendy and Burton.
P. schulzei (Sollas).

Genus *Sphinctrella* Schmidt.

S. annulata (Carter).
S. gracilis (Sollas).
S. theneides **sp. n.**

Family THENEIDÆ.

Genus *Thenea* Gray.

T. muricata (Bowerbank).
T. grayi Sollas.
T. wyvillii Sollas.
T. centrotyla Lendenfeld.

Sub-order ASTROSCLEROPHORA.

Family STELLETTIDÆ.

Genus *Stelletta* Schmidt.

S. purpurea Ridley.
S. herdmani Dendy.
S. mauritiana (Dendy).

Genus *Ecionemia* Bowerbank.

E. acervus Bowerbank.

Genus *Penares* Gray.

P. intermedia (Dendy).

Family Geodiidæ.

Genus *Geodia* Lamarck.

G. perarmata Bowerbank.
G. globostellifera Carter.
G. areolata Carter.
G. sphæroides (Kieschnick).

Genus *Pachymatisma* Bowerbank.

P. bifida **sp. n.**

Genus *Erylus* Gray.

E. lendenfeldi Sollas.

Family Chondrosiidæ.

Genus *Chondrilla* Schmidt.

C. australiensis Carter.

Genus *Chondrosia* Nardo.

C. reniformis Nardo.

Family Tetillidæ.

Genus *Tetilla* Schmidt.

T. cranium (Müller).
T. oxeata **sp. n.**

Genus *Chrotella* Sollas.

C. cavernosa (Lamarck).
C. eurystoma (Keller).

Genus *Paratetilla* Dendy.

P. bacca (Selenka).

Genus *Fangophilina* Schmidt.

F. submersa Schmidt.

Genus *Acanthotetilla* **gen. n.**

A. hemisphærica **sp. n.**

Family Clavulidæ.

Genus *Suberites* Nardo.

S. domuncula (Olivi).
S. ramulosus Ridley and Dendy.
S. kelleri Burton.

Genus *Pseudosuberites* Topsent.

P. hyalinus (Ridley and Dendy).

Genus *Laxosuberites* Topsent.

L. longispiculus **sp. n.**

Genus *Tentorium* Vosmaer.

T. semisuberites (Schmidt).

Genus *Tentorina* **gen. n.**

T. sigmatophora **sp. n.**

Genus *Polymastia* Bowerbank.

P. tubulifera Dendy.
P. murrayi **sp. n.**
P. clavata **sp. n.**

Genus *Radiella Schmidt.*

R. sarsii (Ridley and Dendy).

Genus *Spirastrella* Schmidt.

S. cuspidifera (Lamarck).
S. spinispirulifer (Carter).

Genus *Diplastrella* Topsent.

D. gardineri Topsent.

Genus *Timea* Gray.

T. capitatostellifera (Carter).
T. tethyoides **sp. n.**
T. spherastræa **sp. n.**

Genus *Trachycladus* Carter.

T. tethyoides **sp. n.**
T. cervicornis **sp. n.**

Genus *Placospongia* Gray.

P. carinata (Bowerbank).

Family Astraxinellidæ.

Genus *Hemiasterella* Carter.

H. typus Carter.
H. complicata Topsent.

Family Tethyadæ.

Genus *Tethya* Lamarck.

T. repens Schmidt.

Sub-order Lithistida.

(Since the sub-order is here regarded as a polyphyletic and artificial group, see Burton, 1929, pp. 1–12, no attempt is made to apportion the species to families.)

Genus *Discodermia* Bocage.

D. natalensis Kirkpatrick.
D. emarginata Dendy.

Genus *Theonella* Gray.

T. lacerata Lendenfeld.
T. discifera Lendenfeld.
T. pulchrifolia Dendy.

Genus *Corallistes* Schmidt.

C. bowerbanki (Johnson).

Genus *Taprobane* Dendy.

T. herdmani Dendy.

Genus *Microscleroderma* Kirkpatrick.

M. hirsutum (Kirkpatrick).

Sub-order Sigmatosclerophora.

Family Haplosclеridæ.

Genus *Haliclona* Grant.

H. camerata (Ridley).
H. cribriformis (Ridley).
H. flagellifer (Ridley and Dendy).
H. cf. *ochracea* (Keller).
H. contignata (Thiele).
H. irregularis (Kirkpatrick).
H. expansa (Thiele).
H. obtusispiculifera (Dendy).
H. decidua (Topsent).
H. tabernacula (Row).
H. seychellensis (Dendy).
H. tuberosa (Dendy).
H. cerebrum (Burton).
H. carteri **sp. n.**

Genus *Adocia* Gray.

A. sagittarius (Sollas).
A. fibulatus (Schmidt), var. *microsigma* (Dendy).
A. pigmentifera (Dendy).
A. digitata (Baer).
A. cf. *semifibrosa* (Dendy).
A. tufoides (Dendy).

Genus *Petrosia* Vosmaer.

P. testudinaria (Lamarck).
P. mauritiana (Carter).
P. nigricans Lindgren.

Genus *Oceanapia* Gray.

O. putridosum (Lamarck).
O. fistulosa (Bowerbank).
O. canalis (Ridley).
O. elastica (Keller).
O. media (Thiele).
O. zoologica (Dendy).
O. incrustata (Dendy).
O. cf. *cagayense* (Wilson).

Genus *Callyspongia* Duchassaing and Michelotti.

C. diffusa (Ridley).
C. subarmigera (Ridley).
C. confœderata (Ridley).
C. fibrosa (Ridley and Dendy).
C. spinosissima (Dendy).
C. clathrata (Dendy).
C. barodensis **sp. n.**
C. rowi **sp. n.**

Genus *Gelliodes* Ridley.

G. fibulatus Ridley.

Family Desmacidonidæ.

Sub-family Mycalinæ.

Genus *Biemna* Gray.

B. fortis (Topsent).
B. trirhaphis (Topsent).
B. ciocalytoides **sp. n.**

Genus *Desmacella* Schmidt.

D. annexa Schmidt.

Genus *Mycale* Gray.

M. sulevoidea (Sollas).
M. murrayi (Ridley and Dendy).
M. sulcata (Hentschel).
M. massa (Schmidt), var *oceanica* Topsen
M. topsenti **sp. n.**

Genus *Hamacantha* Gray.

H. mindanaensis Wilson.
H. simplex **sp. n.**

Genus *Guitarra* Carter.

G. fimbriata Carter.

Sub-family Myxillinæ.

Genus *Myxilla* Schmidt.

M. simplex (Baer).
M. dendyi **sp. n.**

Genus *Lissodendoryx* Topsent.

L. ciocalyptoides **sp. n.**
L. damirioides **sp. n.**
L. tubicola **sp. n.**

Genus *Ectyodoryx* Lundbeck.

E. rhaphidiophora **sp. n.**
E. coralliophila **sp. n.**

Genus *Hymedesmia* Bowerbank.

H. murrayi **sp. n.**

Genus *Phorbas* Duchassaing and Michelotti.

P. styliferus **sp. n.**

Genus *Desmapsamma* Burton.

D. anchorata (Carter).

Genus *Iotrochota* Ridley.

I. baculifera Ridley.

Genus *Acanthancora* Topsent.

A. stylifera **sp. n.**

Genus *Damirina* **gen. n.**

D. verticillata **sp. n.**

Genus *Tedania* Gray.

T. nigrescens (Schmidt).

Genus *Strongylacidon* Lendenfeld.

S. inaequalis (Hentschel).

Genus *Lithoplocamia* Dendy.

L. lithistoides Dendy.

Genus *Agelas* Duchassaing and Michelotti.

A. mauritianus (Carter).

Sub-family CLATHRIINÆ.

Genus *Clathria* Schmidt.

C. frondifera (Bowerbank).
C. aculeata Ridley.
C. procera (Ridley).
C. maeandrina Ridley.
C. mixta Hentschel.
C. spicata Hallmann.
C. transiens Hallmann.
C. whiteleggii Dendy.
C. spongiosa **sp. n.**

Genus *Ophlitaspongia* Bowerbank.

O. minor **sp. n.**

Genus *Microciona* Bowerbank.

M. affinis Carter.
M. longitoxa (Hentschel).
M. rhopalophora (Hentschel).
M. densa **sp. n.**
M. longistyla **sp. n.**
M. anonyma **sp. n.**

Genus *Echinodictyum* Ridley.

E. nervosum Ridley.
E. jousseaumei Topsent.

Genus *Antho* Gray.

A. tawiensis (Wilson).

Genus *Echinoplocamia* **gen. n.**

E. arbuscula **sp. n.**

Genus *Acarnus* Gray.

A. topsenti Dendy.

Genus *Plocamilla* Topsent.

P. manaarensis (Carter).

Sub-family RASPELIINÆ.

Genus *Aulospongus* Norman.

A. tubulatus (Bowerbank).

Genus *Rhabderemia* Topsent.

R. indica Dendy.

Genus *Endectyon* Topsent.

E. thurstoni (Dendy).

Genus *Hemectyonilla* **gen. n.**

H. involutum (Kirkpatrick).

Genus *Higginsia* Higgin.

H. petrosioides Dendy.
H. robusta **sp. n.**

Genus *Raspailopsis* **gen. n.**

R. cervicornis **sp. n.**

Family Axinellidæ.

Genus *Amorphinopsis* Carter.

A. megalorhaphis (Carter).

Genus *Axinella* Schmidt.

A. carteri (Dendy).
A. lamellata (Dendy).
A. agariciformis (Dendy).
A. durissima (Dendy).
A. conulosa (Dendy).
A. bidderi **sp. n.**
A. ventilabrum **sp. n.**
A. flabello-reticulata **sp. n.**
A. dragmaxioides **sp. n.**
A. massalis **sp. n.**

Genus *Phakellia* Bowerbank.

P. radiata (Dendy).

Genus *Hymeniacidon* Bowerbank.

H. virgultosa (Carter).
H. variospiculata Dendy.

Genus *Ciocalypta* Bowerbank.

C. penicillus Bowerbank.

Genus *Collocalypta* Dendy.

C. digitata Dendy.

Genus *Sigmaxinella* Dendy.

S. megastyla **sp. n.**

Genus *Stylissa* Hallmann.

S. massa (Carter).
S. coccinea (Keller).

Genus *Ptilocaulis* Carter.

P. spiculifera (Lamarck).

Genus *Raspaigella* Schmidt.

R. salomonensis (Dendy).

R. dendyi **sp. n.**

R. ? *suluensis* (Wilson).

Genus *Pseudaxinyssa* Burton.

P. tenuispiculata Burton.

Order Keratosa.

Genus *Darwinella* Müller.

D. simplex Topsent.

Genus *Aplysina* Nardo.

A. euplectella (Hentschel).

A. mollis Row.

A. primitiva **sp. n.**

Genus *Aplysinopsis* Lendenfeld.

A. reticulata Hentschel.

Genus *Druinella* Lendenfeld.

D. ramosa Thiele.

Genus *Megalopastas* Dendy.

M. retiaria Dendy.

Genus *Spongia* Linnaeus.

S. officinalis Linnaeus.

Genus *Spongionella* Bowerbank.

S. pulvilla (Dendy).
S. nigra Dendy.
S. frondosa (Hentschel).

Genus *Psammaplysilla* Keller.
P. arabica Keller.

Genus *Cacospongia* Schmidt.

C. herdmani (Dendy).
C. symbiotica **sp. n.**

Genus *Dysidea* Johnston.

D. fragilis (Montagu).
D. cinerea Keller.

Genus *Euryspongia* Row.

E. lactea Row.

Genus *Hircinia* Nardo.

H. arenosa Lendenfeld.
H. aruensis Hentschel.

Genus *Carteriospongia* Hyatt.

C. cordifolia Keller.

List of Species Obtained by the John Murray Expedition, in Systematic Order, with Numbers of Stations and Depths.

Name.	Station.	Depth in m.
Pheronema giganteum	122	745
Semperella cucumis	145	494
Monorhaphis dives	119	1204
Monorhaphis sp.	118	1789
Hyalonema affine	176	695
Farrea spirifera	157	229
Farrea occa subsp. *erecta*	162	1829
Sarostegia oculata	42, 54, 152, 153, 162	1415, 1046, 878, 256, 1829
Pleurochorium annandalei	152	878
Myliusia verrucosa	109	640
Aphrocallistes beatrix	54, 108	1046, 781
Placoplegma solutum	54	1046
Euplectella simplex	145	494
Holascus fibulatus	145	494
Leucosolenia gardineri	43	95
Leucetta pyriformis	148	27
Grantessa zanzibaris	10	55
Grantessa sycilloides	24	73–220
Grantessa glabra	43	95
Sycon munitum	24	73–220
Leuconia wasinensis	45	38
Dercitopsis ceylonica	111	Probably between 73–165
Dercitopsis minor	24, 45	73–220, 38
Yodomia perfecta	157	229
Pachastrella monilifera	112, 152, 153, 157	113, 878, 256, 229
Pœcillastra schulzii	123, 157	256–366, 229
Sphinctrella gracilis	89, 123, 177	193, 256–366, 366
Sphinctrella theneides	152	878
Thenea centrotyla	145	494
Thenea grayi	108	781
Thenea muricata	122	745
Thenea wyvillii	177	366
Stelletta purpurea	53	13·5
Stelletta herdmani	45, 111, 112	38, unknown, 113
Stelletta mauritiana	45	38
Ecionemia acervus	45, 111, 112	38, unknown, 113
Penares intermedia	111	depth unknown
Geodia perarmata	27, 45, 112	37, 38, 113
Geodia globostellifera	43	95
Geodia areolata	24, 27, 45, 53, 145	73–220, 37, 38, 13·5
Geodia sphæroides	89, 152	193, 878
Pachymatisma bifida	157	229

Name.	Station.	Depth in m.
Erylus ledenfeldi	111	Depth unknown
Chondrilla australiensis	45	38
Chondrosia reniformis	53	13·5
Tetilla cranium	45, 53	38, 13·5
Tetilla oxeata	43	95
Chrotella cavernosa	27, 43	37, 95
Chrotella eurystoma	24, 45	73–220, 38
Paratetilla bacca	45	38
Fangophilina submersa	106	212
Acanthotetilla hemisphærica	45	38
Suberites domuncula	175	1618
Suberites ramulosus	43, 54, 157	95, 1046, 229
Suberites kelleri	24	73–220
Pseudosuberites hyalinus	194	220
Laxosuberites longispiculus	157	229
Tentorium semisuberites	108	781
Tentorina sigmatophora	157	229
Polymastia tubulifera	53	13·5
Polymastia murrayi	157, 177, 185	229, 366, 2001
Polymastia clavata	24	73–220
Radiella sarsii	108, 145 E	781–494
Spirastrella cuspidifera	45, 53, 111	38, 13·5, unknown
Spirastrella spinispirulifer	111	73–165
Diplastrella gardineri	111, 117	73–165, 366
Timea capitatostellifera	111	73–165
Timea tethyoides	112	113
Timea spherastræa	111	Depth ?
Trachycladus tethyoides	24	73–220
Trachycladus cervicornis	24	73–220
Placospongia carinata	45	38
Hemiasterella typus	27	37
Hemiasterella complicata	24	73–220
Tethya repens	45, 53, 112, 152	38, 13·5, 113, 878
Discodermia natalensis	111	73–165
Discodermia emarginata	123	256–366
Theonella lacerata	43	95
Theonella discifera	45, 111	38, 73–165
Theonella pulchrifolia	157	229
Corallistes bowerbanki	123	256–366
Taprobane herdmani	27, 45	37, 38
Microscleroderma hirsutum	45	38
Haliclona camerata	10	55
Haliclona cribriformis	53, 111	13·5, 73–165
Haliclona flagellifer	M.B. I (d), 157	26, 229
Haliclona cf. *ochracea*	9	245
Haliclona contignata	10, 24, 111	55, 73–220 (? 73–165)
Haliclona irregularis	24, 111, 157	73–220, 73–165, 229
Haliclona expansa	157	229
Haliclona obtusispiculifera	D	23
Haliclona decidua	110	73–165
Haliclona tabernacula	45	38
Haliclona seychellensis	45, 112	38, 113
Haliclona tuberosa	45	38
Haliclona cerebrum	111	73–165
Haliclona carteri	27, 45	37, 38
Adocia sagittarius	139	57

Name.	Station.	Depth in m.
Adocia fibulatus var. *microsigma*	141	44
Adocia pigmentifera	10	55
Adocia digitata	111	73–165
Adocia cf. *semifibrosa*	27	37
Adocia tufoides	157	229
Petrosia testudinaria	10, 111	55, 73–165
Petrosia mauritiana	111	73–165
Petrosia nigricans	9, 10, 111, 157	245, 55, (? 73–165) 229
Oceanapia putridosum	144	31
Oceanapia fistulosa	45	38
Oceanapia canalis	45	38
Oceanapia elastica	139	57
Oceanapia media	111	73–165
Oceanapia zoologica	111, 112	Unknown, 113
Oceanapia incrustata	11	207
Oceanapia cf. *cagayense*	112	113
Callyspongia diffusa	24, 111	73–220, unknown
Callyspongia subarmigera	M.B. L (d), 45, 111, M.B. (b)	26, 38, 73–165, 29
Callyspongia confœderata	45, 53	38, 13·5
Callyspongia fibrosa	27, 45, 53	37, 38, 13·5
Callyspongia spinosissima	24, 45, 50, 53	73–220, 38, 1939, 13·5
Callyspongia clathrata	A	65
Callyspongia barodensis	45	38
Callyspongia rowi	45	38
Gelliodes fibulatus	27	37
Biemna fortis	24, 27	73–220, 37
Biemna trirhaphis	10	55
Biemna ciocalyptoides	27	37
Desmacella annexa	122	732
Mycale sulevoidea	M.B. I (d)	26
Mycale murrayi	24	73–220
Mycale sulcata	24, 53, 112	73–220, 13·5, 113
Mycale massa var. *oceanica*	54	1046
Mycale topsenti	54	1046
Hamacantha mindanaensis	152, 157	878, 229
Hamacantha simplex	157	229
Guitarra fimbriata	11, 177	207, 366
Myxilla simplex	24	73–220
Myxilla dendyi	27, 45	37, 38
Lissodendoryx ciocalyptoides	177	366
Lissodendoryx damirioides	54	1046
Lissodendoryx tubicola	54	1046
Ectyodoryx rhaphidiophora	24	73–220
Ectyodoryx coralliophila	54, 157	1046, 229
Hymedesmia murrayi	111	73–165
Phorbas styliferus	24	73–220
Desmapsamma anchorata	111	73–165
Iotrochota baculifera	10, M.B. I (d)	55, 26
Acanthancora stylifera	45	38
Damirina verticillata	112	113
Tedania nigrescens	9, 10, 27	245, 55, 37
Strongylacidon inaequalis	M.B. I (b)	26
Lithoplocamia lithistoides	9, 45	245, 38
Agelas mauritianus	27	37
Clathria frondifera	M.B. I (d)	26
Clathria aculeata	10, M.B. I (d), 45	55, 29, 38

Name.	Station.	Depth in m.
Clathria procera	M.B. I (d), M.B. I (b)	26, 26
Clathria maeandrina	M.B. I (d)	26
Clathria mixta	53	13·5
Clathria spicata	27	37
Clathria transiens	M.B. I (b)	29
Clathria whiteleggii	24, 27, M.B. II (c)	73–200, 37, 29
Clathria spongiosa	9, 27	245, 38
Ophlitaspongia minor	89	193
Microciona affinis	45, 112	28, 113
Microciona longitoxa	24	73–220
Microciona rhopalophora	157	229
Microciona densa	45	38
Microciona longistyla	45	38
Microciona anonyma	111	73–165
Echinodictyum nervosum	53	13·5
Echinodictyum jousseaumei	9	245
Antho tawiensis	43, 89	95, 193
Echinoplocamia arbuscula	177	366
Plocamilla manaarensis	89	193
Acarnus topsenti	45	38
Aulospongus tubulatus	27, 53	37, 13·5
Rhabderemia indica	27, 209	37, 366
Endectyon thurstoni	45	38
Hemectyonilla involutum	27, 24, 45, 185	37, 73–220, 38, 2001
Higginsia petrosioides	45	38
Higginsia robusta	27, 35, 45	37, 441, 38
Raspailopsis cervicornis	27, 45, 53, 111	37, 38, 13·5, 73–165
Amorphinopsis megalorhaphis	43, 45, 53, 111	95, 38, 13·5, 73–165
Axinella carteri	53	13·5
Axinella lamellata	45	38
Axinella agariciformis	45	38
Axinella durissima	M.B. I (G), 27, 45, 112	26, 37, 38, 113
Axinella conulosa	112	113
Axinella bidderi	35, 45, 54	441, 38, 1046
Axinella ventilabrum	112	113
Axinella flabello-reticulata	112	113
Axinella dragmaxioides	45	38
Axinella massalis	112	113
Phakellia radiata	9, 27, 45, 89, 111, 112	245, 37, 38, 193, (? 73–165), 113
Hymeniacidon virgultosa	27, 45	37, 38
Hymeniacidon variospiculata	45	38
Ciocalypta penicillus	161	46
Collocalypta digitata	112	113
Sigmaxinella megastyla	24	73–220
Stylissa massa	53	13·5
Stylissa coccinea	53	13·5
Ptilocaulis spiculifera	151	101
Raspaigella salomonensis	112	113
Raspaigella ? suluensis	112	113
Raspaigella dendyi	45, 112	38, 113
Pseudaxinyssa tenuispiculata	45	38
Darwinella simplex	45	38
Aplysina euplectella	24	73–220
Aplysina mollis	45	38
Aplysina primitiva	111	73–165

Name.	Station.	Depth in m.
Aplysinopsis reticulata	111	Depth unknown
Druinella ramosa	45	38
Megalopastas retiaria	53	13·5
Spongia officinalis	43	95
Spongionella pulvilla	45	38
Spongionella nigra	27, 45	37, 38
Spongionella frondosa	45	38
Psammaplysilla arabica	M.B. I (d)	26
Cacospongia herdmani	45, 53	38, 13·5
Cacospongia symbiotica	45	38
Dysidea fragilis	24, 45, 109	73–220, 38, 640
Dysidea cinerea	112	113
Euryspongia lactea	45	38
Hircinia arenosa	45, 53	38, 13·5
Hircinia aruensis	53	13·5
Carteriospongia cordifolia	45	38

Analysis of Species Obtained by the John Murray Expedition, Showing Depths and Species Obtained.

Station.	Depth in m.	Name.
53	13·5	*Stelletta purpurea.*
		Geodia areolata.
		Chondrosia reniformis.
		Tetilla cranium.
		Spirastrella cuspidifera.
		Tethya repens.
		Haliclona cribriformis.
		Callyspongia confoederata.
		Callyspongia fibrosa.
		Callyspongia spinosissima.
		Mycale sulcata.
		Clathria mixta.
		Echinodictyum nervosum.
		Aulospongus tubulatus.
		Raspailopsis cervicornis.
		Amorphinopsis megalorhaphis.
		Axinella carteri.
		Stylissa massa.
		Stylissa coccinea.
		Megalopastas retiaria.
		Cacospongia herdmani.
		Hircinia arenosa.
		Hircinia aruensis.
M.B. I (d)	23	*Callyspongia subarmigera.*
		Haliclona obtusispiculifera.
M.B. I (d)	26	*Haliclona flagellifer.*
		Mycale sulevoidea.
		Iotrochota baculifera.
		Clathria aculeata.
		Clathria procera.
		Clathria maeandrina.
		Psammaplysilla arabica.

Station.		Depth in m.		Name.
M.B. I (b)	.	29	.	*Callyspongia subarmigera.*
				Clathria transiens.
				Clathria procera.
				Strongylacidon inaequalis.
M.B. I (c)	.	26	.	*Axinella durissima.*
148	.	27	.	*Leucetta pyriformis.*
M.B. II (c)	.	29	.	*Clathria whiteleggii.*
144	.	31	.	*Oceanapia putridosum.*
27	.	37	.	*Geodia perarmata.*
				Geodia areolata.
				Chrotella cavernosa.
				Hemiasterella typus.
				Taprobane herdmani.
				Haliclona carteri.
				Callyspongia fibrosa.
				Gelliodes fibulatus.
				Biemna fortis.
				Biemna ciocalyptoides.
				Myxilla dendyi.
				Tedania migrescens.
				Agelas mauritianus.
				Clathria spicata.
				Clathria whiteleggii.
				Clathria spongiosa.
				Aulospongus tubulatus.
				Rhabderemia indica.
				Hemectyonilla involutum.
				Higginsia robusta.
				Raspailopsis cervicornis.
				Axinella durissima.
				Phakellia radiata.
				Hymeniacidon virgultosa.
				Spongionella nigra.
45	.	38	.	*Leuconia wasinensis.*
				Dercitopsis minor.
				Stelletta mauritiana.
				Ecionemia acervus.
				Geodia perarmata.
				Geodia areolata.
				Chondrilla australiensis.
				Tetilla cranium.
				Paratetilla bacca.
				Acanthotetilla hemisphærica.
				Spirastrella cuspidifera.
				Placospongia carinata.
				Tethya repens.
				Theonella discifera.
				Taprobane herdmani.
				Microscleroderma hirsutum.
				Haliclona tabernacula.
				Haliclona seychellensis.
				Haliclona tuberosa.
				Haliclona carteri.
				Oceanapia fistulosa.
				Oceanapia canalis.
				Callyspongia subarmigera.

Station.	Depth in m.	Name.
		Callyspongia confœderata.
		Callyspongia fibrosa.
		Callyspongia spinosissima.
		Callyspongia barodensis.
		Callyspongia rowi.
		Acanthancora stylifera.
		Lithoplocamia lithistoides.
		Clathria aculeata.
		Microciona affinis.
		Microciona densa.
		Microciona longistyla.
		Acarnus topsenti.
		Endectyon thurstoni.
		Hemectyonilla involutum.
		Higginsia petrosioides.
		Higginsia robusta.
		Raspailopsis cervicornis.
		Amorphinopsis megalorhaphis.
		Axinella lamellata.
		Axinella agariciformis.
		Axinella durissima.
		Axinella bidderi.
		Axinella dragmaxioides.
		Phakellia radiata.
		Hymeniacidon virgultosa.
		Hymeniacidon variospiculata.
		Raspaigella dendyi.
		Pseudaxinyssa tenuispiculata.
		Darwinella simplex.
		Aplysina mollis.
		Druinella ramosa.
		Spongionella pulvilla.
		Spongionella nigra.
		Spongionella frondosa.
		Cacospongia herdmani.
		Cacospongia symbiotica.
		Dysidea cinerea.
		Hircinia arenosa.
		Carteriospongia cordifolia.
141 .	44 .	*Adocia fibulatus* var. *microsigma.*
161 .	46 .	*Ciocalypta penicillus.*
10 .	55 .	*Grantessa zanzibaris.*
		Haliclona camerata.
		Haliclona contignata.
		Adocia pigmentifera.
		Petrosia nigricans.
		Biemna trirhaphis.
		Iotrochota baculifera.
		Tedania nigrescens.
		Clathria aculeata.
139 .	57 .	*Oceanapia elastica.*
		Adocia sagittarius.
A .	65–68 .	*Callyspongia clathrata.*
43 .	95 .	*Leucosolenia gardineri.*
		Grantessa glabra.
		Geodia globostellifera.

Station.	Depth in m.	Name.
		Tetilla oxeata.
		Chrotella cavernosa.
		Suberites ramulosus.
		Theonella lacerata.
		Antho tawiensis.
		Amorphinopsis megalorhaphis.
		Spongia officinalis.
151	101	*Ptilocaulis spiculifera.*
112	113	*Stelletta herdmani.*
		Ecionemia acervus.
		Geodia perarmata.
		Timea tethyoides.
		Damirina verticillata.
		Microciona affinis.
		Axinella durissima.
		Axinella conulosa.
		Axinella ventilabrum.
		Axinella flabello-reticulata.
		Axinella massalis.
		Phakellia radiata.
		Collocalypta digitata.
		Raspaigella salomonensis.
		Raspaigella ? suluensis.
		Raspaigella dendyi.
111	(Uncertain, probably 73–165).	*Dercitopsis ceylonica*
	73–165	*Spirastrella spinispirulifer.*
		Diplastrella gardineri.
		Timea capitatostellifera.
		Discodermia natalensis.
		Theonella discifera.
		Haliclona cribriformis.
		Haliclona contignata.
		Haliclona irregularis.
		Haliclona cerebrum.
		Adocia digitata.
		Petrosia testudinaria.
		Petrosia mauritiana.
		Petrosia nigricans.
		Oceanapia media.
		Callyspongia subarmigera.
		Hymedesmia murrayi.
		Desmapsamma anchorata.
		Microciona anonyma.
		Raspailopsis cervicornis.
		Amorphinopsis megalorhaphis.
		Phakellia radiata.
		Aplysina primitiva.
	(Uncertain)	*Stelletta herdmani.*
		Ecionemia acervus.
		Penares intermedia.
		Erylus lendenfeldi.
		Spirastrella cuspidifera.
		Oceanapia zoologica.
		Callyspongia diffusa.
		Aplysinopsis reticulata.
89	193	*Sphinctrella gracilis.*

Station.	Depth in m.	Name.
		Geodia sphæroides.
		Ophlitaspongia minor.
		Antho tawiensis.
		Plocamilla manaarensis.
		Phakellia radiata.
11	207	*Oceanapia incrustata.*
		Guitarra fimbriata.
106	212	*Fangophilina submersa.*
24	73–220	*Grantessa sycilloides.*
		Sycon munitum.
		Dercitopsis minor.
		Geodia areolata.
		Chrotella eurystoma.
		Suberites kelleri.
		Polymastia clavata.
		Trachycladus tethyoides.
		Trachycladus cervicornis.
		Hemiasterella complicata.
		Haliclona contignata.
		Haliclona irregularis.
		Callyspongia diffusa.
		Callyspongia spinosissima.
		Biemna fortis.
		Mycale murrayi.
		Mycale sulcata.
		Myxilla simplex.
		Ectyodoryx rhaphidiophora.
		Phorbas styliferus.
		Clathria whiteleggii.
		Microciona longitoxa.
		Hemectyonilla involutum.
		Sigmaxinella megastyla.
		Aplysina euplectella.
		Dysidea fragilis.
157	229	*Farrea spirifera.*
		Yodomia perfecta.
		Pachastrella monilifera.
		Pœcillastra schulzii.
		Pachymatisma bifida.
		Suberites ramulosus.
		Laxosuberites longispiculus.
		Tentorina sigmatophora.
		Polymastia murrayi.
		Theonella pulchrifolia.
		Haliclona flagellifer.
		Haliclona irregularis.
		Haliclona expansa.
		Petrosia nigricans.
		Hamacantha mindanaensis.
		Hamacantha simplex.
		Ectyodoryx coralliophila.
		Microciona rhopalophora.
9	245	*Haliclona* cf. *ochracea.*
		Petrosia nigricans.
		Tedania nigrescens.
		Lithoplocamia lithistoides.

Station.	Depth in m.	Name.
		Clathria spongiosa.
		Echinodictyum jousseaumei.
		Phakellia radiata.
123	256–366	*Pœcillastra schulzii.*
		Sphinctrella gracilis.
		Discodermia emarginata.
		Corallistes bowerbanki.
177	274–366	*Sphinctrella gracilis.*
		Thenea wyvillii.
		Polymastia murrayi.
		Guitarra fimbriata.
		Lissodendoryx ciocalyptoides.
		Echinoplocamia arbuscula.
35	441	*Higginsia robusta.*
		Axinella bidderi.
145 E	494	*Radiella sarsii.*
145	494	*Semperella cucumis.*
		Euplectella simplex.
		Holascus fibulatus.
		Thenea centrotyla.
109	640	*Myliusia verrucosa.*
		Dysidea fragilis.
176	695	*Hyalonema affine.*
122	732	*Pheronema giganteum.*
		Thenea muricata.
108	781	*Aphrocallistes beatrix.*
		Radiella sarsii.
		Tentorium semisuberites.
		Thenea grayi.
152	609–915	*Sarostegia oculata.*
		Pleurochorium annandalei.
		Pachastrella monilifera.
		Sphinctrella theneides.
		Geodia sphæroides.
		Hamacantha mindanæensis.
54	1046	*Sarostegia oculata.*
		Aphrocallistes beatrix.
		Placoplegma solutum.
		Suberites ramulosus.
		Mycale massa var. *oceanica.*
		Mycale topsenti.
		Lissodendoryx damirioides.
		Lissodendoryx tubicola.
		Ectyodoryx coralliophila.
		Axinella bidderi.
119	1207–1463	*Monorhaphis dives.*
42	1415	*Sarostegia oculata.*
175	1618	*Suberites domuncula.*
118	1789	*Monorhaphis* sp.
162	1829	*Farrea occa* subsp. *erecta.*
		Sarostegia oculata.
50	1939	*Callyspongia spinosissima.*
185	2001	*Hemectyonilla involutum.*

Order HEXACTINELLIDA.

Sub-order Amphidiscophora.

Family Pheronematidæ.

Genus *Pheronema* Leidy.

Pheronema giganteum Schulze.

Pheronema giganteum Schulze, 1886 : 66 ; Schulze, 1887 : 250, pls. xlv, xlvi ; Schulze, 1893 : 996 ; Schulze, 1893 : 563 ; Ijima, 1927 ; 10, pl. v, figs. 1–7 ; Okada, 1932 : 6.

Occurrence.—Stn. 122, January 22, 1934, Zanzibar Area (5° 21′ 24″ S., 39° 23′ 00″ E. to 5° 22′ 36″ S., 39° 22′ 18″ E.), 745 m., bottom grey-green mud.

Distribution.—Kei Island; Timor; Japan; 204–276 m., blue mud.

Genus *Semperella* Gray.

Semperella cucumis Schulze.

Semperella cucumis Schulze, 1895 : 45, pl. ix, figs. 1–16 ; Schulze, 1902 : 41, pl. viii, figs. 1–16 ; Schulze, 1904 : 103, pls. xx–xxii, pl. xxiv, fig. 1.

Occurrence.—Stn. 145, March 31, 1934, Maldive Area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m., bottom green mud and sand.

Distribution.—Andamans; Nicobars ; 296–730 m.

Family Monorhaphidæ.

Genus *Monorhaphis* Schulze.

Monorhaphis dives Schulze.

Monorhaphis dives Schulze, 1904 : 121, pl. xliii, figs. 1–20.

Occurrence.—Stn. 119, January 19, 1934. Zanzibar Area (6° 29′ 24″ S., 39° 49′ 54″ E. to 6° 32′ 00″ S., 39° 53′ 30″ E.), 1204 m.

Remarks.—The specimen consists of a badly-preserved fragment, but the spiculation puts its identity beyond doubt.

Distribution.—Coast of Somaliland ; 1644 m.

Monorhaphis sp.

Occurrence.—Stn. 118, Zanzibar Area (4° 05′ 54″ N., 41° 10′ 12″ E. to 4° 17′ 00″ N., 41° 11′ 48″ E.), 1789 m., bottom globigerina ooze.

Remarks.—Three spicules were obtained with the following dimensions : 63, 133 and 138 cm. long and 1·5, 3 and 4 mm. diameter at the centre respectively. No body spicules were found.

Family Hyalonematidæ.

Genus *Hyalonema* Gray.

Hyalonema affine Brandt.

Hyalonema affine Brandt, 1857 ; 606 ; Brandt, 1859 : fol. ; Schultze, 1860 : 9 ; Marshall, 1875 : 224 ; *H.* (*Stylocalyx*) *apertus* Schulze, 1887 : 59 ; *H. apertum* Schulze, 1887 : 214, pls. xxxvii, xxxviii ; Schulze, 1893 : 554 ; Schulze, 1895 : 39, pl. viii, figs. 1–6 ; *H. maehrenthali* Schulze, 1895 : 41, pl. viii, figs. 7–11 ; *H. affine reticulatum* Schulze, 1899 : 112 ; *H. affine japonicum* Schulze, 1899 : 112 ; *H. affine* Schulze, 1902 : 27, pl. vii, figs. 1–11 ; *H. apertum* Schulze, 1904 : 91 ; pls. xxvii, xxviii ; *H. apertum maehrentali* Ijima, 1927 : 72, pl. ii, fig. 15, pl. iv, figs. 1–8, text-figs. 7–15 ; *H. apertum* Okada, 1932 : 19 ; *H. apertum solidum* Okada, 1932 : 21, pl. i, figs. 1–2.

Occurrence.—Stn. 176, May 2, 1934, Gulf of Aden (12° 04′ 06″ N., 50° 38′ 36″ E.), 695 m., bottom green mud and sand.

Remarks.—Two poorly preserved specimens represent this species. In both the body is badly damaged, but in one of them the stalk bears an *Actinia* (like that figured by Schulze, 1902, pl. vii, fig. 1a) and below this a *Palythoa*. The body in both specimens is 30 mm. high and the stalk 140 mm. long.

Distribution.—Japan ; East Indies ; Indian Ocean (W. of Sumatra, Nicobars, Andamans) ; 204–1886 m., bottom green mud, Pteropod ooze.

Sub-order Hexasterophora.

Tribe Hexactinosa.

Sub-tribe Clavularia.

Family Farreidæ.

Genus *Farrea* Bowerbank.

Farrea spirifera Ijima.

Farrea spirifera Ijima, 1927 : 156, pl. xiii, figs. 10–15.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Kei Is. ; 595–984 m.

Farrea occa Bowerbank, subsp. *erecta* Ijima.

Farrea occa erecta Ijima, 1927 : 132, pl. x, figs. 1–12, ?13–16.

Occurrence.—Stn. 162, April 10, 1934, Maldive Area (8° 08′ 30″ N., 72° 58′ 00″ E.), 1829 m., bottom grey mud.

Distribution.—Between Celebes and the Philippines (several localities) ; 278–1633 m.

Genus *Sarostegia* Topsent.

Sarostegia oculata Topsent.

Sarostegia oculata Topsent, 1904 : 4, figs. 1–3 ; Topsent, 1904 : 377 ; *Ramella tubulosa* Schulze, 1904 : 38, pl. xiv, figs. 7–9 ; *Sarostegia oculata* Dendy, 1916 : 219, pl. xlii, figs. 19–31, pl. xliii, figs. 32–36 ; Gravier, 1918 : 20 ; Topsent, 1928 : 87, pl. i, figs. 11–12, pl. iv, fig. 5.

OCCURRENCE.—Stn. 42, October 27, 1933, South Arabian Coast (17° 26′ 00″ N., 55° 49′ 00″ E.), 1415 m., bottom rock and mud ; Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud ; Stn. 152, April 4, 1934, Maldive Area (4° 49′ 00″ N., 72° 46′ 30″ E. to 4° 48′ 00″ N., 72° 40′ 00″ E.), 878 m., bottom green sand ; Stn. 153, April 4, 1934, Maldive Area (4° 45′ 36″ N., 72° 52′ 12″ E. to 4° 42′ 36″ N., 72° 50′ 24″ E.), 256 m. ; Stn. 162, April 10, 1934, Maldive Area (8° 08′ 30″ N., 72° 58′ 00″ E.), 1829 m., bottom grey mud.

DISTRIBUTION.—Cape Verde Islands, 598–1694 m. (Topsent, Schulze) ; off Sumatra, 677 m. (Schulze) ; Seychelles, 823 m. (Dendy) ; Maldives, 256–1829 m. (Murray Expedition).

Sub-tribe SCOPULARIA.

Family EURETIDÆ.

Genus *Pleurochorium* Schrammen.

Pleurochorium annandalei (Kirkpatrick).

Eurete annandalei Kirkpatrick, 1908 : 21, pl. i, figs. 1–13 ; *Pleurochorium annandalei* Ijima, 1927 : 196 ; *P. amandelei* (err.), Ijima, 1927 : 368.

OCCURRENCE.—Stn. 152, April 4, 1934, Maldive Area (4° 49′ 00″ N., 72° 46′ 30″ E. to 4° 48′ 00″ N., 72° 40′ 00″ E.), 878 m., bottom green sand.

DISTRIBUTION.—Off Ceylon (925 and 1207 m.).

Genus *Myliusia* Gray.

Myliusia verrucosa Ijima.

Myliusia verrucosa Ijima, 1927 : 217, pl. xxiv, figs. 17–19.

OCCURRENCE.—Stn. 109, January 13, 1934, Zanzibar Area (5° 10′ 36″ S., 39° 33′ 48″ E.), 640 m., light grey mud.

DISTRIBUTION.—Sulu Archipelago ; 564 m.

Family APHROCALLISTIDÆ.

Genus *Aphrocallistes* Gray.

Aphrocallistes beatrix Gray.

Aphrocallistes beatrix Gray, 1858 : 224 ; Gray, 1858 : 115, pl. xi ; Gray 1867 : 507 ; Thomson, 1868 : 119 ; *Iphiteon beatrix* Bowerbank, 1869 : 325 ; *Aphrocallistes bocagei* Wright, 1870 : 77, pl. i ; Kent, 1870 : 248 ; Schmidt, 1870 : 17, pl. ii, figs. 1, 11, 12 ; Carter, 1873 : 358 ; *A. beatrix* Carter, 1873 : 359 ; *A. bocagei* Marshall, 1875 : 150, pl. xiv, figs. 42–45 ; Marshall, 1876 : 124 ; Schmidt, 1880 : 48, pl. vii, fig. 5 ; *A. beatrix* Priest, 1884 : 12, pl. ii, figs. 14–15 ; *A. bocagei* Schulze, 1886 : 74 ; *A. beatrix* Schulze, 1886 : 75 ; *A. ramosus* Schulze, 1886 : 75 ; *A. beatrix* Schulze, 1887 : 311, pl. lxxxiv, figs.

9–10 ; *A. bocagei* Schulze, 1887 : 313, pl. lxxxii, pl. lxxxiv, figs. 1–8 ; *A. ramosus* Schulze, 1887 : 319, pl. lxxxvi ; *A. bocagei* Kirkpatrick, 1889 : 446 ; Topsent, 1892 : 32 ; *A. ramosus* Topsent, 1892 : 32, pl. v, fig. 12, pl. vii, fig. 10 ; *A. beatrix* Schulze, 1896 : 68, pl. vii, figs. 1–13 ; *A. ramosus* Schulze, 1896 : 76, pl. vii, fig. 14 ; *A. bocagei* Schulze, 1896 : 78, pl. viii, figs. 1–11 ; Schulze, 1899 : 85 ; *A. vastus* Schulze, 1896 : 86, pl. xviii, fig. 3 ; *A. beatrix* Schulze 1900 : 38 ; *A. bocagei* Schulze, 1900 : 39 ; *A. beatrix* Schulze, 1902 : 87, pl. xv, figs. 1–13 ; *A. bocagei* Schulze, 1902 : 93, pl. xvi ; *A. ramosus* Schulze, 1902 : 97, pl. xv, fig. 14 ; *A. beatrix* Schulze, 1904 : 48, pls. xi–xiii, pl. xiv, figs. 1–6 ; *A. bocagei* Topsent, 1904 : 48 ; *A. beatrix* Stephens, 1915 : 430 ; *A. beatrix orientalis* Ijima, 1916 : 173 ; *A. beatrix* Arnesen, 1920 : 10 ; Dendy and Burton, 1926 : 226 ; Ijima, 1927 : 286, pl. xxiv, figs. 20–30, pl. xxv, text-fig. 35 ; Burton, 1928 : 15 ; Topsent, 1928 : 95 ; Burton and Rao, 1932 : 302 ; *A. beatrix orientalis* Okada, 1932 : 51, pl. iv, fig. 1.

Occurrence.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud ; Stn. 108, January 13, 1934, Zanzibar Area (5° 18′ 06″ N., 39° 24′ 12″ E. to 5° 14′ 30″ N., 39° 25′ 36″ E.), 781 m., bottom grey mud.

Remarks.—Examples of this species occur commonly in deep-sea dredgings, probably more frequently than any other Hexactinellid. The geographical range is within the limits of approximately 5° S. and 50° N., except in the Atlantic where (Burton, 1928) it has been recorded for the Greenland-Iceland area.

Distribution.—Atlantic (Greenland, Iceland, SW. Ireland, Azores, Bermuda, West Indies, Morocco, Canaries, Cape Verde Islands, St. Helena, St. Paul, Ascension Is.) ; Indian Ocean (off Bombay, Bay of Bengal, Nicobars, Andamans, Mergui) ; Dutch East Indies ; Pacific (Philippines, Japan) ; 164–1966 m.

Tribe Lyssacinosa.

Family Leucopsacasidæ.

Genus *Placoplegma* Schulze.

Placoplegma solutum Schulze.

Placoplegma solutum Schulze, 1896 : 63, pl. vi, figs. 11–17 ; Schulze, 1897 : 544 ; Schulze, 1902 : 80, pl. xiv, figs. 11–17 ; Ijima, 1898 : 43 ; Schulze, 1904 : 28, pl. vii.

Occurrence.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.

Distribution.—Dar-es-Salaam ; Bay of Bengal (12° N., 90° E.) ; 2925–3008 m.

Family Euplectellidæ.

Genus *Euplectella* Owen.

Euplectella simplex Schulze.

Euplectella simplex Schulze, 1896 : 15, pl. ii, figs. 1–13 ; Schulze, 1902 : 51, pl. x, figs. 1–13 ; Schulze, 1904 : 21, pl. iv, figs. 4–5.

Occurrence.—? Stn. 145, March 31, 1934, Maldive Area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m., bottom green mud and sand.

Distribution.—Zanzibar ; Andamans ; W. of Sumatra ; 402–1668 m., bottom blue mud.

Genus *Holascus* Schulze.

Holascus fibulatus Schulze.

Holascus fibulatus Schulze, 1886 : 40; Schulze, 1887 : 87, pl. xv, figs. 1–5, pl. xvi; Schulze, 1896 : 10; Schulze, 1904 : 8.

Occurrence.—Stn. 145, March 31, 1934, Maldive Area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m.

Distribution.—Dar-es-Salaam; between Kerguelen and South Africa; South of Australia; 2516–2959 m., bottom Globigerina ooze, Diatom ooze, red clay.

Order CALCAREA.

Family Homocœlidæ.

Genus *Leucosolenia* Bowerbank.

Leucosolenia gardineri Dendy.

Leucosolenia gardineri Dendy, 1913 : 2, pl. i, figs. 1–2, pl. iii, figs. 1–3; Dendy and Row, 1913 : 725; *L. gardineri*, var. *vergensis* Kumar, 1924 : 21.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Distribution.—Indian Ocean; 18–25 m.

Family Leucascidæ.

Genus *Leucetta* Haeckel.

Leucetta pyriformis Dendy.

Leucetta pyriformis Dendy, 1913 : 11, pl. i, fig. 7, pl. iv, fig. 3; Dendy and Row, 1913 : 734.

Occurrence.—Stn. 148, April 3, 1934, Maldive Area (4° 53′ 12″ N., 72° 54′ 30″ E. to 4° 51′ 24″ N., 72° 53′ 06″ E.), 27 m., bottom soft cream mud.

Distribution.—Cargados Carajos; 82 m.

Family Heteropiidæ.

Genus *Grantessa* Lendenfeld.

Grantessa zanzibaris Jenkin.

Grantessa zanzibaris Jenkin, 1908 : 449, figs. 98–102; *G. zanzibarensis* Dendy and Row, 1913 : 753.

Occurrence.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.

Distribution.—Zanzibar; 11–15 m.

Grantessa glabra Row.

Grantessa glabra Row, 1911 : 203, pl. xix, fig. 6; Dendy and Row, 1913 : 752.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Distribution.—Red Sea.

Grantessa sycilloides (Schuffner).

Sycortis sycilloides Schuffner, 1877 : 420, pl. xxv, fig. 10 ; *Grantessa sycilloides* Dendy and Row, 1913 : 753.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shells.

Remarks.—It is probable that *Grantessa glabra* Row, from the Red Sea, is synonymous with *G. sycilloides.*

Distribution.—Mauritius.

Family Sycettidæ.

Genus *Sycon* Risso.

Sycon munitum Jenkin.

Sycon munitum Jenkin, 1908 : 443, fig. 91 ; Dendy and Row, 1913 : 747.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock.

Distribution.—Zanzibar ; 13 m.

Genus *Leuconia* Grant.

Leuconia wasinensis (Jenkin).

Leucilla wasinensis Jenkin, 1908 : 454, fig. 104 ; *Leucandra wasinensis* Dendy, 1913 : 24, pl. ii, fig. 5 ; Dendy and Row, 1913 : 772.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—East Africa (Wasin) ; Saya da Malha ; 11–100 m.

Order TETRAXONIDA.

Sub-order Homosclerophora.

Family Plakinidæ.

Genus *Dercitopsis* Dendy.

Dercitopsis ceylonica Dendy.

Dercitopsis ceylonica Dendy, 1905 : 66, pl. ii, fig. 1.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain (probably between 73 and 165 m.).

Distribution.—Ceylon, 182 m.

Dercitopsis minor Dendy.

Dercitopsis minor Dendy, 1916 : 229, pl. xliv, fig. 1, pl. xlv, fig. 1 ; Dendy and Frederick, 1924 : 489.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shell ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Indian Ocean (Cargados Carajos, Amirante, Egmont Reef); 55–80 m.; Western Australia (Abrolhos Island).

Sub-order Streptastrosclerophora.

Family Pachastrellidæ.

Genus *Yodomia* Lebwohl.

Yodomia perfecta Dendy.

Yodomia perfecta Dendy, 1916 : 232, pl. xliv, fig. 2, pl. xlv, fig. 3.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Indian Ocean (Saya de Malha); 273 m.

Genus *Pachastrella* Schmidt.

Pachastrella monilifera Schmidt.

Pachastrella monilifera Schmidt, 1868 : 15, pl. iii, fig. 7 ; *P. abyssi* Schmidt, 1870 : 64, pl. vi, fig. 4 ; Carter, 1876 : 407 ; Schmidt, 1880 : 68 ; Sollas, 1888 : 104, pl. x, fig. 5, pl. xi, figs. 1–31 ; *P. monilifera* Sollas, 1888 : 110 ; Topsent, 1892 : 41 ; Topsent, 1894 : 380, pl. xv, fig. 4 ; *P. ovisternata* Lendenfeld, 1894 : 439, pl. i, figs. 1–3 ; *P. monilifera* Topsent, 1901 : 343 ; 1902 : 346 ; *P. caliculata* Kirkpatrick, 1902 : 227, pl. ii, fig. 4, pl. iii, fig. 4 ; *P. isorrhopa* Kirkpatrick, 1902 : 228, pl. ii, fig. 5, pl. iii, fig. 5 ; *P. monilifera* Lendenfeld, 1903 : 75 ; *P. ovisternata* Lendenfeld, 1903 : 75 ; *P. monilifera* Topsent, 1904 : 92, pl. ii, fig. 2 ; *P. chuni* Lendenfeld, 1906 : 238, pl. xxxviii, figs. 2–45 ; *P. caliculata* Lendenfeld, 1906 : 243, pl. xxxix, figs. 1–13 ; *P. monilifera* Topsent, 1913 : 609 ; Ferrer, 1914 : 7 ; *P. ovisternata* Ferrer, 1914 : 7 ; *P. monilifera* Stephens, 1915 : 13 ; Babić, 1921 : 92 ; Babić, 1922 : 285, fig. U ; Burton, 1926 : 9 ; Topsent, 1928 : 132.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock; Stn. 152, April 4, 1934, Maldive Area (4° 49′ 24″ N., 72° 46′ 30″ E. to 4° 48′ 42″ S., 72° 40′ 30″ E.), 878 m., bottom green sand; Stn. 153, April 4, 1934, Maldive Area (4° 45′ 36″ N., 72° 52′ 12″ E. to 4° 42′ 36″ N., 72° 50′ 24″ E.), 256 m.; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Remarks.—Except that the larger megascleres, in the specimens from Stn. 157, have the ends of the cladi more commonly bifid than usual, these specimens are fairly representative. Through them, the recorded distribution of the species is carried into the Indian Ocean for the first time, apart from the specimens found off South Africa.

Distribution.—Atlantic Ocean (SW. Ireland, Spain, Portugal, Morocco, Azores, Madeira, Canaries, West Africa, South Africa, Tristan da Cunha, Gough Is.); Mediterranean; Natal; 61–2165 m.; bottom rock, sand, mud, gravel or broken shells.

Genus *Pœcillastra* Sollas.

Pœcillastra schulzii (Sollas).

Normania schulzii Sollas, 1886 : 185 ; *N. laminaris* Sollas, 1886 : 186 ; *N. tenuilaminaris* Sollas, 1886 : 186 ; *Pœcillastra schulzei* Sollas, 1888 : 79, pl. ix, figs. 1–29 ; *P. laminaris* Sollas, 1888 : 84 ; *P. tenuilaminaris* Sollas, 1888 : 85, pl. v, figs. 17–18 ; *Pachastrella schulzii*, Lendenfeld, 1903 : 77 ; *P. laminaris* Lendenfeld, 1903 : 78 ; *P. tenuilaminaris* Lebwohl, 1914 : 72, pl. vii, figs. 16–25, pl. ix, fig. 21 ; Dendy, 1916 : 230, pl. xlv, fig. 2 ; *Pœcillastra tenuilaminaris* Dendy and Burton, 1926 : 238.

Occurrence.—Stn. 123, January 22, 1934, Zanzibar Area (5° 19′ 00″ S., 39° 32′ 30″ E. to 5° 19′ 12″ S., 39° 33′ 30″ E.), 256–366 m., bottom green mud, sand and rock; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Indian Ocean (Amirante, Andamans, Mergui Archipelago); Heard Island; Amboina; Pacific Ocean (Japan and east of the Philippines); 73–1829 m.

Genus *Sphinctrella* Schmidt.

Sphinctrella gracilis Sollas.

Sphinctrella gracilis Sollas, 1888 : 89, pl. xiii, figs. 1–2; Topsent, 1902 : 12; *Pachastrella gracilis* Lendenfeld, 1903 : 74; *Sphinctrella gracilis* Topsent, 1904 : 88, pl. iv, fig. 2; Topsent 1928 : 131.

Occurrence.—Stn. 89, December 7, 1933, Northern area of Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shells and rock; Stn. 123, January 22, 1934, Zanzibar Area (5° 19′ 00″ S., 39° 32′ 30″ E. to 5° 19′ 12″ S., 39° 33′ 30″ E.), 256–366 m., bottom green mud, sand and rock; Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock.

Remarks.—There are three typical specimens, 10, 20 and 60 mm. across respectively. The smallest resembles closely the specimen figured by Topsent (1904), and the largest is closely similar in external form to *Thenea fenestrata* Sollas, with a flattened, discoidal form and a series of equatorial pore-recesses.

Distribution.—Azores, Madeira, Cape Verde Is.; 182–1229 m.

Sphinctrella theneides sp. n.

(Text-fig. 1.)

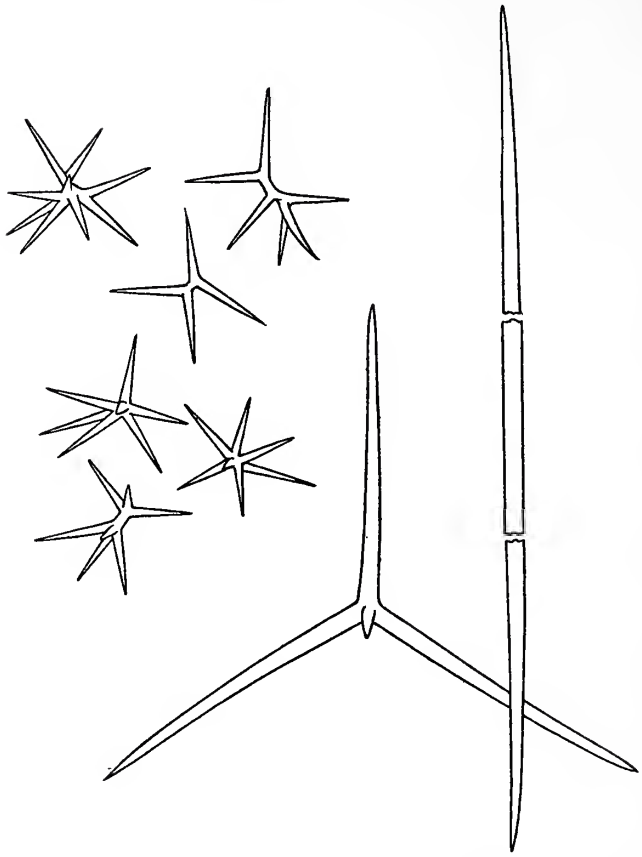
Holotype.—B.M. 1936.3.4.313.

Occurrence.—Stn. 152, April 4, 1934, Maldive Area (4° 49′ 24″ N., 72° 46′ 30″ E. to 4° 48′ 42″ N., 72° 40′ 30″ E.), 878 m., bottom green sand.

Diagnosis.—Sponge subspherical; surface hispid; oscules and pores in equatorial recesses at opposite sides of body, each protected by a fringe of long spicules; texture firm; colour, in spirit, pale yellowish-brown; skeleton of radially-arranged oxea, with a subectosomal layer of short-shafted orthotriænes, more rarely dichotriænes; microscleres streptasters of two sizes.

Spicules:

oxea, 6·0–8·0 by 0·04–0·056 mm.,
orthotriænes, cladi 0·48–0·8 by 0·032–0·05 mm., shaft of same length or slightly longer,
dichotriænes, rare, of similar dimensions,
streptasters 0·022–0·05 mm. across, larger with 4–5 rays.



TEXT-FIG. 1.—*Sphinctrella theneides* sp. n. Oxeote, ×50 and orthotriæne ×50, with group of streptasters, ×500.

Family THENEIDÆ.

Genus *Thenea* Gray.

Thenea Gray, 1867 : 541 ; *Tisiphonia* Thomson, 1869 : 712 ; *Dorvillia* Kent, 1870 : 293 ; *Wyvillethomsonia* Wright, 1870 : 80 ; *Dorvilia* Poctâ, 1883 : 382 ; *Clavellomorpha* Hansen, 1885 : 19 ; *Thisiphonia* Ledenfeld, 1887 : 563 ; *Theuca* Lundbeck, 1907 : 559.

GENOTYPE.—*Tethea muricata* Bowerbank, 1864 : 25, figs. 35, 304, 305.

DIAGNOSIS.—Theneidæ with radially-arranged oxea and long-shafted triænes ; microscleres metasters ; with special pore-areas.

REMARKS.—In dealing with the species belonging to the genus *Thenea*, it becomes quickly apparent that the differences between them are comparatively slight. Previous writers have tended to base their diagnoses on differences in (*a*) shape and size of the microscleres, (*b*) shape and size of the megascleres, and (*c*) external form, in this order of importance.

Of the first, the shape and size of the microscleres, it is only too obvious, when a comparative survey is made, that the microscleres of the various species of *Thenea* are much more closely alike than those of, say, the genus *Stelletta*. There are differences in size, but comparatively little difference in shape. Even the presence or absence of spines on the rays is a matter of doubtful importance, as we know by analogy with other genera of Tetraxonida and with the Hexactinellida. As to size, we find that this varies sufficiently to make it almost worthless in the definition of species. It has been shown, again and again, by various writers, that the microscleres of all Tetraxonida not only vary in size, but that whole categories of spicules may be absent from some parts of an individual sponge, or may be completely lacking in a given individual.

The same remarks may be made of the megascleres which, unlike those of *Stelletta* and other such genera, are remarkably uniform, consisting of oxea, dichotriænes, anatriænes and protiænes.

The external form, however, does offer a possible basis for distinction, as its characters appear to be comparatively stable. It seems possible, therefore, that using, primarily, the external characters, supplemented by details of spiculation, we shall arrive at the most satisfactory basis for classification of this genus.

Before passing to consideration of the species of *Thenea*, it may be useful to consider the range of variation in both size and shape of the spicules. Lendenfeld (1906, p. 222) records that in the two specimens of his *Thenea microclada*, one had streptasters (die grossen Metaster) 0·15–0·29 mm. across, and the other, 0·27–0·4 mm. across. This is a significant record, and one which I followed up by examining the accumulated material of *T. muricata* in the British Museum collection. Using only specimens from the coast of Norway, the type-locality of the species, I found that, in specimens otherwise readily identifiable as *T. muricata* (Bowerbank), the size and shape of the larger streptasters varied considerably. The first six observations were as follows :

Specimen.	Small streptasters. (mm.)	Large streptasters. (mm.)
The holotype	0·021–0·031 across	Absent.
B.M. 10.1.1.1127	0·021–0·028 ,,	R 0·05–0·08 across.
B.M. 10.1.1.1119	0·02–0·035 ,,	C 0·07–0·48 ,,
B.M. 94.11.16.120	0·03–0·035 ,,	R 0·06–0·14 ,,
B.M. 10.1.1.746.iii	0·007–0·02 ,,	C 0·05–0·1 ,,
B.M. 10.1.1.834	Absent	Absent.

(R = rare ; C = Common.)

Not only do the dimensions vary but the characters of the spicules do also. Thus, in some large streptasters, with rays of equal length, the thickness varies perceptibly. In some instances, the rays of the larger streptasters are strongly microspined instead of smooth.

Turning to the rest of the skeleton, and to the morphology, we find that, in addition to variation in size, the following may be found :

(1) The dichotriænes may be replaced by a varying but usually small quantity of plagiotriænes ; but in one specimen the large triænes were exclusively plagiotriænes.

(2) The anatriænes and less commonly the protriænes, may be differentiated into two categories.

(3) The sponge, while usually attached to the substratum by a root-tuft and ropes of long spicules, may, in rare instances, be attached direct to a stone. This may lead to a deformity in shape of the sponge.

(4) The oscules may be single, numerous but small, or converted into irregular crypts similar to the equatorial poriferous crypts. The increase in number of the oscules is usually, t not always, correlated with increase in size, and especially with a dorso-ventral flatten-

ing of the sponge. The formation of osculiferous crypts, in some cases, at all events, appears to be due to malformation of the sponge body (see 3 above), or to the presence of smothering algæ, or organic débris.

(5) The hispidation of the surface may be very much developed (cf. Lendenfeld, 1906, pl. xxi, fig 6, *T. mesotriæna*) or the specimens may appear practically non-hispid, almost smooth, without any equatorial fringe. But of a hundred or more specimens examined, the great majority showed little obvious hispidation apart from the fringe around the oscules and the equatorial crypts.

(6) The body of the sponge tends to flatten and the oscules to multiply in number with the size of the specimen.

Using the external form as the basis for specific identification the position can be expressed as in Text-fig. 2 and in the key on page 187. Both represent however, an ideal situation. In practice there are difficulties which can be but sparingly dealt with in print. For example, the smallest specimens (presumably juvenile) of all species are very similar no matter from which part of the world they come. The body is rounded, usually surmounting a proportionately long stalk, with a pair of crypts at opposite sides of the body. Presumably these crypts are poral and oscular respectively. A typical example is seen in Lendenfeld (1906, pl. xxiii, fig. 39) and in the same work (pl. xxii, figs. 11, 12) young specimens can be seen still attached to the parent. With further growth, so it would seem, changes in shape take place producing the characters exemplified in Text-fig. 2.

The next difficulty lies in the fact that the shapes given in Text-fig. 2 are only rarely attained in this definite form. Either by some slight variation, more often by some distortion as a result of preservation, the ideal characters tend to be masked. Thus, in a jar of some 20 *Thenea grayi* in the British Museum collection only two or three approach the typical form shown in Text-fig. 2. For the rest, some are so damaged that specific morphological characters are indefinable, in others the equatorial crypts extend in places into the upper surface producing an appearance deceptively like that of some specimens of *T. muricata*, where the oscules may be in oscular crypts (as in *T. valdiviæ* Lendenfeld, 1906, pl. xviii, fig. 11). If then, instead of a group of 20 specimens, the collector had in this case brought back one only, identification might have been rendered difficult if not impossible. Or the subsequent determination might have been misleading.

There is a third difficulty. The spiculation, as regards both megascleres and microscleres, is comparatively uniform throughout the genus. So long as the known specimens numbered a few scores it was possible to note and use the small variations in spicular characters. Now, when the British Museum collections alone run into hundreds, the variation and gradations to be found in the total range of recorded specimens are such that we may say for all practical purposes that the spiculation is uniform throughout the genus. Identification must therefore depend upon external characters correlated, where these characters are distorted, with geographical distribution.

The five species, if such they be, listed on p. 187, have a well ordered distribution, which is consistent with what is known of the distribution of sponges generally. Thus, *T. centrotyla* is recorded from the eastern and southern Indian Ocean; *T. grayi*, from the Indian Ocean, Philippines, and Australia. *T. wyvillii*, from the Philippines; *T. fenestrata*, from the Galapagos area, Florida and West Africa and *T. muricata* from the North Atlantic, Arctic Ocean and Japan. There is, therefore, nothing in their distribution to suggest that this grouping is unreasonable.

The typical characters of the 5 species are illustrated in the following key:

Key to the Species of Thenea.

1	Oscules equatorial, set in a cribriform pit at opposite side of body from pore-bearing crypt	2
	Oscules apical	3
2	Skeleton includes microxea	*centrotyla*
	Skeleton without microxea	*grayi*
3	Oscules small, or situated in an irregular apical cribriform crypt	4
	Oscules in a large shallow depression	*wyvillii*
4	Body dorso-ventrally flattened, with an equatorial series of small pore-bearing crypts	*fenestrata*
	Body usually subspherical, rarely dorso-ventrally flattened, and pore-bearing crypts more or less continuous	*muricata*

Thenea centrotyla Lendenfeld.

Thenea centrotyla Ledenfeld, 1906 : 184, pl. xx, figs. 26–31 : *T. corallophila* Dendy and Burton, 1926 : 232, fig. 3 ; *T. andamanensis* Dandy and Burton, 1926 : 235, fig. 4.

Occurrence.—Stn. 145. March 31, 1934, Maldive Area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m., bottom green mud and sand.

Diagnosis.—Sponge subspherical, with upper surface flattened ; oscular and poral recesses situated equatorially and at opposite ends of the body ; surface hispid ; texture firm ; colour, in spirit, light greyish-brown to brown ; skeleton of radially-arranged oxea, dichotriænes, anatriænes, of which there may be more than one category, large protriænes and small promesotriænes ; microscleres streptasters, triacts and microxea.

Spicules :

oxea, 6·8–7·6 by 0·068–0·08 mm.,
oxea, 4·5 by 0·017 mm.,
dichotriænes, cladome 2·4–2·8 mm. across, rhabdome 4·2–5·8 by 0·07 mm. across.
anatriænes, large, cladi 0·1–0·3 mm. chord, rhabdome 6·8 by 0·013–0·03 mm.,
anatriænes, small, cladi 0·017–0·03 mm. chord, rhabdome 6·8 by 0·009–0·01 mm.,
protriænes, cladi 0·6–0·8 mm. long, rhabdome 3·6–6·2 by 0·085–0·1 mm.,
promesotriænes, cladi 0·17–0·28 mm. long, rhabdome 8·0–8·5 by 0·034–0·04 mm.,
streptasters, 0·024–0·1 mm. long, passing with no clear distinction into tetracts, triacts and diacts with rays 0·07–0·3 by 0·007–0·016 mm.,
microxea, usually centrotylote, 0·16–0·45 by 0·005–0·016 mm.

Distribution.—SW. of Ceylon ; Andamans ; New Amsterdam Is. (southern Indian Ocean) ; 738–2414 m.

Remarks.—*Thenea corallophila* and *T. andamanensis* differ, according to Dendy and Burton, in the presence of a root-tuft and minute short-shafted surface anatriænes in *T. andamanensis*, and the much greater abundance of the larger triacts and dichotracts and the smaller size of the microxea in that species. In view of our present knowledge of the range of variation in species of *Thenea*, neither of these seems to present adequate grounds for specific distinction. Further, re-examination of the types has shown that spicules v, t, s, w, of Text-fig. 4 (*T. corallophila*) are also present in *T. andamanensis*, although rare. Moreover, there seems to have been an error in the measurement of the microxea of *T. corallophila*, which are rarely more than 0·25 mm. long.

[Although *T. fenestrata* has not been recorded for the Indian Ocean, its inclusion here makes complete the revision of the genus *Thenea*.]

Thenea fenestrata (Schmidt).

Tisiphonia fenestrata Schmidt, 1880 : 71, pl. x, fig. 2 ; *Thenea fenestrata* Sollas, 1886 : 185 ; *T. wrightii* Sollas, 1886 : 185 ; Sollas, 1888 : 63, pl. viii, figs. 11–20 ; *T. fenestrata* Sollas, 1888 : 71, pl. viii, figs. 1–8 ; *Ancorina* (*Thenea*) *fenestrata* Lendenfeld, 1903 : 55 ; *A.* (*T.*) *wrightii* Lendenfeld, 1903 : 58 ; *Thenea fenestrata* Wilson, 1904 : 88, pl. xiii, figs. 2–4, 6–7, 9 ; *T. echinata* Wilson, 1904 : 91, pl. xii, figs. 1–9 ; *T. lamelliformis* Wilson, 1904 : 95, pl. xii, figs. 10–13, pl. xiii, fig. 1 ; *T. pyriformis* Wilson, 1904 : 98, pl. xiii, figs. 5, 8, 10, 11.

Diagnosis.—Sponge irregularly discoidal, with equatorial pore-recesses and with one or more small oscules on upper surface ; surface even, hispid ; texture firm ; colour, in spirit yellowish- to whitish-grey or brown ; skeleton of radially-arranged oxea, dichotriænes, anatriænes and protriænes occasionally with tylota ; microscleres streptasters, sometimes of two distinct sizes.

Spicules :

- oxea, sometimes differentiated into two sizes 0·5–0·9 by 0·012–0·07 mm.,
- dichotriænes, cladome 1·6–2·7 mm. across, rhabdome 3·1–6·0 by 0·03–0·1 mm.,
- antriænes, cladi 0·1–0·2 mm. chord, rhabdome 0·4–0·7 mm. long by 0·01–0·03 mm. thick,
- anatriænes, of root-tuft, cladi 0·085–0·25 mm. chord, rhabdome (very long ?) by 0·02 mm. thick,
- protriænes (sometimes absent, or replaced by tylota), cladi 0·5–0·8 mm. long, rhabdome 4·0–6·0 by 0·05–0·1 mm.,
- streptasters, of two sizes, with larger streptasters sometimes scarce or even absent, 0·028–0·047 and 0·07–0·35 mm. across (largest microscleres being triacts, tetracts or pentacts).

Distribution.—Galapagos Islands ; Pacific coasts of Mexico and South America ; West Indies ; Brazil ; West Africa ; 900–4115 m. ; bottom mud, ooze or sand.

Remarks.—According to the findings of Schmidt, Sollas and Wilson, the range of *T. fenestrata* includes the tropical Atlantic, from Africa to America, and also the tropical eastern Pacific. *T. wrightii*, also from the tropical eastern Pacific, differs from *T. fenestrata* in comparatively minor details, the most obvious of which is the presence of tylota (? modified protriænes) instead of protriænes. *T. echinata*, also from the eastern tropical Pacific differs from *T. fenestrata* in unimportant differences in the spiculation and in minor differences in the oscular and equatorial fringes, and the same is true for *T. lamelliformis* from the same region.

Thenea grayi Sollas.

Thenea grayi Sollas, 1886 : 183 ; Sollas, 1888 : 65, pl. vi, figs. 21–22 ; *T. malindiæ* Lendenfeld, 1906 : 179, pl. xx, figs. 22–24 ; *T. microspina* Lendenfeld, 1906 : 180, pl. xx, fig. 21 ; *T. nicobarensis* Lendenfeld, 1906 : 181, pl. xx, figs. 18–20 ; *T. rotunda* Lendenfeld, 1906 : 189, pl. xx, fig. 25 ; *T. multiformis* Lendenfeld, 1906 : 217, pl. xxiii, figs. 1–21 ; *T. tyla* Lendenfeld, 1906 : 219, pl. xx, figs. 36–38 ; *T. megaspina* Lendenfeld, 1906 : 223, pl. xxi, figs. 16–22, pl. xxii, figs. 1–5 ; *T. grayi* Wilson, 1925 : 278, pl. xlv, figs. 1–2 ; *T. grayi*, var. *sulcata* Wilson, 1925 : 280.

Occurrence.—Stn. 108, January 13, 1934, Zanzibar Area (5° 18′ 06″ S., 39° 24′ 12″ E. to 5° 14′ 30″ S., 39° 25′ 36″ E.), 781 m., bottom grey mud.

Diagnosis.—Sponge subspherical or ovate to irregularly subspherical, with poral and oscular recesses situated more or less equatorially and at opposite sides of body; surface hispid; texture firm; colour, in spirit, greyish-white to light brown; skeleton of radially-arranged oxea, dichotriænes, anatriænes and protriænes; microscleres streptasters of three sizes.

Spicules:

oxea, 3·0–11·0 by 0·02–0·07 mm.,
dichotriænes, cladome 1·3–3·2 mm. across, rhabdome 2·2–5·8 by 0·03–0·1 mm.,
anatriænes, cladi 0·025–0·23 mm. chord, rhabdome 11·0 by 0·006–0·025 mm.,
anatriænes, of root tuft, cladi 0·035–0·09 mm. chord, rhabdome 4·0–10·3 by 0·004–0·018 mm.,
protriænes, cladi 0·2–1·0 mm. long, rhabdome 4·0–8·0 by 0·08–0·1 mm.,
streptasters, 0·015–0·036 mm. across, divided by size into three groups.

Distribution.—East Africa, southern Indian Ocean, Nicobars; eastern Australia (off Sydney); Philippines; 400–3548 m.; bottom green mud.

Remarks.—The specimens included under this heading can be segregated into two groups, that named *T. grayi* by Sollas and Wilson, from eastern Australia and the Philippines, and those described by Lendenfeld (1906) from the southern half of the Indian Ocean (from East Africa to the Nicobars) under seven different names. Yet all have a similar external form, with poral and oscular recesses equatorial and at opposite ends of the body, and all have the streptasters divided into groups of three sizes. There are, of course, differences in the size of the spicules, but the general occurrence of these two well-marked features leaves little doubt that all represent a single species.

Thenea muricata (Bowerbank).

Tethea muricata Bowerbank, 1858 : 308, pl. xxv, fig. 18; Bowerbank, 1862 : 782, pl. xxxi, figs. 14, 15; Bowerbank 1864 : 25, figs. 35, 304, 305; Gray, 1867 : 541; Bowerbank, 1868 : 131; *Wyvillethomsonia wallichii* Wright, 1870 : 80, pl. ii; *Dorvillia* agariciformis Kent, 1870 : 293, pl. 66; *Tisiphonia agariciformis* Schmidt, 1870 : 68; *Dorvillia agariciformis* Kent, 1871 : 37; ? *Hyalonema parvum* Sars, 1872 : 73; *Tethya agariciformis* Kent, 1872 : 211; *Tethea muricata* Bowerbank, 1872 : 115, pl. v, figs. 1–6; *Tisiphonia agariciformis* Thomson, 1873 : 74, fig. 7; Whiteaves, 1874 : 211; *Dorvillia echinata* Verrill, 1874 : 501; *Tethea muricata* Carter, 1878 : 174; *Wyvillethomsonia wallichii* Norman, 1879 : 13; *Stelletta profunditatis* Schmidt, 1880 : 70; *Tisiphonia agariciformis* Schmidt, 1880 : 71; Keller, 1880 : 271; *Thenea muricata* Vosmaer, 1882 : 5, pl. i, figs. 1–8, pl. ii, figs. 1–21, pl. iv, figs. 114–115; *Thenea wallichii* Sollas, 1882 : 427, pl. xvii; *Tisiphonia agariciformis* Schulze, 1882 : 708; *Thenea muricata* Carter, 1883 : 362; *Thenea wallichii* Carter, 1883 : 362; *Thenea muricata* Vosmaer, 1885 : 4; Hansen, 1885 : 18, pl. v, figs. 6–9, pl. vii, fig. 19; *Clavellomorpha minima* Hansen, 1885 : 19, pl. v, fig. 2; *Thenea wallichii* Marenzeller, 1886 : 17; *T. schmidtii* Sollas, 1886 : 183; *T. delicata* Sollas, 1886 : 185; *T. muricata* Levinsen, 1886 : 343, pl. xxix, fig. 1; *T. delicata* Sollas, 1888 : 60, pl. vi, figs. 10–20, pl. viii, figs. 9–10; *T. schmidtii* Sollas, 1888 : 67, pl. vii, figs. 1–2, pl. viii, figs. 21–22; *T. muricata* Sollas, 1888 : 95, pl. vii, fig. 3; *T. intermedia* Sollas, 1888 : 97, pl. vii, fig. 4; *T. muricata* Topsent, 1892 : 37; *T. schmidtii* Topsent, 1892 : 37; *T. muricata* Topsent, 1894 : 375, pl. xv, figs. 1–5; Lambe, 1896 : 202, pl. iii, fig. 4; *T. grayi* Thiele, 1898 : 23, pl. v, figs. 2–3; *T. grayi*, var. *lateralis* Thiele, 1898 : 23, pl. v, fig. 4; *T. compressa* Thiele, 1898 : 24, pl. v, figs. 5–6; *T. compacta* Thiele, 1898 : 24, pl. v, fig. 7; *T. calyx* Thiele, 1898 : 24, pl. v, figs. 9–10; *T. nucula* Thiele 1898 : 25, pl. v, fig. 8; *T. hemisphärica* Thiele, 1898 : 25, pl. v, fig. 12; *T. muricata* Lambe, 1900 : 26; Lambe, 1900 : 164; *Ancorina* (*Thenea*) *grayi* Ledenfeld, 1903 : 56; *A.* (*T.*) *grayi grayi* Lendenfeld, 1903 : 56; *A.* (*T.*) *grayi lateralis* Lendenfeld, 1903 : 57; *A.* (*T.*) *grayi compressa* Lendenfeld, 1903 : 57; *A.* (*T.*) *grayi thielei* Lendenfeld, 1903 : 57; *A.* (*T.*) *grayi calyx* Lendenfeld, 1903 : 57; *A.* (*T.*) *grayi nucula* Lendenfeld, 1903 : 57; *A.* (*T.*) *hemisphærica* Lendenfeld, 1903 : 57; *A.* (*T.*) *grayi irregularis*

Lendenfeld, 1903 : 57 ; *A.* (*T.*) *delicata* Lendenfeld, 1903 : 55 ; *A.* (*T.*) *schmidtii* Lendenfeld, 1903 : 58 ; *Thenea schmidti* Topsent, 1904 : 85 ; *T. valdiviæ* Lendenfeld, 1906 ; 190, pl. xvii, figs. 6–49, pl. xviii, figs. 1–19, pl. xix, figs. 1–20, pl. xx, figs. 1–13 ; *T. bojeadori* Lendenfeld, 1906 : 209, pl. xx, figs. 32–33 ; *T. pendula* Lendenfeld, 1906 : 210, pl. xxii, figs. 6–19 ; *T. levis* Lendenfeld, 1906 : 215, pl. xx, figs. 34–35 ; *T. microclada* Lendenfeld, 1906 : 221, pl. xxiii, figs. 37–44 ; *T. megastrella* Ledenfeld, 1906 : 225, pl. xxiii, figs. 22–36 ; *T. muricata* Arndt, 1912 : 112 ; Topsent, 1913 : 12 ; *T. grayi*, var. *grayi* Lebwohl, 1914 : 27, pl. iv, figs. 1–47 ; *Ancorina* (*Thenea*) *muricata* Babić, 1914 : 152, figs. 1–3 ; *Thenea muricata* Stephens, 1915 : 11 ; *T.* (*muricata*) *schmidtii* Babić, 1915 : 276 ; Babić, 1916 : 389 ; *T. muricata* Stephens, 1917 : 3 ; Arnesen, 1920 : 13 ; *T.* (*muricata*) *schmidti* Babić, 1921 : 92 ; Babić, 1922 : 282 ; *T. muricata* Ferrer, 1922 : 248 ; *T. schmidtii* Ferrer, 1922 : 248 ; Rezvoi, 1924 : 241 ; Rezvoi, 1928 : 75 ; Topsent, 1928 : 129 ; Hentschel, 1929 : 918 ; Burton, 1930 : 488 ; Burton, 1934 : 6.

Occurrence.—Stn. 122, January 22, 1934, Zanzibar Area (5° 21′ 24″ S., 39° 23′ 00″ E. to 5° 22′ 36″ S., 39° 22′ 18″ E.), 745 m., bottom grey-green mud.

Diagnosis.—Sponge spherical or subspherical, with conspicuous, equatorial pore-sieves, and usually with rooting processes ; surface strongly hispid ; oscules apical ; texture firm, fragile ; colour, in spirit, white to whitish- or yellowish-grey ; skeleton of radially-arranged oxea, dichotriænes, anatriænes and protriænes ; microscleres streptasters of varying sizes.

Spicules :

oxea 1·25–18·0 by 0·01–0·09 mm.,
dichotriænes, cladome 1·1–3·5 mm. across, rhabdome 1·5–12·0 by 0·037–0·15 mm.,
anatriænes, cladi 0·02–0·9 mm. chord, rhabdome 1·0–21·5 by 0·007–0·045 mm.,
protriænes, cladi 0·2–2·0 mm. long, rhabdome 8·0–21·5 by 0·02–0·95 mm.,
streptasters, 0·008–0·55 mm. long.

Remarks.—There are twelve specimens, 25 to 60 mm. across, agreeing closely with those figured by Lendenfeld (1906) under *T. valdiviæ*. While identifying these the opportunity was taken to make a survey of all known specimens of *Thenea*, particularly of those in the British Museum collection. As a result, it is possible to make the following tentative comments on the species included here, for the first time, as synonyms of *T. muricata*.

Thenea bojeadori Lendenfeld is obviously a young specimen, and the dimensions of its spicules come well within the limits of those recorded for authentic specimens of *T. muricata*. The same may be said of *T. microclada* Lendenfeld. Others of the so-called species included as synonyms of *T. muricata*, for example, *T. delicata* Sollas, *T. levis* Lendenfeld, *T. megastrella* Lendenfeld, *T. microspina* Lendenfeld, *T. pendula* Lendenfeld and *T. schmidtii* Sollas, have all such strong general resemblance to *T. muricata* that it is not possible to recognize them apart, especially when we consider the range of variation in external form and spicules that can be found in typical examples of that species. The differences between *T. valdiviæ* Lendenfeld and *T. muricata* are said by Lendenfeld (1906, p. 207–208) to be the simple oscules in *T. muricata*, as against the oscular recesses in *valdiviæ*, together with the larger dimensions of the dichotriænes in *valdiviæ*. The variations already recorded for the oscular openings in *T. muricata* effectively dispose of the first point. As to the second, it need only be said that I have compared preparations of the holotype of *T. muricata* with preparations labelled by Lendenfeld "*Thenea valdiviæ* : Valdivia," and that it is not possible to see any real differences between them, except for the absence of large streptasters in some specimens of *T. muricata*.

There is some difficulty about *T. pyriformis*, which although having a strong resemblance to *T. muricata* in spiculation, differs markedly in external form. Some light is shed on this by five specimens from Naples, in the British Museum collection, all of which are somewhat distorted in form, and one of which is singularly like *T. pyriformis* in appearance. This suggests two possibilities, either that *T. pyriformis* is a teratological form of *T. muricata*, or that *T. pyriformis* is a separate species found, so far, only in the Mediterranean and off the Pacific coast of Mexico. By the nature of things the second alternative is much the more unlikely. *T. hemisphärica* (pl. v, fig. 11) appears to be slightly coated with debris, which may account for its atypical appearance; and *T. irregularis* (pl. v, fig. 12) abundantly coated with foreign matter, is almost identical with a deformed specimen from Norway, in the British Museum collection.

In conclusion it suffices to say that in the series in the British Museum, of *Thenea muricata* from the North Atlantic, may be found an exactly similar set of specimens to those described by Thiele from Japan under half a dozen different specific names.

Thenea wyvillii Sollas.

Thenea wyvilli Sollas, 1886 : 184 ; Sollas, 1888 : 74, pl. vi, figs. 1–9 ; *Ancorina* (*Thenea*) *wyvillii* Lendenfeld, 1903 : 56.

Occurrence.—Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock.

Diagnosis.—Sponge composed of a lower, rounded portion roofed above by a cupola-like upper part; surface even, minutely hispid; oscules large, apical; texture firm; colour, in spirit, whitish; skeleton of radially-arranged oxea, dichotriænes, anatriænes and protriænes; microscleres streptasters.

Spicules:

- oxea, 7·9 by 0·07–0·084 mm.,
- dichotriænes, cladome 1·4 mm. across, rhabdome 4·28 by 0·1 mm.,
- anatriænes, cladi 0·095 mm. chord, rhabdome 0·88 by 0·008 mm.,
- anatriænes, radical, cladi 0·1 mm. chord, rhabdome 18·2 by 0·025 mm.,
- protriænes, cladi 0·5 mm. long, rhabdome 6·8 by 0·072 mm.,
- streptasters, of three sizes, 0·02–0·025, 0·035 and 0·07–0·11 mm. across, largest with 2–7 rays.

Distribution.—Philippines; Gulf of Aden; West Africa; 174–1300 m., bottom mud and rock.

Remarks.—The fringes to both the equatorial and the oscular recesses are developed to a varying degree in the four specimens of the Murray Collection. In the two smallest, there is none. In those ranging from 25 to 40 mm. across the fringes are most strongly developed. In one, 65 mm. across, they are feebly developed (? disappearing); and in the four largest they are again absent. Except in the smallest specimen, in which it is relatively simple, the oscular recess is never less than a quarter and usually one-third or more of the total diameter of the sponge.

A specimen obtained by the "Rosaura" from West Africa while typical in all other respects, appears to have been unattached and without basal tuft. A few incipient and small tufts of long spicules at the base may be the vestiges of rooting ropes.

Sub-order ASTROSCLEROPHORA.

Family STELLETTIDÆ.

Genus *Stelletta* Schmidt.

Stelletta purpurea Ridley.

Stelletta purpurea Ridley, 1884 : 473, pl. xl, fig. E, pl. xliii, fig. j ; Burton, 1929 : 415.

(For synonymy see Burton, 1926 : 44.)

OCCURRENCE.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shell and Lithothamnion.

DISTRIBUTION.—Suez Canal ; Red Sea ; Indian Ocean ; Indo-Pacific ; Australia ; New Zealand ; Antarctic ; littoral to 275 m.

Stelletta herdmani Dendy.

(Text-fig. 2.)

Stelletta herdmani Dendy, 1905 : 77, pl. ii, fig. 6.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 12″ N., 39° 13′ 18″ E.), 113 m., bottom coral rock.

REMARKS.—The specimen from Stn. 45 is fairly typical, but the other two can be assigned to this species only with hesitation. The specimen from Stn. 111 is small and irregularly massive. The skeleton is a halichondroid reticulation of oxea, with occasional triænes lying just under the surface, or protruding slightly beyond it. The triænes are like those of *S. herdmani*, but with occasional diænes. The microscleres include ectosomal strongylasters, 0·012–0·017 mm. diameter and anthasters 0·02 mm. diameter. In possessing anthasters the specimen differs from *S. herdmani* but makes a near approach to *S. centrotyla* Lendenfeld.

The specimen from Stn. 112 is massive but flattened, and agrees in appearance and texture with *S. grubii* as figured by Topsent (1894, pl. xiii, fig. 7), and with specimens from Port Erin in the British Museum collection. The skeleton agrees with that of the holotype of *S. herdmani* except that the cladi of the triænes are longer and the shafts shorter. Also, while most of the cladi are normal (see Text-fig. 2A, B), many have recurved ends (Text-fig. 2C, D, E), or are reduced to two or one (Text-fig. 2F, G), or have the ends of the cladi bifid.

DISTRIBUTION.—Ceylon and west coast of India, down to 183 m.

Stelletta mauritiana (Dendy).

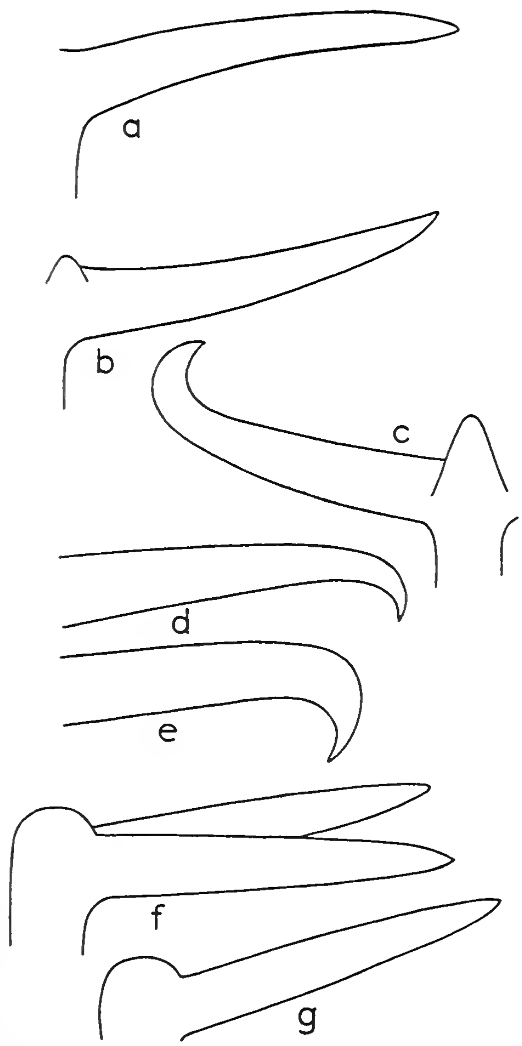
Dragmastra lactea, var. *mauritiana* Dendy, 1916 : 238, pl. xlvi, fig. 7.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

REMARKS.—Here are two specimens assigned to *Stelletta mauritiana* (Dendy) with some hesitation. The first is clavate, 50 mm. high and 9 mm. across at its broadest point.

The second is cushion-shaped, 10 mm. across. In both the surface is even but harsh to the touch, the colour is pale yellow to light brown. Both are without oscules. The texture is firm.

The spicules are similar in both specimens: oxea, 1·4 by 0·047 mm. (against 0·75 by 0·02 mm. in the holotype); dichotriænes with cladome 0·16–0·43 mm. across, and shaft



TEXT-FIG. 2.—*Stelletta herdmani* Dendy. Cladi of orthotriænes to show abnormalities. ×300. Most of the cladi in the specimen from Stn. 112 are as in *a* and *b*, but many have the shape shown in *c* or *d* and *e*. The more abnormal forms shown in *f* and *g* are not uncommon and there is a tendency in some for the cladi to bifurcate near the distal end.

0·48 by 0·02–0·048 mm. Occasionally orthotriænes, of similar size to the dichotriænes, may be seen. The microscleres are oxyasters and oxyspherasters, up to 0·016 mm. diameter, but, whereas in the holotype the majority are oxyspherasters of about 0·008 mm. diameter, with a few oxyasters up to 0·016 mm., in these two specimens the majority are oxyasters of 0·012–0·016 mm. diameter. Other features in which differences from the holotype can be seen are, that in these two specimens no trichodragmata were found, but cortical oxea, 0·25 by 0·002–0·003 mm., are present projecting in an almost continuous palisade at the surface. Cortical oxea may be present in the holotype, but the surface of that specimen is obscured by a *Latrunculia*.

DISTRIBUTION.—Mauritius.

Genus *Ecionemia* Bowerbank.

Ecionemia acervus Bowerbank.

Ecionemia acervus Bowerbank, 1862 : 1101, pl. lxxiii, fig. 1 ; Bowerbank, 1864 : 173, pl. xxviii, fig. 355 ; Bowerbank, 1873 : 322, pl. xxx, figs. 1–6 ; *Stelletta acervus* Ridley, 1884 : 627 ; *S. bacillifera* Carter, 1887 : 78, pl. vi, figs. 9–14 ; *Ecionema acervus* Sollas, 1888 : 196 ; *E. nigrum* Sollas, 1888 : 198 ; *E. rotundum* Sollas, 1888 : 198 ; *Thalassomora nigra* Lendenfeld, 1888 : 40 ; *Ecionema rotundum* Topsent, 1893 : 175 ; *Stelletta lobata* Kieschnick, 1896 ; 527 ; ? *S. truncata* Kieschnick, 1896 : 528 ; *Ancorina simplex* Lendenfeld, 1897 : 96, pl. ix, figs. 12–34 ; *Ecionema baculifera* Lindgren, 1897 : 485 ; *Stelletta lobata* Kieschnick, 1898 : 27 ; *S. truncata* Kieschnick, 1898 : 32 ; *Ecionema baculifera* Lindgren, 1898 : 335, pl. xvii, fig. 17, pl. xix, fig. 27 ; *E. bacilifera* Lindgren, 1899 : 88 ; *Ecionemia agglutinans* Thiele, 1899 : 7, pl. iv, fig. 1, pl. v, fig. 2 ; *Stelletta truncata* Kieschnick, 1900 : 553 ; *Ecionemia bacilliferum* Kirkpatrick, 1900 : 131 ; *E. cribrosa* Thiele, 1900 : 31, pl. ii, fig. 7 ; *E. cinerea* Thiele, 1900 : 32, pl. ii, fig. 8 ; *E. nigrescens* Thiele, 1900 : 34, pl. ii, fig. 9 ; *Ancorina amboinensis* Lendenfeld, 1903 : 63 ; *A. lobata* Lendenfeld, 1903 : 63 ; *A. nigra* Lendenfeld, 1903 : 64 ; *A. acervus*, Lendenfeld, 1903 : 64 ; *A. rotunda* Lendenfeld, 1903 : 65 ; *A. agglutinans* Lendenfeld, 1903 : 65 ; *A. cinerea* Lendenfeld, 1903 : 65 ; *A. bacillifera* Lendenfeld, 1903 : 66 ; *A. simplex* Dragnewitsch, 1905 : 3 ; Dragnewitsch, 1906 : 441 ; *Ecionemia carteri* Dendy, 1905 : 79, pl. i, fig. 5, pl. iii, fig. 1 ; *Ancorina bacillifera* Baer, 1906 : 7, pl. i, fig. 3, pl. iii, figs. 11–19 ; *Ecionemia cinerea* Bösraug, 1913 : 236, pl. xviii, figs. 23–44, pl. xix, figs. 1–53 ; *E. carteri* Dendy, 1916 : 242 ; *Ancorina brevidens* Dendy and Frederick, 1924 : 493, pl. xxvi, fig. 9 ; *Ecionemia cribrosa* Wilson, 1925 : 297.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 m. ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

DISTRIBUTION.—Indian Ocean (Zanzibar, Seychelles, Amirante, Ceylon, Christmas Island, Mergui Archipelago) ; Indo-Pacific (Java, Celebes, Amboina, Ternate, Philippines, Fiji) ; Australia (Great Barrier Reef, SW. Australia) ; West Africa (*teste* Sollas, 1888, but this locality should be accepted doubtfully) ; littoral to 23 m.

Genus *Penares* Gray.

Penares intermedia (Dendy).

Plakinastrella intermedia Dendy, 1905 : 67, pl. i, fig. 4, pl. ii, fig. 2 ; *P. schulzei* Dendy, 1905 : 69, pl. ii, fig. 3.

OCCURRENCE.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ N., 39° 14′ 12″ E.), depth uncertain, 73–165 m.

REMARKS.—Dendy's original figures suggest clearly that both the species described under *Plakinastrella* belong to *Penares*, and that there is little to distinguish them. Re-examination of the types amply confirms both points.

DISTRIBUTION.—Ceylon ; 183 m.

Family Geodiidæ.

Genus *Geodia* Lamarck.

Geodia perarmata Bowerbank.

Geodia perarmatus Bowerbank, 1873 : 8, pl. ii, figs. 1–11 ; *G. perarmata* Carter, 1880 : 131, pl. vi, figs. 32–35 ; Sollas, 1888 : 245 ; *Sidonops perarmata* Lendenfeld, 1903 : 101 ; *Geodia perarmata* Dendy, 1905 : 83 ; Burton, 1926 : 15.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom shells and sand ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 112, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Distribution.—Ceylon ; False Bay, South Africa ; 33–183 m.

Geodia globostellifera Carter.

Geodia globostellifera Carter, 1880 : 134, pl. vi, fig. 38 ; *Cydonium globostelliferum* Sollas, 1888 : 261 ; *Geodia globostellifera* Lendenfeld, 1903 : 111 ; *nec G. globostellifera* Ridley, 1884.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Distribution.—Gulf of Manaar.

Geodia areolata Carter.

Geodia areolata Carter, 1880 : 133, pl. vi, figs. 36–37 ; Sollas, 1888 : 246 ; *Sidonops areolata* Lendenfeld, 1903 : 103 ; *Geodia areolata* Dendy, 1905 : 87.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shells ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion ; Stn 145, March 31, 1934, Maldive area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m., bottom green mud and sand.

Remarks.—The specimens are fairly typical in all respects except that the choanosomal oxyasters have a maximum diameter of 0·045 mm.

Distribution.—Gulf of Manaar, up to 183 m.

Geodia sphæroides (Kieschnick).

Cydonium sphæroides Kieschnick, 1896 : 529 ; *Geodia arripiens* Lindgren, 1897 : 486 ; 1898 : 346, pl. xviii, figs. 10, 18, pl. xx, fig. 5 ; *Geodia sphæroides* Thiele, 1900 : 41, pl. ii, fig. 14 ; Lendenfeld, 1903 : 110 ; Hentschel, 1912 : 314.

Occurrence.—Stn. 89, December 7, 1933, Northern Area of Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shells and rock ; Stn. 152, Maldive Area (4° 49′ 24″ S., 72° 46′ 30″ E. to 4° 48′ 42″ S., 72° 40′ 30″ E.), 878 m., bottom green sand.

Distribution.—Cochin-China ; Aru Is. ; Ternate ; 18–45 m.

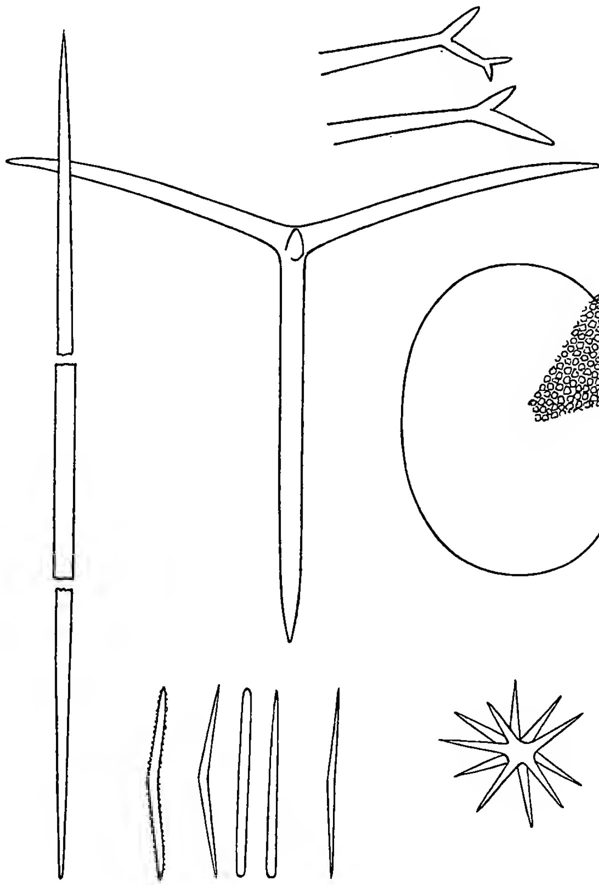
Genus *Pachymatisma* Bowerbank.

Pachymatisma bifida sp. n.

(Text-fig. 3.)

Holotype.—B.M. 1936.3.4.339.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.



Text-fig. 3.—*Pachymatisma bifida* sp. n. Oxeote, ×50, triæne, showing variation in ends of rays, ×50, sterraster, ×250, oxyaster, ×500, and microxea and microstrongyla, ×250.

Diagnosis.—Sponge massive, rounded ; surface uneven, mainly non-hispid ; oscules simple, 1–2 mm. diameter, distributed evenly over upper surface ; texture hard; colour, in spirit, pale yellow ; main skeleton of radially arranged oxea and dichotriænes (rarely orthotriænes) ; microscleres sterrasters, ectosomal microxea to microstrongyla and choanosomal oxyasters.

Spicules :

(1) oxea, 0·9 by 0·05 mm.,

(2) triænes, with cladi irregular, bifid (rarely trifid or unbranched), cladome 0·8–1·0 mm. across, rhabdome 0·9–1·1 by 0·048–0·06 mm.,

(3) sterrasters 0·12–0·16 mm. across,

(4) microxea to microstrongyla, usually centrotylote, 0·07–0·1 by 0·004–0·005 mm.,

(5) choanosomal oxyasters, 0·04–0·06 mm. diameter.

Genus *Erylus* Gray.

Erylus lendenfeldi Sollas.

Stelletta euastrum (pars) Carter, 1880 : 136, pl. vii, fig. 42 ; *Erylus lendenfeldi* Sollas, 1888 : 239 ; Lendenfeld, 1903 : 85 ; Dendy, 1916 : 257, pl. xlvii, fig. 4 ; *nec Stelletta euastrum* Schmidt.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 m.

Distribution.—Freemantle, South Australia ; Amirante ; Indian Ocean ; 37–80 m.

Family Chondrosiidæ.

Genus *Chondrilla* Schmidt.

Chondrilla australiensis Carter.

C. australiensis Carter, 1873 : 23, pl. i, figs. 10–14, 16 ; Lendenfeld, 1885 : 153 ; *C. papillata* Lendenfeld, 1885 : 153, figs. 13–16 ; *C. corticata* Lendenfeld, 1885 : 154, figs. 17–20 ; *C. papillata* Carter, 1886 : 278 ; *C. corticata* Lendenfeld, 1888 : 70 ; *C. australiensis* Lendenfeld, 1888 : 71 ; *C. papillata* Lendenfeld, 1888 : 71 ; *C. globulifera* Keller, 1891 : 327, pl. xviii, figs. 34–35 ; *C. australiensis* Lindgren, 1897 : 484 ; Lindgren, 1898 : 38 ; *C. ternatensis* Thiele, 1900 : 65, pl. iii, fig. 19 ; *C. australiensis* Dendy, 1905 : 132 ; *C. australiensis*, var. *lobata* Dendy, 1905 : 132 ; *C. australiensis* Hentschel, 1909 : 377 ; Hentschel, 1912 : 320 ; Dendy, 1916 : 101 ; Dendy, 1916 : 267 ; *Chondrillastra australiensis* Topsent, 1918 : 604 ; *C. papillata* Topsent 1918 : 606 ; *C. corticata* Topsent, 1918 : 606 ; *C. globulifera* Topsent, 1918 : 607 ; *C. ternatensis* Topsent, 1918 : 608 ; *C. australiensis* Dendy and Frederick, 1924 : 496 ; Burton, 1924 : 207 ; Burton and Rao, 1932 : 325.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Red Sea ; Indian Ocean (Okhamandal, Ceylon, Madras, Cargados Carajos, Amirante, Seychelles) ; Indonesia (Ternate, Aru Is.) ; Cochin-China ; Australia (Great Barrier Reef, Port Jackson, Port Phillip, SW. Australia, Abrolhos Is., Port Western) ; littoral to 68 m., bottom rocks with sand and coral, mud and shells.

Genus *Chondrosia* Nardo.

Chondrosia reniformis Nardo.

Chondrosia reniformis Nardo, 1847 : 272 ; *Gummina gliricauda* Schmidt, 1862 : 38, pl. iii, fig. 20 ; *G. ecaudata* Schmidt, 1862 : 38, pl. iii, fig. 21 ; *Chondrosia reniformis* Schmidt, 1862 : 40 ; *C. gliricauda* Schmidt, 1864 : 30 ; *Chondrosia reniformis* Schmidt, 1864 : 30 ; *Gummina ecaudata* Koelliker, 1864 : 69, pl. viii ; *Chondrosia reniformis* Schmidt, 1868 : 1 ; Schulze, 1877 : 97, pl. viii ; Carter, 1881 : 248 ; Graeffe, 1882 : 315 ; *C. ramsayi* Lendenfeld, 1886 : 147, pl. iii, figs. 6–9 ; *C. reniformis* Vosmaer, 1887 : 325 ; (?) Levinsen, 1887 : 512 ; Lendenfeld, 1889 : 458, pl. xxvii, figs. 89, 90, 93, pl. xxix, figs. 94–112, pl. xxx, figs. 113–136, pl. xxxi, figs. 137–157, pl. xxxii, figs. 158–179, pl. xxxiii, figs. 180–187 ; Topsent, 1894 : 37 ; Lendenfeld, 1896 : 38, pl. i, figs. 7, 11, 12, pl. ix, figs. 118, 119 ; Topsent, 1896 : 568, pl. xxiii, figs. 1–5, pl. xxii, fig. 12b ; Topsent, 1897 : 428 ; Kirkpatrick, 1900 : 129 ; *C. corticata* Thiele, 1900 : 67, pl. iii, fig. 21 ; *C. debilis* Thiele, 1900 : 68 ; *C. reniformis* Dendy, 1905 : 133 ; Topsent, 1906 : 568 ; Hentschel, 1909 : 378 ; *C. reniformis* var. *minor* Hentschel, 1909 : 379, pl. xxiii, fig. 19 ; *C. reniformis* Hentschel, 1912 : 322 ; Stephens, 1915 : 437 ; Babić 1921 : 89 ; Babić, 1922 : 269 ; Topsent 1925 : 630 ; Topsent 1928 : 143 ; Burton and Rao, 1932 : 324 ; Burton, 1933 : 236 ; Burton, 1936 : 8.

Occurrence.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Remarks.—This is essentially a species of tropical and subtropical waters and for this reason Levinsen's (1887 and 1893) records for the Kara Sea and Cattegat must be suspect. I have examined numerous collections from the British Isles, Norway and the Arctic and have not found this species among them. Yet it is practically never absent from collections made in warmer waters.

Distribution.—? Kara Sea; ? Cattegat; Mediterranean; Cape Verde Islands; San Thomé; South Africa; Red Sea; Indian Ocean (Ceylon, Xmas Is.); Ternate, Amboina, Aru Is.; Australia (east, north-west and south-west coasts); Galapagos Is. littoral to 123 m., bottom sand, rock and coral.

Family Tetillidæ.

Genus *Tetilla* Schmidt.

Tetilla cranium (Müller).

Alcyonium cranium Müller, 1776 : 255 ; Müller, 1789 : 5, pl. lxxxv, fig. 1 ; *Tethya cranium* Lamarck, 1815: 71 ; *Alcyonium cranium* Lamarck, 1816 : 347 ; *Spongia pilosa* Montagu, 1818 : 119, pl. xiii, figs. 1–3 ; *Tethya cranium* Fleming, 1828 : 519 ; *Tethium cranium* Blainville, 1834 : 544 ; *Tethea cranium* Johnston, 1842 : 83, pl. i, figs. 1–8 ; Bowerbank, 1864 : 183, pl. xxxi, fig. 362 ; Bowerbank, 1866 : 83 ; *Tethya cranium* Schmidt, 1866 : 14, pl. i, fig. 14 ; Gray, 1867 : 543 ; *Tethea cranium* Wright, 1870 : 224 ; *Craniella tethyoides* Schmidt, 1870 : 66, pl. vi, fig. 9 ; *Tethya cranium* Carter, 1871 : 104 ; *T. cranium* Carter, 1872 : 419, pl. xxii, fig. 9 ; *Tethea unca* Bowerbank, 1872 : 118, pl. v, figs. 7–10 ; *T. cranium* Bowerbank, 1874 : 35, 315, pls. xiv, lxxxix ; *Tethya cranium*, var. *abyssorum* Carter, 1876 : 405, pl. xvi, fig. 49 ; *T. cranium*, var. *typica* Bowerbank, 1882 : 41 ; *T. cranium*, var. *acufera* Bowerbank, 1882 : 42 ; *T. cranium*, var. *abyssorum* Bowerbank, 1882 : 42 ; *Craniella mülleri* Vosmaer, 1885 : 6, pl. ii, figs. 9–15, pl. v, figs. 1–2 ; *Tethya cranium* Hansen, 1885 : 18, pl. v, figs. 3–4, pl. vii, fig. 16 ; *Craniella carteri* Sollas, 1886 : 181 ; *C. schmidtii* Sollas, 1886 : 182 ; *C. mülleri* Vosmaer, 1887 : 322 ; *Tethya sibirica* Fristedt, 1887 : 436, pl. xxiv, figs. 22–28, pl. xxviii, fig. 17 ; *Craniella schmidtii* Sollas, 1888 : 38–39, pl. xlii, figs. 20–21 ; *C. abyssorum* Sollas, 1888 : 50 ; *C. cranium* Sollas, 1888 : 51 ; *C. tethyoides* Sollas, 1888 : 54 ; *C. zetlandica* Sollas, 1888 : 55 ; *C. cranium* Topsent, 1892 : 36 ; *C. spinosa* Lambe, 1894 : 35, pl. iv, fig. 1 ; *C. cranium* Topsent, 1894 : 388, pl. xv, figs. 6–14 ; Lendenfeld, 1897 : 84 ; *C. globosa* Thiele, 1898 : 26, pl. v, fig. 15, pl. vii, fig. 14 ; *C. ovata* Thiele, 1898 : 27, pl. v, fig. 16, pl. vii, fig. 15 ; *C. varians* Thiele, 1898 : 27, pl. v, figs. 17–18, pl. vii, figs. 16–17 ; *C. cranium* Lambe, 1900 : 277 ; Lambe, 1900 : 164 ; *Tethya tethyoides* Lendenfeld, 1903 : 24 ; *T. oscari* Lendenfeld, 1903 : 25 ; *T. abyssorum* Ledenfeld, 1903 : 25 ; *Craniella cranium* (pars), Topsent, 1904 : 99 ; *C. elegans* Dendy, 1905 : 95, pl. iv, fig. 1 ; *C. cranium* Lundbeck, 1909 : 454 ; *Tethya cranium* Topsent, 1913 : 12, pl. iii, fig. 3, pl. v, fig. 12 ; *T. abyssorum* Topsent, 1913 : 13, pl. v, figs. 4–6 ; *Craniellopsis azorica* Topsent, 1913 : 15, pl. iii, fig. 2, pl. v, figs. 1–2 ; *Tethya ovata* Lebwohl, 1914 : 5, pl. i, figs. 1–29 ; *T. cranium*, Babić, 1921 : 91 ; Babić 1922, : 276, fig. P ; Hentschel, 1929 : 916 ; *T. sibirica* Hentschel, 1929 : 916.

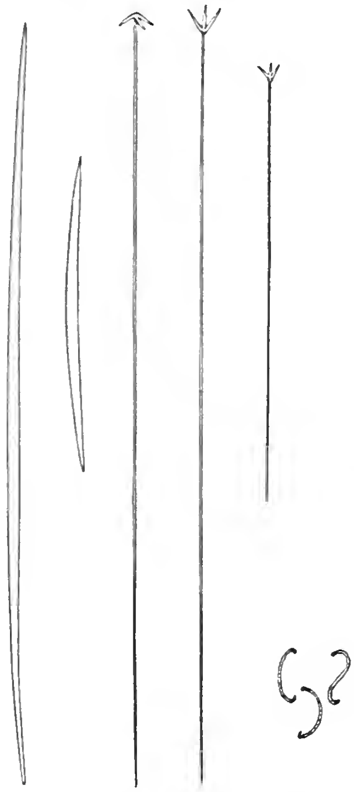
Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ B., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Remarks.—Although there are only two specimens from the present collection, they constitute the third record from the Indian Ocean. This is the more remarkable since the species has been so frequently recorded elsewhere. The significance of the new rceord is, however, lost except it be related to our total knowledge of the species. It is necessary, therefore, to include here a complete synonymy list, such as has not been published hitherto. Included in this synonymy list should be *Craniella disigma* Topsent, characterized by the possession of two well-marked categories of sigmaspiræ, although otherwise identical with

Tetilla cranium. In a jar of 30 specimens, in the British Museum collection, identified by Carter as *Craniella cranium*, all are typical except one, which, while differing in no other character from the rest, has two well marked categories of sigmaspiræ. The differentiation of the sigmaspiræ would appear, therefore, to be of occasional and sporadic occurrence, and without taxonomic significance.

Tetilla cranium Müller grows typically in the deeper waters of the continental shelf and is distributed throughout the Arctic, the North Atlantic and North Pacific ; and some specimens have been recorded from South Africa, Australasia and the Antarctic. It is spherical to oval in shape, with a minutely papillate surface and ranges in size from a few millimeters to some 300 mm. (exceptionally up to 500 mm.) in diameter. The skeleton consists of oxea, protriænes, anatriænes and sigmaspiræ with a cortical palisade of stout microxea.

Distribution.—Arctic ; western Atlantic to the Azores ; South Africa (Natal) ; West Indies ; Vancouver ; Japan ; Ceylon ; 9–1828 m.



Text-fig. 4.—*Tetilla oxeata* sp. n. Oxea, of two sizes, anatriænes, and protriænes of two sizes, all ×500 sigmaspiræ, ×500.

Tetilla oxeata sp. n.

(Text-fig. 4.)

Holotype.—1936.3.4.377.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Diagnosis.—Sponge subspherical, with incipient root-tuft ; surface subpapillate, with faintly-marked longitudinal grooves ; oscule apical ; texture firm ; colour, in spirit, yellowish-green ; skeleton of radially-arranged oxea, anatriænes, and protriænes of two sizes, with small oxea scattered regularly throughout choanosome ; microscleres sigmaspiræ.

Spicules :

(1) oxea, 2·0 by 0·032 mm.,
(2) oxea, 0·6–0·8 by 0·02–0·034 mm.,
(3) anatriænes, cladi 0·035 mm. chord, rhabdome 1·1–2·0 by 0·004–0·007 mm.
(4) protriænes, rarely prodiænes, cladi 0·07 mm. long, rhabdome 2·0 by 0·007 mm.,
(5) protriænes, cladi 0·05 mm. long, rhabdome 1·1 by 0·004 mm.,
(6) sigmaspiræ 0·012–0·014 mm. chord.

Remarks.—The species finds its nearest relative in *T. monodi* Burton from West Africa.

Genus *Chrotella* Sollas.

Chrotella Sollas, 1886 : 180 ; *Cinochyra* Sollas, 1886 : 182 ; *Cinachyra* Sollas 1887 : 20 ; *Cinachrya* Sollas, 1888 : cxxv ; *Spiretta* Lendenfeld, 1888 : 42 ; *Cinachyrella* Wilson, 1925 : 356.

Chrotella cavernosa (Lamarck).

Tethya cavernosa Lamarck, 1815 : 70 ; Lamarck, 1816 : 385 ; Topsent, 1930 : 5, pl. ii, figs. 9–10.

(For synonymy and literature see Burton, 1934 : 523, under *Cinachyra australiensis.*)

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Distribution.—Red Sea and Indian Ocean generally ; East Indies ; Australia ; littoral to 91 m.

Chrotella eurystoma (Keller).

Cinachyra eurystoma Keller, 1891 : 338, pl. xix, figs. 46–48 ; *Tetilla barodensis* Dendy, 1916 : 105, pl. i, fig. 3.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shell ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Red Sea ; Indian Ocean (Okhamandal) ; 27–31 m.

Genus *Paratetilla* Dendy.

Paratetilla bacca (Selenka).

Stelletta bacca Selenka, 1867 : 569, pl. xxxv, figs. 14, 15 ; *Tethya merguiensis* Carter, 1883 : 366, pl. xv, figs. 6–8 ; Carter, 1887 : 80 ; *Tetilla merguiensis* Sollas, 1888 : 14 ; *T. ternatensis* Kieschnick, 1896 : 527 ; *T. merguiensis* Topsent, 1897 : 437, pl. xviii, figs. 4–5, pl. xxi, fig. 34 ; *T. bacca* Lindgren, 1897 : 485 ; Lindgren 1898 : 46 ; *T. amboinensis* Kieschnick, 1898 : 10 ; *T. violacea* Kieschnick, 1898 : 15 ; *T. rubra* Kieschnick, 1898 : 18 ; *T. amboinensis* Kieschnick, 1900 : 556, pl. xlv, figs. 1–7 ; *T. violacea* Kieschnick, 1900 : 559, pl. xlv, figs. 8–15 ; *T. rubra* Kieschnick, 1900 : 560, pl. xlv, figs. 23–29 ; *T. bacca* Thiele, 1900 : 39, pl. ii, fig. 13 ; Kirkpatrick, 1900 : 132 ; Lendenfeld, 1903 : 19 ; *Cinachyra amboinensis* Lendenfeld, 1903 : 26 ; Kirkpatrick, 1905 : 665 ; *Paratetilla cineriformis* Dendy, 1905 : 97, pl. iii, fig. 7 ; *P. eccentrica* Row, 1911 : 306, pl. xxxv, fig. 1, pl. xxxvi, fig. 8, text-figs. 5–7 ; *Cinachyra amboinensis* Hentschel, 1912 : 331 ; *P. bacca* Dendy, 1921 : 21 ; *P. bacca*, var. *violacea* Dendy, 1921 : 22, pl. i, fig. 6 ; *P. bacca*, var. *corrugata* Dendy, 1921 : 23, pl. i, fig. 7 ; *P. arcifera* Wison, 1925 : 381, pl. xl, fig. 2, pl. xlviii, fig. 6.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The single specimen, 50 mm. across, differs from most recorded specimens of this species in that the rhabdome of the orthotriænes, in this case measuring up to 0·9 by 0·048 mm., is consistently longer than the cladi, which do not exceed 0·64 mm. in length. Otherwise, the spiculation is typical except for the presence of abundant raphides, 0·3 mm. long, distributed in bundles throughout the choanosome. These correspond, evidently, to the "short, slender oxea, 0·3 by 0·002 mm." mentioned by Dendy (1921, p. 24) for his *P. bacca*, var. *corrugata*. I have re-examined all the material of *P. bacca* in the British Museum collection and find that in most of Dendy's (1921) specimens these raphides are present but scattered, and that in the other specimens (identified by Row, Kirkpatrick, Dendy, Sollas and Carter) they may be absent, sparingly present or abundant. The present specimen is, however, the first one I have seen to carry these spicules in dragmata.

Distribution.—Red Sea; Indian Ocean (Ceylon, Praslin Reef, Coevity, Egmont Reef, Salomon, Diego Garcia, Christmas Island); Indo-Pacific (Mergui Archipelago, Java, Amboina, Torres Straits, Philippines, Samoa); 8–18 m.

Genus *Fangophilina* Schmidt.

Fangophilina submersa Schmidt.

Fangophilina submersa Schmidt, 1880 : 73, pl. ix, fig. 3; Sollas, 1888 : 55; *Spongocardium gilchristi* Kirkpatrick, 1902 : 224, pl. ii, fig. 1, pl. iii, fig. 1; *Fangophilina submersa* Kirkpatrick, 1905 : 666; *F. gilchristi* Kirkpatrick, 1905 : 666; *F. hirsuta* Lendenfeld, 1906 : 157, pl. x, figs. 11–29, pl. xi, figs. 1–6, pl. xii, figs. 1–14; *F. kirkpatricki* Lendenfeld, 1906 : 169, pl. x, figs. 14–17; *F. submersa* Topsent, 1923 : 2.

Occurrence.—Stn. 106, January 12, 1934, Zanzibar Area (5° 38′ 54″ S., 39° 15′ 42″ E. to 5° 40′ 18″ S., 39° 17′ 36″ E.), 212 m., bottom green mud.

Remarks.—Ten specimens only have hitherto been recorded, from widely-separated localities, under three different specific names. Topsent's (1923) suggestion that all represent varieties of a single species is supported by my own observations on a further group of specimens from a single locality off the South African coast. In these the differences between the supposed species could be seen.

Distribution.—Caribbean Sea; Cape Verde Is.; Natal; Dar-es-Salaam; 217–400 m.

Acanthotetilla **gen. n.**

Genotype.—*Acanthotetilla hemisphærica* **sp. n.**

Diagnosis.—Tetillidæ with radially-arranged surface brushes of long oxea and protriænes; with the choanosome densely filled with stout acanthoxea; sigmaspiræ absent.

Acanthotetilla hemisphærica **sp. n.**

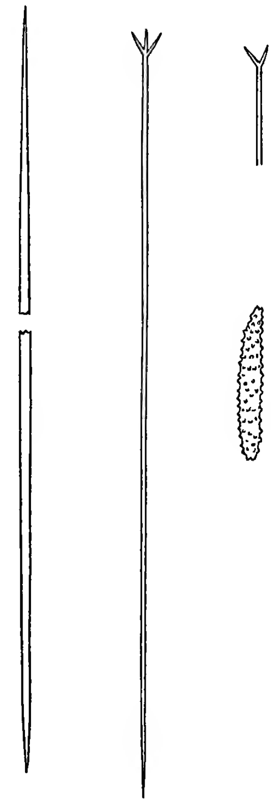
(Text-fig. 5.)

Holotype.—B.M. 1936.3.4.530.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge massive, hemispherical; surface strongly pilose; oscules not apparent; texture firm, almost stony; colour, in spirit, pale flesh; skeleton of densely-packed acanthoxea with oxea and protriænes projecting at surface; megascleres oxea, 4·0 by 0·032 mm., protriænes, occasionally prodiænes, cladi 0·056 m. long, shaft 2·0 by 0·014 mm., and acanthoxea, 0·4 by 0·06 mm.; microscleres absent.

Remarks.—Externally this sponge has the appearance of a normal Tetillid, but the presence of acanthoxea in association with oxea and protriænes is most remarkable. It is possible that the acanthoxea represent, more properly, microscleres derived from the sigmaspiræ characteristic of the Tetillidæ.



Text-fig. 5.—*Acanthotetilla hemisphærica* sp. n. Oxeote, protriæne, head of prodiæne, acanthoxeote, all ×50.

Numerous embryos are present, of two kinds. The first is oval, 0·16 mm. along the long axis and composed of large granular cells. The larger are nearly spherical, 0·55 mm. diameter, heavily pigmented a rich amber so that their structure is not obvious.

Family Clavulidæ.

Genus *Suberites* Nardo.

Suberites domuncula (Olivi).

Alcyonium domuncula Olivi, 1792 : 241; *Suberites domuncula* Topsent, 1900 : 225, pl. vi, figs. 1–9.

(For synonymy see Burton, 1953.)

Occurrence.—Stn. 175, May 1, 1934, Gulf of Aden (12° 37′ 24″ N., 51° 21′ 12″ E. to 12° 43′ 18″ N., 51° 19′ 12″ E.), 1618 m., bottom green mud.

Remarks.—This is the first record for the Indian Ocean area, and it may represent a distribution through the Suez Canal from the Mediterranean.

Distribution.—Throughout the Northern Hemisphere.

Suberites ramulosus Ridley and Dendy.

Suberites ramulosus Ridley and Dendy, 1886 : 487 ; *S. ramulosa*, var. *cylindrifera* Ridley and Dendy, 1886 : 487 ; *S. ramulosus* Ridley and Dendy, 1887 : 207; *S. ramulosus*, var. *cylindrifera* Ridley and Dendy, 1887 : 208, pl. xxix, fig. 5, pl. xliii, figs. 13–14.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m. ; Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud ; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Philippines ; 174–1280 m.

Suberites kelleri Burton.

Suberites incrustans Keller, 1891 : 318, pl. xvii, figs. 19–20 ; *S. kelleri* Burton, 1930 : 536 ; *nec S. incrustans*, Hansen.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shells and (?) rock.

Distribution.—Red Sea.

Genus *Pseudosuberites* Topsent.

Pseudosuberites hyalinus (Ridley and Dendy).

Hymeniacidon ? hyalinus Ridley and Dendy, 1887 : 168, pl. xlv, fig. 6 ; *Pseudosuberites hyalinus* Topsent, 1898 : 103 ; Topsent, 1900 : 170, pl. ii, fig. 9 ; Topsent, 1913 : 26, pl. iii, fig. 10 ; Kirkpatrick, 1908 : 21, pl. xxvi, fig. 7 ; Row 1911 : 305 ; Hentschel, 1914 : 52 ; *P. hyalinus*, var. *compacta* Hentschel, 1914 : 53, pl. iv, fig. 1 ; Topsent, 1917 : 37 ; *Pseudosuberites hyalinus* Burton, 1929 : 445.

Occurrence.—Stn. 194, May 7, 1934, Gulf of Aden (13° 16′ 00″ N., 46° 20′ 24″ E. to 13° 16′ 36″ N., 46° 14′ 00″ E.), 220 m.

Remarks.—This species, most commonly recorded from the Antarctic, has also been found off Norway, in the Mediterranean and at Suez. It is here recorded for the Gulf of Aden.

Distribution.—Between Norway and Bear Island ; Banyuls ; Suez ; south-west coast of Patagonia ; Antarctic ; 40–456 m.

Genus *Laxosuberites* Topsent.

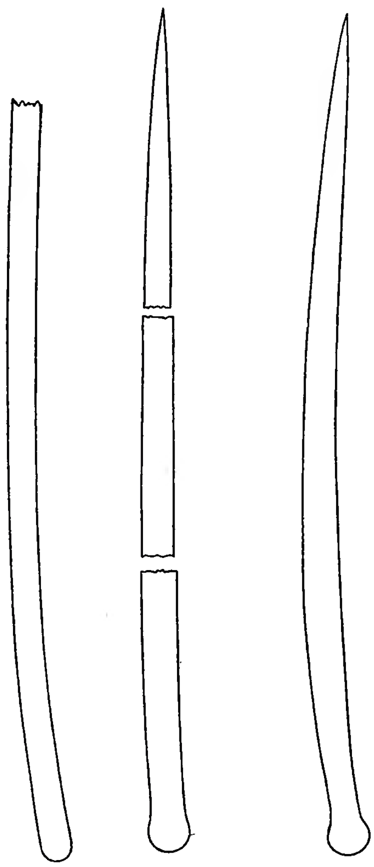
Laxosuberites longispiculus **sp. n.**

(Text-fig. 6.)

Holotype.—B.M. 1936.3.4.339.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Diagnosis.—Sponge a small incrustation on a piece of rock; oscules not apparent; texture soft; colour, in spirit, white; skeleton of tylostyli, rarely styli, of two sizes, 0·56–0·8 by 0·024 and 1·8–2·4 by 0·014–0·024 mm. respectively, with numerous intermediates, echinating on substratum; microscleres absent.



Text-fig. 6.—*Laxosuberites longispiculus* sp. n. Style and tylostyli, ×200.

Genus *Tentorium* Vosmaer.

Tentorium semisuberites (Schmidt).

Thecophora semisuberites Schmidt, 1870 : 50, pl. vi, fig. 2; *T. ibla* Thomson, 1873 : 148, fig. 24; *T. semisuberites* Whiteaves, 1874 : 9; *T. ibla* Verrill, 1874 : 500, pl. viii; *T. elongata* Marenzeller, 1877 : 12, pl. ii, fig. 4; *T. semisuberites* Vosmaer, 1882 : 30; Vosmaer, 1885 : 18, pl. i, figs. 23–24, pl. iii, figs. 22–26; *Tentorium semisuberites* Ridley and Dendy, 1886 : 489; Ridley and Dendy, 1887 : 221; Vosmaer, 1887 : 329, pl. ii, fig. 4, pl. xxi, fig. 19; *Thecophora semisuberites* Fristedt, 1887 : 433; *Tentorium semisuberites* Topsent, 1892 : 132; Lambe, 1896 : 198, pl. iii, fig. 2; Lambe, 1900 : 25; Lambe, 1900 : 163; Topsent, 1904 : 124; Arndt, 1912 : 113; Topsent, 1913 : 25; Ferrer, 1914 : 19; Pawsey and Davis, 1924 : 14; Topsent, 1928 : 151; pl. vi, fig. 10; Rezvoj, 1928 : 81; Hentschel, 1929 : 924; Burton, 1932 : 337.

Occurrence.—Stn. 108, January 13, 1934, Zanzibar Area (5° 18′ 06′ S., 39° 24′ 12″ E. to 5° 14′ 30″ S., 39° 25′ 36″ E.), 781 m., bottom grey mud.

Distribution.—Arctic Ocean between Canada and Barents Sea; Western North Atlantic (Nova Scotia, Gulf of St. Lawrence, north-east coast of U.S.A.); Eastern North

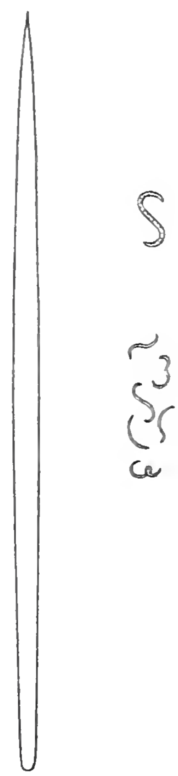
Atlantic (Norway, Shetlands, Lousy Bank, coast of Asturias); Azores; Inaccessible Is.; Tristan da Cunha; 37–3018 m., bottom mud, muddy sand, gravel, rarely rocky.

Tentorina gen. n.

Genotype.—*Tentorina sigmatophora* **sp. n.**

Diagnosis.—Clavulidæ with skeleton of strongyloxea, sparsely present in choanosome and forming a continuous tangential layer in ectosome; microscleres sigmaspiræ.

Remarks.—The external form of the genotype and also the structure of the skeleton recall those of the genus *Tentorium*. On the other hand, the megascleres are typical of the genus *Tethya* and the microscleres of *Tetilla*.



Text-fig. 7.—*Tentorina sigmatophora* sp. n. Strongyloxeote, ×200, sigmaspiræ, ×500 (single sigmaspira, above, ×750).

Tentorina sigmatophora sp. n.

(Text-fig. 7.)

Holotype.—B.M. 1936.3.4.516.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Diagnosis.—Sponge small, conical; surface even, smooth; oscules apical (?); texture soft, delicate; colour, in spirit, pale yellow; megascleres strongyloxea, 0·45–0·6 by 0·01–0·02 mm.; microscleres sigmaspiræ, 0·012 mm. chord.

Genus *Polymastia* Bowerbank.

Polymastia tubulifera Dendy.

Polymastia tubulifera Dendy, 1921 : 148, pl. iv, fig. 6, pl. xviii, fig. 7.

OCCURRENCE.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

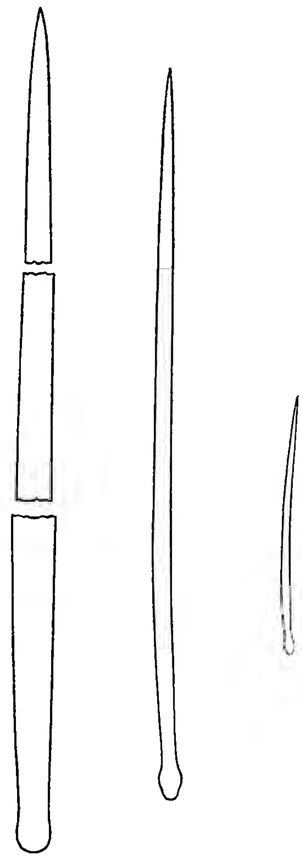
DISTRIBUTION.—Indian Ocean (Saya de Malha) ; 90 m.

Polymastia murrayi **sp. n.**

(Text-fig. 8.)

HOLOTYPE.—B.M. 1936.3.4.305.

OCCURRENCE.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock ; Stn. 177, May 2, 1934, Gulf of



TEXT-FIG. 8.—*Polymastia murrayi* sp. n. Tylostyli, of three sizes, ×200.

Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock ; Stn. 185, May 5, 1934, Gulf of Aden (13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E.), 2001 m., bottom green mud.

DIAGNOSIS.—Sponge subspherical (?), with a stout fleshy papilla ; surface hispid, except on papilla ; oscule small, apical on papilla ; texture firm ; colour, in spirit, greyish ; skeleton of stout radiating bundles of tylostyli, with a subectosomal, tangential layer medium-sized tylostyli and a dermal palisade of small tylostyli.

Spicules :

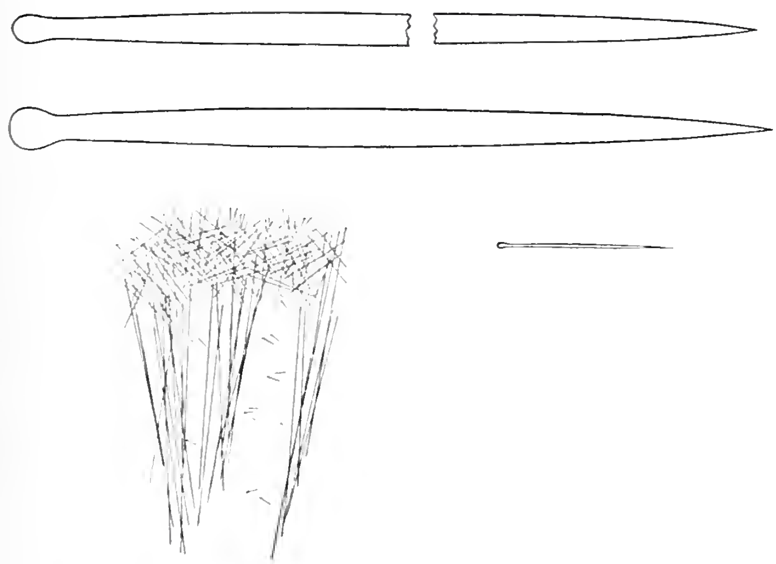
large tylostyli, 1·8 by 0·028 mm.,
medium-sized tylostyli, 0·48 by 0·014 mm.,
small tylostyli, 0.14–0·17 by 0·006 mm.,

Systematic notes.—There is only a fragment of this sponge, including the papilla, and the interior is sufficiently cleaned of flesh to leave doubt as to the presence or absence of small tylostyli in the choanosome.

Three small specimens must also be included in this species. They are subspherical, somewhat flattened dorso-ventrally, 10–20 mm. diameter. The spicules do not differ much in size from those of the holotype. On the other hand, the tangential subectosomal layer of tylostyli is more diffuse, and the radial bundles not so strongly marked. This may be due to the immature state of the specimens. In all three, both small and medium-sized tylostyli are abundantly scattered between the radial bundles of large tylostyli.

The characteristic feature of the species appears to be the single fleshy papilla, which is short and stout, and is surrounded by an area relatively less hispid, than the general surface of the sponge.

Although the bases of the large tylostyli of the holotype, of the specimen from Stn. 157, and one of those from Stn. 185 are all of the same shape, in the second specimen from Stn. 185 the large megascleres vary from styli to tylostyli, although in the latter the shape of the base is often typical for the species.



Text-fig. 9.—*Polymastia clavata* sp. n. Tylostyli, of three sizes, ×200 ; section at right angles to surface, ×10.

Polymastia clavata sp. n.

(Text-fig. 9.)

Holotype.—B.M. 1936.3.4.497.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shells and (?) rock.

Diagnosis.—Sponge stipitate, with body irregularly rounded and bearing short, blind papillæ ; surface even, hispid ; oscules not apparent ; texture firm ; colour, in spirit, pale yellowish-grey ; skeleton of slender radial bundles of long tylostyli, with a cortical layer of shorter tylostyli irregularly and densely arranged, and an ectosomal palisade of small, hair-like tylostyli ; megascleres tylostyli, of the radial bundles, 1·2 by 0·02 mm., tylostyli of the cortical layer, 0·24–0·8 by 0·012–0·036 mm., and tylostyli of the ectosomal palisade, 0·12 by 0·003 mm.

Remarks.—The species differs from all known species in its external form, as well as in details of its spiculation, particularly in the hair-like shape of the smallest tylostyli.

Genus *Radiella* Schmidt.

Radiella sarsii (Ridley and Dendy).

Trichostemma sarsii Ridley and Dendy, 1886 : 488 ; Ridley and Dendy, 1887 : 218, pl. xliii, figs. 1–3 ; *T. sarsi* Topsent, 1892 : 132 ; 1904, p. 120 ; *T. sarsii* Dendy, 1921 : 151 ; *T. sarsi*, Topsent 1928 : 154.

Occurrence.—Stn. 108, January 13, 1934, Zanzibar Area (5° 18′ 06″ S., 39° 24′ 12″ E. to 5° 14′ 30″ S., 39° 25′ 36″ E.), 781 m., bottom grey mud ; Stn. 145 E, April 2, 1934, Maldive Area (4° 58′ 42″ S., 73° 16′ 24″ E.), 494 m., bottom green mud and sand.

Remarks.—The 18 specimens from Stn. 108 and the 12 specimens from Stn. 145 agree closely with the "Challenger" specimens (Stn. 73). They range in diameter from 9 to 22 mm.

Distribution.—Azores (861–2102 m.) ; Madeira (1477–2380 m.) ; Morocco (851 m.) ; Saya de Malha, Indian Ocean (5(?)–914 m.) ; Australia, off Queensland (1829 m.).

Genus *Spirastrella* Schmidt.

Spirastrella cuspidifera (Lamarck).

Alcyonium cuspidiferum Lamarck, 1813 : 168 ; Lamarck, 1816 : 401 ; *Suberites capensis* Carter, 1882 : 350 ; *Spirastrella cunctatrix* var., Carter, 1882 : 351 ; *Suberites* sp., Carter, 1882 : 352 ; *Spirastrella vagabunda* Ridley, 1884 : 468, pl. xliii, fig. e ; *S. vagabunda*, var. *trincomaliensis* Ridley, 1884 : 468 ; *S. congenera* Ridley, 1884 : 469, pl. xliii, fig. d ; *S. punctulata* Ridley, 1884 : 623, pl. liv, fig. p ; *Suberites capensis* Carter, 1886 : 114 ; *Spirastrella solida* Ridley and Dendy, 1886 : 491 ; 1887 : 231, pl. xli, fig. 7, pl. xlv, fig. 13 ; *S. trincomaliensis* Carter, 1887 : 74, pl. vi, figs. 7–8 ; *Suberites inconstans* Dendy, 1887 : 154 ; *S. inconstans*, var. *globosa* Dendy, 1887 : 155, pl. ix, fig. 1 ; *S. inconstans* var. *mœandrina* Dendy, 1887 : 155, pl. x, fig. 1 ; *S. inconstans*, var. *digitata* Dendy, 1887 : 155, pl. ix, fig. 2 ; ? *Papillina panis* (pars) Lendenfeld, 1888 : 58 ; *Suberites mastoideus* Keller, 1891 : 317, pl. xvii, figs. 16–18 ; *Spirastrella punctulata*, Topsent, 1893 : 177, fig. 4 ; *S. vagabunda*, var. *arabica* Topsent, 1893 : 177, fig. 1 ; *S. cylindrica* Kieschnick, 1896 : 534 ; *S. solida* Topsent, 1897 : 440 ; *S. carnosa* Topsent, 1897 : 441 ; *S. papillosa*, var. *porosa* Dendy, 1897 : 253 ; *Vioa florida* Lendenfeld, 1897 : 108, pl. x, figs. 78–105 ; *Spirastrella solida* Lindgren, 1897 : 484 ; 1898 : 43 ; *S. lacunosa* Kieschnick, 1898 : 45 ; *S. spiculifera* Kieschnick, 1898 : 45 ; *Spirastrella inconstans* Thiele, 1899 : 10, pl. i, fig. 3, pl. v, fig. 4 ; *S. cylindrica* Thiele, 1900 : 69, pl. iii, fig. 23 ; *S. lacunosa* Kieschnick, 1900 : 575 ; *S. spiculifera* Kieschnick, 1900 : 575 ; *S. carnosa* Kirkpatrick, 1900 : 128 ; *S. inconstans* Sollas, 1902 : 216, pl. xiv, fig. 3 ; *S. lacunosa* Dragnewitsch, 1905 : 13 ; *S. vagabunda* Dendy, 1905 : 122 ; *S. vagabunda*, var. *trincomaliensis* Dendy, 1905 : 123 ; *S. vagabunda*, var. *tubulodigitata* Dendy, 1905 : 123 ; *S. vagabunda*, var. *fungoides* Dendy, 1905 : 124 ; *S. vagabunda*, var. *gallensis* Dendy, 1905 : 124 ; *S. tentorioides* Dendy, 1905 : 125, pl. v, fig. 7 ; *S. cunctatrix* Hentschel, 1909 : 382 ; *S. tentorioides*, var. *australis* Hentschel, 1909 : 383 ; *S. digitata* Hentschel, 1909 : 385, pl. xxii, fig. 7, text-fig. 18 ; *Suberites capensis* Vosmaer, 1911 : 12 ; *Spirastrella congenera* Vosmaer, 1911 : 12 ; *S. punctulata* Vosmaer, 1911 : 14 ; *S. vagabunda* Vosmaer, 1911 : 14, pl. xi, fig. 5 ; *Suberites inconstans* Vosmaer, 1911 : 18 ; *S. trincomaliensis* Vosmaer, 1911 : 20 ; *Spirastrella cylindrica* Vosmaer, 1911 : 21 ; *S. carnosa* Vosmaer, 1911 : 22 ; *Vioa florida* Vosmaer, 1911 : 23 ; *Spirastrella tentorioides* Vosmaer, 1911 : 24 ; *S. digitata* Vosmaer, 1911 : 25 ; *S. purpurea* (pars), Vosmaer, 1911 : 6, pl. i, figs. 1–9, pl. ii, figs. 1, 3–4, 6, pl. iii, figs, 1–2, pl. iv, figs. 1–9, pl. v, figs. 1–23, pl. vi, figs. 1–12, pl. vii, figs. 1–6, pl. viii, figs. 2–3, 5–6, pl. ix, figs. 1–9, pl. xi, fig. 2, pl. xii, figs. 10, 12, pl. xiii, fig. 4, pl. xiv, figs. 2–4 ; *S. purpurea* Hentschel, 1912 : 324 ; *S. montiformis* Hallmann, 1912 : 119, pl. xxi, fig. 3, text-fig. 21 ; ? *Papillina panis* (pars), Hallmann, 1914 : 294 ; *Spirastrella vagabunda*, var. *arabica* Topsent, 1918 : 550, fig. x ; *S. punctulata* Topsent, 1918 : 551, fig. xi ; *S. solida* Topsent, 1918 : 551, fig. xii ; *S. carnosa* Topsent, 1918 : 551, fig. xiii ; *S. vagabunda* Dendy, 1921 : 139 ; *S. globularis* Dendy, 1921 : 141, pl. iv. fig. 5, pl. xviii, fig. 18 ; *S. vagabunda* Dendy and Frederick, 1924 : 508 ; Wilson 1925 : 343 ; *S. cuspidifera* Topsent, 1933 : 41, pl. ii, fig. 4, text-fig. 4 ; *S. inconstans* Burton, 1934 : 570 ; *Cliona arndtii* de Laubenfels, 1936 : 152.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shell and Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 m.

Diagnosis.—Sponge typically digitate or composed of a bunch of stout, erect, digitate processes springing from a basal mass, often fungiform, or massive with submeandrine surface, occasionally boring ; surface minutely hispid, even or thrown into meandrine folds, plentifully beset with commensal cirripedes ; oscules scattered in massive forms, at summit of processes in digitate forms ; texture hard, incompressible ; colour, in life, orange or brick-red, in spirit, yellow to brown ; skeleton a coarse isodictyal, multispicular reticulation of tylostyli, 0·6 by 0·022 mm. ; microscleres slender spinispiræ, beset with wart-like processes, 0·006–0·048 mm., or even 0·07 mm. long, and stout spinispiræ, 0·05–0·06 mm. long.

Distribution.—Red Sea and Gulf of Aden ; Indian Ocean (Ceylon, Madras, Diego Garcia, Seychelles, Amirante, Egmont, Salomon, Coin Peros, Cargado Carajos, Mauritius) ; Zanzibar ; Mozambique ; Port Elizabeth ; Malay Area (Mergui Archipelago, Pulau Bidang, Singapore, Java, Xmas Is , Celebes, Ternate, Amboina, Aru and Kei Islands, Philippines) ; Australia (Torres Straits, Great Barrier Reef, Queensland, Port Jackson, Port Phillip Heads, Abrolhos Is., Sharks Bay) ; littoral to 59 m., bottom sand, rock, mud, shells and, above all, coral.

Spirastrella spinispirulifer (Carter).

Suberites spinispirulifer Carter, 1879 : 345, pl. xxviii, figs. 6–7 ; Carter 1886 : 456 ; *Spirastrella dilatata* Kieschnick, 1896 : 534 ; *S. spinispirulifer* Dendy, 1897 : 251 ; *S. dilatata* Thiele, 1900 : 70, pl. ii, fig. 22.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock(?).

Distribution.—South Africa (Port Elizabeth) ; Australia (Port Western, Port Phillip) ; Ternate.

Genus *Diplastrella* Topsent.

Diplastrella gardineri Topsent.

Diplastrella gardineri Topsent, 1918 : 549, fig. viii.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m. ; Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock.

Remarks.—The dimensions of the spicules, which were not given by Topsent, are: tylostyli, 0·44 by 0·012 mm., diplasters, 0·012–0·02 mm. across, and amphiasters (? young diplasters), 0·008 mm. across.

Distribution.—Maldives, 42 m.

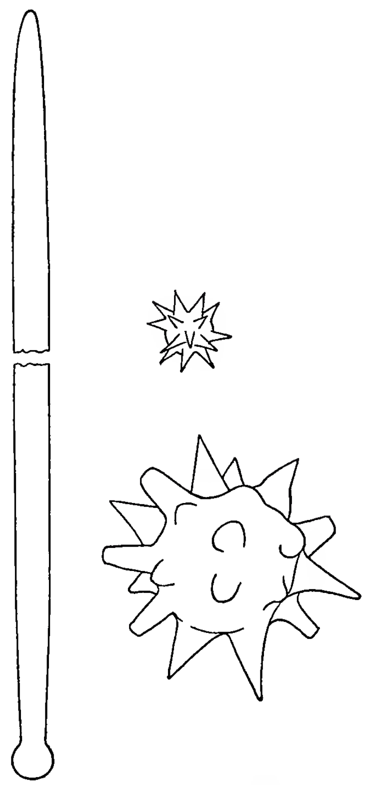
Genus *Timea* Gray.

Timea capitatostellifera (Carter).

Hymedesmia capitatostellifera Carter, 1880 : 51, pl. iv, fig. 12.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

Distribution.—Gulf of Manaar.



Text-fig. 10.—*Timea tethyoides* sp. n. Tylostyle, ×200, and two sizes of spherasters, ×500.

Timea tethyoides **sp. n.**

(Text-fig. 10.)

Holotype.—B.M. 1936.3.4.304.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ N., 39° 13′ 18″ E.), 113 m., bottom coral rock.

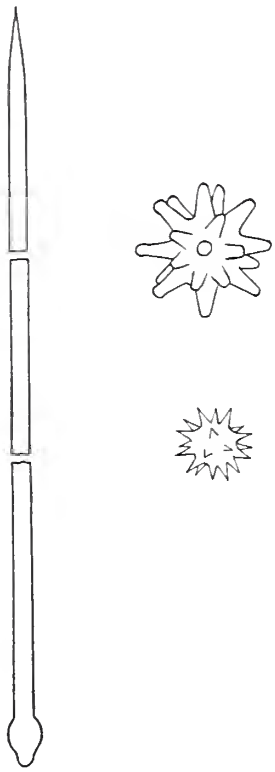
Diagnosis.—Sponge encrusting; surface uneven, hispid; oscules not apparent; texture soft; colour, in spirit, light greyish-brown; skeleton of tylostyli, 0·4–0·8 by 0·022 mm., arranged in divergent brushes arising from substratum, with small tylostyli near surface; microscleres choanosomal spherasters, with conical rays, rounded distally in early stages of development, later much-branched, 0·08 mm. diameter, and ectosomal spherasters, with rays conical and obtusely pointed, 0·02 mm. diameter.

Timea spherastræa sp. n.

(Text-fig. 11.)

HOLOTYPE.—B.M. 1936.3.4.303.

OCCURRENCE.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ N., 39° 14′ 12″ E.), (depth ?).



TEXT-FIG. 11.—*Timea spherastræa* sp. n. Tylostyle, ×200, and spherasters, ×500.

DIAGNOSIS.—Sponge encrusting; surface uneven, hispid in patches; oscules not apparent; texture soft; colour, in spirit, greyish; skeleton of sparsely distributed tylostyli, 1·1 by 0·012 mm.; microscleres spherasters, smaller with pointed, larger with conical obtusely-pointed rays, 0·02–0·035 mm. diameter.

Genus *Trachycladus* Carter.

Trachycladus tethyoides sp. n.

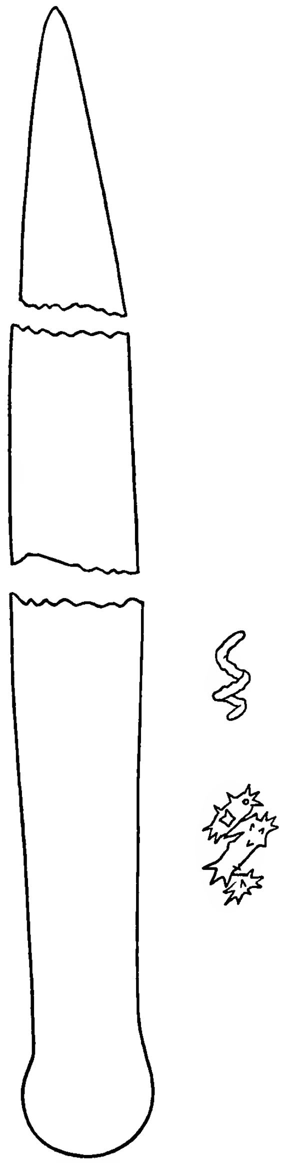
(Text-fig. 12.)

HOLOTYPE.—B.M. 1936.3.4.576.

OCCURRENCE.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock.

Diagnosis.—Sponge subspherical, surface minutely and irregularly papillate, strongly hispid; oscules not apparent; texture firm, barely compressible; colour, in spirit, pale yellow; skeleton of loose radial strands of tylostyli, variable in size but averaging 2·0 by 0·09 mm.; microscleres spinispiræ, passing rarely to microstrongyla, 0·03 mm. chord.

Remarks.—The species differs from all others in external form, and in the presence of tylostyli for megascleres.



Text-fig. 12.—*Trachycladus tethyoides* sp. n. Tylostyle, ×300, sigmaspiræ, ×500.

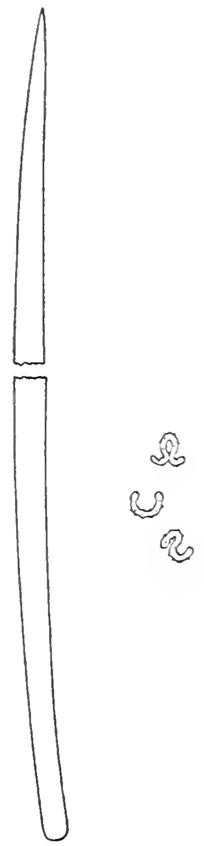
The only other feature worthy of note is that each of the three specimens recorded here bears on its surface an incrustation of *Biemna fortis* (Topsent), so thin that it is not immediately apparent even in sections. More obvious is the presence of numerous raphides scattered generally throughout the choanosome of the *Trachycladus* and appearing there as proper spicules. In fact, one could be led to believe, at first glance, that they belonged to the *Trachycladus*.

Trachycladus cervicornis sp. n.

(Text-fig. 13.)

Holotype.—B.M. 1936.3.4.610.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock.



Text-fig. 13.—*Trachycladus cervicornis* sp. n. Tylostyle, ×200, sigmaspiræ, ×500.

Diagnosis.—Sponge erect, stipitate, dichotomously branched; surface minutely papillate, strongly hispid; oscules not apparent; texture firm, compressible; colour, in spirit, pale yellow; skeleton of long, smooth styli, 1·4 by 0·02 mm., arranged in a dense axial core, with single spicules projecting well beyond surface of sponge; microscleres spinispiræ, 0·008 mm. chord.

Remarks.—This is a well marked species differing from other species of *Trachycladus* in external form and in the large size of the megascleres.

Genus *Placospongia* Gray.

Placospongia carinata (Bowerbank).

Geodia carinata Bowerbank, 1858 : 308, 314, pl. xxv, fig. 19, pl. xxvi, fig. 10; Bowerbank 1864 : 254, pl. x, fig. 163; Bowerbank, 1874 : 298, pl. xlvi, figs. 1–5 Bowerbank, 1875 : 295; *Placospongia carinata* Ridley, 1884 : 376, 481; Sollas, 1888 : 272; *P. intermedia* Sollas, 1888 : 273; *P. carinata* Lindgren, 1897 : 485; Lindgren, 1898 : 45, pl. xviii, fig. 26; *P. mixta* Thiele, 1900 : 72, pl. iii, fig. 25; *P. carinata*

Vosmaer and Vernhout, 1902 : 9, pl. i, figs. 1–4, pl. ii, fig. 5, pl. iv, figs. 9–13, pl. v, figs. 1, 5, 7–9, 11; Dendy, 1905 : 126 ; Hentschel, 1912 : 324 ; Dendy, 1921 : 144.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Indian Ocean (Ceylon, Cargados Carajos, Egmont, Coevity) ; Straits of Malacca, Java, Ternate ; Torres Straits ; 13–55 m., bottom sand.

Family Astraxinellidæ.

Genus *Hemiasterella* Carter.

Hemiasterella typus Carter.

Hemiasterella typus Carter, 1879 : 146, pl. xxi, fig. 9 ; Sollas, 1888 : 434 ; Topsent, 1919 : 6.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

Remarks.—The single specimen is vasiform and stipitate, 160 mm. high and 140 mm. across. The microscleres, up to 0·05 mm. diameter, may have smooth pointed rays or strongylote and microspined rays.

Distribution.—(Hitherto unknown.)

Hemiasterella complicata Topsent.

Hemiasterella complicata Topsent, 1919 : 7, figs. 2–5.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shingle.

Remarks.—A typical specimen, vasiform and stipitate, 45 mm. high.

Distribution.—Madagascar.

Family Tethyadæ.

Genus *Tethya* Lamarck.

Tethya Lamarck, 1815 : 69 ; *Tethia* Lamarck, 1816 : 384 ; *Thethya* Cuvier, 1817 : 250 ; *Jethya* Rafinesque, 1820 : 364 ; *Donatia* Nardo, 1833 : 522 ; *Lyncuria* Nardo, 1834 : col. 715 ; *Tethea* Siebold, 1843 : 363 ; *Tethyum* Lieberkühn, 1859 : 522 ; *Thetea* Schmidt, 1866 : 13 ; *Amniscos* Gray, 1867 : 542 ; *Columnitis* Schmidt, 1870 : 25 ; *Thetya* Studer, 1879 : 120 ; *Ichthya* Mereschkowsky, 1880 : 418 ; *Alemo* Wright, 1881 : 13 ; *Columnites* Lendenfeld, 1890 : 397 ; *Tethycordyla* de Laubenfels, 1934 : 8 ; *Tethytimea* de Laubenfels, 1936 : 164 ; *Taboga* de Laubenfels, 1936 : 452.
(See also Burton, 1934 : 568.)

Diagnosis.—Clavulidæ with main skeleton of radiating bundles of strongyloxea (styli or tylota) ; microscleres large cortical spherasters and various types of smaller asters scattered in cortex and choanosome.

Remarks.—Only three names included in the present list of synonyms of *Tethya* call for comment. The type of *Taboga* (*T. taboga*) is clearly synonymous with *Tethya diploderma* Schmidt. *Tethycordyla* and *Tethytimea* are equally recognizable as representing *Tethya repens* Schmidt. *Tethycordyla* was established for a small stalked sponge, but it appears that, throughout its range, *Tethya repens* is almost invariably stalked.

De Laubenfels (1936, p. 164) agrees that the genotype of *Tethytimea* "probably should be called *repens*." He adds that "Schmidt's description (of *Tethya repens*), however, is very unsatisfactory and the synonymy is not certain." I have indicated (1924, p. 1036) in my revision of the genus *Donatia* that I had access to Schmidt's original material. Moreover, having re-examined this and compared it with the original description of the genotype of *Tethytimea*, my impression that *Tethya repens* Schmidt and *Tethytimea* (*Donatia*) *tylota* (Hentschel) are synonymous is fully confirmed.

Tethya repens Schmidt.

Tethya repens Schmidt, 1870 : 51 ; *Tethya repens* Sollas, 1888 : 439 ; *Donatia fissurata*, var. *extensa* Hentschel, 1909 : 374, pl. xxii, fig. 6, text-fig. 14 ; *D. tylota* Hentschel, 1912 : 317, pl. xvii, fig. 6 ; *D. stellagrandis* Dendy, 1916 : 266, pl. xliv, fig. 8, pl. xlviii, fig. 5 ; *Tethya repens* Topsent, 1918 : 574 ; *Donatia fissurata*, var. *extensa* Topsent, 1918 : 599 ; *D. tylota* Topsent, 1918 : 599 ; *Donatia stellagrandis* Topsent, 1918 : 600 ; *Donatia repens* Burton, 1924 : 1036 ; *Donatia repens* Dendy and Burton, 1926 : 247 ; *Tethycordyla thyris* de Laubenfels, 1934 : 8 ; *Tethytimea tylota* de Laubenfels, 1936 : 164.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 12″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock ; Stn. 152, April 4, 1934, Maldive Area (4° 49′ 24″ N., 72° 46′ 30″ E. to 4° 48′ 42″ N., 72° 40′ 30″ E.), 878 m., bottom green sand.

Remarks.—The 18 specimens, from two widely separated areas, are all very alike and agree closely with Hentschel's *Donatia fissurata*, var. *extensa*. The spiculation also agrees closely with that of Hentschel's specimen, as well as the others represented in the synonymy list, except in the size of the large spherasters. In the specimens hitherto recorded, the spherasters have ranged in size from 0·08 to 0·25 mm. diameter. In the present collection the maxima for the spherasters are, for nearly two-thirds of the specimens, 0·4 mm. diameter, for another, 0·6 mm. diameter, and, for the occasional specimen, 0·5 mm. diameter.

At first sight it appeared probable that the present specimens represented a new species, but the very close agreement between them and the other specimens accepted under *Tethya repens*, in all respects but the maximal size of the spherasters, is against this. Moreover, since the present specimens were collected off the coasts of Arabia and off Zanzibar it is doubtful whether they represent a geographical variety, while the bathymetric range, 13·5–113 m., as compared with that of previously known specimens, 7–877 m., does not suggest an ecological variety. Further, the specimens from Stn. 45 alone show all maxima between approximately 0·35–0·6 mm. diameter in the spherasters.

It is of interest to record that in some specimens the cortex may contain mainly spherasters measuring 0·08–0·25 mm. diameter, with a few reaching a diameter of 0·4 or even 0·6 mm., and in others the cortex is almost entirely filled with spherasters of 0·3–0·6 mm. diameter with a few of the smaller sizes scattered between. It does seem therefore that we must accept a fairly wide range of variation in the sizes of the spherasters and in their relative abundance as normal for the species.

Distribution.—SW. Australia ; Aru Island ; Indian Ocean (Amirante, Andamans) ; Florida and West Indies ; 7–877 m.

Order LITHISTIDA.

Genus *Discodermia* Bocage.

Discodermia natalensis Kirkpatrick.

Discodermia natalensis Kirkpatrick, 1903 : 172, pl. iv, figs. 2–3 ; Burton, 1929 : 5.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

Distribution.—Natal ; 91–183 m.

Discodermia emarginata Dendy.

Discodermia emarginata Dendy, 1905 : 99, pl. iv, fig. 4 ; Wilson, 1925 : 455 ; *D. emarginata*, var. *lamellaris* Wilson, 1925 : 456, pl. xliii, fig. 5.

Occurrence.—Stn. 123, January 22, 1934, Zanzibar Area (5° 19′ 00″ S., 39° 32′ 30″ E. to 5° 19′ 12″ S., 39° 33′ 30″ E.), 256–366 m., bottom green sand, mud and rock.

Distribution.—Ceylon ; Philippines ; 183 m.

Genus *Theonella* Gray.

Theonella lacerata Lendenfeld.

Theonella lacerata Lendenfeld, 1906 : 347, pl. xliv, figs. 1–13, pl. xlv, figs. 1–7.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Distribution.—Sumatra ; 371 m.

Theonella discifera Lendenfeld.

Theonella discifera Lendenfeld, 1906 : 351, pl. xliii, figs. 5–18.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Distribution.—West coast of Australia, 65 m.

Theonella pulchrifolia Dendy.

Theonella pulchrifolia Dendy, 1921 : 5, pl. ix, fig. 1.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Remarks.—The species is represented by a small, ear-shaped specimen, 5 mm. high, the spiculation of which agrees very closely with that of the holotype except that the microscleres are microstrongyla instead of microxea.

Distribution.—Salomon ; 209–273 m.

Genus *Corallistes* Schmidt.

Corallistes bowerbanki (Johnson).

Dactylocalyx bowerbanki Johnson, 1863 : 257 ; *D. masoni* Bowerbank, 1869 : 91, pl. vi, figs. 1–4 ; *D. bowerbanki* Bowerbank, 1869 : 94, pl. vi, figs. 5–8 ; *Corallistes typus* Schmidt, 1870 : 22, pl. iii, fig. 3 ; *Dactylocalyx bowerbanki* Carter, 1873 : 437 ; *D. masoni* Carter, 1873 : 437 ; *Corallistes bowerbanki* Carter, 1876 : 460 ; Zittel, 1878 : 103 ; *C. masoni* Zittel, 1878 : 103 ; *C. typus* Zittel, 1878 : 103 ; *C. typus* Sollas, 1888 : 301, pl. xxxiv, figs. 14–18a ; *C. masoni* Sollas, 1888 : 303, pl. xxxiv, figs. 1–13 ; *C. bowerbanki* Sollas, 1888 : 308 ; Topsent, 1892 : 51, pl. viii, fig. 2 ; *Coscinospongia masoni* Lendenfeld, 1903 : 136 ; *C. typus* Lendenfeld, 1903 : 136 ; *C. bowerbankii* Lendenfeld, 1903 : 137 ; *Corallistes typus* Burton, 1929 : 5.

Occurrence.—Stn. 123, January 22, 1934, Zanzibar Area (5° 19′ 00″ S., 39° 32′ 30″ E. to 5° 39′ 12″ S., 39° 33′ 30″ E.), 256–366 m., bottom green mud, sand and rock.

Distribution.—Portugal, Azores, Madeira, Pernambuco, Florida, Natal ; 91–684 m.

Genus *Taprobane* Dendy.

Taprobane herdmani Dendy.

Taprobane herdmani Dendy, 1905 : 103, pl. i, fig. 8, pl. iv, fig. 2; Dendy, 1921 : 7, pl. i, fig. 1.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Amirantes ; Gulf of Manaar ; 16–71 m.

Genus *Microscleroderma* Kirkpatrick.

Microscleroderma hirsutum Kirkpatrick.

Microscleroderma hirsutum Kirkpatrick, 1903 : 173, pl. iv, fig. 1.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The specimens include a complex mass of caliculate individuals, 170 mm. across, and some fragments, all with typical spiculation.

Distribution.—Natal ; 165 m.

Sub-order Sigmatosclerophora.

Family HaploscleridÆ.

Genus *Haliclona* Grant.

Haliclona camerata (Ridley).

Reniera camerata Ridley, 1884 : 605, pl. liii, fig. H, pl. liv, fig. n ; Topsent, 1897 : 474 ; Dendy, 1921 : 31 ; *Haliclona camerata* Burton, 1934 : 531.

Occurrence.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.

Remarks.—A typical specimen 25 mm. across.

Distribution.—Indian Ocean (Seychelles, Amirante, Salomon) ; Amboina ; Great Barrier Reef ; 4–31 m.

Haliclona cribriformis (Ridley).

Reniera cribriformis Ridley, 1884 : 606, pl. liii, fig. G, pl. liv, fig. o ; Topsent, 1897 : 475, pl. xviii, fig. 10 ; Dendy, 1921 : 31.

Occurrence.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

Distribution.—Seychelles ; Amboina ; 22–80 m., bottom coral.

Haliclona flagellifer (Ridley and Dendy).

Gellius vagabundus, var. γ Vosmaer, 1885 : 28, pl. v, figs. 37–38 ; *G. flagellifer* Ridley and Dendy, 1886 : 333 ; Ridley and Dendy, 1887 : 42, pl. xiii, figs. 5, 10 ; Lundbeck, 1902 : 71, pl. ii, fig. 9, pl. xiv, fig. 1 ; Stephens, 1921 : 5 ; Dendy, 1921 : 26 ; *G. vagabundus* Babić, 1921 : 3 ; Babić 1922 : 228, fig. H ; *G. flagellifer* Dendy, 1924 : 320 ; Rezvoj, 1928 : 91 ; Burton, 1928 : 114 ; *G. vagabundus* Topsent, 1928 : 314, pl. xi, fig. 1 ; *G. flagellifer* Hentschel, 1929 : 978.

Occurrence.—Stn. M.B. I (d), September 17, 1933, Bay between Great Hanish and Suyul Hanish Islands, Red Sea, 26 m., bottom sand, shells and coral ; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Remarks.—The specimen from Stn. 157 is encrusting, about 1 mm. thick, with oxea 0·32 by 0·02 mm., ordinary sigmata 0·03–0·08 mm. chord and flagellate sigmata 0·09 mm. chord. The specimen from Stn. M.B. I (d) is massive, 10 mm. across, with microscleres of similar dimensions but with oxea measuring 0·17 by 0·01 mm.

Distribution.—Arctic (Iceland, Barents Sea) ; North Atlantic (Canada : *teste* Stephens, 1921, SW. Ireland, Azores) ; Mediterranean (Monaco, Adriatic) ; Marion Is. ; Indian Ocean (Andamans, Saya da Malha) ; New Zealand ; 91–1378 m.

Haliclona cf. *ochracea* (Keller).

Ceraochalina ochracea Keller, 1889 : 387, pl. xxiv, fig. 46.

Occurrence.—Stn. 9, September 17, 1933, Red Sea (13′ 35″ 30″ N., 42° 35′ 05″ E.), 245 m.

Remarks.—The present specimen is so strikingly like the holotype, as figured by Keller, that it can be called in a literal sense, practically identical with it. Its spicules measure 0·2 by 0·012 mm., as against 0·1 by 0·0015 mm. in the holotype. In spite of the difference in the sizes of the spicules, however, I feel confident that this is a further representative of Keller's species.

Distribution.—Red Sea.

Haliclona contignata (Thiele).

Petrosia contignata Thiele, 1899 : 20, pl. ii, fig. 8, pl. v, fig. 13.

Occurrence.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m. ; Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ N., 39° 14′ 12″ E.), 73–165 m.

Distribution.—Celebes.

Haliclona irregularis (Kirkpatrick).

Stylotella irregularis Kirkpatrick, 1900 : 137, pl. xii, fig. 4, pl. xiii, fig. 6 ; *Axinosia irregularis* Hallmann, 1914 : 349.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m. ; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Indian Ocean (Christmas Island), littoral.

Haliclona expansa (Thiele).

Protoschmidtia expansa Thiele, 1903 : 939, fig. 4 ; Burton, 1928 : 116.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Ternate ; Andamans ; 2377 m.

Haliclona obtusispiculifera (Dendy).

Chalina obtusispiculifera Dendy, 1905 : 150, pl. x, fig. 9.

Occurrence.—Stn. D (?), September 9, 1933, Red Sea, 23 m.

Distribution.—Ceylon.

Haliclona decidua Topsent.

Reniera decidua Topsent, 1906 : 560.

Occurrence.—Stn. 110, January 14, 1934, Zanzibar Area (5° 03′ 42″ S., 39° 15′ 24″ E. to 5° 05′ 48″ S., 39° 15′ 12″ E.), 73–165 m., bottom rock (?).

Distribution.—Red Sea.

Haliclona tabernacula (Row).

Reniera tabernacula Row, 1911 : 316, fig. 9 ; *R. spinosella* Row, 1911 : 317, fig. 10 ; *Halichondria bubastes* Row, 1911 : 319, fig. 11 ; *Reniera spinosella* Burton, 1926 : 73 ; *R. tabenacula* Burton, 1926 : 74 ; *nec R. spinosella* Thiele, 1905.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Suez Canal ; Red Sea.

Haliclona seychellensis (Dendy).

Petrosia seychellensis Dendy, 1921 : 35, pl. ii, figs. 3–4, pl. xii, fig. 5.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 112, January 15, 1933, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Remarks.—There are nine large specimens, the largest 130 mm. across, and one fragment. Although collected at two widely-separated stations there is a fair agreement between them in external and internal characters.

Distribution.—Indian Ocean (Amirante, 40–156 m., Seychelles, 68 m.).

Haliclona tuberosa (Dendy).

Reniera tuberosa Dendy, 1921 : 33, pl. iii, fig. 2, pl. xii, fig. 2.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Indian Ocean (Saya de Malha, Diego Garcia) ; 100 m.

Haliclona cerebrum (Burton).

Protoschmidtia cerebrum Burton, 1928 : 116, pl. i, fig. 2.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Remarks.—There is a much damaged specimen, with a skeleton of strongyla forming a close-meshed reticulation, which seems to belong here. The consistency is hard, almost stony, and what little can be seen of the external features agrees with what is known of the holotype. The spicules themselves are 0·4 by 0·016 mm., which is larger than those of the holotype and they should perhaps be described as substrongyla. Despite these differences, and in spite of the geographical separation, the identification of this specimen with the holotype from the Andamans seems fairly well justified.

Distribution.—Andamans ; 82–378 m.

Haliclona carteri **sp. n.**

Isodictya simulans (No. 71), Carter, 1887 : 69 ; *nec Isodictya simulans* Bowerbank.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge encrusting ; surface even, undulating, minutely hispid ; oscules small, scattered ; texture firm ; colour, dried, light brown ; skeleton a dense, somewhat confused, subisodictyal reticulation ; megascleres oxea, 0·14 by 0·008 mm. ; microscleres absent.

Distribution.—Mergui Archipelago.

Genus *Adocia* Gray.

Adocia sagittarius (Sollas).

Gellius sagittarius Sollas, 1902 : 212, pl. xv, fig. 7 ; *G. angulatus*, var. *canaliculata* Dendy, 1905 : 136, pl. ix, fig. 7 ; *G. canaliculata* Burton, 1928 : 114 ; *nec G. angulatus*, var. *canaliculata* Topsent, 1904.

Occurrence.—Stn. 139, March 25, 1934, Maldive Area (Anchorage, E. side of Kolumadulu Atoll : 2° 13′ 30″ N., 73° 09′ 00″ E.), 57 m., bottom coral sand.

Distribution.—Arabian Sea ; Ceylon ; west coast of Malay Peninsula ; littoral to 1150 m.

Adocia fibulatus (Schmidt), var. *microsigma* (Dendy).

Gellius fibulatus Dendy, 1905 : 136 ; *G. fibulatus*, var. *microsigma* Dendy, 1916 : 107 ; Dendy, 1921 : 26 ; *Adocia fibulatus*, var. *microsigma* Burton, 1934 : 539.

Occurrence.—Stn. 141, March 26, 1934, Maldive Area (3° 04′ 30″ N., 73° 22′ 42″ E.), 44 m., bottom coarse sand, shells and coral.

Distribution.—Indian Ocean (Okhamandal, Ceylon, Coevity, Coin Peros, Egmont Reef); Great Barrier Reef; 0–31 m.

Adocia pigmentifera (Dendy).

Reniera pigmentifera Dendy, 1905 : 143, pl. ix, fig. 10.

Occurrence.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.

Distribution.—Ceylon, 18 m.

Adocia digitata (Baer).

Halichondria digitata Baer, 1906 : 12, pl. i, fig. 7, pl. iv. figs. 12–14.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Remarks.—The single specimen, a fragment, is digitate, 25 mm. long and 3 mm. diameter. The colour is greenish-yellow and the skeleton like that described by Baer, except that the spicules measure 0·17 by 0·009 mm. instead of 0·1 by 0·005 mm.

Distribution.—Zanzibar.

Adocia cf. *semifibrosa* (Dendy).

Reniera semifibrosa Dendy, 1916 : 111, pl. ii, fig. 13.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

Remarks.—The skeleton of the present specimen contains a good deal of sand in its slender fibres, so that an exact comparison with known species is not possible. It could with equal justice be assigned to *Adocia ramusculoides* (Topsent), *A. hornelli* (Dendy) or *A. fibroreticulata* (Dendy), all from this same area of the Indian Ocean.

Adocia tufoides (Dendy).

Reniera tufoides Dendy, 1921 : 33, pl. ii, fig. 2, pl. xii, fig. 3.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Amirante, 512 m.

Petrosia testudinaria (Lamarck).

Alcyonium testudinarium Lamarck, 1815 : 167; Lamarck, 1816 : 401; *Reniera crateriformis* Carter, 1882 : 115; *R. testudinaria* Ridley, 1884 : 409; *R. crateriformis* Carter, 1887 : 71; *Petrosia testudinaria* Dendy, 1889 : 77, pl. iii, figs. 1–3; Dendy, 1905 : 144, fig. 1; Hentschel, 1912 : 403; Topsent, 1920 : 7; Wilson, 1925 : 399, pl. xl, fig. 6; *P. testudinaria* var. *fistulophora* Wilson, 1925 : 401, pl. xl, fig. 5, pl. xli, figs. 1–2, pl. xlviii, fig. 8; *P. testudinaria* Topsent, 1933 : 40.

Occurrence.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand; Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

DISTRIBUTION.—Ceylon; Mergui; Aru Is.; Queensland, Australia; Philippines; 7–15 m.

Petrosia mauritiana (Carter).

Chalina polychotoma, var. *mauritiana* Carter, 1885 : 402, pl. xiv, fig. 13.

OCCURRENCE.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

REMARKS.—Carter's original specimen has the main skeleton a loose reticulation of strongyla, 0·017 by 0·003 to 0·32 by 0·018 mm. In addition, there is a dense tangential ectosomal skeleton of similar spicules.

DISTRIBUTION.—Mauritius.

Petrosia nigricans Lindgren.

Petrosia nigricans Lindgren, 1897 : 480; Lindgren, 1898 : 5, pl. xvii, fig. 5, pl. xix, fig. 4; *P. imperforata* Thiele, 1899 : 20, pl. ii, fig. 7, pl. v, fig. 12; *P. cancellata* Thiele, 1903 : 938, fig. 3; *P. similis*, var. *delicatula* Dendy, 1905 : 145; *P. similis*, var. *halichondrioides* Dendy, 1905 : 145; *P. densissima* Dendy, 1905 : 145, pl. ix, fig. 9; *P. nigricans*, var. *irregularis* Hentschel, 1912 : 405; *P. mammiformis* Dendy, 1921 : 36, pl. xii, fig. 6; *P. dura* Dendy and Frederick, 1924 : 498.

OCCURRENCE.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand; Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ N., 39° 14′ 12″ E.), (73–165 m.); Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

DISTRIBUTION.—Ceylon, Salomon, Java, Celebes, Ternate, SW. Australia; 18–137 m.

Genus *Oceanapia* Gray.

Oceanapia putridosum (Lamarck).

Alcyonium putridosum Lamarck, 1815 : 168; Lamarck, 1816 : 402; 1836 : 608; *Rhizochalina putridosa* Ridley and Dendy, 1886 : 332; Ridley and Dendy, 1887 : 33, pl. viii, fig. 5, pl. ix, figs. 1, 7; Whitelegge, 1906 : 406; ? Wilson, 1925 : 419; ? Burton, 1928 : 118; *Phlœodictyon putridosum* Topsent, 1933 : 42, pl. iii, fig. 8; *nec Rhizochalina putridosa* Topsent, 1892.

OCCURRENCE.—Stn. 144, March 31, 1934, Maldive Area (5° 26′ 06″ N., 73° 22′ 24″ E.), 31 m., bottom coral, shell and sand.

DISTRIBUTION.—Australia (Bass Strait, Port Jackson), 55–70 m., ? Philippines; ? Indian Ocean (Orissa Coast).

Oceanapia fistulosa (Bowerbank).

Desmacidon fistulosa Bowerbank, 1873 : 19, pl. iv, figs. 7–8; Carter, 1882 : 121.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DISTRIBUTION.—Australia (Freemantle).

Oceanapia canalis (Ridley).

Rhizochalina canalis Ridley, 1884 : 422, pl. xxxix, fig. F, pl. xli, fig. r.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Arafura Sea ; Torres Straits ; Port Darwin ; 17–66 m.

Oceanapia elastica (Keller).

Reniera elastica Keller, 1891 : 306, pl. xvi, figs. 3, 7 ; *Petrosia elastica* Lindgren, 1897 : 480 ; Lindgren, 1898 : 5, pl. xviii, fig. 13, pl. xix, fig. 5 ; *Oceanapia elastica* Burton, 1934 : 546.

Occurrence.—Stn. 139, March 25, 1934, Maldive Area (2° 13′ 30″ N., 73° 09′ 00″ E.), 57 m., bottom coral and sand.

Distribution.—Red Sea ; Java ; Australia (Great Barrier Reef) ; 34–45 m.

Ocenapia media (Thiele).

Rhizochalina media Thiele, 1899 : 19, pl. iv, fig. 2, pl. v, fig. 11.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Distribution.—Celebes.

Occanapia zoologica (Dendy).

Reniera zoologica Dendy, 1905 : 143, pl. ix. fig. 8.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 m. ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Distribution.—Indian Ocean (Gulf of Manaar).

Oceanapia incrustata (Dendy).

Phlœodictyon incrustatum Dendy, 1921 : 49, pl. xii, fig. 15.

Occurrence.—Stn. 11, September 18, 1933, Red Sea (12° 55′ 42″ N., 43° 11′ 42″ E. to 12° 53′ 36″ N., 43° 11′ 18″ E.), 207 m., bottom rock.

Distribution.—Indian Ocean (Egmont Reef).

Oceanapia cf. *cagayense* (Wilson).

Phlœodictyon cagayense Wilson, 1925 : 420, pl. xlii, fig. 3, pl. xlviii, fig. 10.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Remarks.—Of the two specimens, one is large, in pieces, and probably measured 100 mm. across when complete. It is irregularly massive and the colour is a deep greenish-grey, almost black. The second, a fragment, is digitate, a slightly lighter colour than the first, and about 30 mm. long. In appearance and in the structure of the skeleton both bear a strong resemblance to Wilson's species, and the spicules are oxea and substrongyla. The main difference rests in the dimensions of the spicules, which are 0·36 by 0·012 mm., against 0·2 by 0·01–0·014 mm. in the holotype.

Distribution.—Philippines.

Genus *Callyspongia* Duchassaing and Michelotti.

Callyspongia diffusa (Ridley).

(For synonymy see Burton, 1934 : 541.)

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth uncertain, 73–165 m.

Distribution.—Ceylon ; Singapore ; Java ; Australia (Torres Straits, east and south-west coasts) ; littoral to 18 m.

Callyspongia subarmigera (Ridley).

Cladochalina subarmigera Ridley, 1884 : 397, pl. xxxix, fig. H, pl. xli, fig. L ; *Chalinopora subarmigera* Lendenfeld 1887 : 767 ; *Chalina subarmigera* Lindgren, 1897 : 481 ; Lindgren, 1898 : 13 ; *Callyspongia subarmigera* Burton, 1934 : 540.

Occurrence.—Stn. M.B. I (d), September 17, 1933, Red Sea, 26 m. ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?) ; Stn. M.B. I (b), September 17, 1933, Bay between Great Hanish and Suyul Hanish Islands, Red Sea, 29 m., bottom sand, shell and coral.

Distribution.—Northern Australia (Torres Straits, Albany Island) ; Cochin-China ; 5–45 m.

Callyspongia confœderata (Ridley).

Tuba confœderata Ridley, 1884 : 400 ; *Siphonella laxa* Lendenfeld, 1887 : 803, pl. xxiv, fig. 55 ; *Siphonochalina confœderata* Lendenfeld, 1887 : 803, pl. xxv, fig. 60 ; *S. typica* Lendenfeld, 1887 : 804, pl. xxiv, fig. 54, pl. xxvii, figs. 2–19 ; *S. elastica* Lendenfeld, 1887 : 805 ; *S. paucispina* Lendenfeld, 1887 : 805 ; *S. axialis* Lendenfeld, 1887 : 805, pl. xxiv, fig. 53 ; *S. extensa* varr. *dura*, *elegans* Lendenfeld, 1887 : 806 ; *Siphonella tuberculata* Lendenfeld, 1887 : 808 ; *Spinosella confœderata* Topsent, 1897 : 479, pl. xix, fig. 20 ; *Callyspongia confœderata* Burton, 1934 : 541.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Distribution.—Amboina ; Australia (north, west and east coasts).

Callyspongia fibrosa (Ridley and Dendy).

Dasychalina fibrosa Ridley and Dendy, 1886 : 330.

(For synonymy see Burton, 1934 : 540.)

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn.

53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Distribution.—? Off Bahia and Bermuda; ? Mergui; Ceylon; Java; Cochin-China; Aru and Kei Is.; Philippines; Great Barrier Reef; 10–45 m.

Callyspongia spinosissima (Dendy).

Pachychalina spinosissima Dendy, 1887 : 524, pl. xliv; *P. subcylindrica* Dendy, 1905 : 148, pl. x, figs. 1–2; Dendy, 1921 : 41, pl. viii, fig. 1; *Cladochalina subcylindrica* Burton, 1927 : 511.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion; Stn. 50, October 31, 1933, South Arabian Coast (18° 38′ 00″ N., 58° 05′ 00″ E.), 1939 m., bottom brown mud; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Diagnosis.—Sponge composed of long, subcylindrical branches; surface smooth, often bearing stout spines; texture firm but compressible; oscules conspicuous and scattered along branches; colour, in spirit, yellowish-brown; main skeleton a coarse, irregular reticulation of multispicular fibres, often subdivided by uni- or bispicular fibres; ectosomal tangential skeleton similar; spicules oxea, 0·16–0·2 by 0·006–0·01 mm.

Distribution.—Indian Ocean (Providence, Ceylon, Christmas Island); 16–53 m.

Callyspongia clathrata (Dendy).

Chalina clathrata Dendy, 1905 : 151, pl. x, fig. 3; *Callyspongia clathrata* Burton, 1934 : 543.

Occurrence.—Stn. A, September 6, 1933, Red Sea (29° 17′ 00″ N., 32° 43′ 00″ E.), 65 m., bottom soft yellow mud.

Distribution.—Ceylon.

Callyspongia barodensis **sp. n.**

Siphonochalina communis (pars), Dendy, 1905 : 155; *S. crassifibra* Dendy, 1916 : 114.

Holotype.—B.M. 25.11.1.230.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge tubular; surface even, smooth; oscules apical; texture firm, elastic; colour, in spirit, yellow to brown; main skeleton a subrectangular reticulation of multispicular fibres (20–30 spicules); ectosomal skeleton a triangular reticulation of multispicular fibres (5–8 spicules) subdivided by a secondary, uni- to bispicular mesh; megascleres oxea, 0·07 by 0·003 mm.; microscleres absent.

Distribution.—Indian Ocean (Okhamandal, Ceylon); 5–15 m.

Callyspongia rowi **sp. n.**

Gelliodes poculum, var., Row, 1911 : 328.

Holotype.—B.M. 12.2.1.53.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DIAGNOSIS.—Sponge tubular ; surface even, smooth ; oscules apical ; texture soft, fragile ; colour, in spirit, yellowish-white ; main skeleton a subregular rectangular reticulation of multispicular fibres (ascending fibres 3–7 spicules, connectives 2–5 spicules), with occasional uni- or bispicular secondary connectives ; ectosomal skeleton a tangential reticulation of uni- or trispicular fibres, enclosing triangular to rectangular mesh, subdivided by a unispicular reticulation ; megascleres oxea, 0·14 by 0·008 mm. ; microscleres absent (sigmata recorded by Row appear to be foreign).

DISTRIBUTION.—Red Sea ; 9 m.

Genus *Gelliodes* Ridley.

Gelliodes fibulatus Ridley.

? *Gellius couchi*, var. *ceratina* Ridley, 1884 : 423 ; *Gelliodes fibulatus* Ridley, 1884 : 427, pl. xxxix, fig. I, pl. xli, fig. b ; ? *Fibularia ramosa* Carter, 1887 : 71, pl. vii, figs. 1–3 ; *Gelliodes fibulata* Ridley and Dendy, 1887 : 47, pl. xii, fig. 2 ; Lendenfeld, 1887 : 793 ; ? *Pachychalina joubini* Topsent, 1897 : 480, pl. xix, fig. 19 ; *P. fragilis* Lindgren, 1897 : 481 ; Lindgren, 1898 : 8 ; *Gelloides* (sic) *ramosa* Kieschnick, 1898 : 47 ; ? *Pachychalina conulosa* Kieschnick, 1898 : 51 ; *Gelloides ramosa* Kieschnick, 1900 : 565, pl. xliv, fig. 3 ; ? *Pachychalina conulosa* Kieschnick, 1900 : 568, pl. xliv, fig. 8 ; *Gelliodes fibulatus* Hentschel, 1912 : 393 ; ? *Cladochalina joubini* Burton, 1927 : 510 ; *Sigmaxynissa fibulata* Burton, 1928 : 115 ; *nec Fibularia ramosa* Carter, 1882.

OCCURRENCE.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

DISTRIBUTION.—Malay Area (Mergui Archipelago, Amboina, Java, Aru Is., Torres Strait) ; 5–20 m. (? also to 65 m.).

Family DESMACIDONIDÆ.

Sub-family MYCALINÆ.

Genus *Biemna* Gray.

Biemna fortis (Topsent).

Desmacella fortis Topsent, 1897 : 463, pl. xxi, fig. 30 ; Sollas, 1902 : 213 ; *Biemna fortis* Hentschel, 1912 : 350 ; Burton, 1930 : 523.

OCCURRENCE.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

DISTRIBUTION.—Red Sea, Amboina (Topsent) ; Malay Peninsula, littoral (Sollas) ; Aru and Kei Islands ; 18–40 m., on rocks (Hentschel).

Biemna trirhaphis (Topsent).

Desmacella peachi, var. *trirhaphis* Topsent, 1897 : 461, pl. xviii, fig. 9, pl. xxi, fig. 35 ; *Biemna trirhaphis* Burton, 1930 : 523.

OCCURRENCE.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m.

DISTRIBUTION.—Amboina.

Biemna ciocalyptoides sp. n.

(Text-fig. 14.)

Holotype.—B.M. 1936.3.4.431.

Occurrence.—Stn. 27, October 12, 1933. Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shingle.

Diagnosis.—Sponge massive, pyramidal, bearing numerous erect, slender, pointed processes; surface mainly smooth, minutely aculeate on the processes; oscules conspicuous, 2–5 mm. diameter, irregularly scattered; texture firm, compressible, fragile; colour

Text-fig 14.—*Biemna ciocalyptoides* sp. n. Style, ×150, sigmata, of two sizes, and microxea, in dragmata and one isolated spicule with hair-like raphides between, ×600.

in spirit, pale yellowish-grey; skeleton of irregularly scattered styli, 0·9 by 0·032 mm.; microscleres sigmata, of two sizes, 0·012–0·02 and 0·052–0·075 mm. chord respectively, microxea, 0·16 by 0·004 mm., in dragmata, and hair-like raphides, 0·16 mm. long, in wisp-like dragmata measuring 0·4 mm. long.

Remarks.—The species is characterized by its striking external form and by the undulating, wisp-like strands of raphides. In addition, it differs from all known species of *Biemna* in other details of its spiculation.

It is not possible to be sure of the exact measurements of the raphides. The dragmata measure about 0·4 mm. in length, but in spicule preparations the separated raphides are too fine and too sinuous to be followed readily; and although individual spicules were measured, always about 0·16 mm. long, there was the constant suspicion that they might be incomplete. For the most part, the dragmata remain intact after boiling in nitric acid, and, as a consequence, it is not easy to find individual spicules to measure.

Genus *Desmacella* Schmidt.

Desmacella annexa Schmidt.

(For synonymy see Burton, 1930 : 525.)

Occurrence.—Stn. 122, January 22, 1934, Zanzibar Area (5° 21′ 24″ S., 39° 23′ 00″ E. to 5° 22′ 36″ S., 39° 22′ 18″ E.), 732 m., bottom grey-green mud.

Remarks.—This is the second record for the Indian Ocean of a common North Atlantic species. The present specimen is, moreover, more nearly typical than those from the "Investigator" collections (see Burton, 1928, p. 120).

Distribution.—Iceland; Norway; south-west Ireland to Bay of Biscay; Mediterranean; Florida; Indian Ocean (Gulf of Oman and Laccadive Sea); 40–1331 m., bottom sand and shells, coral, Pteropod ooze.

Genus *Mycale* Gray.

Mycale (*Mycale*) *sulevoidea* (Sollas).

Esperella sulevoidea Sollas, 1902 : 213, pl. xiv, figs. 8–9, pl. xv, fig. 10; *Mycale sulevoidea* Hentschel, 1912 : 335, pl. xiii, fig. 6, pl. xviii, fig. 14.

Occurrence.—Stn. M.B.I.(d), September 17, 1933, Red Sea, 26 m., bottom sand, shells and coral.

Distribution.—Straits of Malacca; Arafura Sea; littoral to 18 m.

Mycale (*Mycale*) *murrayi* (Ridley and Dendy).

Esperella murrayi Ridley and Dendy, 1886 : 338; Ridley and Dendy, 1887 : 67, pl. xiii, figs. 11, 13–18, pl. xiv, fig. 1.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.) 73–220 m., bottom coarse sand, shingle and (?) rock.

Remarks.—Topsent (1924) saw in *Esperella murrayi* a synonym of the North Atlantic *Mycale lingua* (Bowerbank). He may have been right in this, but in view of small differences in the spiculation, and the wide geographical separation, it is preferable to retain a distinction between the two, at least for the moment.

Distribution.—Off Port Jackson, Australia, 55–64 m.

Mycale (*Mycale*) *sulcata* Hentschel.

Mycale sulcata Hentschel, 1911 : 307, fig. 11.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″E.), 113 m., bottom coral rock.

Remarks.—This species is represented by a small encrusting specimen, having the large anisochelæ so characteristic in shape. Instead of small sigmata (0·014–0·016 mm.) it has large sigmata, 0·04–0·086 mm. chord but mainly of the larger sizes. In addition, the subtylostyli are 0·8 by 0·02 mm., the anisochelæ are 0·04–0·1, 0·024 and 0·016 mm. chord respectively, and the trichodragmata up to 0·12 mm. long. In spite of these differences, however, the striking appearance of the large anisochelæ is still sufficient to identify this specimen with Hentschel's species.

DISTRIBUTION.—South-West Australia ; 1–6 m.

Mycale (*Mycale*) *massa* (Schmidt) var. *oceanica* Topsent.

Mycale massa, var. *oceanica* Topsent, 1924 : 91, fig. 2 m–n.

OCCURRENCE.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.

REMARKS.—This small, oval specimen, 30 mm. high, has a skeleton very like that described for the var. *oceanica* from the Atlantic. Its megascleres are strongyloxea, 1·0 by 0·02 mm. ; its microscleres anisochelæ, of three sizes, 0·09–0·1, 0·04–0·044 and 0·02 mm. chord respectively, sigmata, of two sizes, 0·01–0·012 and 0·052–0·072 mm. chord respectively, and trichodragmata, 0·03–0·1 mm. long. Not only do the dimensions of the spicules agree closely, but their shapes do also.

It is interesting to find the typical Mediterranean species having a variety in the Atlantic, and the same variety (apparently) in the Indian Ocean.

DISTRIBUTION.—North-West Africa ; Azores; 140–175 m.

Mycale (*Mycale*) *topsenti* **sp. n.**

(Text-fig. 15.)

HOLOTYPE.—B.M. 1936.3.4.542.

OCCURRENCE.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.

DIAGNOSIS.—Sponge small, massive rounded ; surface uneven, markedly hispid, with inconspicuous pore-cracks ; oscules not apparent ; texture soft, compressible ; colour, in spirit, pale yellow to dark greenish-grey ; skeleton of ascending bundles of subtylostyli ending in a tangential layer of similar megascleres beyond which extend diffuse brushes projecting at right angles to surface ; megascleres subtylostyli, 0·9 by 0·018 mm. ; microscleres anisochelæ of three sizes, 0·088, 0·04 and 0·02 mm. chord respectively, sigmata, 0·06–0·08 mm. chord, and trichodragmata, 0·06 mm. long.

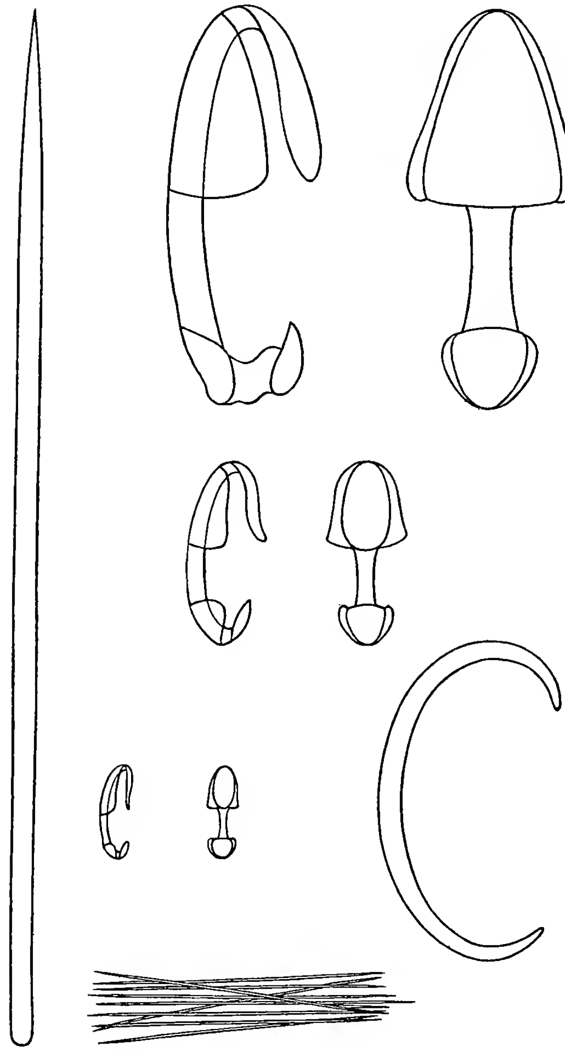
REMARKS.—The shapes of the spicules and the combination of categories present gives this species a strong resemblance to *M. pellucida* (Ridley) and *M. gelatinosa* (Ridley), which have much in common with each other. But whereas these two fall into the subgenus *Ægagropila* (see Topsent, 1924), the present species is more properly to be placed in the subgenus *Mycale*.

Genus *Hamacantha* Gray.

Hamacantha mindanaensis Wilson.

Hamacantha esperioides, var. *mindanaensis* Wilson, 1925 : 437.

OCCURRENCE.—Stn. 152, April 4, 1934, Maldive Area (4° 49′ 24″ N., 72° 46′ 30″ E. to 4° 48′ 42″ N., 72° 40′ 30″ E.), 878 m., bottom green sand ; Stn. 157, April 6, 1934, Maldive



Text-fig. 15.—*Mycale topsenti* sp. n. Subtylostyle, ×150, anisochelæ of three sizes, sigma and trichodragmata, all ×600.

Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Distribution.—Philippines.

Hamacantha simplex sp. n.

(Text-fig. 16.)

Holotype.—B.M. 1936.3.4.412.

Occurrence.—Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Diagnosis.—Sponge thinly encrusting; surface smooth, even; oscules not apparent; textile soft; colour, in spirit, white; main skeleton a confused reticulation of oxea, 0·24 by 0·007 mm., with a ectosomal, tangential reticulation of similar spicules; microscleres diancistra, 0·17 mm. chord, and sigmata, 0·017–0·02 mm. chord.

Genus *Guitarra* Carter.

Guitarra fimbriata Carter.

(For synonymy see Burton, 1929 : 426.)

Occurrence.—Stn. 11, September 18, 1933, Red Sea (12° 55′ 42″ N., 43° 11′ 42′ E. to 12° 53′ 36″ N., 43° 11′ 18″ E.), 207 m., bottom rock; Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.). 366 m., bottom green mud and rock.

Distribution.—Gulf of Mexico; Azores; Falkland Islands; South Georgia; Antarctic; New Zealand; Indian Ocean (Okhamandal); 64–1165 m.

Text-fig. 16.—*Hamacantha simplex* sp. n. Oxeote, ×150, diancistron and sigmata, ×600.

Sub-family Myxillinæ.

Genus *Myxilla* Schmidt.

Myxilla simplex (Baer).

Dendoryx simplex Baer, 1906 : 21, pl. ii, fig. 7, pl. v, figs. 20–25; *Myxilla simplex* Stephens, 1915 : 447, pl. xxxix, figs. 1b, 4c.

Occurrence.—Stn. 24, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shells and (?) rock.

Remarks.—It is surprising to find this species represented in the hauls from the Gulf of Aden and I was inclined at first to doubt the accuracy of the identification. The spiculation is, however, so closely similar to that described by Stephens that there is little room for doubt.

Distribution.—South Africa (Table Bay, Saldanha Bay); littoral to 46 m.

Myxilla dendyi **sp. n.**

Myxilla incrustans Dendy, 1921 : 89; *nec M. incrustans* (Johnson) Autt.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge massive or encrusting, and agglutinating, usually containing a considerable quantity of sand and other foreign matter in its tissues; surface even, smooth; texture soft and compressible; vent not seen; pores in sieves; colour, in spirit, pale greyish-yellow to light brown; skeleton a subisodictyal network of acanthostyli, with mucronate tornota; microscleres chelæ spatuliferæ and sigmata of one size only.

Dimensions of spicules:

(1) acanthostyli, 0·16 by 0·008 mm.,
(2) tornota, with a single mucron at each end, 0·16 by 0·003 mm.,
(3) chelæ spatuliferæ, 0·02 mm., chord,
(4) sigmata, up to 0·035 mm. chord.

Remarks.—This species has some resemblance to the well known *Myxilla incrustans* (Johnson) but differs in four well defined characters:

(1) The spicules are smaller;
(2) the chelæ are not differentiated into two categories;
(3) the tornota have no ornament other than the single mucron;
(4) the body of the sponge is filled with foreign matter.

Distribution.—Praslin Reef, Indian Ocean.

Genus *Lissodendoryx* Topsent.

Lissodendoryx ciocalyptoides **sp. n.**

(Text-fig. 17.)

Holotype.—B.M. 1936.3.4.488.

Occurrence.—Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock.

Diagnosis.—Sponge incomplete, consisting of a hollow digitate process; surface rugose, hirsute; oscules not apparent; texture soft; colour, in spirit, pale yellow; skeleton subisodictyal, ascending fibres 2–4 spicules thick, connectives uni- or bispicular; megascleres styli, 0·6 by 0·024 mm., tornota, with ends strongylote, subtylote or bluntly oxeote, 0·28 by 0·008 mm.; microscleres isochelæ, 0·08 mm. chord, rarely as little as 0·04 mm. chord.

Remarks.—The species differs from others of the genus in the absence of a second category of microscleres combined with the large size of the styli.

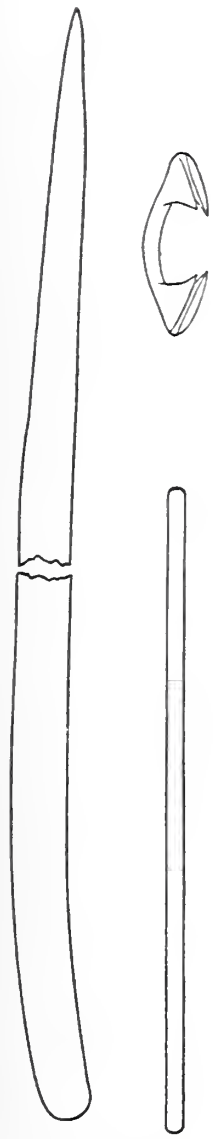
Lissodendoryx damirioides **sp. n.**

(Text-fig. 18)

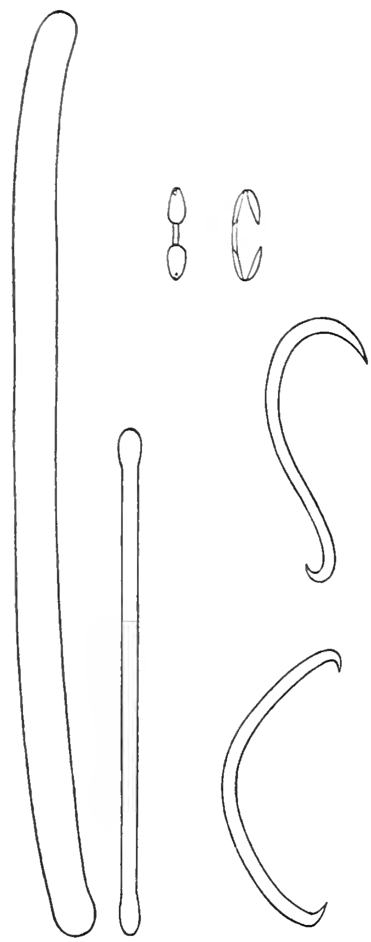
Holotype.—B.M. 1936.3.4.547.

Occurrence.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.

Diagnosis.—Sponge small, encrusting to irregular, low-lying and massive; surface uneven, subaculeate; oscules minute, scattered; texture delicate, friable; colour, in spirit, pale yellow; skeleton an irregular sub-isodictyal reticulation of smooth, flexuous strongyla, 0·41 by 0·018 mm.; tornota with tylote ends scattered in ectosome and interstitially to main skeleton, 0·22 by 0·006 mm.; microscleres isochelæ, 0·02 mm. chord, and sigmata, 0·06 mm. chord.



TEXT-FIG. 17.—*Lissodendoryx ciocalyptoides* sp. n. Style and tornote, ×300, isochela, ×600.



TEXT-FIG. 18.—*Lissodendoryx damirioides* sp. n. Stongyle and tornote, × 300, isochelæ and sigmata, ×600.

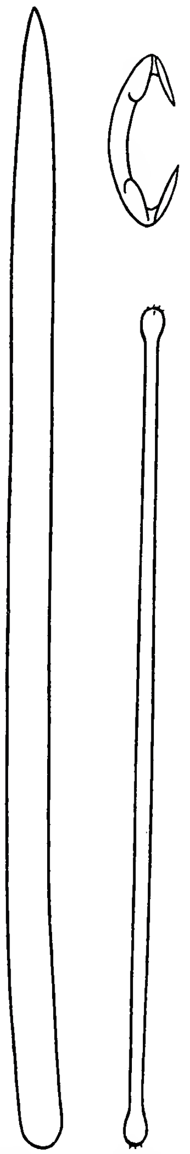
REMARKS.—At first sight these specimens appeared to represent a new genus related to *Damiria* Keller and *Damiriopsis* Burton. Their real place seems, however, to be in the genus *Lissodendoryx*, where they find their nearest relative in *L. grata* (Thiele). Examination of the new species leads to the suggestion that *Damiria simplex* Keller and *Damiriopsis brondstedti* Burton should be more correctly regarded as aberrant members of the genus *Lissodendoryx*.

Lissodendoryx tubicola sp. n.

(Text-fig. 19.)

Holotype.—B.M. 1936.3.4.555.

Occurrence.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.



Text-fig. 19.—*Lissodendoryx tubicola* sp. n. Style and tornote, ×300, isochela, ×600.

Diagnosis.—Sponge small, encrusting to low-lying and irregularly massive, living on worm-tubes ; surface subcerebriform, minutely hispid ; oscules minute, scattered ; texture soft, compressible ; colour, in spirit, pale yellow ; skeleton an irregularly subisodictyal reticulation of smooth styli, 0·5 by 0·018 mm. ; tornota with tylote ends, occasionally bearing a few microspines, 0·36 by 0·006 mm. ; microscleres isochelæ, 0·028–0·036 mm. chord.

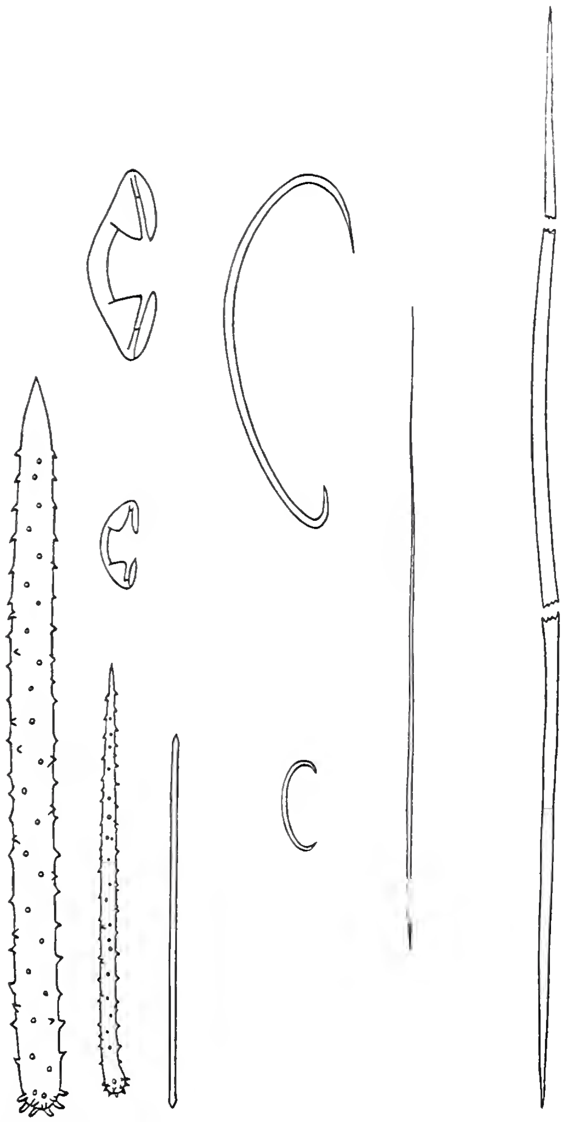
Genus *Ectyodoryx* Lundbeck.

Ectyodoryx rhaphidiophora **sp. n.**

(Text-fig. 20.)

Holotype.—B.M. 1936.3.4.482.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shells and (?) rock.

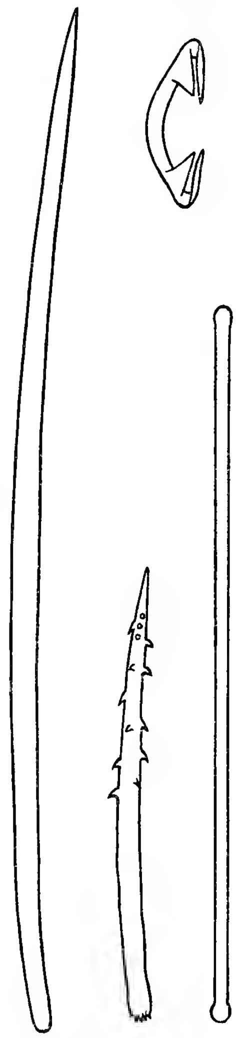


Text-fig. 20.—*Ectyodoryx rhaphidiophora* sp. n. Acanthostyli and tornote, ×300, isochelæ, sigmata and raphides, of two sizes, ×600.

Diagnosis.—Sponge massive, somewhat lobose; surface even, minutely hispid; oscules small, scattered; texture soft, compressible; colour, in spirit, yellowish-brown; skeleton a subisodictyal reticulation of acanthostyli, 0·32 by 0·016 mm., sparingly echinated at nodes by curved acanthostyli, 0·1–0·22 by 0·008 mm., and with scarce tornota, strongyote or subtylote or submucronate at ends, 0·16 by 0·004 mm., scattered interstitially;

microscleres isochelæ, of two sizes, 0·016–0·02 and 0·04–0·06 mm. chord respectively, sigmata, of two sizes, 0·02 and 0·08 mm. chord respectively, and trichodragmata, 0·14 by 0·002 mm. and 0·4 by 0·004 mm.

Remarks.—The species is distinguishable from others of the genus by the presence of trichodragmata.



Text-fig. 21.—*Ectyodoryx coralliophila* sp. n. Style, acanthostyle and tornote, ×300, isochela, ×600.

Ectyodoryx coralliophila sp. n.

(Text-fig. 21.)

Holotype.—B.M. 1936.3.4.505.

Occurrence.—Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud; Stn. 157, April 6, 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Diagnosis.—Sponge encrusting to massive and low-lying on coral; surface uneven, glabrous; oscules small, inconspicuous; texture soft, delicate; colour, in spirit, pale yellowish-brown; skeleton a scattered and irregular reticulation of smooth styli, echinated at nodes by acanthostyli, with an ectosomal, tangential layer of tornota; megascleres styli, 0·45 by 0·012 mm., acanthostyli, 0·2 by 0·012 mm., and tornota with tylote ends, 0·32 by 0·006 mm.; microscleres isochelæ arcuatæ, 0·024–0·052 mm. chord.

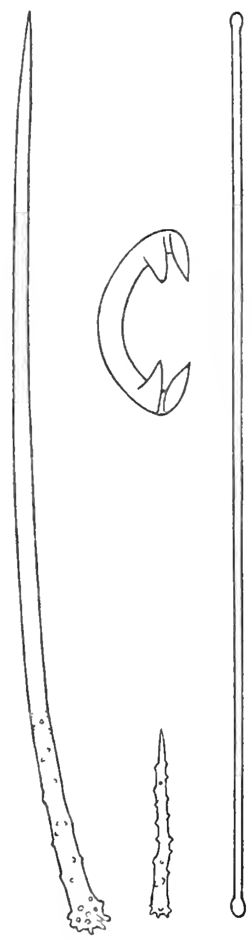
Genus *Hymedesmia* Bowerbank.

Hymedesmia murrayi sp. n.

(Text-fig. 22.)

Holotype.—B.M. 1936.3.4.487.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.



Text-fig. 22.—*Hymedesmia murrayi* sp. n. Acanthostyli, of two sizes, and tornote, ×300, isochela, ×600.

Diagnosis.—Sponge thinly encrusting; surface even; oscules not apparent; texture soft; colour, in spirit, whitish; skeleton of wisp-like fibres of tornota, with single tornota scattered in ectosome, and occasional acanthostyli; megascleres acanthostyli, of two sizes, larger spined in basal third only, 0·4 by 0·008 mm., smaller entirely-spined, 0·08 by 0·008 mm., tornota, with strongylote to submucronate ends, 0·4 by 0·004 mm.; microscleres isochelæ, 0·04–0·044 mm. chord.

Genus *Phorbas* Duchassaing and Michelotti.

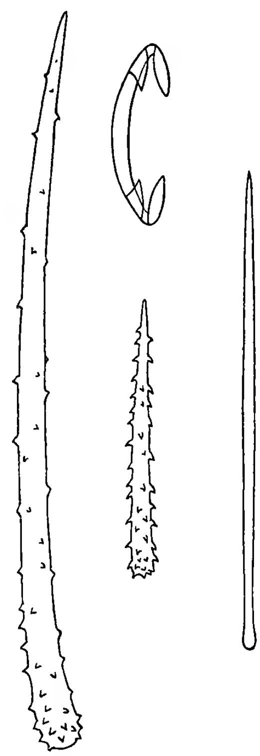
Phorbas styliferus **sp. n.**

(Text-fig. 23.)

Holotype.—1936.3.4.526.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coral, sand and shells.

Diagnosis.—Sponge lamellar, irregular, with much foreign debris incorporated; surface uneven, minutely hispid; oscules not apparent; pores in sieves; texture firm,



Text-fig. 23.—*Phorbas styliferus* sp. n. Acanthostyli, of two sizes, and tornote, ×300, isochela, ×600.

compressible; colour in spirit, light brown; skeleton of ascending plumose fibres, branching and anastomosing, of large and small acanthostyli, cored by styliform tornota, with ectosomal brushes of similar tornota; spicules acanthostyli, 0·12 by 0·008 and 0·32 by 0·012 mm., the two sizes connected by intermediates; tornota styliform, 0·212 by 0·004 mm.; microscleres isochelæ, 0·028–0·068 mm. chord.

Remarks.—The specimen is fragmentary and is in a poor state of preservation. In addition to the sand and calcareous debris included in the tissues, there are in places foreign spicules, such as large oxea and anatriænes. Some raphides noted in places are probably also foreign to this sponge.

Genus *Desmapsamma* Burton.

Desmapsamma anchorata (Carter).

Fibularia anchorata Carter, 1882 : 283 ; *Desmacidon reptans* Ridley and Dendy, 1886 : 345 ; Ridley and Dendy, 1887 : 105, pl. xxiii, fig. 7 : Lindgren, 1897 : 482 ; Lindgren, 1898 : 21 ; *D. carterianum* Arndt, 1927 : 147 ; *Desmapsamma anchorata* Burton, 1934 : 547.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Distribution.—West Indies ; Bahia ; Great Barrier Reef ; 13–82 m.

Genus *Iotrochota* Ridley.

Iotrochota baculifera Ridley.

Iotrochota baculifera Ridley, 1884 : 435, pl. xxxix, fig. M, pl. xlii, fig. f ; *I. baculifera*, var. *flabellata* Dendy, 1887 : 158 ; Dendy, 1889 : 84 ; *I. baculifera* Topsent, 1893 : 174 ; Topsent, 1897 : 455 ; Lindgren, 1897 : 482 ; Lindgren, 1898 : 18 ; Thiele, 1899 : 18, pl. ii, fig. 6 ; *I. baculifera*, var. *tumescens* Kirkpatrick, 1900 : 136, pl. xiii, fig. 1 ; *I. baculifera* Thiele, 1903 : 947 ; Dendy, 1905 : 165 ; *I. baculifera*, var. *minor* Hentschel, 1911 : 329 ; *I. baculifera* Hentschel, 1912 : 347 ; Dendy, 1916 : 123 ; Dendy, 1921 : 97 ; Burton and Rao, 1932 : 353.

Occurrence.—Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m. ; Stn. M.B. I(d), September 17, 1933 ; Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m.

Distribution.—Okhamandal ; Ceylon ; Madras ; Providence ; Amirante ; Seychelles ; Mascarenes ; Nicobars ; Christmas Is. ; Celebes ; Amboina ; Ternate ; Cochin-China ; Aru Is. ; Port Darwin ; South-West Australia ; littoral to 66 m., bottom mud, sand, rock and coral.

Genus *Acanthancora* Topsent.

Acanthancora stylifera, **sp. n.**

(Text-fig. 24.)

Holotype.—B.M. 1936.3.4.600.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

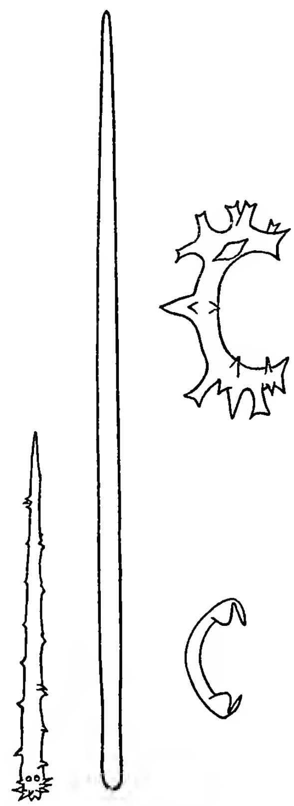
Diagnosis.—Sponge encrusting, small, agglutinating ; surface even ; oscules not apparent ; texture firm, compressible ; colour, in spirit, pale yellow ; skeleton a dense mass of spined chelæ, with stylote tornota scattered between acanthostyli (presumably) echinating substratum ; megascleres acanthostyli, 0·16 by 0·008 mm., tornota styliform, 0·36 by 0·008 mm. ; microscleres isochelæ arcuatae, 0·026 mm. chord, and spined isochelæ, 0·04 mm. chord including spines.

Remarks.—The holotype is a very small specimen growing among a mixture of calcareous debris, and the form of the skeleton is obscured by the abundant spined chelæ. Acanthostyli occur in the boiled-out spicule preparations though they were not seen in hand sections. It is presumed that these echinate the substratum.

Damirina gen. n.

Genotype.—*Damirina verticillata* **sp. n.**

Diagnosis.—Myxillinæ with skeleton an isodictyal reticulation of verticillately-spined acanthostrongyla ; with dermal tornota ; microscleres absent.



Text-fig. 24.—*Acanthancora stylifera* sp. n. Acanthostyle and tornote, ×300, isochelæ, simple and ornamented, ×600.

Damirina verticillata sp. n.

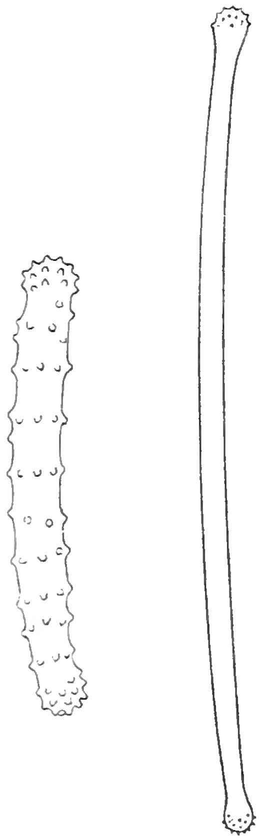
(Text-fig. 25.)

Holotype.—B.M. 1936.3.4.510.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Diagnosis.—Sponge encrusting, with hollow fistulæ ; surface even, glabrous ; oscules (? at ends of fistulæ) ; texture firm, friable ; colour, in spirit, deep brown ; main skeleton a unispicular, subisodictyal skeleton of acanthostrongyla, 0·2 by 0·02 mm., with tornota, having tylote ends microspined, 0·36 by 0·01 mm. ; microscleres absent.

Remarks.—The genus *Damirina* is of uncertain position and finds its nearest relatives among certain Myxillinæ with reduced spiculation, such as *Damiriella* Burton (1935, p. 404).



TEXT-FIG. 25.—*Damirina verticillata* sp. n. Acanthostrongyle and tornote, ×300.

Genus *Tedania* Gray.

Tedania nigrescens (Schmidt).

Myxilla anhelans (pars) Schmidt, 1862 : 72 ; *Reniera nigrescens* Schmidt, 1862 : 74 ; *R. digitata* Schmidt, 1862 : 75, pl. vii, fig. ii ; *R. ambigua* Schmidt, 1864 : 39, pl. iv, fig. 8 ; *Thalysias ignis* Duchassaing and Michelotti, 1864 : 83, pl. xviii, figs. 1–2 ; *Tedania digitata* Gray, 1867 : 520 ; *T. ambigua* Gray, 1867 : 520 ; *Reniera muggiana* Schmidt, 1868 : 28 ; *R. ambigua* Schmidt, 1868 : 31 ; ? *Halichondria aspera* Bowerbank, 1875 : 287 ; *Reniera digitata* Carter, 1882 : 287, pl. xi, fig. 3 ; *Tedania digitata* Ridley, 1884 : 417 ; Carter, 1886 : 52 ; *T. digitata*, var. *verrucosa* Carter, 1886 : 53 ; *T. digitata* Ridley and Dendy, 1887 : 51, pl. ix, fig. 3 ; *T. digitata* varr. *fibrosa*, *bermudensis* Ridley and Dendy, 1887 : 51 ; *T. nigrescens* Vosmaer, 1887 : 338 ; *T. digitata* Dendy, 1887 : 157 ; *T. rubicunda* Lendenfeld, 1888 : 190 ; *T. rubra* Lendenfeld, 1888 : 191 ; *T. chevreuxi* Topsent, 1891 : 13, pl. ii, figs. 1–2 ; *T. assabensis* Keller, 1891 : 313, pl. xvi, figs. 11–12 ; *T. brucei* Wilson, 1894 : 320, pls. xix, xx ; *T. digitata* Dendy, 1895 : 258 ; Lindgren, 1897 : 481 ; *T. digitata*, var. *vulcani* Lendenfeld, 1897 : 112, pl. x, figs. 117–119 ; *T. digitata* Lindgren, 1898 : 17, pl. xix, fig. 10 ; Wilson, 1902 : 395 ; *T. digitata* var. *sansibarensis* Baer, 1906 : 17, pl. i, fig. 11, pl. iv, figs. 26–31, pl. v, figs. 1–2 ; *T. digitata*, var. *fragilis* Baer, 1906 : 18, pl. ii, fig. 3 ; *T. digitata*, var. *conica* Baer, 1906 : 19, pl. ii, fig. 4 ; *T. ignis* Verrill, 1907 : 339 ; *T. assabensis* Row, 1911 : 353 ; *T. digitata* Hentschel, 1911 : 332 ; *T. digitata*, var. *inermis* Hentschel, 1911 : 333 ; *T. digitata*, var. *polytyla* Hentschel, 1911 : 333 ; *T. rubicunda* Hentschel, 1911 : 334 ; *T. digitata* Hentschel, 1912 : 348 ; *T. dirhaphis* Hentschel, 1912 : 349, pl. xix, fig. 20 ; *T. digitata*, var. *rubicunda* Hallmann, 1914 : 366, pl. xvii, fig. 4, text-fig. 11 ; *T. digitata*, var. *rubra* Hallmann, 1914 : 371, text-fig. 12 ; *T. nigrescens* Topsent, 1920 : 16 ; *T. digitata* Dendy, 1921 : 99 ; *T. nigrescens* Babić, 1921 : 84 ; Babić, 1922 : 245 ; *T. digitata* Topsent, 1925 : 703 ; *T. assabensis* Burton, 1926 : 81 ; *T. digitata* Shaw, 1927 : 434 ; Arndt, 1927 : 146, pl. iii, fig. 7 ;

Topsent, 1928 : 247 ; *T. chevreuxi* Burton, 1929 : 71 ; *T. nigrescens* Burton, 1932 : 346, fig. 44 ; Burton and Rao, 1932 : 353 ; *Xytopsihis asperus* de Laubenfels, 1936 : 61.

Occurrence.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 40° 35′ 05″ E.), 245 m. ; Stn. 10, September 17, 1933, Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m. ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

Remarks.—This species has been recorded many times from a world-wide belt bounded by latitudes 40° north and 40° south, outside which it is rarely found (see Burton 1932, p. 346). It is apparently of common occurrence, having been taken from sandy, muddy and rocky substrata, from corals and from mangrove roots. Its abundance and ecology seem to approximate to those of the *Hymeniacidon perlevis* in the north temperate zone. Most abundant in the littoral zone and in shallow waters, it has hitherto been found at depths not exceeding 120 m.

Distribution.—Between latitudes 40° N. and 40° S. ; littoral to 245 m.

Genus *Strongylacidon* Lendenfeld.

Strongylacidon inæqualis (Hentschel).

Cacochalina truncatella, var. *mollissima* Lendenfeld, 1887 : 763, pl. xxvii, fig. 27 ; *Batzella inæqualis* Hentschel, 1911 : 325, fig. 20 ; Burton, 1927 : 292 ; Burton, 1934 : 550.

Occurrence.—Stn. M.B. II(b), October 28, 1933, coastal zone of Arabian coast (17° 33′ 30″ N., 56° 01′ 30″ E.), 26 m.

Remarks.—*Cacochalina truncatella* var. *mollissima* and *Batzella inæqualis* appear to be identical in all respects, but the first was taken at Port Chalmers, New Zealand, and the second off the South-West coast of Australia. The present specimens agree very closely in the size and shape of the spicules and in the structure of the skeleton. Their external form is irregularly branched (probably repent) and in their present macerated condition look very like what is understood by a *Cacospongia*. The surface tissues are gone, so that it is not possible to say if the surface was smooth. There is, however, every indication that it was conulose ; and this constitutes the main difference between the " John Murray " specimens and those described by Lendenfeld and Hentschel.

Distribution.—Port Chalmers, New Zealand (depth unknown) ; South-West Australia ; 0·7–5·5 m.

Genus *Lithoplocamia* Dendy.

Lithoplocamia lithistoides Dendy.

Lithoplocamia lithistoides Dendy, 1921 : 79, pl. xiv, fig. 6.

Occurrence.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Mauritius, 183 m. ; Seychelles, 71 m.

Genus *Agelas* Duchassaing and Michelotti.

Agelas mauritianus (Carter).

Ectyon mauritianus Carter, 1883 : 310, pl. xii, fig. 3 ; *Agelas mauritianus* Ridley and Dendy, 1887 : 164, pl. xxix, fig. 10 ; *A. cavernosa* Thiele, 1903 : 963, fig. 28 ; *A. mauritiana* Dendy, 1905 : 174.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

Distribution.—Mauritius ; Ceylon ; Ternate ; (the "Challenger" record for Tristan da Cunha is almost certainly incorrect).

Sub-family Clathriinæ.

Genus *Clathria* Schmidt.

Clathria frondifera (Bowerbank).

Halichondria frondifera Bowerbank, 1875 : 288 ; *Amphilectus frondifera* Vosmaer, 1880 : 115 ; *Clathria frondifera* Ridley, 1884 : 488, pl. xlii, fig. i, pl. liii, fig. J.

Occurrence.—Stn. M.B. I (d), September 17, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m., bottom sand, shells and coral.

Distribution.—Straits of Malacca ; Thursday Island ; Price of Wales Channel, Percy Island and Fitzroy Island, Australia ; 7–20 m., bottom sand, mud and shells.

Clathria aculeata Ridley.

Clathria aculeata Ridley, 1884 : 443, pl. xl, fig. I, pl. xlii, fig. K ; Ridley and Dendy, 1887 : 147 ; Burton, 1934 : 558.

Occurrence.—Stn. 10, September 17, 1933. Red Sea (13° 31′ 00″ N., 42° 31′ 00″ E.), 55 m. ; Stn. M.B. I (d), September 19, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 29 m., bottom sand, shells and coral ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The skeletons of both the "Alert" and the "Challenger" specimens agree in their gross structure, though they differ in the finer details of spiculation. The same is true of the Barrier Reef specimens. In all there is a network of spongin fibres cored by subtylostyli and echinated by acanthostyli, with main styli (often spined or tuberculated at the base) sparingly echinating the fibres. There is a dermal skeleton of smaller subtylostyli and the microscleres are isochelæ palmatæ, and toxa varying from 0·04 to 0·35 mm. long. The present specimens, though separated geographically resemble the others closely.

It is possible that *C. coralliophila* Thiele is synonymous with *C. aculeata*.

Distribution.—Australia (Torres Straits and Great Barrier Reef) ; 5–15 m., bottom sand and coral mud.

Clathria procera (Ridley).

Rhaphidophlus procerus Ridley, 1884 : 451, pl. xxxix, fig. K, pl. xlii, fig. O ; *Echinonema gracilis* Ridley, 1884 : 617, pl. liv, fig. l ; *Rhaphidophlus spiculosus* Dendy, 1889 : 86, pl. iv, fig. 4 ; *Clathria spiculosa*, et var. *ramosa* Dendy, 1905 : 171 ; *C. spiculosa*, et varr. *ramosa*, *macilenta* Hentschel, 1912 : 363–364 ; *C. spiculosa* Dendy, 1916 : 128 ; *C. procera* Dendy, 1921 : 64 ; *Tenacia procera* Burton and Rao, 1932 : 340.

Occurrence.—Stn. M.B. I (d), September 17, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m., bottom sand, shells and coral; Stn. M.B. II (b), October 28, 1933, Arabian Coast (17° 33′ 30″ N., 56° 01′ 30″ E.), 26 m.

Remarks.—It is probable that *Clathria cervicornis* Thiele (1903 : 959) is synonymous with this species.

Distribution.—Indian Ocean (Arabian Sea, Okhamandal, Gulf of Manaar, Cape Cormorin, Ceylon, Tuticorin, Amirante, Seychelles, Praslin Reef, Cargados Carajos, Mascarene Is.); Aru Is.; Australia; Port Darwin; 4–71 m., bottom sand, mud, shells and dead coral.

Clathria mœandrina Ridley.

Clathria mœandrina Ridley, 1884 : 614, pl. liii, fig. I, pl. liv, fig. h.

Occurrence.—Stn. M.B. I (d) September 17, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m., bottom sand, shells and coral.

Distribution.—Amirante; 31 m., bottom coral.

Clathria mixta Hentschel.

Clathria mixta Hentschel, 1912 : 367, pl. xiii, fig. 8, pl. xix, fig. 30.

Occurrence.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N. 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Remarks.—The specimen is irregularly massive and the skeleton typical except for the absence of small toxa and the inclusion of much sand in the fibres.

Distribution.—Aru Island; 18 m., bottom rocky.

Clathria spicata Hallmann.

Echinonema anchoratum, var. *lamellosa* Whitelegge, 1901 : 82; *Clathria spicata* Hallmann, 1912 : 210; Dendy, 1921 : 65, pl. v, fig. 2, pl. xiii, fig. 4; *nec Echinonema anchoratum*, var. *lamellosa* Lendenfeld, 1888.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.

Remarks.—Dendy speaks of there being no well developed dermal skeleton. This is, however, true of the abraided parts of the surface only. Where the surface is intact, the smaller subtylostyli are arranged in surface brushes, not only in the present specimen but in Dendy's (1921) specimen.

Distribution.—Indian Ocean (Cargados Carajos); Western Australia; 55 m.

Clathria transiens Hallmann.

Clathria transiens Hallmann, 1912 : 226, pl. xxxiii, figs. 1–3, pl. xxxiv, fig. 2, text-figs. 47–48a.

Occurrence.—Stn. M.B. I (b), September 17, 1933, Red Sea, 29 m., bottom sand, shells and coral.

Distribution.—East coast of Australia; 55 m.

Clathria whiteleggii Dendy.

Clathria whiteleggii Dendy, 1921 : 67, pl. vii, fig. 1, pl. xiii, fig. 5.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–200 m., bottom coarse sand and shingle ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. M.B. II (c), October 28, 1933, Arabian Coast (17° 33′ 30″ N., 56° 01′ 30″ E.), 29 m.

Remarks.—The two specimens are very like the holotype in form, though more irregularly clathrate, and with spiculation almost identical.

A single small specimen consisting of a mass of irregular slender branches, each 1 or 2 mm. in diameter, is doubtfully assigned to this species. The skeleton is very like that of the holotype except that the main styli are always smooth at the base, the acanthostyli are rare and the auxiliary subtylostyli measure 0·4 by 0·004 mm. instead of 0·33 by 0·006 mm.

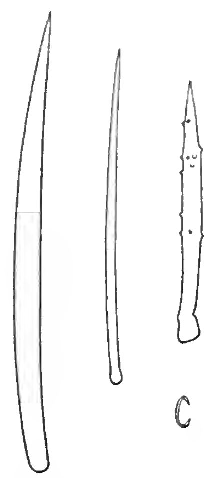
Distribution.—Indian Ocean (Saya de Malha) ; 100 m.

Clathria spongiosa **sp. n.**

(Text-fig. 26.)

Holotype.—1936.3.4.427.

Occurrence.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells.



Text-fig. 26.—*Clathria spongiosa* sp. n. Style, subtylostyle and acanthostyle, ×200, sigma, ×300.

Diagnosis.—Sponge subflabellate, palmo-digitate or ramose, with irregular nodose branches ; surface uneven, minutely hispid ; oscules not apparent ; texture firm, elastic ; colour, in spirit, reddish-brown ; skeleton an irregular reticulation of stout horny fibres, with main styli, 0·3–0·4 by 0·017 mm., coring, serially-arranged or subplumose, or scattered interstitially ; with acanthostyli, 0·17 by 0·014 mm., echinating on fibres and ectosomal skeleton of loose brushes of subtylostyli ; microscleres sigmata, 0·014 mm. chord.

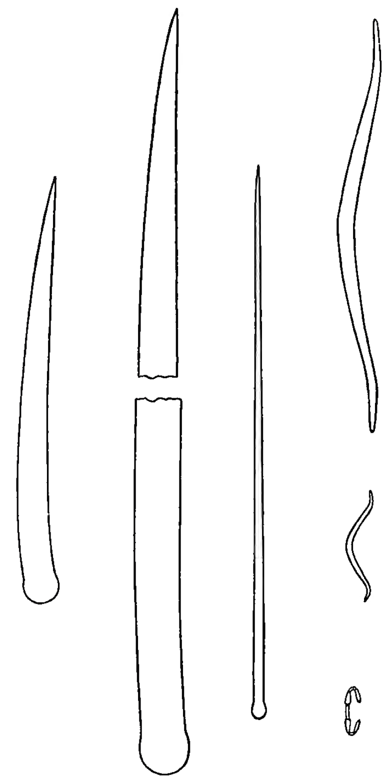
Genus *Ophlitaspongia* Bowerbank.

Ophlitaspongia minor **sp. n.**

(Text-fig. 27.)

HOLOTYPE.—B.M. 1936.3.4.609.

OCCURRENCE.—Stn. 89, December 7, 1933, Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shells and rock.



TEXT-FIG. 27.—*Ophlitaspongia minor* sp. n. Styli, of two sizes, and auxiliary subtylostyli, ×200, toxa of two sizes, and isochela, ×300.

DIAGNOSIS.—Sponge small, stipitate, irregularly branching; surface even, minutely hispid; oscules not apparent; texture firm; colour in spirit, pale cream; skeleton a subisodictyal almost halichondroid, reticulation of tylostyli, with auxiliary subtylostyli mainly in an ectosomal layer; main spicules styli to subtylostyli or even tylostyli, 0·28–0·8 by 0·02–0·032 mm.; auxiliary subtylostyli, 0·32–0·42 by 0·005–0·008 mm.; microscleres isochelæ palmatæ, 0·022 mm. chord, and toxa, 0·045–0·18 mm. chord.

REMARKS.—The species finds its nearest relative in *Echinoclathria hjorti* Arnesen, from the Canaries, which clearly belongs to *Ophlitaspongia*. Indeed, but for the geographical separation I would have accepted the present specimen as a mere variety of Arnesen's species.

KEY TO THE SPECIES OF *Ophlitaspongia*.

1.	Microscleres present	2
	Microscleres absent	12
2.	Microsclcres isochelæ and toxa	3
	Microscleres toxa only	9

3.	Largest toxa always less than 0·1 mm. chord	4
	Largest toxa exceeding 0·1 mm. chord	6
4.	Isochelæ 0·015 mm. chord or less	5
	Isochelæ exceeding 0·015 mm. chord	*arcifera*
5.	Isochelæ 0·01 mm. chord	*confragosa*
	Isochelæ 0·012–0·015 mm. chord	*californiana*
6.	Toxa slender and in dragmata	*thetidis*
	Toxa stout, strongly curved, not in dragmata	7
7.	Isochelæ not exceeding 0·016 mm. chord	*thielei*
	Isochelæ exceeding 0·016 mm. chord	8
8.	Fibres cored and echinated by main styli	*hjorti*
	Fibres cored mainly by auxiliary subtylostyli	*rimosa*
9.	Main megascleres more than 0·3 mm. long	*basifixa*
	Main megascleres less than 0·3 mm. long (average)	10
10.	Toxa more than 0·1 mm. chord	*pennata*
	Toxa less than 0·1 mm. chord	11
11.	Sponge encrusting to massive	*seriata*
	Sponge branching	*subhispida*
12.	Sponge massive with tubular oscules	*tubulosa*
	Sponge branching or flabellate	see note below

Note.—There are five species, all described from Australia that are either branching or flabellate, stipitate, and with similar spiculations. They will probably prove, eventually, to be synonymous. These species are :

O. axinelloides Dendy.
O. chalinoides (Carter).
O. inornata Hallmann.
O. leporina (Lamarck) (= *O. tenuis* (Carter)).
O. nodosa (Carter).

Genus *Microciona* Bowerbank.

Microciona affinis Carter.

Microciona affinis Carter, 1880 : 41, pl. iv, fig. 15.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Diagnosis.—Sponge thinly encrusting ; colour, in spirit, white or pale yellow ; skeleton of basally-tuberculate styli, 0·14–1·0 by 0·024–0·038 mm., and acanthostyli, 0·1–0·15 by 0·006–0·008 mm., both spicules echinating substratum ; auxiliary subtylostyli, basally microspined, 0·3–0·6 by 0·006–0·01 mm. ; microscleres isochelæ, 0·012 mm. chord, and toxa, 0·06–0·1 mm. chord, strongly curved and 0·002 mm. thick.

Remarks.—The holotype is represented by a small piece mounted whole and it contains no toxa. The two specimens recorded here agree closely with it in all respects, but in the Zanzibar specimen one toxon was found, and in that from the Arabian coast not more than half a dozen. It seems, therefore, that toxa constitute a scanty but constant part of the skeleton, which may be missing from preparations of small fragments of the sponge.

Distribution.—Gulf of Manaar.

Microciona longitoxa (Hentschel).

Hymeraphia longitoxa Hentschel, 1912 : 381, pl. xx, fig. 39.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shell.

Remarks.—The single specimen consists of an irregular lobe, 60 mm. high by 40 by 20 mm. The surface seems to have lost its ectosomal tissues and the present appearance is cerebriform and minutely hirsute. The oscules are small, few in number, and each is the centre of 4 or 5 radiating grooves. The texture is firm but compressible ; the colour, in spirit, light brown.

There is sufficient likeness to Hentschel's description to leave no doubt of the identity of the present specimen. It remains therefore to record the few details in which the encrusting holotype and this massive specimen differ. The skeleton consists of a close network of stout spongin fibres, with main styli coring and arranged in a plumose manner, and echinated by acanthostyli. The main styli are almost identical in shape and size with those of the holotype, and there are the same infrequent intermediates between them and the acanthostyli. The latter measure, however, 0·1–0·28 by 0·008–0·02 mm. The auxiliary sybtylostyli are few and measure 0·3 by 0·004 mm., or half the size of those of the holotype. The toxa are typical, except that most of them are nearly 0·8 mm. long, and the chelæ, although typical in form, measure 0·02 as against 0·013 mm.

Distribution.—Aru Is. ; 15 m.

Microciona rhopalophora (Hentschel).

Hymeraphia rhopalophora Hentschel, 1912 : 380, pl. xx, fig. 37.

Occurrence.—Stn. 157, April, 6 1934, Maldive Area (4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E.), 229 m., bottom coral rock.

Remarks.—A very thin crust contains acanthostyli, singly or in brushes, 0·1–0·45 mm. long, of very similar type to those figured by Hentschel. In addition, there are dermal styli, 0·45 by 0·006 mm. on an average. The larger tylostyli are missing, but there are several incomplete spicules which might well be the remains of such spicules broken in mounting the specimen.

This present specimen is clearly a young one. Throughout the greater part of it the tissues are without spicules, and the dermal styli particularly are sparsely present. The absence (or apparent absence) of the large tylostyli may be due merely to age.

Distribution.—Aru Is. ; 16 m.

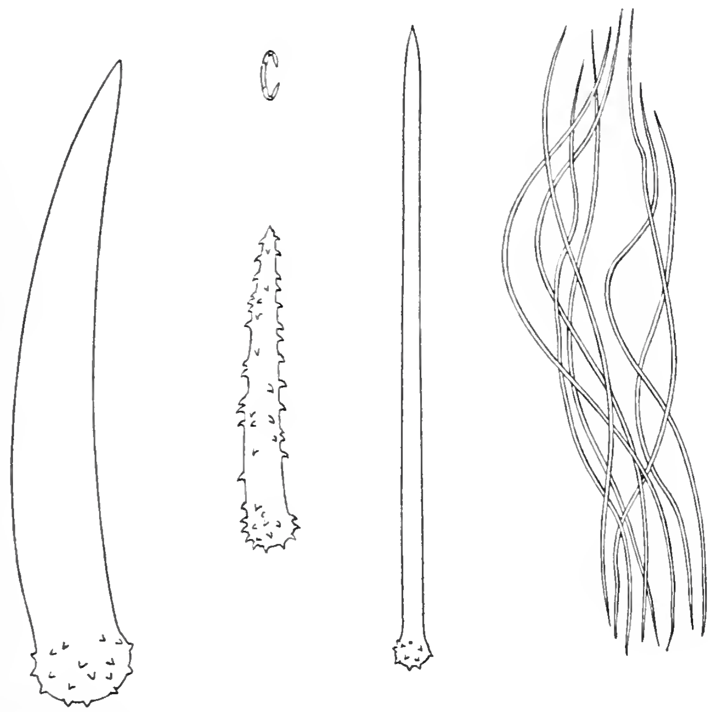
Microciona densa **sp. n.**

(Text-fig. 28.)

Holotype.—B.M. 1936.3.4.456.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge massive, lobate ; surface sub-cerebriform ; oscules minute, scattered ; texture firm, incompressible ; colour, in spirit, light brown ; skeleton of dense columns of styli and acanthostyli arranged in a semi-plumose manner, with aspiculous or sparingly spiculous spongin connectives; auxiliary spicules subtylostyli, sparingly associated with main skeleton and forming a dense ectosomal layer; main styli smooth or, more commonly, spined basally, very stout, 0·28 by 0·04 mm.; acanthostyli 0·14 by 0·016 mm.; auxiliary subtylostyli, 0·28 by 0·008 mm.; microscleres isochelæ palmatæ, 0·012 mm. chord, and hair-like toxa, usually in wisp-like bundles, 0·28 mm. long.



TEXT-FIG. 28.—*Microciona densa* sp. n. Style, acanthostyle and auxiliary subtylostyle, ×200, isochela and wisp-like toxa, ×300.

REMARKS.—The holotype consists mainly of two confluent lobes. It is distinguished from all the other species of *Microciona* mainly by the denseness of its skeleton and the robust character of its main megascleres.

Microciona longistyla sp. n.

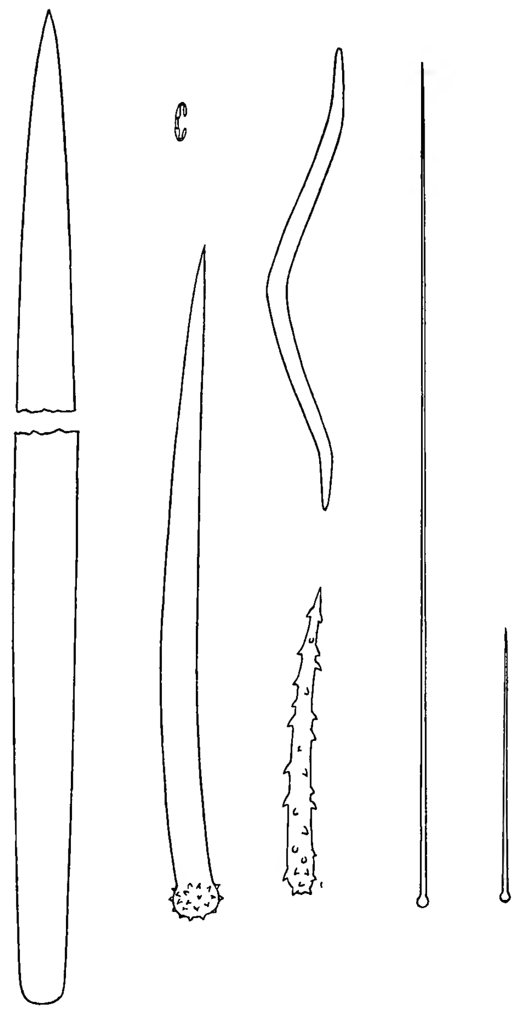
(Text-fig. 29.)

HOLOTYPE.—B.M. 1936.3.4.583.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DIAGNOSIS.—Sponge small, low-lying and massive; surface hispid; oscules not apparent; texture firm compressible; colour, in spirit, pale yellow; skeleton of plumose columns of styli and tuberculate tylostyli, echinated by acanthostyli, with interstitial and ectosomal subtylostyli; megascleres, 0·32–1·2 by 0·024–0·04 mm. (smaller tylostyli sparingly-spined along shaft as well as basally tuberculate), acanthostyli, 0·06–0·2 by 0·016 mm., interstitial subtylostyli, 0·56 by 0·004 mm., and ectosomal subtylostyli, 0·18 by 0·004 mm.; microscleres isochelæ, 0·016 mm., and toxa, 0·09–0·24 mm. chord.

Remarks.—The species is characterized, above all, by the size of the tylostyli. The isochelæ are very rare, and it is possible that the few seen may be foreign to the sponge.



Text-fig. 29.—*Microciona longistyla* sp. n. Style, basally-tuberculate tylostyle, acanthostyle and auxiliary subtylostyli, ×200, isochela and toxon, ×300.

Microciona anonyma sp. n.

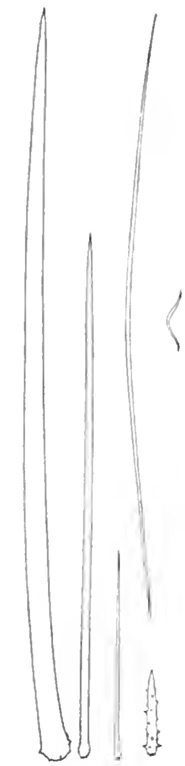
(Text-fig. 30.)

Holotype.—B.M. 1936.3.4.575.

Occurrence.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rack (?).

Diagnosis.—Sponge thinly encrusting; surface even, minutely hispid; oscules not apparent; texture soft; colour, in spirit, pale yellow; skeleton of acanthostyli echinating substratum, with columns of subtylostyli rising from substratum, echinated by large styli or tylostyli, and with ectosomal brushes of smaller subtylostyli; megascleres styli or tylostyli, often basally-spined, 0·36–0·8 by 0·012–0·02 mm., auxiliary subtylostyli 0·36–0·52 by 0·006–0·008 mm., ectosomal sybtylostyli, 0·2 by 0·003 mm., and acanthostyli, 0·08 by 0·008 mm.: microscleres toxa, of usual form, 0·04 mm. chord, and hair-like, 0·2–0·4 mm. long.

REMARKS.—The holotype is a small incrustation, mixed up with organic debris and tiny fragments of a *Petrosia* sp. indet. Its characters are ill-defined and its nearest relative is *Microciona longitoxa* Hentschel, which has isochelæ in addition to toxa, and one kind of subtylostyli only.



TEXT-FIG. 30.—*Microciona anonyma* sp. n. All spicules, ×200.

Genus *Echinodictyum* Ridley.

Echinodictyum nervosum Ridley.

? *Spongia nervosa* Lamarck, 1813 : 450 ; 1816 : 377 ; *Echinodictyum nervosum* Ridley, 1881 : 496, pl. xxviii, figs. 7–10 ; ? *Spongia nervosa* Topsent, 1932 : 114.

OCCURRENCE.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

DISTRIBUTION.—South-east coast of Arabia.

Echinodictyum jousseaumi Topsent.

Echinodictyum jousseaumi Topsent, 1892 : 24, pl. i, fig. 3 ; Burton, 1931 : 348, pl. xxiii, fig. 7.

OCCURRENCE.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand.

DISTRIBUTION.—Red Sea ; Natal.

Genus *Antho* Gray.

Antho tawiensis (Wilson).

Lissodendoryx tawiensis Wilson, 1925 : 432, pl. xlii, fig. 4, pl. xlix, fig. 5.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.; Stn. 89, December 7, 1933, northern area of Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shingle and rock.

Remarks.—The four specimens are small and irregular, but one at least is incipiently cup-shaped. The spiculation of all is fairly typical though styli, smooth or basally-spined, 0·28 by 0·017 mm., are associated with the main skeleton, and the acanthostyli measure 0·16 by 0·014 mm. instead of 0·28–0·35 by 0·005 mm. Embryos are present in some specimens.

It seems that this species is as variable as *Antho involvens* (Schmidt) (see Burton, 1933, pp. 504–508 under *Dictyoclathria beanii* (Bowerbank), a species which must now be known as *Antho involvens*).

Distribution.—Philippines.

Echinoplocamia gen. n.

Genotype.—*Echinoplocamia arbuscula* **sp. n.**

Diagnosis.—Clathriinæ with reticulate skeleton of amphitylota and styli echinated by acanthostyli; with auxiliary subtylostyli; microscleres toxa.

Echinoplocamia arbuscula sp. n.

(Text-fig. 31.)

Holotype.—B.M. 1936.3.4.413.

Occurrence.—Stn. 177, May 2, 1934, Gulf of Aden (12° 01′ 54″ N., 50° 39′ 12″ E.), 366 m., bottom green mud and rock.

Diagnosis.—Sponge ramose; surface hispid; oscules not apparent; texture firm; colour, in spirit, brown; skeleton a reticulation of spongin fibres, with ascending fibres cored by plumosely-arranged styli, often basally-microspined, 0·35–0·9 by 0·018–0·03 mm., connective fibres cored by amphytylota, microspined at each end, 0·24 by 0·035 mm., the whole echinated by acanthostyli, 0·05–0·07 by 0·005–0·007 mm.; auxiliary subtylostyli, basally-microspined, 0·28 by 0·003 mm.; microscleres toxa, up to 0·1 mm. long.

Remarks.—The holotype is in an unsatisfactory state of preservation, being fragmentary and macerated, 8 mm. long by 4 mm. diameter. The characters of the skeleton are, however, sufficiently striking to justify their description.

Genus *Plocamilla* Topsent.

Plocamilla manaarensis (Carter).

Dictyocylindrus manaarensis Carter, 1880 : 37, pl. iv, fig. 1; *Dirrhopalum manaarensis* Ridley, 1881 : 482; *Plocamia manaarensis* Dendy, 1905 : 179, pl. viii, fig. 1; Burton and Srinivasa Rao, 1932 : 355; *Plocamilla manaarensis* Burton, 1935 : 402; *nec Plocamia manaarensis* Lambe, 1894.

Occurrence.—Stn. 89, December 7, 1933, northern area of Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shingle and rock.

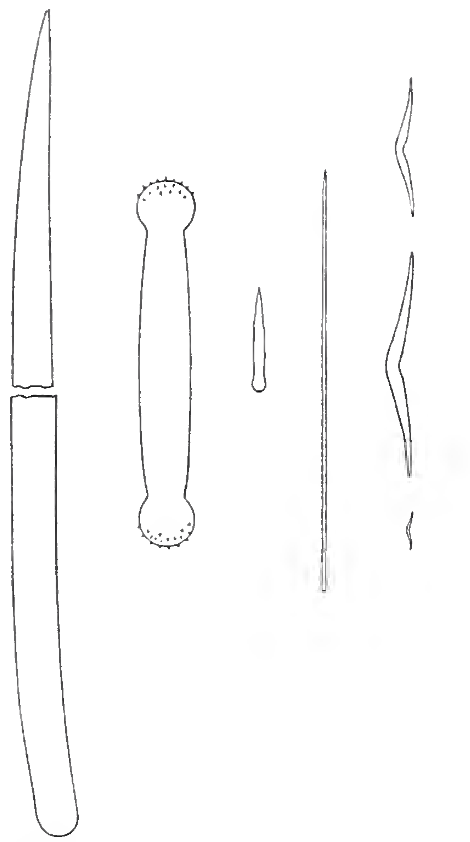
Remarks.—A small branching specimen 20 mm. high.
Distribution.—West coast of India ; Ceylon ; Laccadives ; 41–57 m.

Genus *Acarnus* Gray.

Acarnus topsenti Dendy.

Acarnus topsenti Dendy, 1921 : 98, pl. iv, fig. 3, pl. xv, fig. 8.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.
Distribution.—Indian Ocean (Cargados Carajos) ; 55–165 m.



Text-fig. 31.—*Echinoplocamia arbuscula* sp. n. Style, amphitylote, acanthostyle and auxiliary subtylostyle, ×200, toxa, ×300.

Sub-family Raspeliinæ.

Genus *Aulospongus* Norman.

Aulospongus tubulatus (Bowerbank).

Haliphysema tubulatus Bowerbank, 1873 : 29, pl. vii ; *Aulospongus tubulatus* Norman, 1878 : 267 ; Dendy, 1889 : 89, pl. v, fig. 11 ; Dendy, 1921 : 61.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E, to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 53, November 2.

1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle and Lithothamnion.

DISTRIBUTION.—Ceylon ; Amirantes ; 51–53 m.

Genus *Rhabderemia* Topsent.

Rhabderemia indica Dendy.

Rhabderemia indica Dendy, 1905 : 180, pl. xii, fig. 10.

OCCURRENCE.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 209, May 17, 1934, Red Sea (15° 54′ 36″ N., 41° 13′ 00″ E.), 366 m., bottom green and brown mud and rock.

DISTRIBUTION.—Ceylon.

Genus *Endectyon* Topsent.

Endectyon thurstoni (Dendy).

Raspailia thurstoni Dendy, 1887 : 161, pl. xii, fig. 1 ; *Hemectyon thurstoni* Burton and Rao, 1932 : 347.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DISTRIBUTION.—India (Cape Cormorin, Madras, Tuticorin) ; 70 m.

Hemectyonilla **gen. n.**

GENOTYPE.—*Stylostichon involutum* Kirkpatrick 1903 : 250, pl. v, fig. 6, pl. vi, fig. 17.

DIAGNOSIS.—Raspeliinæ with skeleton of plumose columns of large and small rhabdostyli ; and with slender oxea (styloids ?), more rarely styli, occurring interstitially to columns and in ectosomal brushes ; microscleres absent.

Hemectyonilla involutum (Kirkpatrick).

Stylostichon involutum Kirkpatrick, 1903 : 250, pl. v, fig. 16, pl. vi, fig. 17 ; *Plumohalichondria gardineri* Dendy, 1921 : 87, pl. ii, fig. 9, pl. xv, fig. 4.

OCCURRENCE.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shell ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion; Stn. 185, May 5, 1934, Gulf of Aden (13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ E., 49° 16′ 24″ E.), 2001 m.

DISTRIBUTION.—Natal ; Amirante ; 37–80 m., bottom broken shells.

Genus *Higginsia* Higgin.

Higginsia petrosioides Dendy.

Higginsia petrosioides Dendy, 1921 : 126, pl. vii, fig. 9, pl. xvii, fig. 7.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—There are 50 specimens all closely similar in external form and spiculation. They are massive and rounded, with surface mainly papillate. In places the surface may be apparently smooth, but closer examination shows, even here, incipient papillæ. The oscules are small, few and scattered, about 1 mm. diameter, and the summit of each papilla bears a pore, presumably inhalant. The colour, in all, is yellow.

Apart from the main oxea being slightly thicker, up to 0·05 mm., the skeleton differs in no respect from that of the holotype except that in all but one specimen the acanthoxea form a distinct ectosomal layer, as well as being scattered in the choanosome.

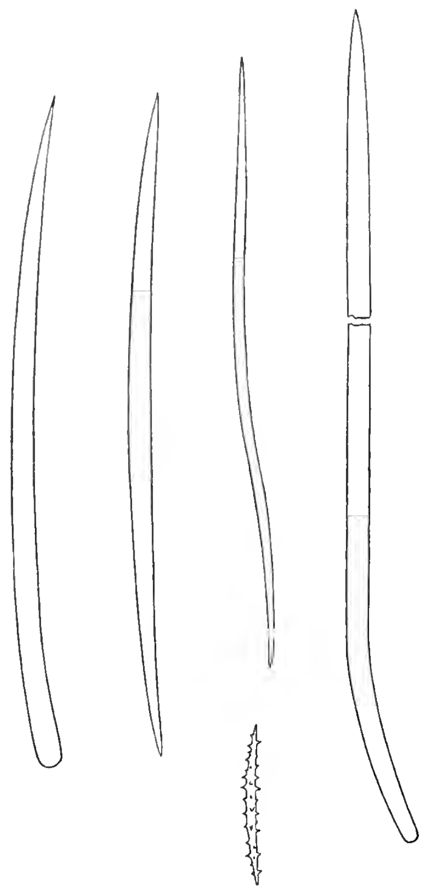
Distribution.—Indian Ocean (Seychelles, 80 m.).

Higginsia robusta sp. n.

(Text-fig. 32.)

Holotype.—B.M. 1936.3.4.342.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells; Stn. 35, October 16, 1933,



Text-fig. 32.—*Higginsia robusta* sp. n. Styli, oxeote and styloid, ×100, acanthoxeote, ×300.

Gulf of Aden (13° 14′ 24″ N., 46° 14′ 12″ E. to 13° 13′ 24″ N., 46° 10′ 00″ E.), 441 m., bottom green mud, sand and shingle; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N. to 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Diagnosis.—Sponge ranging from clavate to stipitate, when small, to branching or flabellate in large specimens; surface papillose; oscules not apparent; texture firm;

colour, in spirit, yellow to yellowish-green ; skeleton in small specimens of dense ascending plumose columns of styli, sometimes modified to oxea, in larger specimens of a dense axial concentration with longer styli radiating to surface ; megascleres styli or oxea, 0·3–0·88 by 0·016–0·032 mm., longer styli, 1·4–2·0 mm., scattered irregularly among spicules of main skeleton, and styloids with ends oxeote, rarely bidentate, in ectosomal brushes or interstitial to main skeleton, 0·48–0·8 by 0·004–0·014 mm. ; microscleres acanthoxea, chiefly in ectosomal layer, 0·05–0·07 mm. long.

Remarks.—The dozen specimens are obviously conspecific but whereas in the majority the main skeleton is composed almost entirely of styli there is much variation, the larger specimens having a mixture of styli and oxea, with in one case the oxea predominating.

The present specimens are related to *H. mixta* (Hentschel) but differ in the smaller size of the acanthoxea.

Key to the Species of *Higginisia*.

1.	Main megascleres seldom exceeding 0·9 mm. in length	2
	Main megascleres seldom less than 1·0 mm. long	*papillosa*
2.	With long slender styli included in main skeleton	3
	Without long slender styli	*petrosioides*
3.	With ectosomal styloids mainly oxeote, rarely stylote, and very rarely bidentate . . .	4
	With ectosomal styloids bidentate at one end	*bidentifera*
4.	Main megascleres up to 0·032 mm. thick	5
	Main megascleres up to 0·021 mm. thick	*coralloides*
5.	Surface of sponge strongly hispid	*mixta*
	Surface of sponge papillose, non-hispid	*robusta*

Raspailopsis gen. n.

Genotype.—*Raspailopsis cervicornis* **sp. n.**

Diagnosis.—Corticate Raspeliinæ with axial skeleton of large and small styli embedded in spongin fibres, an extra axial skeleton of small styli and brushes of pseudoxea, each such brush having one long style at its centre ; microscleres absent.

Remarks.—A second species should be placed in this genus, namely, *Raspailia* (*Syringella*) *nuda* Hentschel (1909, p. 383), in which the positions of the short styli and pseudoxea are reversed. Otherwise, the two species are very alike.

Neither of these species is typical of the sub-family Raspeliinæ but the ectosomal brushes with long styli set at their centres is indicative of their affinities.

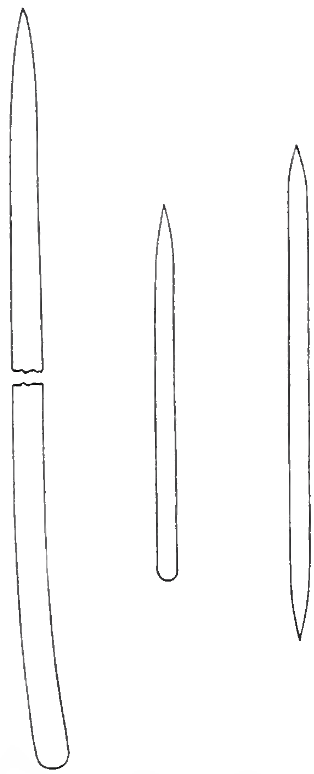
Raspailopsis cervicornis sp. n.

(Text-fig. 33.)

Holotype.—B.M. 1936.3.4.604.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 24″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Diagnosis.—Sponge erect, stipitate, dichotomously branched or caliculate; surface even, strongly hispid; oscules not apparent; texture firm, incompressible; colour, in spirit, dark grey; spicules large styli, base sometimes slightly tylote, 1·6–3·0 by 0·032–0·05 mm., small styli, 0·5 by 0·024 mm., and tornotiform pseudoxea, 0·66 by 0·028 mm.



Text-fig. 33.—*Raspailopsis cervicornis* sp. n. Styli, of two sizes, and tornotiform pseudoxeote, ×100.

Family Axinellidæ.

Genus *Amorphinopsis* Carter.

Amorphinopsis Carter, 1887 : 77; *Dactylella* Thiele, 1898 : 55; *Trachyopsis* Dendy, 1905 : 147; *Migas* Sollas, 1908 : 395; *Dactyella* Annandale, 1915 : 470, *nec Dactylella* Gray.

Genotype.—*Amorphinopsis excavans* Carter, 1887 : 77.

Diagnosis.—Axinellidæ with skeleton of oxea, variable in size, arranged loosely, without order or in loose fibres running to surface and projecting beyond; without special ectosomal skeleton.

Amorphinopsis megalorhaphis (Carter).

Amorphina megalorhaphis Carter, 1881 : 368; *A. megalorrhaphis* Ridley, 1884 : 416; *Halichondria solida* Ridley and Dendy, 1886 : 326; *Amorphinopsis excavans* Carter, 1887 : 77, pl. v, figs. 12–15; *Halichondria solida* Ridley and Dendy, 1887 : 4, pl. ii, fig. 5; *H. solida*, var. *rugosa* Ridley and Dendy, 1887 : 4; *H. panicea*, var. Dendy, 1887 : 157; *H. granulata* Keller, 1891 : 310, pl. xvi, fig. 8; *H. tuberculata* Keller, 1891 : 310, pl. xvi, fig. 10; *H. panicea*, var. *rameswarans* Thurston, 1895 : 102–105; *H. variabilis* Lindgren, 1897 : 480; *H. armata* Lindgren, 1897 : 480; *H. dura* Lindgren, 1897 : 480; *H. cavernosa* Topsent, 1897 : 477, pl. xix, fig. 16; *H. variabilis* Lindgren, 1898 : 3, pl. xviii, fig. 1, pl. xix, fig. 1; *H. armata* Lindgren, 1898 : 3, pl. xvii, fig. 1, pl. xix, fig. 2; *H. dura*

Lindgren, 1898 : 4, pl. xvii, fig. 2, pl. xix, fig. 3 ; *Dactylella hilgendorfi* Thiele, 1898 : 56, pl. v, fig. 25, pl. iv, fig. 8, pl. viii, fig. 41 ; *H. solida* Kirkpatrick, 1900 : 139 ; *H. solida*, var. *rugosa* Kirkpatrick, 1900 : 139 ; *H. panicea*, var. *megalorhaphis*, Dendy, 1905 : 146 ; *H. panicea*, var. *hemispherica* Dendy, 1905 : 146 ; *Trachyopsis halichondrioides* Dendy, 1905 : 147, pl. x, fig. 10 ; *Halichondria papillata* Baer, 1906 : 11, pl. i, fig. 5, pl. iv, figs. 7–9 ; *Migas porphyrion* Sollas, 1908 : 395 ; *Trachyopsis halichondrioides* Row, 1911 : 321 ; *Halichondria variabilis* Hentschel, 1912 : 408 ; *Spongosorites* sp. Sewell, 1913 : 346 ; *Amorphinopsis excavans* Annandale, 1915 : 467 ; fig. 4A ; *A. excavans*, var. *digitifera* Annandale, 1915 : 469, figs. 4B, 5 ; *Halichondria panicea* Dendy, 1921 : 37 ; *H. aplysinoides* Dendy, 1921 : 39, pl. iii, figs. 3–5, pl. xii, fig. 9 ; *H. panicea* Wilson, 1925 : 394 ; *H. variabilis* Wilson, 1925 : 396 ; *Trachyopsis halichondrioides* Wilson, 1925 : 409 ; Burton, 1926 : 75, figs. 6–7.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m. ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shell, Lithothamnion ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m.

Remarks.—Attention has already been drawn (Burton, 1926) to the variation in the skeleton of specimens from the Suez Canal, identified under *Trachyopsis halichondrioides*, and it is my experience that there is here a species, recorded under a variety of names, which occupies in the Indian Ocean and Indo-Pacific the position held by *Halichondria panicea* in the northern hemisphere. The specimens represented in the synonymy list given here have certain features in common, and the differences between them are no more than the differences found over a wide range of *H. panicea*, from which the present species differs most markedly in the absence of a special ectosomal skeleton.

One specimen in the present collection is a subcylindrical fragment, 30 by 10 mm., whitish, with an irregular, subaculeate surface and a single small oscule, 1 mm. diameter, towards one end. The skeleton is an irregular reticulation of oxea, in which the spicules run more or less vertical to the surface. The oxea measure 1·2 by 0·03 to 2·0 by 0·08 mm., the majority being of the larger size. The specimen is included in this species with some hesitation since the oxea are rather thicker than usual.

Distribution.—The Indian Ocean generally, eastwards to Formosa, the Philippines, and New Hebrides and southwards to Australia (Torres Straits and Bass Straits) : littoral to 183 m.

Genus *Axinella* Schmidt.

Axinella carteri (Dendy).

Acanthella carteri Dendy, 1889 : 93, pl. iv, fig. 6 ; *A. aurantiaca* Keller, 1889 : 396, pl. xxiv, fig. 47 ; *A. carteri* Dendy, 1905 : 193, pl. viii, fig. 6 ; *A. aurantiaca* Topsent, 1906 : 562 ; Row, 1911 : 356 ; *A. carteri* Dendy, 1921 : 119, pl. v, fig. 5.

Occurrence.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shell and Lithothamnion.

Remarks.—The single specimen is flabellate, 12 cm. high by 12 cm. across, resembling closely the type of *Acanthella aurantiaca*. The spicules are styli 0·4 mm. long.

In the original description of *A. carteri*, Dendy mentioned the presence of a second category of styli, long and slender, lying between the main fibres of the skeleton. It seems that the occurrence of these spicules is sporadic, and the fact that they have not been found in the present specimen need not invalidate its being identified with Dendy's species.

Distribution.—Red Sea ; Indian Ocean (Gulf of Manaar, Cargados Carajos, Diego Garcia, Amirante, Salomon, Seychelles) ; 7–80 m.

Axinella lamellata (Dendy).

Spongosorites lamellata Dendy, 1905 : 184, pl. xii, fig. 2.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The 26 specimens, ranging from 5 to 10 cm. high, have a stronger outward resemblance to *Axinella* (*Ceratopsis*) *ramosa* (Thiele) than *A. lamellata*. In fact, the only reason for separating these two species seems to lie in the size of their megascleres, which are 0·7–1·4 mm. long in Thiele's species and 0·95 mm. in Dendy's. In the present specimens, on the other hand, they rarely exceed 0·5 mm. in length.

Distribution.—Ceylon.

Aximella agariciformis (Dendy).

Thrinacophora agariciformis Dendy, 1905 : 186, pl. xii, fig. 6 ; *Dragmacidon agariciformis* Hallmann, 1917 : 639.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Ceylon.

Axinella durissima (Dendy).

Thrinacophora durissima Dendy, 1905 : 187, pl. xii, fig. 5 ; *Sigmaxinella durissima* Dendy, 1921 : 113 ; *S. durissima*, var. *massalis* Dendy, 1921 : 113, pl. v, fig. 4, pl. vii, fig. 4 ; *S. durissima*, var. *erecta* Dendy, 1921 : 113, pl. vii, fig. 5 ; *S. durissima*, var. *tethyoides* Dendy, 1921 : 114, pl. vii, fig. 6.

Occurrence.—Stn. M.B. I (c), September 17, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m., bottom coral rock ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 112, January 15, 1933, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Occurrence.—Indian Ocean (Providence, Amirante, Saya de Malha, Seychelles, Ceylon) ; 54–143 m.

Axinella conulosa (Dendy).

Phakellia conulosa Dendy, 1921 : 116, pl. vi, fig. 4, pl. xvii, fig. 2 ; *P. conulosa*, var. *mauritiana* Dendy, 1921 : 117, pl. vi, fig. 5.

Occurrence.—Stn. 112, January 15, 1933, Zanzibar Area (5° 04′ 57″ N., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Distribution.—Indian Ocean (Mauritius, Cargados Carajos) ; 55–183 m.

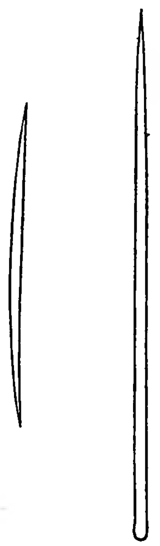
Axinella bidderi sp. n.

(Text-fig. 34.)

Holotype.—B.M. 1936.3.4.316.

Occurrence.—Stn. 35, October 16, 1933, Gulf of Aden (13° 14′ 24″ N., 46° 14′ 12″ E. to 13° 13′ 24″ N., 46° 10′ 00″ E.), 441 m., bottom green mud, sand and shells; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion; Stn. 54, November 3, 1933, South Arabian Coast (21° 50′ 00″ N., 59° 52′ 00″ E.), 1046 m., bottom green mud.

Diagnosis.—Sponge flabellate, stipitate; surface even, minutely hispid; oscules not apparent; texture firm, flexible; colour, in spirit, brown to reddish-brown; skeleton an



Text-fig. 34.—*Axinella bidderi* sp. n. Oxeote and style, ×100.

irregular reticulation of ascending, subplumose fibres, with (mainly) unispicular connectives; megascleres oxea, 0·35–0·48 by 0·007–0·024 mm., and styli, 0·35–0·96 by 0·007–0·024 mm.; microscleres trichodragmata, of occasional occurrence, possibly.

Systematic notes.—In the specimen from Stn. 35, and in one specimen from Stn. 45, the oxea and styli are of about equal length, 0·35–0·48 mm., but in the second specimen from Stn. 45, otherwise agreeing in all respects with the first two, the styli occasionally measure up to 0·96 mm. long, and there are, in addition trichodragmata.

From Stn. 54 there is an encrusting specimen growing on a worm-tube which agrees closely with the specimen from Stn. 45 except in external form.

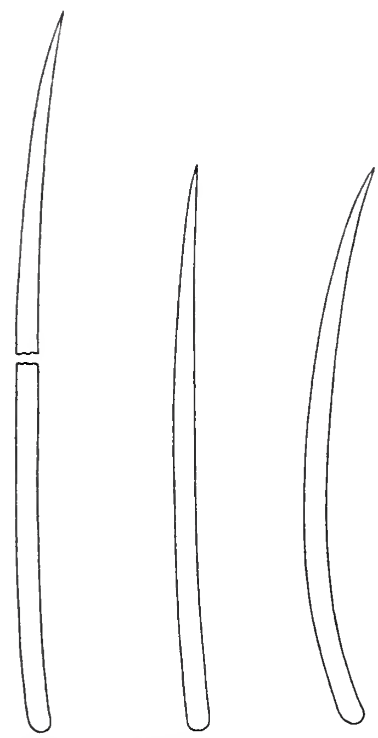
Axinella ventilabrum sp. n.

(Text-fig. 35.)

Holotype.—B.M. 1936.3.4.315.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ N., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Diagnosis.—Sponge flabellate, substipitate; surface uneven, minutely hispid, prominently marked by a dendritic system of raised ridges (representing an internal system of skeleton bundles running from base to apex of sponge); oscules not apparent ; texture firm, flexible ; colour, in spirit, pale yellowish-brown ; skeleton a dense, confused reticulation of styli of two sizes (in dendritic systems of fibres, spicules are even more densely packed) ; megascleres styli, of two sizes, 1·6 by 0·032 and 0·8 by 0·032 mm. respectively ; microscleres absent.



Text-fig. 35.—*Axinella ventilabrum* sp. n. Styli, of two sizes, ×100.

Axinella flabello-reticulata sp. n.

(Text-fig. 36.)

Holotype.—B.M. 1936.3.4.325.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ N., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Diagnosis.—Sponge flabellate (to subcaliculate ?), substipitate ; inner surface even, outer surface marked with a reticulation of ridges, both surfaces minutely hispid ; oscules not apparent ; texture firm, flexible ; colour, in spirit, pale brownish-yellow ; skeleton an irregular reticulation, mainly multispicular (2–6 spicules), of styli, sharply bent in basal third, 0·6 by 0·04 mm. ; microscleres absent.

Axinella dragmaxioides sp. n.

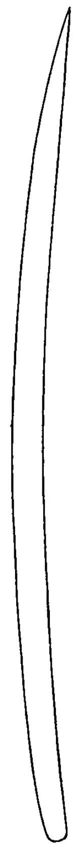
(Text-fig. 37.)

Holotype.—B.M. 1936.3.4.319.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DIAGNOSIS.—Sponge caliculate, rarely flabellate ; surface even, minutely hispid, outer surface of cup often marked by a number of low, rounded mounds ; oscules not apparent ; texture firm, flexible ; colour, in spirit, pale yellow to brown ; skeleton a dense irregular unispicular reticulation ; megascleres styli, 1·1 by 0·04 mm. ; microscleres absent.

TEXT-FIG. 36.—*Axinella flabello-reticulata* sp. n. Style, ×100.



TEXT-FIG. 37.—*Axinella dragmaxioides* sp. n. Style, ×100.

TEXT-FIG. 38.—*Axinella massalis* sp. n. Style and microxeote, × 100.

Axinella massalis sp. n.

(Text-fig. 38.)

HOLOTYPE.—B.M. 1936.3.4.509.

OCCURRENCE.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

DIAGNOSIS.—Sponge irregularly massive ; surface uneven, hispid, harsh to touch ; oscules few, small, scattered ; texture firm, barely compressible ; colour, in spirit, ash grey to dark brown ; skeleton an irregular reticulation of styli, 0·45–0·64 by 0·03–0·044 mm., with microxea, 0·24 by 0·006–0·012 mm. and trichodragmata, 0·036 mm. long, scattered interstitially.

REMARKS.—The species varies from the known species of *Axinella* bearing microxea and trichodragmata in its external form as well as in details of its spiculation.

Genus *Phakellia* Bowerbank.

Phakellia radiata (Dendy).

Axinella mastigophora Lindgren, 1897 : 483 ; Lindgren, 1898 : 32, pl. xvii, fig. 6, pl. xix, fig. 20 ; *Bubaris radiata* Dendy, 1916 : 131, pl. i, fig. 8, pl. iv, fig. 24 ; *B. conulifera* Dendy, 1921 : 62, pl. vii, fig. 3, pl. xiii, fig. 2 ; Burton, 1928 : 130 ; *B. columnata* Burton, 1928 : 130, pl. ii, fig. 1 ; *nec Axinella mastigophora* Schmidt.

OCCURRENCE.—Stn. 9, September 17, 1933, Red Sea (13° 35′ 30″ N., 42° 35′ 05″ E.), 245 m., bottom rock and sand ; Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom sand and shells ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 89, December 7, 1933, Northern Area of Arabian Sea (19° 14′ 00″ N., 69° 42′ 18″ E.), 193 m., bottom sand, shells and rock ; Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), (73–165 m.) ; Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

REMARKS.—There is, in the Indo-Pacific area, a group of species which certainly belong to the genus *Phakellia* and probably constitute a single species. Their common characteristic is a skeleton composed of plumose columns of styli of two sizes with their bases implanted in an axial core of short strongyla. The group includes *Axinella mastigophora* Lindgren (*nec* Schmidt), *Bubaris radiata* and *B. conulifera*, both of Dendy, and *B. columnata* Burton. If these can be accepted as a single species, as seems likely, then the specimen from Stn. 27 must be included with them. It has the external form of *B. columnata*, with the axial spicules slightly vermiform as in *Axinella mastigophora* Lindgren ; but although the dimensions of the various spicule categories, and the shape of the styli, are in accord with those of the rest of this group, the axial spicules are bluntly-ended oxea instead of strongyla.

A specimen from Stn. 112 is thinly flabellate, very like *Bubaris columnata* except that the longitudinal ridges are very few in number and ill-defined. The spiculation is, however, typical except that the axial spicules are oxea instead of strongyla.

From Stn. 89 there comes a small, thinly encrusting specimen, bearing isolated, erect processes. The skeleton consists of a basal layer of oxea and strongyla, and two categories of styli with their bases implanted therein. The erect processes have an axial core of, mainly, strongyla with some oxea, and radially-arranged styli. The skeleton of the basal mass and that of the processes is markedly different. The strongyla (with some oxea) of the processes are up to 0·8 mm. long and are bent in the middle ; the oxea (with some strongyla) of the basal mass rarely exceed 0·4 mm. long and are often slightly vermiform. The large styli of the processes sometimes attain a length of 3 mm.

In addition there are 8 other specimens from Stns. 9, 45, 111 and 112, all of which are typical of *Bubaris radiata* (*sensu stricto*). Two are 20 and 25 mm. high respectively, both columnar, the first dividing into two and the second into three digitate processes at the apex. The remaining six specimens are globular or subglobular, 5–45 mm. high.

DISTRIBUTION.—Indian Ocean (Okhamandal coast, Providence, Andamans) ; Pacific (Straits of Formosa) ; 71–165 m.

Genus *Hymeniacidon* Bowerbank.

Hymeniacidon virgultosa (Carter).

Axinella virgultosa Carter, 1887 : 68, pl. v, fig. 11 ; Dendy, 1916 : 118.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom shells and sand ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Indian Ocean (Okhamandal, Mergui Archipelago) ; 27–31 m.

Hymeniacidon variospiculata Dendy.

Hymenicidon variospiculata Dendy, 1921 : 122, pl. xvii, fig. 4.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Salomon ; 137 m.

Genus *Ciocalypta* Bowerbank.

Ciocalypta penicillus Bowerbank.

Spongia cavernosa Lamarck, 1813 : 371 ; Lamarck, 1816 : 353 ; *Ciocalypta penicillus* Bowerbank, 1864 : 180, pl. xxx, fig. 360 ; Bowerbank, 1866 : 81 ; Gray, 1867 : 522 ; *Axinella penicillus* Schmidt, 1870 : 76 ; *Ciocalypta tyleri* Bowerbank, 1873 : 21, pl. iv, figs. 9–12 ; *C. penicillus* Bowerbank, 1874 : 33, pl. xiii, figs. 2–4 ; *C. leei* Bowerbank, 1874 : 255, pl. lxxxvi, figs. 1–4 ; *C. penicillus*, var. *tuberculata* Carter, 1876 : 235 ; *C. penicillus* Ridley, 1881 : 116 ; *C. leei* Ridley, 1881 : 116 ; *C. penicillus* Bowerbank, 1882 : 38 ; *C. leei* Bowerbank, 1882 : 38 ; *Leucophlœus massalis* Carter, 1883 : 323, pl. xiv, fig. 15 ; *Ciocalypta penicillus*, var. *aciculata* Carter, 1885 : 366 ; *Leucophlœa massalis* Carter, 1885 : 366 ; *Ciocalypta tyleri* Carter, 1885 : 366 ; ? *Stylotella polymastia* Lendenfeld, 1888 : 186, pl. iv, fig. 1 ; *Ciocalypta penicillus* Topsent, 1888 : 140 ; *C. tyleri*, var. *manaarensis* Dendy, 1889 : 91 ; *Apatospongia fallax* Marshall, 1892 : 16, pl. viii, figs. 1–5 ; *C. penicillus* Marshall, 1897 : 238 ; *C. tyleri* Marshall, 1897 : 239 ; *C. penicillus*, var. *gracilis* Topsent, 1897 : 445, pl. xviii, figs. 6–7 ; *Apathospongia fallax* Delage, 1899 : 172 ; *Ciocalypta tyleri* Dendy, 1905 : 197 ; ? *C. tyleri*, var. *aberrans* Dendy, 1905 : 198 ; ? *C. tyleri* Row, 1911 : 359 ; Hentschel, 1912 : 422 ; *C. melichlora* Hentschel, 1912 : 423 ; *C. rutila*, var. *gracilis* Hentschel, 1912 : 423 ; *C. heterostyla* Hentschel, 1912 : 424, pl. xiv, fig. 3, pl. xxi, fig. 58 ; *C. mertoni* Hentschel, 1912 : 424, pl. xiv, fig. 4, pl. xxi, fig. 59 ; ? *C. stalagmites* Hentschel, 1912 : 426, pl. xxi, fig. 60 ; ? *C. oculata*, var. *maxima* Hentschel, 1912 : 428, pl. xxi, fig. 61 ; ? *Leucophlœus incrustans* Ferrer, 1912 : 17 ; ? *Ciocalypta polymastia* Hallmann, 1914 : 353, fig. 7 ; *C. weltneri* Arnesen, 1920 : 24, pl. ii, fig. 7, pl. v, fig. 1 ; *C. penicillus* Topsent, 1921 : 687 ; *C. penicillus*, var. *dendyi* Topsent, 1921 : 690 ; *C. penicillus* Ferrer, 1922 : 2 ; Topsent, 1925 : 635 ; Arndt, 1928 : 54, figs. 60–61 ; Topsent, 1930 : 13 ; *C. alleni* de Laubenfels, 1936 : 134 ; *nec Spongia cavernosa* Pallas.

Occurrence.—Stn. 161, April 8, 1934, Maldive Area (5° 04′ 48″ N., 72° 50′ 30″ E.), 46 m., bottom coarse sand.

Remarks.—A few fragmentary fistulæ occur, with oxea only for spicules.

Distribution.—Coasts of Europe (from southern England to Spain and Portugal) ; Mediterranean ; Canaries ; South Africa ; Red Sea ; Ceylon ; Indo-Pacific ; Australia ; New Zealand ; 6–40 m.

Genus *Collocalypta* Dendy.

Collocalypta digitata Dendy.

Collocalypta digitata Dendy, 1905 : 199, pl. vii, fig. 6, pl. xiii, figs. 1–2.

Occurrence.—Stn. 112. January 15. 1933. Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom rock and coral.

Distribution.—Gulf of Manaar.

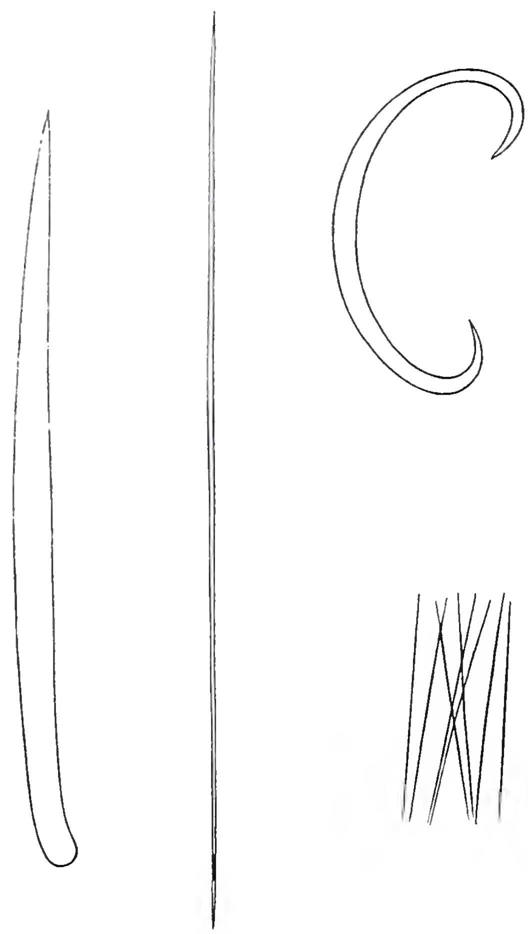
Genus *Sigmaxinella* Dendy.

Sigmaxinella megastyla **sp. n.**

(Text-fig. 39.)

Holotype.—B.M. 1936.3.4.536.

Occurrence.—Stn. 24, October 9. 1933. Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shells and (?) rock.



Text-fig. 39.—*Sigmaxinella massalis* sp. n. Style ×100, trichites, of two sizes, and sigma, ×600.

Diagnosis.—Sponge massively digitate ; surface strongly hispid, harsh to touch ; oscules not apparent ; texture firm, slightly compressible ; colour, in spirit, pale yellow ; skeleton of loose plumose columns of styli running from centre of lobe to surface ; megascleres styli, usually slightly curved in basal third, 1·0 by 0·07 mm. ; microscleres sigmata, 0·06–0·08 mm. chord, and trichites, scattered, of two sizes, 0·1 and 0·4 mm. long.

REMARKS.—The holotype was either moribund when taken or has macerated since and is not in a good condition for accurate description. The microscleres are numerous, distributed generally through the tissues, but more especially at the surface ; and throughout their occurrence is patchy. It could be that they represent foreign inclusions and that the sponge belongs to *Axinella*, but after due consideration it is assumed that the microscleres are proper to this specimen and that it represents a new species of *Sigmaxinella* characterized by the large size of the styli.

Genus *Stylissa* Hallmann.

Stylissa massa (Carter).

Axinella virgultosa, var. *massa* Carter, 1887 : 68, pl. vii, figs. 6–7 ; *Stylotella conulosa* Topsent, 1897 : 466 ; *Hymeniacidon conulosa* Lindgren, 1897 : 483 ; Lindgren, 1898 : 31, pl. xvii, fig. 13, pl. xix, fig. 19 ; ?*Suberites mollis* Kieschnick, 1898 : 46 ; Kieschnick, 1900 : 576, pl. xliv, fig. 4.

OCCURRENCE.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

DISTRIBUTION.—Mergui Archipelago ; Amboina ; Java ; ? Ternate.

Stylissa coccinea (Keller).

Reniera coccinea Keller, 1891 : 307, pl. xvi, figs. 5–6 ; *Hymeniacidon coccinea* Burton, 1926 : 81.

OCCURRENCE.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

REMARKS.—The single typical specimen contains no sigmaspiroids (cf. Burton, l.c.). Embryos are present.

DISTRIBUTION.—Red Sea ; Suez Canal.

Genus *Ptilocaulis* Carter.

Ptilocaulis spiculifera (Lamarck).

Spongia spiculifera Lamarck, 1813 : 449 ; Lamarck, 1816 : 376 ; *Ptilocaulis gracilis* Carter, 1883 : 321, pl. xiii, fig. 8, pl. xiv, fig. 13 ; *Axinella spiculifera* Ridley, 1884 : 617, pl. liv, fig. b ; Dendy, 1921 : 115, pl. viii, fig. 7 ; *Ptilocaulis digitatus* Topsent, 1928 : 172, pl. ii, fig. 52, pl. vi, fig. 15 ; *P. digitatus*, var. *spiculifera*, Topsent, 1932 : 111, pl. v, fig. 8 ; *P. spiculifer* Topsent, 1933 : 23.

OCCURRENCE.—Stn. 151, April 3, 1934, Maldive Area (4° 50′ 00″ N., 72° 50′ 12″ E.), 101 m., bottom coral rock.

DISTRIBUTION.—West Indies ; Cape Verde Is. ; Indian Ocean (Amirante) ; Australia (King Island) ; 40–52 m.

Genus *Raspaigella* Schmidt.

Raspaigella salomonensis (Dendy).

Spongosorites salomonensis Dendy, 1921 : 125, pl. xvii, fig. 6.

OCCURRENCE.—Stn. 112, January 15, 1933, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

DISTRIBUTION.—Salomon ; 110–219 m.

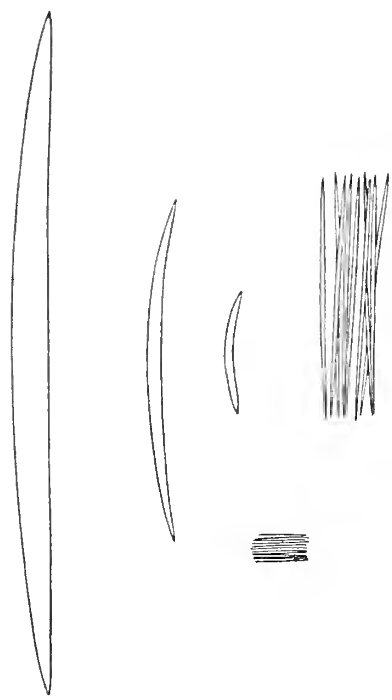
Raspaigella ? suluensis (Wilson).

Spongosorites suluensis Wilson, 1925 : 331, pl. xxxviii, fig. 8, pl. xlviii, fig. 3.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Remarks.—A small irregular, massive sponge about 2 cm. across is referred doubtfully to this species. The ectosome is lacking entirely, and the interstices of the sponge contain sufficient calcareous debris to suggest that it has been subject to wave action on the bottom of the sea. The spicules are large oxea and frequent styli, average 1·0 by 0·048 mm., small oxea, average 0·24 by 0·012 mm. long, and trichodragmata. The last-named are abundant and measure 0·012, 0·028, 0·04 and 0·12 mm. (with, possibly, intermediates between these sizes). It would be inadvisable to refer so incomplete a specimen to a new species and its nearest relative is *Spongosorites suluensis*, which contains " not very abundant " trichodragmata 0·1 mm. long. Otherwise there is a fairly close agreement.

Distribution.—Philippines.



Text-fig. 40.—*Raspaigella dendyi* sp. n. Oxea, of three sizes, ×100, trichodragmata, of two sizes, ×600.

Raspaigella dendyi **sp. n.**

(Text-fig. 40.)

Holotype.—B.M. 1936.3.4.354.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 112, January 15, 1933, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Diagnosis.—Sponge massive, rounded, sometimes with large and small erect digitate processes ; surface even, non-hispid ; oscules, up to 4 mm. diameter, grouped in one or more depressions on upper surface ; texture hard ; colour, in spirit, a pale yellowish-brown ; skeleton a loose, scattered reticulation of large and small oxea, with dense, ectosomal feltwork of, mainly, small oxea ; megascleres oxea, of three sizes, 0·9 by 0·048, 0·45 by 0·024, and 0·17 by 0·01 mm. respectively ; microscleres trichodragmata, of two sizes, 0·32 by 0·008 and 0·035–0·07 by 0·014 mm. respectively.

Genus *Pseudaxinyssa* Burton.

Pseudaxinyssa tenuispiculata Burton.

Pseudaxinyssa tenuispiculata Burton, 1931 : 350, pl. xxiii, fig. 10.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—A fragment, resembling the holotype in appearance and texture, is assigned with hesitation to this species. Its spicules are oxea, styli and pseudoxea but all are double the size of those originally described.

Distribution.—Natal.

Order KERATOSA.

Family Darwinellidæ.

Genus *Darwinella* Müller.

Darwinella simplex Topsent.

Darwinella simplex Topsent, 1892 : xxvii ; Topsent, 1904 : 55, pl. ix, fig. 3 ; Topsent, 1905 : clxxvi ; Dendy, 1905 : 204, pl. xv, figs. 1–2.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Western Mediterranean ; Azores ; Ceylon ; 200 m.

Family Aplysinidæ.

Genus *Aplysina* Nardo.

Aplysina euplectella (Hentschel).

Stelospongia euplectella Hentschel, 1912 : 442, pl. xv, fig. 5, pl. xvi, fig. 8.

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand, shingle and (?) rock.

Distribution.—Aru Is.

Aplysina mollis Row.

Aplysina mollis Row, 1911 : 376, pl. xxxviii, fig. 18 ; Burton, 1926 : 82.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Suez Canal ; Red Sea ; 8 m.

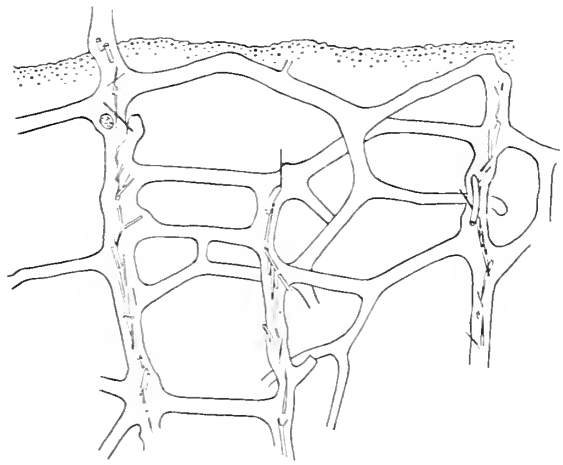
Aplysina primitiva **sp. n.**

(Text-fig. 41.)

HOLOTYPE.—B.M. 1936.3.4.532.

OCCURRENCE.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), 73–165 m., bottom rock (?).

DIAGNOSIS.—Sponge encrusting; surface conulose, even and smooth between conuli; oscules small, inconspicuous; texture soft; colour, in spirit, light purple; skeleton a delicate reticulation, with meshes somewhat irregular and confused, more or less oblong and measuring 0·3 by 0·1 mm.; diameter of fibres 0·05 mm.



TEXT-FIG. 41.—*Cacospongia symbiotica* sp. n. Section at right angles to surface, ×15.

REMARKS.—Although the structure of the fibres in this species recalls that of the fibres of *Aplysilla*, the fact that the skeleton forms a definite network is justification for regarding it as a species of *Aplysina*.

Genus *Aplysinopsis* Lendenfeld.

Aplysinopsis reticulata Hentschel.

Aplysinopsis reticulata Hentschel, 1912 : 437, pl. xv, fig. 1, pl. xvi, fig. 9.

OCCURRENCE.—Stn. 111, January 14, 1934, Zanzibar Area (5° 04′ 18″ S., 39° 14′ 12″ E.), depth unknown.

REMARKS.—The single specimen is small and massive, and has the reticulations of the surface considerably less strongly marked than in the holotype. The skeleton, on the other hand, appears to be typical.

DISTRIBUTION.—Aru Is.; 10–40 m.

Genus *Druinella* Lendenfeld.

Druinella ramosa Thiele.

Druinella ramosa Thiele, 1899 : 24, pl. iii, fig. 3, pl. iv, fig. 5.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DISTRIBUTION.—Celebes.

Genus *Megalopastas* Dendy.

Megalopastas retiaria Dendy.

Megalopastas retiaria Dendy, 1921 : 137, pl. iv, fig. 27.

Occurrence.—Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Distribution.—Okhamandal ; 7 m.

Family Spongiidæ.

Genus *Spongia* Linnaeus.

Spongia officinalis Linnaeus.

Occurrence.—Stn. 43, October 28, 1933, South Arabian Coast (17° 29′ 00″ N., 55° 47′ 00″ E.), 95 m.

Remarks.—A small, irregularly massive specimen appears to belong to this species, but is much too small to be assigned to any of the many varieties.

Genus *Spongionella* Bowerbank.

Spongionella pulvilla (Dendy).

Megalopastas pulvillus Dendy, 1905 : 206, pl. xv, fig. 3.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Gulf of Manaar.

Spongionella nigra Dendy.

Spongionella nigra Dendy, 1889 : 94 ; *Megalopastas nigra* Dendy, 1905 : 205, pl. xiv, fig. 7, pl. xv, figs. 5–8.

Occurrence.—Stn. 27, October 12, 1933, Gulf of Aden (11° 57′ 12″ N., 50° 35′ 00″ E. to 11° 56′ 42″ N., 50° 39′ 12″ E.), 37 m., bottom shells and sand ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The four specimens include two of less than 1 cm. across, irregularly encrusting. The third is some 2 cm. high and irregularly massive, and the fourth is nearly 3 cm. across. In one only is the flesh retained and this is pale yellow in colour. The skeleton in each is closely similar to that of the holotype.

Distribution.—Gulf of Manaar.

Spongionella frondosa (Hentschel).

Hippospongia frondosa Hentschel, 1912 : 435, pl. xvi, fig. 4.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Remarks.—The generic position of this species must remain in doubt until such time as a revision of the species, as well as the genera, of Keratosa can be made. It is not a true *Spongia*. Perhaps its closest affinities are with *Spongionella*.

Distribution.—Aru Is. ; 10–40 m., bottom coral rock.

Genus *Psammaplysilla* Keller.

Psammaplysilla arabica Keller.

Psammaplysilla arabica Keller, 1889 : 358, pl. xxii, figs. 23–27.

OCCURRENCE.—Stn. M.B. I (d), September 17, 1933, Red Sea (13° 39′ 30″ N., 42° 43′ 00″ E.), 26 m., bottom sand, shell and coral.

REMARKS.—A single irregularly massive specimen, 20 mm. high and the same across, coloured purple-brown in spirit.

DISTRIBUTION.—Reefs at Suakin ; 4–10 m., on coral.

Genus *Cacospongia* Schmidt.

Cacospongia Schmidt, 1862 : 26 ; *Taonura* Carter, 1882 : 108.

GENOTYPE.—*Cacospongia mollior* Schmidt, 1862 : 27.

DIAGNOSIS.—Keratosa with skeleton a rectangular reticulation of medullated fibres ; without ectosomal skeleton, foreign inclusions, filaments or horny spicules.

Cacospongia herdmani (Dendy).

Aplysina herdmani Dendy, 1905 : 225, pl. xvi, fig. 4.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

DISTRIBUTION.—Ceylon.

Cacospongia symbiotica **sp. n.**

(Text-fig. 43.)

HOLOTYPE.—B.M. 1936.3.4.391.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DIAGNOSIS.—Sponge irregularly massive, with numerous bivalves (species not determined) set in body vertically to surface ; surface minutely conulose, and slightly shaggy from projecting ends of main fibres ; oscules small, scattered ; texture compressible, elastic ; pale brown to brownish-purple ; skeleton subscalariform, of ascending fibres, about 1 mm. apart, 0·06–0·12 mm. diameter, cored with broken spicules, and connective fibres, without foreign inclusions, 0·02–0·06 mm. diameter ; without special ectosomal skeleton.

REMARKS.—There are 22 specimens, ranging from 10 to 60 mm. across. The skeleton is typically a regularly scalariform reticulation but this may readily become more irregular, especially in those cases where large sand-grains are included in the tissues.

Genus *Dysidea* Johnston.

Dysidea fragilis (Montagu).

(For synonymy see Burton, 1934 : 582.)

Occurrence.—Stn. 24, October 9, 1933, Gulf of Aden (11° 53′ 42″ N., 51° 13′ 12″ E.), 73–220 m., bottom coarse sand and shingle ; Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 109, January 13, 1934, Zanzibar Area (5° 10′ 36″ S., 39° 33′ 48″ E.), 640 m., bottom light-grey mud.

Remarks.—The sample from Stn. 109 includes an irregularly massive fragment and two digitate processes 60 by 6 mm., completely macerated. It is similar to that figured by me (l.c., fig. 26). The specimen from Stn. 45 is 10 mm. high by 6 mm. across and 3 mm. thick, a thin erect lamella bearing two incipient digitate processes. The third specimen (Stn. 24) is irregularly ramose, about 25 mm. across, with slender branches averaging 3 mm. diameter. The skeleton of these last two specimens contains sponge spicules only and approximates to that shown in my fig. 31 (l.c.).

Dysidea cinerea Keller.

Dysidea cinera Keller, 1889 : 337, pl. xx, fig. 2 ; Row, 1911 : 365 ; *Spongelia cinerea* Dendy, 1916 : 140 ; *Dysidea cinerea* Burton, 1926 : 82.

Occurrence.—Stn. 112, January 15, 1934, Zanzibar Area (5° 04′ 57″ S., 39° 13′ 18″ E.), 113 m., bottom coral rock.

Distribution.—Red Sea ; Indian Ocean (Okhamandal Coast) ; 16 m.

Genus *Euryspongia* Row.

Euryspongia lactea Row.

Euryspongia lactea Row, 1911 : 366, pl. xxxix, fig. 23, pl. xli, figs. 27–28 ; Burton, 1926 : 82.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

Distribution.—Suez Canal ; Red Sea.

Genus *Hircinia* Nardo.

Hircinia arenosa Lendenfeld.

Hircinia arenosa Lendenfeld, 1889 : 583, pl. xxxvi, fig. 3 ; Kirkpatrick, 1903 : 256.

Occurrence.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion ; Stn. 53, November 2, 1933, South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

Remarks.—Of the two specimens from Stn. 45, one is irregular but incipiently cup-shaped, 40 mm. across by 10 mm. high, the other cup-shaped and 170 mm. high, being 180 mm. across the mouth of the cup. Consequently, the first agrees in external form with Kirkpatrick's South African specimens, the second with the holotype, from Australia. A similar series was obtained from Stn. 53. The five smallest, from 30 to 90 mm. high, are very like Kirkpatrick's smallest specimen, another is of irregular form, incipiently cup-shaped, 40 mm. across and 20 mm. high, and the largest is subglobose with an oscular depression on the upper surface. This last specimen is hollow, with openings connecting the central cavity with the exterior.

The skeleton in all differs from that of the holotype in containing more spicule-fragments than sand.

DISTRIBUTION.—Australia (all coasts); South Africa. 155 m.

Hircinia aruensis Hentschel.

Hircinia aruensis Hentschel, 1912 : 445, pl. xvi, fig. 6 ; Burton, 1934 : 580.

OCCURRENCE.—Stn. 53, November 2, 1933. South Arabian Coast (19° 22′ 36″ N., 57° 53′ 00″ E.), 13·5 m., bottom rock, shingle, shells and Lithothamnion.

DISTRIBUTION.—Aru Is.; Great Barrier Reef; 12–30 m., bottom coral rock or hard and shelly.

Genus *Carteriospongia* Hyatt.

Carteriospongia cordifolia Keller.

Carteriospongia cordifolia Keller, 1889 : 352, pl. xxi, fig. 15 ; *Phyllospongia cordifolia* Row, 1911 : 378.

OCCURRENCE.—Stn. 45, October 29, 1933, South Arabian Coast (18° 03′ 30″ N., 57° 02′ 30″ E.), 38 m., bottom Lithothamnion.

DISTRIBUTION.—Red Sea, 9 m.

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BY
HELEN M. MUIR-WOOD, D.Sc., F.G.S.

WITH FIVE PLATES AND FOUR TEXT-FIGURES

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(*Department of Palæontology, British Museum (Natural History)*)

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I. INTRODUCTION

A small collection of Brachiopoda was obtained by the John Murray Expedition

(1933–1934) from nine stations, five of these are off the Maldive Islands in the Indian Ocean, one in the Persian Gulf, one from the Gulf of Aden, and one off Zanzibar. The Maldive Island dredgings yielded the greatest amount of material, including a large number of spirit specimens of a new genus and species of terebratulid. This is allied to the Recent species '*Terebratula*' *cubensis* Pourtales from the West Indies, and '*T.*' *sphenoidea* Philippi which is found as a fossil in the Lower Pliocene and ?Miocene of the Mediterranean area. A third form usually identified as '*T.*' *sphenoidea* occurs in the East Atlantic. It requires further examination and may be a subspecies of '*T.*' *cubensis* or a new species. These species have been assigned to a new genus *Dallithyris*.

The John Murray specimens are preserved in the British Museum (Natural History) department of Palaeontology and registered under the numbers quoted in the report. They have been identified as follows :—

Lingula sp. (immature), *Cryptopora maldivensis* sp. nov., *Chlidonophora chuni* Blochmann, *Dallithyris murrayi* gen. et sp. nov., *Dyscolia johannisdavisi* (Alcock), and immature specimens of a terebratelloid, *Leptothyris ignota* gen. et. sp. nov.

There have been a number of previous expeditions to the Indian Ocean, each of which has added to our knowledge of the fauna. These expeditions are listed on p. 285 together with the brachiopods obtained. Owing to the rather scattered literature on this subject a complete list of brachiopod species at present known from the Indian Ocean, Red Sea, and Persian Gulf is given for reference and comparison with the fauna obtained by the John Murray Expedition.

The distribution of species related to those found in the Indian Ocean indicates some link with the West Indies and Eastern Atlantic. This was probably by the way of southern Europe and the Tethys in Tertiary times, a subject dealt with more fully in 'Conclusions' on p. 311.

II. STATIONS AT WHICH BRACHIOPODS WERE DREDGED

(1) Gulf of Oman

Station 74. 25° 17′ 00″ N., 56° 45′ 00″ E. at depth of 160 metres (87 fathoms) with grab of modified Petersen type.
Lingula sp. (immature). One specimen [ZB. 1554].

(2) Off Zanzibar

Station 120. 5° 49′ 12″ S. 41° 28′ 12″ E. to 5° 52′ 24″ S. 41° 40′ 12″ E. at depth of 2900 metres (1585 fathoms) with Agassiz trawl.
Leptothyris ignota gen. et sp. nov. One specimen [ZB. 1555] possibly an immature? terebratelloid

(3) Maldive Islands

Station 145. 4° 58′ 42″ N., 73° 16′ 24″ E. at depth of 510 fathoms with tow net.
Cryptopora maldivensis sp. nov. Eleven specimens. [ZB. 1558–65] [ZB. 2972–74]

Station 157. 4° 43′ 48″ N., 72° 55′ 24″ E. to 4° 44′ 00″ N., 72° 54′ 18″ E. at depth of 229 metres (125 fathoms) with triangular dredge.

Dallithyris murrayi gen. et sp. nov. Numerous specimens [ZB. 1570–1584]

Station 158. 4° 42′ 30″ N., 72° 42′ 30″ E. to 4° 36′ 48″ N., 72° 48′ 54″ E. at depth of 786–1170 metres (430–620 fathoms) with Agassiz trawl.
Dyscolia johannisdavisi (Alcock). One detached valve. [ZB. 1566]

Station 159. 4° 47′ 30″ N., 72° 45′ 18″ E. to 4° 48′ 00″ N., 72° 51′ 36″ E. at depth of 914–1463 metres (500–900 fathoms) with Monegasque trawl.
Dyscolia johannisdavisi (Alcock). One detached valve. [ZB. 1567]

(4) Minikoi

Station 162. 8° 08′ 30″ N., 72° 58′ 00″ E. at depth of 1829–2051 metres (1000–1120 fathoms) with Agassiz trawl.
Chlidonophora chuni Blochmann. Two specimens. [ZB. 1568–69]

(5) Gulf of Aden

Station 185. 13° 48′ 06″ N., 49° 16′ 48″ E. to 13° 48′ 36″ N., 49° 16′ 24″ E. at depth of 2000 metres (1093 fathoms) with Agassiz trawl.
Leptothyris ignota gen. et sp. nov. (? Immature terebratelloid) Two specimens. [ZB. 1556–57]

III. PREVIOUS EXPEDITIONS AND RECORDS OF BRACHIOPODS FROM THE PERSIAN GULF, GULF OF ADEN AND INDIAN OCEAN (EXCLUDING SUMATRA, JAVA, ETC., AND S.E. COAST OF AFRICA, S. OF DURBAN)

The Indian Ocean has been crossed by a number of expeditions and specimens have been dredged at varying depths. These expeditions and the species obtained are listed for reference and comparison with the small John Murray collection.

I. "Challenger" Expedition, 1873–78. Report by T. Davidson, 1880. Listed by J. Murray, 1897.

Species

Discinisca stella (Gould). Singapore at 11–49 fath.
Tegulorhynchia pyxidata (Dav.). Heard I. at 150 fath.
Terebratula uva Dav. non Brod. [= *Gryphus* sp.] Heard I. at 150 fath.
Liothyrella moseleyi (Dav.). W. of Kerguelen I. at 210 fath.
Eucalathis murrayi (Dav.). Off Kerguelen I. at 600 fath.
Terebratulina septentrionalis Dav. non Couthouy [= *meridionalis* Jackson] Marion I. at 150 fath.
Platidia anomioides (Scacchi and Philippi). Marion I. at 100 fath.
Terebratella dorsata (Gmelin). [= *enzenspergeri* Bloch.] Off Royal Sound, Kerguelen I. at 20–30 fath.
Magellania(?) *kerguelenensis* (Dav.). Kerguelen I. at 20–60 fath.
Kraussina pisum (Lamarck). Off Natal in 150 fath.

2. " Gazelle " Expedition, 1874–76. Identifications by T. Studer, 1889.

Species

Lacazella mauritiana identified by Dall, 1921. Mauritius.
Rhynchonella pyxidata (Dav.). Between Kerguelen I. and Heard I.
" *Liothyrina* " sp. Mauritius at 411 metres (224 fath.).
Magellania kerguelenensis (Dav.). Kerguelen I.
Terebratella dorsata (Gmelin) [= *enzenspergeri* Bloch.]. Kerguelen I. at 37–55 m., (20–30 fath.) and 115 m. (62 fath.).
Waldheimia [? *Magellania*] *dilatata* (Lam.) [? = *venosa* Solander]. Kerguelen I. at 14–18 m. (8–10 fath.).

3. " Transit of Venus " Expedition, 1871–75. Report by E. A. Smith, 1879.

" *Waldheimia* " [? *Magellania*] *dilatata* (Lamarck). Observatory Bay, Kerguelen I. at 4 fath.

4. " Investigator " Expedition to Indian Ocean. Report by Alcock, 1894, 1902.

Species

Lingula sp.
Crania sp.
" *Terebratula* " sp., minute form in Laccadive Sea at 865–880 fath. on Globigerina Ooze [may = *Chlidonophora chuni* Blochmann].
" *Terebratula* " sp. small form off Ceylon in 20–30 fath.
Dyscolia johannisdavisi (Alcock) in 719 fath. off Uliganu island, N. Maldive atoll.

5. Indian Ocean, Chun, 1900. Figured a brachiopod identified by Blochmann, 1906, as *Chlidonophora chuni* Bloch.

6. " Valdivia " Expedition. Report by Blochmann, 1906.

Species

Liothyrella winteri Bloch. St. Pauls Deep, and Kerguelen I. at 371 fath.
Chlidonophora chuni Bloch. Maldive Islands at 2253 fath.
Terebratella enzenspergeri Bloch. Kerguelen I.

7. " Marine Survey " Expedition to the Indian Ocean. Report by Joubin, 1906.

Species

" *Kingena* " [*Frenulina* ?] *alcocki* Joubin. Off S. India in 187 metres. (102 fath.)

8. South Burma Coast, 4 miles off mouth of Hinzé Basin. Report by Sewell, 1912. *Lingula* larvae.

9. " Sealark " Expedition, 1905, to Indian Ocean. Report by Dall, 1910.

Species

Hemithyris sladeni Dall. Off Saya de Malha Banks at 153–123 fath.
Liothyrina sp.= [*Dallithyris murrayi* nov.] Off Saya de Malha Banks at 153–123 fath.
Kraussina gardineri Dall. Off Saya de Malha Banks at 153–123 fath.

10. Indian Ocean. Report by Blochmann, 1908.

SPECIES

Terebratulina valdiviae Bloch. S. coast of Nias I., S.W. of Sumatra at 376 fath.
" *Liothyrina* " [? = *Dallithyris*] *cernica* Crosse.

11. Indian Ocean and Red Sea. Ashworth, 1915.

SPECIES

Lingula larvae in S. part of Red Sea, and S. of Colombo, Ceylon.
Pelagodiscus larvae, W. of Cape Comorin, S. India.
Lingula sp. from coast of Burma ; Trang, Siam ; W. coast of Malaya ; Andaman Islands.

12. Persian Gulf at Dabai, N.W. coast of Oman. Report by Jackson, 1921.

SPECIES

Terebratulina caputserpentis [= *retusa* Linn.] var. *abbreviata* Jackson.
Mühlfeldtia truncata var. *paucistriata* Jackson.

13. " Valdivia ", German Deep Sea Expedition to Indian Ocean. Report by Helmcke, 1940.

SPECIES

Pelagodiscus atlanticus (King) larvæ. { Stn. 238. W. part of Indian Ocean at 2490 metres (1361 fath.).
Stn. 135, at 1500 metres. (818 fath.).
Stn. 63, at 2492 metres. (1362 fath.).
Lingula larvæ. { Stn. 207, N.W. coast of Sumatra at 0–30 metres. (0–16 fath.).
Stn. 215, E. of Ceylon at 2500 metres. (1367 fath.).
Stn. 271, Gulf of Aden at 1200 metres. (658 fath.).
Crania valdiviæ Helmcke. Stn. 165, E. of St. Paul I. at 672 metres. (367 fath.).
Valdiviathyris quenstedti Helmcke. Stn. 165, E. of St. Paul I. at 672 metres.
Cryptopora bœttgeri? Helmcke. Stn. 242, near Dar-es-Salam at 404 metres. (220 fath.).
" *Rhynchonella* " *valdiviæ* Helmcke. Stn. 165, E. of St. Paul I. at 672 metres.
Chlidonophora chuni Bloch. { Stn. 219, S. of Suadive I.
Stn. 220, S. of Suadive I.
Stn. 227, S. of Maldive I. at 2745 metres. (1500 fath.).
Terebratulina valdiviæ Bloch. Stn. 191, near W. coast of Sumatra at 1750 metres.
Liothyrella winteri Bloch. Stn. 165, E. of St. Paul I. at 672 metres.

14. East coast of Africa. Report by Jackson, 1952.

Species	
Lingula sp. aff. *exusta* Reeve	Delagoa Bay.
Lingula murphiana Reeve	Durban.
Agulhasia davidsoni King	Off Durban at 54 fath.
Kraussina rubra (Pallas)	Coast of Natal.
Megerlina pisum (Lam.)	Off Natal.

IV. SPECIES OF BRACHIOPODS PREVIOUSLY OBTAINED FROM THE INDIAN OCEAN, PERSIAN GULF, AND GULF OF ADEN, BUT EXCLUDING THOSE FROM SUMATRA, JAVA, ETC., AND FROM THE S.E. COAST OF AFRICA, S. OF DURBAN.

On account of the extremely scattered literature dealing with the Recent brachiopods dredged from the Indian Ocean a list of species so far known from this region has been compiled and is set out for reference. The full distribution of each species is not given.

Lingula larvæ. N.W. coast of Sumatra; E. of Ceylon and S. of Colombo; Gulf of Aden; S. part of Red Sea.
Lingula hians Swainson. Bombay.
Lingula murphiana Reeve. Durban; Karachi; Ceylon.
Lingula translucida Dall. Karachi.
Lingula sp. Coast of Burma; Trang, Siam; W. coast of Malaya.
Lingula unguis (Linné). Singapore.
**Lingula* sp. Off Aden.
Lingula sp. Off Singapore (possibly = Jackson's (1952) *L.* sp. aff. *exusta* Reeve from Delagoa Bay).
Discinisca indica Dall. Ceylon.
Pelagodiscus larvæ. W. of Cape Comorin, S. India and W. part of Indian Ocean.
Crania sp.
Lacazella mauritiana Dall. Off Mauritius.
Valdiviathyris quenstedti Helmcke. St. Paul I.
"*Hemithyris*" [?*Aetheia*] *sladeni* Dall. Saya de Malha Banks.
Tegulorhynchia pyxidata (Dav.) Kerguelen and Heard Islands.
"*Rhynchonella*" *valdiviæ* Helmcke. E. of St. Paul I.
**Cryptopora* sp. (? *bœttgeri* Helmcke). Off Dar-es-Salam.
Liothyrella winteri (Blochmann). St. Paul I. at 371 fath.
Liothyrella moseleyi (Dav). W. of Kerguelen I., off Crozet I. at 210 fath.
*"*Liothyrina*" sp. [*Dallithyris*? *murrayi* nov.] Saya de Malha Banks.
Dallithyris (?) *cernica* (Crosse). Mauritius.
Agulhasia davidsoni King. Off Durban.
Terebratulina retusa var. *abbreviata* Jackson. Persian Gulf, N.W. coast of Oman.
Terebratulina abyssicola Adams and Reeve. S.E. coast of Africa.
Terebratulina valdiviæ Bloch. Near W. coast of Sumatra.
Terebratulina meridionalis Jackson [*septentrionalis* auctt.] Off Marion I.
**Chlidonophora chuni* Blochmann. Maldive I.
**Dyscolia johannisdavisi* (Alcock). Maldive I.

* An asterisk indicates that the species was also obtained by the John Murrray Expedition. In the case of the *Lingula* and *Cryptopora*, however, there is some doubt whether the species is the same.

Platidia anomioides (Scacchi and Philippi). Prince Edward I; Marion I. at 150 fath.
Morrisia gigantea Deshayes. Reunion I.
[= *Pantellaria echinata* (Fischer and Oehlert) according to Dall, 1921]
[= *Mühlfeldtia truncata* var. *paucistriata* Jackson. according to Jackson, 1921].
Mühlfeldtia [= *Megerlia*] *truncata* var. *paucistriata* Jackson, Persian Gulf, N.W. coast of Oman.
Kraussina rubra (Pallas). Coast of Natal.
Kraussina natalensis (Krauss). Natal.
Kraussina gardineri Dall. Saya de Malha Banks.
Megerlina pisum (Lam.). Mauritius ; Natal.
Megerlina davidsoni (Velain). St. Paul I., interior of crater.
" *Kingena* " [*Frenulina*?] *alcocki* Joubin. Off S. India.
Terebratella enzenspergeri Blochmann. Kerguelen I. at 20–30 fath.
Magellania? *kerguelenensis* (Dav.). Off Kerguelen I., Marion I. at 150 fath.

V. SYSTEMATIC DESCRIPTIONS

Class INARTICULATA

Order ATREMATA

Superfamily Lingulacea Waagen, 1885

Family Lingulidæ Gray, 1840

Genus *Lingula* Bruguière, 1797

Lingula sp.

Pl. 4, fig. 8

Occurrence.—Station 74. Gulf of Oman at 87 fathoms. One immature specimen obtained by Petersen grab. No. ZB. 1554.

Description.—This dried specimen is elongate-oval in outline tapering slightly posteriorly and anteriorly. It is 6·5 mm. in length with the greatest width 3·5 mm. occurring midway between the umbo and anterior margin.

The shell is whitish medianly to pale brown anteriorly, and is thin and semi-transparent. The two valves are firmly attached to one another with no anterior or posterior gape.

The visceral cavity seen through the shell extends to within 1·5 mm. of the anterior margin. It is elongate-oval in outline and tapers anteriorly to a rounded extremity. The scars of attachment of the oblique (transmedian, middle and lateral) muscles can be seen through the shell.

The pedicle is 0·5 mm. in diameter and 5 mm. in length, and originally had a short sand-tube still attached to the apex.

Remarks.—This small specimen is of considerable interest since no species of *Lingula* has been described from the Persian Gulf or Red Sea area. In Asia adult specimens of recent *Lingula* have not been recorded further west than Karachi.

Sixteen larvæ of *Lingula* were obtained from the southern part of the Red Sea by J. H. Ashworth (1915) at lat. 15° N. and long. 42° E. There are also two dried specimens of a *Lingula* labelled Aden in the British Museum (Natural History) collections Nos. ZB. 86 and ZB. 114, presented by two different donors, which may be adults of the same species as the young shell obtained in the Gulf of Oman, and of the larvae obtained by Ashworth.

The history of these two Aden specimens is unfortunately unknown. Their shells are similar in size and colour, spathulate in outline, having a maximum length of 49 mm. and width of 23 mm. The shell tapers to an acute umbo in the pedicle valve and then curves anteriorly attaining maximum width about midway between the umbo and anterior margin. It then maintains a constant width to the anterior margin which is subrounded. The valves gape posteriorly and ventrally. The shell is thin with fine longitudinal striations and varies in colour from deep cream to pale brown with dark brown blotches anteriorly. The young of this species would probably have whitish or cream-coloured shells. The colour of these adult specimens is unlike that of any species of *Lingula* from the East Indies and Pacific region, but it is not yet known how far colour can be relied on in the distinction of species.

In shape and size the Aden specimens are nearest to *L. murphiana* Reeve, but the shell is less solid and lacks the anteriorly placed median ridge in the brachial valve interior, and the distinctive bright brown and green colouring of that species. The shell outline slopes more gently to the umbo and the lateral margins are slightly more curved than in *L. murphiana*. The latter species occurs at Karachi, on the coast of the Andaman Islands and in the type locality of Moreton Bay, Queensland, and according to Jackson (1952 : 6), it has a still wider distribution, and may occur near Durban, Natal.

Lingula translucida Dall also occurs at Karachi. Dall (1921) described but did not figure his species from Java and the Philippines, It is a smaller form than the Aden specimens and has a very thin, polished, translucent shell not gaping anteriorly, and of a ruddy brown colour and paler brown at the umbones. A third species *L. unguis* (Linné) (usually recorded as *L. anatina* Lamarck or by Jackson (1952 : 6) as *L. lingua* Solander) obtained from Karachi, and doubtfully from Zanzibar by Helmcke (1939a : 227) is a slightly smaller shell than the Aden species with the lateral margins more parallel. The shell is usually predominantly greenish in colour, paler at the umbones and often light brown. Young specimens often have the median whitish and lateral brownish colour of the small specimen from the Gulf of Oman.

The only species described from the African coasts is *L. parva* E. A. Smith. This was obtained from Whydah Bay, Dahomey, West Africa [British Museum specimen no. ZB 931], and has recently been found off Sierra Leone (nos. ZB. 1544–1555]. The type specimen is about 10 mm. long and 5 mm. wide and is of a whitish colour. It may be a young form like the Sierra Leone specimens which were obtained from the stomachs of fishes. So far *L. parva* has not been recorded from the eastern coast of Africa. *Lingula* sp. aff. *exusta* Reeve has been recorded by Jackson (1952 : 6) from Delagoa Bay, S. E. Africa. This is said to be light brown in colour and about 20 mm. long and 8 mm. wide, and to be comparable to specimens obtained from Singapore.

The young specimen from Oman may, therefore, be the juvenile stage either of the Aden shells or of *L. unguis* (Linné), but further collecting along the Persian and Oman coasts is needed to confirm this.

Class ARTICULATA

Suborder Rhynchonelloidea Moore, 1952

Superfamily Rhynchonellacea Schuchert, 1896

Family Cryptoporidae Muir-Wood, 1955

This family was erected by Muir-Wood (1955) for the genus *Cryptopora* Jeffreys, 1869, but it has never been defined. S. S. Buckman (1918 : 72) had previously assigned

Cryptopora to the family Dimerellidae on the grounds that it had a triangular open delthyrium with very narrow marginal deltidial plates, a high dorsal median septum, and long crura, and that it was comparable to the Triassic genus *Dimerella*. Thomson (1927 : 145) emended the Dimerellidae and excluded *Hemithiris* and the Tertiary genera with poorly developed deltidial plates, but retained *Cryptopora* in this family. *Dimerella* has proved to be unrelated to *Cryptopora* which is found only in the Tertiary, and in Recent seas.

A new family Cryptoporidae has, therefore, been erected (Muir-Wood, 1955 : 76, 91). This is defined as—

Biconvex to sulcate Rhynchonelloidea with narrow to auriculate deltidial plates and hypothyrid foramen. Dorsal median septum developed as a prominent plate medianly; crura raduliform, springing from socket-ridges. Dental lamellae developed in pedicle valve. Recent species with one pair of metanephridia, lophophore consisting of two posteriorly fused and elongate brachia with small anterior coil. (circinate type).

Range.—Tertiary (Oligocene) to Recent.

Genera.—*Cryptopora* Jeffreys, 1869 ; and *Mannia* Davidson, 1874.

The genus *Mannia* has usually been classified as a terebratelloid but the shell is impunctate and the shell surface bears minute spicules. It has a high median septum similar to that of *Cryptopora* but it is slightly thickened. The crura are curved and raduliform and the hinge and beak characters are similar to those of *Cryptopora*. The single species *Mannia nysti* Dewalque is from the Upper Miocene (Diestian), near Antwerp, Belgium.

Genus *Cryptopora* Jeffreys, 1869

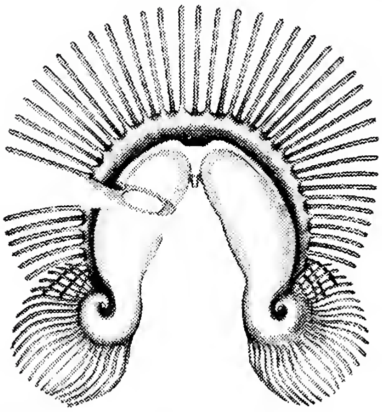
Cryptopora Jeffreys, 1869 : 136.
Atretia Jeffreys, 1870 : 421 (for *Cryptopora* non *Cryptoporus* Motschulsky, 1858, Coleop.).
Atretia Jeffreys, 1876 : 250.
Neatretia Fischer and Oehlert, 1891 : 122 (for *Atretia* Jeffreys non *Atretium* Cope, 1861 (Reptile).
Cryptopora Jeffreys ; Thomson, 1927 : 146.
Cryptopora Jeffreys ; Helmcke, 1940 : 282.

The above synonymy was discussed by Thomson (1927 : 147) who pointed out that *Cryptopora* is not preoccupied by *Cryptoporus* Motschulsky 1858. *Atretia* and *Neatretia* are, therefore, synonyms of *Cryptopora*.

Diagnosis.—Shell small, smooth or finely striated, or weakly capillate, thin and transparent, impunctate, fibrous. Valves biconvex to incipiently sulcate, umbo short, erect, hypothyrid ; deltidial plates narrow to ? auriculate. Dorsal valve with small cardinal process ; long curving crura (raduliform), with denticulate extremities ; high median septum ; reduced hinge plates. Pedicle valve with hinge teeth supported by short dental lamellæ.

Description.—Helmcke (1940 : 279) gave the first description of the soft parts of *Cryptopora* in his species *C. bœttgeri*. His material permitted him to make serial sections and these showed that the lophophore is not spirolophous with the spiral cones consisting of a number of turns as in *Hemithiris*, but consists of two elongate diverging brachia fused posteriorly and coiled at their anterior end, the short coil being laterally directed, and the cirri centrifugal. This type of lophophore has not been previously described and may be known as circinate (Text-fig. 1.).

Cryptopora was also found by Helmcke to have one pair of metanephridia or excretory organs instead of the two pairs found in other recent rhynchonellids. The one pair in *Cryptopora* is supported by the ileo-parietal band.



Text-fig. 1.—*Cryptopora bœttgeri* Helmcke. Reconstruction of lophophore by Helmcke from serial sections and here named circinate type. This type of lophophore has not been previously figured or described. (After Helmcke, 1940, p. 279, fig. 29.) Specimen from Stn. 109 or 110 of German Deep Sea Exped. (Valdivia) from Agulhas Bank off S. Africa in either 500 or 564 metres (273 or 307 fathoms). Much enlarged.

Species at present assigned to Genus and Distribution.

FOSSIL

Terebratula (*Megerlea*) *haasi* Andreæ, 1884. Middle Oligocene, Lobsann, Lower Alsace.
Rhynchonella discites Dreger, 1888. Miocene, Möllersdorf, Vienna Basin.
Rhynchonella lovisati Dreger, 1911. Miocene, N.W. Sardinia.
Hemithyris parvillima Sacco, 1902. Miocene, near Turin, Italy.
? *Terebratella acutirostra* Chapman, 1913. Miocene, Victoria, Australia.

RECENT

Cryptopora gnomon Jeffreys, 1869 (*Atretia gnomon* Jeffreys, 1870, 1876). N. Atlantic N.W. of Ireland and off W. coast of Ireland at 1380 and 1443 fath. (Porcupine Exp.); off Tromso, Norway in 650 fath. (N. Atlantic Exp.); Davis Straits at 1000 and 1450 fath. (Valorous Exp.); N. of Azores, 2200 fath. (Talisman Exp.); S. of Martha's Vineyard in 1537 fath. (U.S. Bureau Fish.); off Key West, Florida in 120 fath.; off Cuba in 180 fath. and 780 fath.; W. of St. Thomas I., West Indies at 390 fath.; off Morocco and Azores at 1192–2199 fath. (Talisman).

Cryptopora bœttgeri Helmcke, 1940. S. part of Agulhas Bank, S. Africa, Stn. 109 of German Deep-Sea Exp., lat 35° 19′ S., long. 20° 12′ E. at 500 m. (273 fath.), and Stn. 110 at 564 m. (307 fath.); ?Stn. 242 near Dar-es-Salam at 404 metres. (220 fath.).

Cryptopora brazieri Crane, 1886. E. coast of Australia, Port Stephens, off Cabbage Tree Island in 25 fath., and off Wollongong, New South Wales in 100 fath.; Masthead I., Queensland; Cape Piller, Tasmania; off Eyre's Peninsula, South Australia.

Helmcke (1940 : 289) recorded a species of *Cryptopora* from Stn. 242 (Valdivia Exp.) lat. 6° 34′ S. long. 39° 35′ E. off Dar-es-Salam, E. Africa. The shell of the single specimen had decomposed and it was not possible to compare it with *C. bœttgeri*. It may, however, have been comparable to the new species described here from the Maldive Islands, which appears to be distinct and intermediate in distribution between the S. African and Australian species.

The distribution of this small genus is of considerable interest. The fossil species appear to have been Tethyan forms while at the present day it ranges from 100 to over 2000 fathoms and has been dredged from both sides of the Atlantic; off S. Africa; Indian Ocean, Maldive Islands; and east and south coast of Australia. Helmcke (1940, text-fig. 34 : 286) published a map to show the world distribution of the genus.

Remarks.—The specimens figured by Toulmin (1940: 229, pl. 28, figs. 12–14) as *Cryptopora*? sp. from the Eocene, Salt Mountain limestone of Alabama are doubtfully referred to this genus. The high median septum is said to be lacking in the brachial valve of sectioned specimens, the shell is more elongate and the valves more convex than in species of *Cryptopora*.

The small species *Megerlea*? *haasi* Andreæ of which numerous specimens 2·5 mm. long and 2 mm. wide were collected by that author from the Rupelthon (Oligocene) of Lobsann, Alsace is from the figures and description undoubtedly an early *Cryptopora*. The open delthyrium, pedicle collar, and erect umbo of *M. haasi* together with the high median septum, impunctate fibrous shell which is highly polished and smooth except for fine striations or capillæ, all agree with Recent species.

Cryptopora maldivensis sp. nov.

Pl. 5, figs. 1–7, text-fig. 2

Occurrence.—Station 145, Maldive Islands, at 510 fathoms. Eleven dried specimens, nos. ZB. 1558–1565, 2972–74.

Type specimens.—Holotype. No. ZB. 1558. Paratypes nos. ZB. 1559–1565, 2972–74.

Diagnosis.—*Cryptopora* about 5 mm. long, 5 mm. wide and 1·2 mm. thick; shell ivory white, iridescent, slightly capillate, expanding rapidly from acutely pointed erect umbo; greatest width anterior to half shell length; crura diverging slightly along anterior half of their length; median septum, a prominent angular plate curving anteriorly and posteriorly down to valve floor.

Description.—*Exterior*. The shell is sub-circular in outline and expands rapidly from the acutely tapering erect umbo. The anterior margin is rounded and the commissure plane. Both valves are very slightly convex. The interarea is well developed, the delthyrium triangular, and the deltidial plates narrow and extending along the lateral delthyrial margin. The pedicle is exceptionally long and thread-like. The shell-surface is smooth except for a few fine radiating capillæ which are best developed on the anterior half of the shell, and are fairly widely spaced. Growth lines are numerous. The shell is thin and the fibres of which it is composed form a very fine mosaic which may appear almost like punctation.

Internal characters.—In the pedicle valve the minute teeth are supported by short diverging dental lamellæ which do not project anteriorly beyond the umbonal cavity. The musculature is obscure. A low rounded median ridge (myophragm) may extend from just below the level of the teeth and flatten out near the anterior margin. It probably separated the muscle scars. In the brachial valve there is a minute cardinal process supported by a narrow plate which extends along the hinge margin and probably represents reduced hinge plates. The small curving socket ridges extend at an angle to the hinge plates and support the narrow raduliform crura, and buttress the minute hinge sockets. The crura are gently curved and converge slightly, and then extend parallel to one another and are denticulate at their anterior extremity. The crura are about one-third of the shell length. The septum is not in contact with the hinge plates but is developed as a low ridge a short distance below the hinge. It curves rapidly upwards (posteriorly) as a short, prominent, hatchet-shaped ridge and then curves rapidly downwards to the shell floor again. (Text-fig. 2).

TEXT-FIG. 2.—*Cryptopora maldivensis* sp. nov. Paratype. Lateral view of brachial valve to show crura, and the prominent hatchet-shaped septum. Stn. 145, John Murray Exped., Maldive Islands at 510 fathoms. ZB. 1562.

Nothing is known of the soft parts of this species.

DIMENSIONS.—*Holotype.* Maximum length 4·1 mm. long ; maximum width 3·7 mm. thickness 1·2 mm. ; paratype, no. ZB. 1562, length 5·5 mm., width 5 mm. (separated valves)

DISTINGUISHING CHARACTERS.—*Cryptopora maldivensis.* sp. nov. differs from the type species *C. gnomon* in its slightly larger dimensions, broader shell, less convex valves, and absence of sulcus in the brachial valve, more erect umbo, in its greyer colour and more iridiscent shell surface, in its slightly more curved crura and more hatchet-shaped median septum.

It differs from *C. brazieri* in its slightly larger dimensions, in its lighter coloured and less solid shell, without closely placed growth lines or a thickened shell margin anteriorly, more tapering and acute umbo, and in its more angular septum. It differs from *C. bœttgeri* Helmcke in its slightly larger dimensions, broader shell outline, less translucent and lighter coloured shell, and in its slightly more approximate and converging crura.

Specimens of a species of *Cryptopora* dredged from a depth of 54 fathoms off Cape Natal, Durban, S. Africa, which may be *C. bœttgeri* Helmcke, show an amazing extension of the deltidial plates which fuse to form an auriculate expansion round the foramen. (Pl. 5, fig. 11). These specimens were presented to the British Museum (Natural History) by Dr. Barnard, formerly Director of the South African Museum and bear the registered numbers ZB. 1448, 1631–33. The shell of these specimens is more translucent ; browner in colour, and more capillate than *C. maldivensis.*

REMARKS.—The muscle scars are usually obscure but were described by Crane (1886 : 184) in the ventral valve of *C. brazieri* as being long and narrow [diductors] with a diamond-shaped central scar [adductors]. The scars were observed in this species, specimen no. B. 14626, and were rather anteriorly placed, the adductors being elongate pear-shaped and the narrow tapering adductors set on a low ridge between the diductors.

Suborder TEREBRATULOIDEA Muir-Wood, 1955

Superfamily TEREBRATULACEA Waagen, 1883

Family CANCELLOTHYRIDÆ Muir-Wood, 1955

DIAGNOSIS.—Shell costellate or capillate, punctate with externally branching pores. Dental lamellæ absent. No hinge plates ; socket ridges fused with crural bases ; cardinal process developed. Pedicle muscles attached to floor of valve. Loop short, crural processes sometimes uniting to form a ring. Lophophore spirolophous, subplectolophous or plectolophous. Spicules developed.

Subfamilies (1) CANCELLOTHYRINÆ Thomson, 1926, emend.,
(2) CHLIDONOPHORINÆ subfam. nov.

The subfamily Cancellothyrinæ was proposed by Thomson in 1926 as a subfamily of Terebratulidæ to include the genera *Cancellothyris*, *Terebratulina*, *Agulhasia*, *Murravia*, *Disculina*, *Chlidonophora* and *Eucalathis*. The more advanced genera *Cancellothyris* and *Terebratulina* have a plectolophous lophophore, a terebratulinid loop, no hinge-plates, a cardinal process and uniplicate to sulciplicate folding. The sub-family Cancellothyrinæ was elevated to family rank by Muir-Wood in 1955 and is here subdivided into the subfamilies Cancellothyrinæ Thomson, 1926 emend. and the Chlidonophorinæ subfam. nov. The Cancellothyrinæ emended includes the genera *Cancellothyris*, *Terebratulina* and possibly *Disculina* and *Murravia*, though this latter genus has a hypothyrid foramen and a sulcate brachial valve. *Agulhasia* differs from *Terebratulina* in its high interarea and small anteriorly placed hypothyrid foramen, its terebratulid loop, small dorsal septum supporting a bilobate cardinal process, and narrow hinge-plates, and will have to be removed from the Cancellothyrinæ, possibly to a new subfamily.

The new subfamily Chlidonophorinæ is proposed for the genus *Chlidonophora*, and possibly also *Eucalathis*.

The subfamily Cancellothyrinæ may be defined as having :— Crural processes fused in adult to form short ring-like loop. Lophophore plectolophous in Recent adult forms. Foramen submesothyrid to epithyrid. Valves biconvex, anterior commissure rectimarginate to sulciplicate. Test capillate or costellate. Pedicle short.

Subfamily Chlidonophorinæ nov.

Loop short, simple, with crura converging but not uniting. Spicules numerous, terebratulinid. Lophophore spirolophous, subplectolophous, or plectolophous. Hinge line rather wide, Valves biconvex, anterior commissure rectimarginate to uniplicate. Test costellate. Pedicle long and dividing into hair-like filaments.

Genus *Chlidonophora* Dall, 1903

Chlidonophora Dall, 1903 : 1538.
Chlidonophora Dall ; Thomson, 1927 : 181.
Chlidonophora Dall ; Helmcke, 1939*b* : 234.
Chlidonophora Dall ; Helmcke, 1940 : 239.

TYPE SPECIES.—*Megerlia* (?) *incerta* Davidson, 1878.

Species assigned to Genus and Distribution.

RECENT

Chlidonophora incerta (Davidson 1878) Atlantic off west coast of Africa, 24° 26′ W., 1° 47′ N., at 1850 fathoms (Challenger); Gulf of Mexico at 1181 fathoms; off Bequia, Windward Islands, 1507–1591 fathoms; off Havana, Cuba in 292 fathoms.

Chlidonophora chuni Blochmann, 1906.—Valdivia Stn. 219, S. of Suadive (Maldive) Islands, Indian Ocean at 2253 metres (1283 fathoms); at Valdivia Station 220 at 2219 metres (1213 fath.); and Station 227, W. of Chagos Bank off the Maldive Islands at 2745 metres (1500 fath.). Alcock (1902) recorded it from 865–880 fathoms off the Laccadive Islands, Indian Ocean (Investigator).

Chlidonophora may be defined as:— Shell small, subrounded, hinge wide, nearly straight, valves biconvex, costellate, anterior commissure rectimarginate or slightly uniplicate. Foramen hypothyrid, deltidial plates disjunct. No dental lamellæ or dorsal median septum. Cardinal process small, transverse, hinge plates replaced by inner socket ridges. Loop short, terebratulid, projecting ventrally.

The genus *Chlidonophora* was defined but not figured by Dall (1903 : 1538) with *Terebratulina ? incerta* Davidson as type species. The only other species assigned to the genus was *Terebratulina filosa* Conrad, 1866, from the Cretaceous or Eocene of Alabama and Texas, U.S.A. *T. guadeloupæ* Roemer is said to be allied, and *T. rigida* Sowerby, *T. ornata* Roemer and *T. gracilis* (Schlotheim) from the European Cretaceous were thought to belong to the same group. Without dissecting or sectioning examples of these fossil species, however, it is uncertain whether they can be assigned to *Chlidonophora*.

Distinguishing characters.—*Chlidonophora* differs from species of *Eucalathis* in its larger dimensions, more circular and less rostrate shell outline, wider hinge, plectolophous lophophore, and different form of loop, which projects ventrally and not dorsally as in *Eucalathis*. The *Eucalathis* lophophore is commonly described as schizolophous that is divided into two parts anteriorly often by a median septum. The lophophore observed, however, in *E. murrayi* (Dav.) B.M. ZB. 1202 was of spirolophous type, (pl. 4, figs. 2, 3) consisting of two spirally coiled arms which are united posteriorly by a membrane bearing long anteriorly directed cirri which overhang the shorter centripetally arranged cirri of the two spiral coils. (Figd. Davidson 1878, pl. 2, figd. 1*d*). More material is needed in order to study the development of this type of lophophore and to ascertain if this constitutes the adult stage in *Eucalathis*.

Chlidonophora differs from species of *Terebratulina* in its more circular and less rostrate shell outline, wider hinge line and in the different form of loop. The lophophore differs from that of *Terebratulina* in its more curving side arms and incomplete median coil.

Chlidonophora chuni Blochmann

Pl. 4, figs. 5–7

Terebratula sp. Alcock, 1894 : 139.
Terebratulina Chun, 1900 : 404, 405 and figures.
Terebratula sp. Alcock, 1902 : 283.
Chlidonophora chuni Blochmann, 1906 : 695.
Chlidonophora chuni Blochmann ; Dall, 1921 : 323.
Chlidonophora chuni Blochmann ; Thomson, 1927 : 182.
Chlidonophora chuni Blochmann ; Helmcke, 1939*b* : 234, figs. 169, 233.
Chlidonophora chuni Blochmann ; Helmcke, 1940 : 239, text-fig. 6.

Occurrence.—Station 162. Minikoi at 1829–2051 metres (1000–1120 fath.). Two specimens, Nos. ZB. 1568–1569.

Description.—The shell is approximately circular in outline with a rather long, slightly curving hinge line in the dorsal valve. The hinge line is separated from the lateral margin by a slight angle. The greatest width occurs about halfway down the length. Both valves are moderately convex, the pedicle valve has a very shallow median sulcus anteriorly and the brachial valve a corresponding low fold. The anterior commissure is plane or incipiently uniplicate. The umbo is erect, the foramen hypothyrid, and the deltidial plates narrow and disjunct. The beak-ridges are acute and the interarea is low. A pedicle collar infills the posterior part of the delthyrium. The pedicle was not preserved in either of the John Murray specimens, but in one of Blochmann's original specimens from the Suadive Islands [ZB. 1407] it is about 10 mm. in length and then subdivides to form very fine threads which attach themselves to or pierce shells of *Globigerina* (Pl. 4, fig. 5), presumably by means of acid secreted by the pedicle threads. Both valves are ornamented anteriorly by about 30 fine, bifurcating costellæ which are slightly curved on the lateral slopes, and are usually absent near the hinge. The costellæ increase in width anteriorly, and become subangular, and intercalations occur. Growth-lines are numerous and form closely spaced prominent concentric lamellæ on the anterior part of the shell. The shell is yellowish-white in colour.

Interior of shell.—The long setæ which are said by Blochmann (1906) to extend from the mantle margin in each valve were not preserved in any of the specimens examined. The inner margin of each valve is finely denticulate, and this probably assists in the articulation of the valves. The depressions between the small prominences may house the setæ which act as a strainer to prevent the entrance of foreign particles.

The mantle was not preserved in any of the specimens of *C. chuni* examined, but four main vascular trunks were observed in each valve of the related species of *C. incerta* (Dav.). The two median trunks (vascula media) were united in one pedicle valve of the latter species but were in close proximity in two other valves. The lateral trunks (vascula myaria) branch anteriorly, but differ from those of *Terebratulina* in which there are numerous bifurcating branches (Pl. 4, fig. 1). No genital products were observed in the main trunks.

The lophophore is of plectolophous type, but with the side arms curving and converging anteriorly and remaining well separated posteriorly. The two margins of the side arms, both bearing cirri, are widely separated in this genus, unlike those of *Terebratulina* where the two margins are in fairly close proximity. The median coil of the lophophore was incipient only. The term subplectolophous* may be employed for this type of lophophore (ref. Pl. 4). The loop was concealed by the lophophore but is probably of the same type as that of *C. incerta* (Dav.). In this species (Pl. 3, fig. 8) there are no hinge plates but only rather prominent inner socket ridges which extend almost vertically, and project posteriorly a short distance beyond the hinge margin. The crura spring from the anterior end of the socket-ridges, converge slightly, and terminate in small crural processes. The descending branches of the loop are united by a curved band, and the whole loop which is about one-third the length of the brachial valve is ventrally deflected. In the related species *C. incerta* (Dav.). the cardinal process is laterally elongated and short postero-anteriorly. The hinge sockets are strongly buttressed by the inner socket ridges and accommodate the small

* Thomson (1927 : 180) mentions but does not define this term for the lophophore of *Chlidonophora*, *Agulhasia* and *Eucalathis*. It is here used for the *Chlidonophora* type of lophophore.

wedge-shaped teeth. No dental lamellæ are developed.

Dimensions of no. ZB. 1569.—Length 6 mm.; width 5·2 mm.; thickness 2·5 mm.

Blochmann (1906 : 695) gives the dimensions of type specimens of *C. chuni* as length 7 mm., width 6·8 mm., thickness 3 mm.

Distinguishing characters.—*C. chuni* Blochmann differs from *C. incerta* (Dav.) in its considerably smaller dimensions, more circular shell outline, and slightly more prominent subangular costæ. The pedicle in *C. incerta* usually consists of a number of separate threads extending from the foramen. In *C. chuni* there is a single thin pedicle about 10 mm. in length which then sub-divides into numerous very fine filaments. These pierce the foraminiferal tests, so enabling the shell to anchor on a loose bottom of Globigerina ooze.

Chlidonophora chuni differs from *Eucalathis murrayi* (Davidson) from between the Kermadec and Fiji Islands, in its wider hinge, more numerous costellæ, hypothyrid foramen, longer pedicle, plectolophous instead of spirolophous lophophore, and different form of the loop. It differs from *Eucalathis tuberata* (Jeffreys) from the eastern Atlantic in its larger dimensions, finer capillæ, and lack of prominent concentric ornament and development of numerous small spines on the flanks. *E. ergastica* Fischer and Oehlert also from the eastern Atlantic is slightly larger than *E. tuberata* and has fewer spines.

Family Dyscoliidæ Fischer and Oehlert, 1891

This family was proposed by Fischer and Oehlert (1891 : 23), and defined in 1892*b* (p. 18). It has never been adopted since it has been thought to be synonymous with Cancellothyridæ (olim Terebratulininæ). *Dyscolia* cannot, however, be grouped with *Terebratulina* and *Cancellothyris* on account of differences in internal morphology, such as the cardinalia, loop, and lophophore, as well as external shell characters. It also differs from Recent terebratulid genera in the development of a marginal flange in each valve, the capillate ornament, and in its cardinalia, form of loop, and simple disk-like lophophore, instead of the normal plectolophous lophophore with long side arms and a median coil.

The family Dyscoliidæ includes at present the Recent genus *Dyscolia*. The fossil genus *Waisiuthyrina* (type species *W. margineplicata* Beets) from the Upper Oligocene (= Mio-Pliocene) of Celebes, East Indies, should from its external shell characters be assigned to this family. The loop is unfortunately unknown, and the shell is said to be smooth instead of irregularly capillate. It possesses the curious incurved flange anteriorly in both valves, and the beak characters, shell outline, cardinalia and teeth are similar to those of *Dyscolia*. The dorsal adductor scars are very posterior and pear-shaped, and there is a low median dorsal ridge (myophragm) which is not in contact posteriorly with the cardinalia.

The Dyscoliidæ may be defined as :—

Terebratuloidea with adult lophophore consisting of a short subrectangular disk, concave ventrally, with long centrifugal cirri. Spicules developed. Loop very short, terebratuliform, but crural processes inconspicuous. Myophragm sometimes present in brachial valve. No dental lamellæ.

Range.—?Cretaceous to Recent.

The range of this family may be given with certainty as Miocene to Recent, but it is probable that the species ‘ *Terebratula* ’ *diphimorpha* Stoliczka (1872 : 25, pl. 7, figs. 4, 5) from the Ootatoor Group (Cenomanian) of S. India belongs to the Dyscoliidæ. This species is said to be near to '*T.*' *guiscardiana* Meneg., and has a rather similar external form with anterior flanges, capillate ornament, and prominent growth lines. The internal characters of *T. diphimorpha* are unfortunately unknown.

In the trigonal shell outline and short umbo the Dyscoliidæ resemble the Upper Jurassic and Lower Cretaceous (Neocomian) genera *Pygope*, *Pygites* and *Antinomia* which, however, are never capillate. The loop is of similar length and form as in the pygopids, the vascular trunks are much branched, and the anterior margin also tends to be recurved inwards in these forms. The brachial valve in these genera is, however, usually sulcate and the pedicle valve medianly folded in early growth stages. This median portion of the shell frequently does not increase in length but the lateral portions extend anteriorly and tend to converge, and finally may fuse leaving a central or posteriorly placed cavity. In some species, however, the shell develops normally without a median perforation and is trigonal in outline rather like the dyscoliids.

Genus *Dyscolia* Fischer and Oehlert

Dyscolia P. Fischer and D. P. Oehlert, 1890*a* : 70.
Dyscolia Fischer and Oehlert, 1891 : 18.
Dyscolia Fischer and Oehlert, 1892*b* : 18.
Dyscolia Fischer and Oehlert ; Dall, 1921 : 322.
Dyscolia Fischer and Oehlert ; Thomson, 1927 : 199.
Dyscolia Fischer and Oehlert ; Blochmann, 1908 : 638.
Dyscolia Fischer and Oehlert ; Helmcke, 1939*b* : 238.

Type species. *Terebratulina wyvillei* Davidson, 1878.

Species (at present known) and Distribution.

RECENT

Dyscolia johannisdavisi (Alcock), 1894. Indian Ocean in 719 fathoms off Uliganu island, N. Maldive atoll, (Investigator), one specimen.

Dyscolia subquadrata (Jeffreys), 1878. Atlantic Ocean in 500–600 fathoms off coast of Portugal near Setubal and mouth of Tagus (Yacht ' Norma '). 2 specimens ? immature and 2 loose valves ; Bay of Biscay in 645 fath. (Travailleur) very young specimens.

Dyscolia wyvillei (Davidson), 1878. First recorded from West Indies, N.W. of St. Thomas, off Culebra Island in 390 fathoms (Challenger Stn. 24) ; off coasts of Morocco at 1216 metres (664 fath.) and Soudan at 1435 metres (784 fath.) (Travailleur and Talisman); off Cape Finistère, Spain, in 1051 fathoms (Recorded Dall, 1921) ; off the Azores at 736, 1135, 1300 and 1557 metres (401, 611, 710, 850 fath.) (Hirondelle) ; Canary Islands at 1250 metres (683 fath.) (Prince of Monaco, Hirondelle Stn. 1118).

FOSSIL

Terebratulina guiscardiana (emend. by Seguenza, 1865, from *Terebratula* in errata). Pliocene, Messina, Italy.

Diagnosis of genus.—Shell large, solid, biconvex, subtrigonal, with anterior and lateral flange in each valve. Anterior commissure rectimarginate to incipiently biplicate.

Shell often capillate and with prominent growth lines. Umbo short, foramen marginate to labiate, epithyrid, almost apical. Pedicle collar present. Hinge plates divided. Cardinal process transverse. Loop very short, crural processes inconspicuous and not joined, transverse band with slight median wave. Vascular sinuses much branched.

Remarks.—Fischer and Oehlert (1890*a* : 70) in addition to *T. wyvillei* assigned the species *Terebratulina subquadrata* Jeffreys, *Terebratula guiscardiana* Seg., and *T. lankesteri* Walker from the British Cretaceous to *Dyscolia*. The latter species however, does not appear to be related.

In *T. guiscardiana* Seg. (1865, pl. 3, fig. 6*a*) the cardinalia are similar to those of the Recent species, but the loop is imperfectly known. The shell is capillate, often in zigzag pattern, and a flange is present in each valve. No septum is shown in Seguenza's figure, and investigation of this species by means of serial sections showed that there is no septum in the brachial valve. The cardinal process is laterally elongated and longitudinally ridged.

The specimen recorded as *Dyscolia wyvillei* from the Canary Islands, Azores, and off the coasts of Spain, Morocco, and Soudan, are more rounded and less elongate pear-shaped and smaller than the type specimen from the West Indies. The capillation is more clearly defined and resembles that of *D. subquadrata* (Jeffreys). It is possible that these eastern Atlantic forms are adults of *D. subquadrata* which is imperfectly known. The syntype figured by Jeffreys (1878, pl. 22, figs. 4, 4*a*) and by Davidson (1886, pl. 2, figs. 15, 16) from Setubal, Portugal is obviously a young shell of small size which lacks the characteristic marginal flange in each valve.

Dyscolia johannisdavisi (Alcock)

Pl. 1, figs. 1, 3, 4

Terebratula johannisdavisi Alcock, 1894 : 139.
Terebratula johannisdavisi Alcock, 1902 : 283, fig. 83.
Terebratula johannisdavisi Alcock ; Joubin, 1907 : 6.
Terebratula johannisdavisi Alcock ; Blochmann, 1908 : 638.
Terebratula wyvilli Davidson ; Thomson (in part), 1927 : 201.
Dyscolia johannisdavisi (Alcock) ; Helmcke, 1939*b* : 239, fig. 241.
Dyscolia johannisdavisi (Alcock) ; Helmcke, 1940 : 261, figs. 22, 25*b*.

Occurrence.—Station 158 at 430–620 fathoms. One detached brachial valve; station 159 at 500–900 fathoms. One detached pedicle valve.

Description.—The brachial valve [ZB. 1566] is 58.5 mm. long and expands rapidly from the small incurved umbo attaining a maximum width of 51.5 mm. about 37 mm. anterior to the umbo. It then gradually decreases in width to the evenly rounded anterior margin. The commissure is plane, and no part of the anterior or lateral flange is preserved. There is no fold or sinus in either valve.

The external shell surface shows faint traces of capillation laterally and posteriorly, and growth lines are rather prominent. The shell is grayish-white in colour, opaque and lustreless.

The pedicle valve [ZB. 1567] is slightly smaller than the brachial valve (54.5 mm. long) and imperfect. A small part of the anterior flange is preserved. The umbo is short and truncated by the almost apical foramen, which is marginate and incipiently labiate.

The symphytium is short and has no median line of junction. A small pedicle collar is present.

The interior of the brachial valve shows no trace of muscle scars or vascular markings and the brachial loop is not preserved. The hinge plates are fused anterior to the small transverse cardinal process then diverge from one another as small concave triangular plates. The crural bases are subparallel and extend from the anterior end of the hinge plates. The inner socket ridges are not well demarcated from the hinge plates, and the outer socket ridges are also ill-defined. The sockets are shallow and are concealed posteriorly by the inner socket ridges and the hinge plates, while anteriorly they are bounded by a low rounded ridge parallel to the hinge margin. The cardinalia are surprisingly simple for such a large shell, and the two valves seem to have been poorly articulated.

In the interior of the pedicle valve the teeth are small and probably slightly imperfect, but two small socket-like depressions are present posterior to each tooth, and a third just anterior to it which presumably aided articulation with the brachial valve. Traces of four main vascular trunks were seen in this valve and the postero-lateral parts of the valve were faintly mammillated, resembling ovarian markings of Palæozoic species. The muscle scars are obscure but the diductors appear to be pear-shaped and to have enclosed the rather small, narrow and more posterior adductors.

Remarks.—Unfortunately no specimen of *D. johannisdavisi* was available for comparison and it appears to be extremely rare. Alcock's type specimen is slightly larger, 73 mm. long and 68 mm. wide and his figure (1902, fig. 83) shows the prominent growth-lines but not the capillation. The shell is described as smooth and very finely punctate. The loop is figured and said to be about 1/5th of the length of the brachial valve. The two valves are said to have an incurved margin. Helmcke (1940 : 260) discussed the species of *Dyscolia*, and gave a full description of *D. wyvillei.* He also published the description and photographs of Alcock's type specimen of *D. johannisdavisi* (reproduced in pl. 1, fig. 1) made by Blochmann who borrowed it in 1907 from India, but did not describe or figure it in his 1908 paper.

Blochmann's description (in Helmcke, 1940 : 263) states that the pedicle valve of *D. johannisdavisi* is capillate umbonally with traces of zigzag marking in places. Growth lines are said to be well developed. The shell is said to be very finely punctate with 68 punctæ in a square mm. The loop is said to have been broken off but to have been replaced by Blochmann. It is figured by Helmcke (1940, text-fig. 22 : 264). Four views of the exterior of Alcock's species about 3/4 natural size are also given by Helmcke who pointed out the differences in hinge plates between *D. johannisdavisi* and *D.* '*wyvillei*' figured by him from Boavista, Cape Verde Islands, (Helmcke, 1940, text-fig. 23). He considered the Indian Ocean species to be distinct but used the specific name '*wyvillei*' for the West Indies form as well as those from the East Atlantic. The species *D. subquadrata* (Jeffreys) was said to be little known.

The holotype of *Dyscolia wyvillei* (Davidson) from the West Indies is, however, preserved in the British Museum (Natural History) no. ZB. 1356 and consists of two attached valves with partly preserved loop. This species and *D. johannisdavisi* (Alcock) have been considered synonymous by a number of authors, but there seem to be certain differences in the two forms, which appear to justify the retention of the two species. The shell tapers more posteriorly and the greatest width is more anterior in *D. wyvillei* and the anterior and lateral flanges are less marked. The umbo in *D. wyvillei* is more produced and the foramen less apical and the concave symphytium is longer and better exposed. The capillation is slightly more prominent in the West Indies shell which is cream or light brown in colour and more solid than in *D. johannisdavisi*. (Pl. 1, figs. 2*a*, *b*).

In *D. wyvillei* the internal margin of both valves is finely denticulate, the denticles extending right round the shell margin and supplementing the rather weak articulation along the hinge, and probably serving also as a strainer to keep out predators and large particles. These denticles were not preserved in the two valves of *D. johannisdavisi*, and are not visible in the photographs of the type specimen. They were observed in the fossil species *D. guiscardiana*, and in the smaller species *D. subquadrata* (Jeffreys). The latter has well-defined radial capillæ which sometimes form a zigzag pattern, a character not observed in the type specimen of *D. wyvillei*. The specimens of the latter species dredged from the eastern Atlantic off the Azores (Fischer and Oehlert, 1892*b*, pl. 2, figs. 3*a–f*) are strongly capillate and appear to be nearer to *D. subquadrata* than to *D. wyvillei*. It is possible that the specimen of *D. subquadrata* figured by Davidson (1886, pl. 2, figs. 15, 16) from off Setubal, Portugal is a young form only since it lacks the flanges in each valve.

The genital markings of *D. johannisdavisi* correspond with those described and figured by Fischer and Oehlert (1891 : 26, pl. 6, fig. 3*h*) for *Dyscolia wyvillei* [? = *D. subquadrata* (Jeffreys)] from the Eastern Atlantic. They do not extend into the vascular sinuses as in Terebratelloid genera but form a network with a polygonal mesh like *Terebratulina*.

Fischer and Oehlert (1891 : 22, fig. 1) figure a section through the disk-like lophophore and show that it consists of two reduced brachial arms, joined medianly and each pierced by the brachial canal and smaller efferent canal. The posterior half of the disk is supported by the loop. The brachial lip and groove extend round the disk and are interrupted only on the middle of the slightly lobed anterior margin. The cirri are set in two rows along the margin of the brachial groove. The mouth is situated posteriorly. This type of lophophore seems to be unique and intermediate between the trocholophous and schizolophous types. It is here designated dyscoliid type. In *Dyscolia* the disk is about one-third the length of the brachial valve.

The spicules of *Dyscolia* '*wyvillei*' were figured by Fischer and Oehlert (1891 : 23, fig. 2), two from the mantle, and four from the brachial cirri, the former stellate and rather solid and the latter elongated with no lateral branches. Spicules are said to occur on the brachial disk as well as in the mantle, those of the disk having a more simplified structure and fewer branches. No spicules were preserved in the two separated valves of *D. johannisdavisi*, nor were they described by Helmcke (1940) in the type specimen.

Family Terebratulidæ Gray, 1940

Genus *Dallithyris** gen. nov.

Diagnosis.—Shell subtrigonal to subpentagonal in outline. Pedicle valve usually more convex than brachial valve, no median fold or sulcus ; anterior commissure plane to slightly waved dorsally, lateral commissure dorsally convex. Foramen marginate to labiate, epithyrid, symphytium short. Loop short, narrow, transverse band with broad ribbon and median plication, crural bases extending along inner margins of hinge plates. Cardinal

* Named in honour of the celebrated American zoologist and palæontologist W. H. Dall.

process short, transverse, lobate. Vascular sinuses obscure, branching. Lophophore plectolophous, cirri long. Spicules abundant, cirri socles absent.

TYPE-SPECIES.—*Dallithyris murrayi* sp. nov.

SPECIES ASSIGNED TO GENUS AND DISTRIBUTION

RECENT

Gryphus cubensis (Pourtales) 1867. Off Havana, Cuba in 270 fath., Gulf of Mexico (Pourtales); Florida Strait in 200 and 400 fath., off Cuba in 2690 fath., off St. Vincent in 88 fath. (Blake); off Porto Rico in 224 fath., off Little Bahamas in 338 fath., Martinique in 210 fath. (Blake); Barbados in 100 fath. (Blake).

Dallithyris sp. nov.? West of Portugal in 274 and 292 fath. (Porcupine); Bay of Biscay in 277 and 578 fath. (Travailleur); Josephine Bank in 200 fath. (Italian Exp.); Azores at 599 metres (327 fath.) and 950 metres (519 fath.) (Pr. of Monaco); Canary Islands at 1098 metres (600 fath.) (Pr. of Monaco); off N. coast of Spain (Travailleur) near Ascension I. (Hirondelle); Mediterranean (Washington).

?*Terebratula cernica* Crosse, 1873. Off coast of Mauritius, found in stomach of fish.

Dallithyris murrayi sp. nov. Maldive Islands, Indian Ocean at 120 fath. Saya de Malha Banks, near Mauritius between 153 and 123 fath.

FOSSIL

Terebratula sphenoidea Philippi, 1844.—Pliocene, Lamanto, Calabria, Italy, and from Middle and Upper Zancleano (Lower Pliocene) from a number of localities in Sicily.

Terebratula sphenoidea var. *taurinensis* Sacco, 1902, Miocene, Turin Hills.

Terebratula sphenoidea var. *præcedens* Sacco, 1902, Ur. Eocene, Gassino, Turin, Italy.

Terebratula deltoidea Seguenza, 1865. Upper Miocene, Messina, Sicily.

RANGE.—Tertiary, ?Eocene to Recent.

It is uncertain whether *T. sphenoidea* var. *præcedens* Sacco from the Eocene of Italy is really a *Dallithyris*, and investigation of the internal structure would be required to confirm this. The range of the genus may, therefore, be Miocene or Pliocene to Recent.

DISTINGUISHING CHARACTERS.—*Dallithyris* differs from *Gryphus* in the uneven convexity of the valves, in its more trigonal shell outline with the greatest width occurring anteriorly, and in the undulating lateral commissure. The loop is narrower owing to the descending branches being more parallel, and the transverse band has a broader ribbon and a more prominent median plication than that of *Gryphus*. The four vascular sinuses in *Gryphus* are straight and well defined, but are very obscure and slightly curved in *Dallithyris* and branch anteriorly. The hinge plates in *Dallithyris* are slightly broader than in *Gryphus*.

It differs from *Liothyrella* in its more trigonal shell outline, and less produced umbo. The loop in *Liothyrella* is broader with more diverging descending branches and the ribbon is narrower than in *Dallithyris* and lacks the prominent median plication of the transverse band.

The hinge plates, loop and spicules were figured by Dall (1910) in the specimen dredged from the Saya de Malha Banks. The spicules show a general resemblance to those figured by Blochmann (1908, pl. 37, figs. 11–13) from the ventral mantle of *D.* "*sphenoidea*" from the eastern Atlantic and " *D. cubensis* " from Ascension I. and Florida Strait, but are nearer to those obtained from *D. murrayi* sp. nov.

Blochmann (1908 : 612, 618) divided the Recent terebratulids into (1) Forms with cirrensockel [cirri socles or spicules at the base of the lophophore cirri], for example species of *Liothyrella,* and (2) those without cirrensockel [cirri socles] such as *Gryphus vitreus, Terebratula sphenoidea, T. cubensis,* etc. This classification was commented on by Thomson (1918) who stated that cirri socles had not been found in *Liothyrella fulva* (Bloch.) though they were present in other species of *Liothyrella,* and suggested that they might be present in the young and resorbed in the adult.

Eichler (1911 : 397) discussed this question with regard to the species *Liothyrella antartica* (Bloch.). He found spicules in the dorsal body wall of young specimens but not in the ventral body wall or the mantle of either valve. He then examined the spicules developed in successive growth stages, and found cirri socles developed at a very early stage, but not developed in every cirrus. Resorption was found to play a part in the spicule development causing changes in the cirri socles of the outer row of cirri and disappearance from the inner row.

The subject of spicules requires much additional research. E.-Deslongchamps (1865) described and figured them in a number of Recent genera such as *Terebratulina, Kraussina, Gryphus, Megerlia, Thecidea.* He pointed out their absence in the genera *Magellania Macandrevia,* the rhynchonelloids and *Lingula.* They occur normally along the main vascular trunks, in the body wall and along the cirri, and vary in form in different parts of the mantle. The subject was discussed briefly by Muir-Wood (1955 : 54) when they were shown to be absent in the Class Inarticulata and present in some Articulata, such as the Terebratuloidea but are absent in the Rhynchonelloidea and in some genera of the Terebratelloidea.

' *Terebratula* ' *sphenoidea* Philippi, originally described from the Pliocene of Sicily and Calabria, was later recorded by Jeffreys (1878 : 404) from Recent seas ; it was said to be a variety of *T. vitrea* and to be identical with *T. cubensis* Pourtales. Jeffreys' specimens were from the east Atlantic and Bay of Biscay. Comparison of the fossil and Recent forms of *T. sphenoidea,* however, shows distinct differences between them. The fossil form is elongate-oval to subtrigonal with slightly waved anterior commissure and curved lateral commissure. Growth lines are numerous and well demarcated. The loop figured by Philippi (1844, pl. 18, fig. 6*e*), and by Seguenza (1871, pl. 1, fig. 26) is narrow and of dallithyrid type, with a broad medianly plicated ribbon forming the transverse band, the anterior margin of which is inverted V-shaped, with sharply angular points projecting anteriorly. Jeffreys (1878 : 404, pl. 22, figs. 6, 6*a*) figured the loop of what is presumed to be the eastern Atlantic form, but unfortunately no precise locality is given. It differs from the fossil *D. sphenoidea* in the very slightly indented anterior margin of the transverse band, and the slight median plication. The exterior of the shell of Jeffreys' ' *T.*' *sphenoidea* (*ibid.* fig. 6) is represented erroneously as capillate. The Recent species *D. cubensis* (Pourtales) from the West Indies islands is a shorter, broader, more convex and more trigonal shell than *D. sphenoidea* with faintly defined growth lines and more curved lateral commissure. The loop has a less angular plication and less angular projections of the transverse band. A study needs to be made of the eastern Atlantic form which is sufficiently distinct both from *D. cubensis* and *D. sphenoidea* to merit a new subspecific or specific name. Blochmann (1908) considered this form to be a new species.

Species of *Dallithyris* show a remarkable external resemblance to species of *Dallina,* a long-looped terebratelloid genus with dental lamellæ and a dorsal median septum. *Dallithyris murrayi* resembles *Dallina septigera* (Loven) from Norwegian waters and *Dallina raphælis* Dall from the shores of Japan. *Dallithyris cubensis* resembles *Dallina floridana* (Pourtales) superficially and the two species occur together off Florida.

Dallithyris murrayi sp. nov.

Pl. 2, figs. 1, 4–8 ; pl. 3, figs. 1–4 ; pl. 5, fig. 8

Liothyrina sp. indet. Dall, 1910 : 439, pl. 26, figs. 1, 2.
Liothyrina sp. indet. Dall ; J. W. Jackson, 1921 : 46.

Occurrence.—Station 157. Maldive Islands at 120 fath. numerous specimens. [Nos. ZB. 1570–1584].

Previously recorded distribution.—A single imperfect specimen was obtained from the southern slope of the sea bottom, S. of Saya de Malha Banks, Indian Ocean, between 153 and 123 fath. by the Sealark Exped. in 1905. (Dall 1910).

Diagnosis.—Shell subtrigonal, about 44 mm. long, 33 mm. wide and 30 mm. thick, solid, smooth, cream coloured, finely punctate ; pedicle valve shovel-shaped, medianly flattened, and at angle to steep sub-parallel flanks ; brachial valve opercular about half thickness of pedicle valve ; anterior commissure dorsally waved ; lateral commissure strongly deflected dorsally.

Type specimen.—Holotype from station no. 157, Maldive Islands at 120 fathoms, no. ZB. 1570. Paratypes from same locality and horizon no. ZB. 1571–1584.

Description.—*External characters.* The foramen is moderately large, marginate to labiate, and epithyrid, with obscure beak ridges. The pedicle is short and the proximal part is solid but distally it splits into a number of separate strands which enabled it to attach more closely to a loose sandy sea bottom. (Pl. 2, fig. 1). The symphytium is short, concave, without median division, and scarcely visible when the two valves are attached. The shell varies from thin and translucent in the young stage to rather solid, but it is always cream-coloured. Growth lines are inconspicuous and there are very fine irregular longitudinal striations on some specimens. In adult specimens the junction of the lateral and anterior commissures is subangular. The umbo of the brachial valve is incurved.

Internal characters.—In the interior of the pedicle valve the teeth are small, somewhat wedge-shaped and project postero-dorsally.

The adductor muscle in dried shells is long and thread-like and divides into four in the brachial valve with two branches on each side of a centre line. Each of these is again subdivided into a number of finer threads which form a dendritic pattern on attachment to the valve floor.

In the pedicle valve the adductor muscle divides into two parts each of which has a double attachment to the shell floor as posterior and anterior adductors. The attachment of the adductors forms a dendritic pattern as in the brachial valve. The posterior adductors are slightly posterior to and more laterally placed than the anterior adductors. The pedicle muscles are attached to the hinge plates and to the posterior part of the pedicle valve. The diductors are attached more posteriorly and laterally to the adductors and also form a dendritic pattern. The genital products enclosed between the two mantle layers form an elongate patch with a polygonal mesh outside the body cavity, and anterior and lateral to the muscle scars in both valves. (Pl. 2, figs. 6, 8).

In the interior of the brachial valve the cardinal process is laterally elongated, semi-circular in outline, and multilobate and serves for the attachment of the diductor muscles. The hinge plates are rather broad, triangular and slightly concave. The inner socket ridges form a narrow raised outer (postero-lateral) margin to the hinge plates, while the crural bases extend along their inner margin. The hinge-sockets are deep and narrow and extend back under the hinge plates. The crural processes project from the anterior end of the hinge plates without any development of crura and converge slightly. The ribbon of the descending branches of the loop increases in width and passes directly into the broad ribbon of the transverse band which is medianly plicated, the plication sometimes extending dorsally as a short projection. (Pl. 3, figs. 1–4). The anterior margin of the transverse band is strongly emarginate. The loop is 8 mm., long in a brachial valve 36·5 mm. in length.

The vascular markings are usually obscure, but may be outlined by the calcareous spicules. The latter vary in shape in different parts of the mantle, but are elongate and little branching along the four main vascular trunks in each valve. Dall (1910, pl. 26, fig. 2) figured spicules from the posterior part of the mantle of the brachial valve of his specimen of '*Liothyrina*' sp. (= *Dallithyris* sp.? = *D. murrayi*) from the south of the Saya de Malha Banks, Indian Ocean. The spicules of *D. cubensis* and the species identified as *Terebratula sphenoidea* were figured by Blochmann (1906, pl. 37), and the *D. cubensis* spicules appear to be comparable to those figured by Dall, and to those of *D. murrayi* (Pl. 5, fig. 8), obtained from the ventral mantle. A single much branched spicule of *T. sphenoidea* (× 52) from the eastern Atlantic was figured by Fischer and Oehlert (1891 : 59, fig. 6).

Removal of the shell and loop of specimens of *D. murrayi* in dilute Hcl. allowed the mantle, lophophore and soft parts to be studied. The anterior and lateral margins of the mantle bear a row of short setæ.

In preparations stained with safranin and also with hæmatoxalin and eosin the four main vascular trunks were seen to bifurcate and each branch to fork near the anterior margin of the mantle. This agrees fairly well with the pattern shown by Davidson (1886, pl. 2, fig. 22) for the species *D. cubensis* (Pourtales).

The lophophore was studied in adult specimens and in a young form ZB. 1581, 14 mm. in length and 15 mm. wide. In the adult ZB. 1580 the side branches were 20 mm. long and the median coil had two complete whorls and was 15 mm. across dorso-ventrally. In the young specimen the side arms were 7 mm. long and the median coil was smaller and had one incomplete whorl.

The cirri or filaments are relatively short in the young shell, but are 5–6 mm. in length in the adult and often curled at the tips. The two tubes which are coiled side by side in the plectolophous median coil are united by a membrane and appear as a single vertical coil having cirri fringing each outer margin.

The mouth is situated at the posterior end of the median plication of the transverse band and is partly supported by the layer of mantle joining the two crural processes. The alimentary canal was 2 mm. in length in the young specimen previously mentioned and a few millimetres only in the adult.

No study was made of the histology.

The mantle, composed of an inner and outer lamina, was difficult to observe owing to its extreme fragility. When the shell was removed in acid the mantle tended to tear owing to the close attachment of mantle to shell by the cæcæ occupying the punctæ. The inner layer of the mantle in each valve is arched up from the outer layer (in contact with shell) and fuses to form the body wall, at the anterior end of which is the mouth. The row of cirrhi above the mouth extends across the crural processes which are enclosed in a thin mantle layer which also covers the loop. The side arms of the lophophore are attached to the transverse band of the loop. The portion of mantle covering the loop extends also across the hinge plates enclosing the attachment of the stout pedicle adjustor muscles.

The hinge sockets and cardinal process did not appear to be covered by a mantle layer. The dorsal adductor muscle strands project ventrally through a small cavity posteriorly placed between the hinge plates and all the muscle strands appear to be enclosed in a sheath composed of mantle and to be attached directly to the shell.

DIMENSIONS.—Holotype. ZB. 1570. Length of pedicle valve 36·5 mm.; width 30·2 mm.; thickness 25 mm.; length of brachial valve 32·8 mm.

Paratype no. ZB. 1573. Length of pedicle valve 44 mm.; width 32·8 mm.; thickness 29 mm.; length of brachial valve 39·2 mm.

DISTINGUISHING CHARACTERS.—*Dallithyris murrayi* differs from *D. cubensis* (Pourtales) in its considerably larger dimensions, deeper pedicle valve, and more opercular brachial valve, more parallel lateral shell margins, and slightly more produced umbo. The shell in *D. murrayi* is more solid and less translucent than in *D. cubensis*. *D. murrayi* resembles *D. cubensis* in having the pedicle terminally divided into a number of short strands, in having similar deflection of the lateral commissure, in the form of the loop, obscure branching pallial sinuses, and the similar position of the genital products in a large patch, with polygonal divisions, and laterally arranged to the muscle scars. Pourtales gave the dimensions of the largest specimen of *D. cubensis* as length 1 1/10th inch (= 28 mm.), width 9/10th inch (= 22 mm.), thickness 7/10th inch (= 17 mm.).

Phillippi (1844) gave the dimensions of *T. sphenoidea* from the Pliocene of Italy as—Length 12 lines (= 25 mm.); width 10 lines (= 21 mm.), thickness 6 lines (= 13 mm.). This species differs from *D. murrayi* in its smaller dimensions, less convex valves and less arched lateral commissure. The relationship of *T. cernica* Crosse to *D. murrayi* is uncertain. Crosse (1874, pl. 1, fig. 3) figured a dorsal view of the single specimen which is too poor for accurate determination, but shows it to be a smaller, more elongate form than *D. murrayi*. Crosse compares it, however, with *T. cubensis* and says that it has a similar flexuous lateral margin. This may indicate that it is a *Dallithyris*.

The small species *Gryphus capensis* Jackson described from 29 miles S.W. of Cape St. Francis in 75 fath., and 73 miles S.W. of Cape St. Blaize, S. Africa, in 125 fath., does not appear to be a *Dallithyris* though its loop has more parallel descending branches than normally occurs in species of *Gryphus* or *Liothyrella*. The ribbon, however, of the transverse band appears to be narrow and to lack the prominent median plication of *Dallithyris*. There is a low median septum in the brachial valve of *G. capensis*, which is absent from species of *Dallithyris*. The vascular sinuses and spicules in this species are unfortunately not described.

Suborder TEREBRATELLOIDEA Muir-Wood, 1955

Superfamily TEREBRATELLACEA Allan, 1940

Three dried specimens of what is presumed to be an immature growth-stage of a terebratelloid species were obtained at a depth of over one thousand fathoms from two widely separated stations. These specimens could not be identified with any previously described species, and were considered to be of sufficient interest to be described and named. It is possible that more material may be collected by future expeditions and additional specimens may be found in existing collections.

Genus *Leptothyris* gen. nov.

Type species.—*Leptothyris ignota* sp. nov.

Occurrence.—Station 120, off Zanzibar at 1585 fathoms. One specimen, no. ZB. 1555. Station 185, Gulf of Aden at 1093 fathoms. Two specimens, no. ZB. 1556–1557.

Diagnosis.—Shell elongate-oval, tapering to umbo, moderately coarsely punctate. Valves biconvex, smooth, with row of tubercles diverging from umbo of pedicle valve. Loop with descending branches attached to high plate-like septum, no ring or hood developed (= pre-campagiform stage, or platidiiform stage of Beecher). Cardinal process small. Inner socket ridges raised above sockets and continuous with crural bases; no hinge plates. Lophophore spirolophous, with septum posteriorly placed to spires. No true dental lamellæ, but margin of delthyrium thickened.

Remarks.—This small form does not fit into the existing terebratelloid classification on account of its spirolophous lophophore, and high plate-like septum without any development from it of a ring as in terebratellids, or of a hood as in dallinids. The three specimens are of similar size and may of course be adult in spite of the open delthyrium and narrow deltidial plates.

Leptothyris ignota sp. nov.

Pl. 4, fig. 6; Pl. 5, figs. 12–14

Type specimen.—Holotype, no. ZB. 1555. Paratypes, nos. ZB. 1556–1557.

Diagnosis.—As for genus.

Description.—*Exterior*. The shell is elongate-oval in outline with the greatest width about midway down length. It tapers posteriorly to the slightly rounded umbo. The delthyrium is almost unmodified by the narrow deltidial plates.

A row of minute papillæ is developed from the apex of the ventral umbo in what would normally be the position of the beak ridges. The shell is cream-coloured, smooth, without marked growth lines. The two valves are slightly convex, the convexity of the pedicle valve being slightly greater than that of the brachial valve. The anterior commissure is plane and the lateral one not waved.

Internal characters.—In the interior of the pedicle valve muscle scars could not be distinguished. The gonads occupy a large area anterior and lateral to the body chamber on the posterior half of the shell. This gonadal patch appeared to have been originally subdivided by a polygonal mesh. No main vascular trunks could be distinguished. The small teeth have slightly swollen bases and project a short distance into the delthyrium. Dental lamellæ could not be distinguished but the lateral margins of the delthyrium are thickened.

In the brachial valve of all three specimens the spirolophous lophophore was preserved. The two small spirals are medianly placed at right angles to the plane of symmetry and their anterior margin is one mm. posterior to the anterior margin of the shell. The spirals are covered by a very thin web of mantle (inner epithelium), but when this was removed in no. ZB. 1556 the spirals were found to be separate anteriorly and to have centrifugal cirri. The high septum is posteriorly placed in relation to the spirals unlike the arrangement in a schizolophous lophophore, where the lophophore is indented anteriorly and supported by the septum. It is not known whether this spirolophous lophophore is a growth stage in the development of the lophophore or the adult lophophore as in the genus *Eucalathis*.

The loop was not preserved entire but the slender broken descending branches were seen as well as the point of their attachment to the septum. In specimen no. ZB. 1556 when the lophophore was removed the crural bases and slender curved crural processes were alone preserved. The median septum projects above the valve floor as a prominent plate with a rounded contour, but it is not continuous posteriorly to the hinge.

The cardinal process is minute and bilobed and unites the two socket ridges without development of hinge plates. The socket ridges project slightly like two small ears beyond the hinge of the brachial valve, as in the terebratulinids, and extend anteriorly almost vertically across the inner margin of the small hinge sockets.

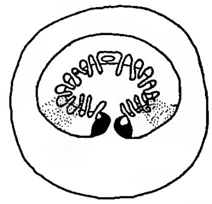
Nothing is known of the muscle scars and gonads in the brachial valve. The mouth appeared to be supported by the highest part of the posterior edge of the plate-like septum.

Dimensions.—Holotype (separated valves) maximum length 5 mm., maximum width 4·1 mm.; Paratype no. ZB. 1557, length 5 mm., width 4 mm., thickness 2 mm.

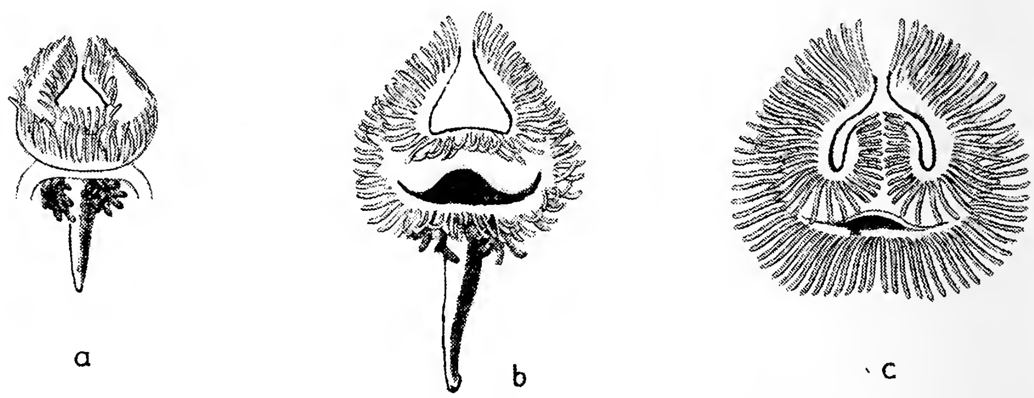
Remarks.—*Leptothyris ignota* has been compared with the small terebratelloid described by Davidson (1880 : 47, pl. 4, figs. 6*a*, *b*, and 1886 : 101, pl. 18, figs. 2, 3, 3*a*) as '*Magasella*' *incerta*. It differs, however, in its larger dimensions, more coarsely punctate shell, and more convex valves. In Davidson's little species the lophophore is unknown but the loop has a similar high septum, and attached descending branches without any development of a ring or a hood from the septum. '*Magasella*' *incerta* was dredged from west of St. Thomas I., West Indies, at a depth of 390 fathoms. It is not a *Platidia* as quoted by Elliott (1953 : 264). The immature Pliocene shell described by Muir-Wood (1938) and mentioned by Elliott (1953) though in a similar stage of loop development (pre-campagiform) is unrelated to *Leptothyris ignota* and has different cardinalia.

Owing to the spirolophous lophophore and the immature form of the loop it is quite impossible to assign *Leptothyris ignota* to any family of the suborder Terebratelloidea and superfamily Terebratellacea at present described.

It may be helpful to summarize the stages of the development of the lophophore in the higher terebratelloids as set out by Beecher (1895), and modified by later authors. This subject and the development of the loop were discussed by Muir-Wood (1955) who reproduced Beecher's text-figures of the successive lophophore growth-stages—taxolophous, trocholophous, schizolophous, zygolophous, and plectolophous in the higher terebratelloids and terebratuloids. Percival (1944) described the earliest stage of development of the lophophore cirri as outgrowths of part of the inner epithelium posterior to the mouth. Further growth of cirri to the left and right forms a ring of cirri round the mouth (= taxolophous stage). The mouth at present circular becomes crescentic, and its anterior margin develops as a flap within the circle of cirri. This flap is the beginning of the brachial fold. The lophophore as described by Percival (1944) and Williams (1956) is now crescent-shaped and not a closed circle as described by Beecher (trocholophous stage). Williams figured this (1956, fig. 6, 1) and stated that it was 'capable of accelerated and differential growth at the tips of the antero-median horns'. His diagram shows that the median vertical coil of the later plectolophous stage is derived from the 'horns', and the side arms from two lateral growth areas. (Text-fig. 3). The crescentic shape of the lophophore with erect cirri (but with arms not deflected) is confirmed by Morse (1871, pl. 2., fig. 27) in the early stage of *Terebratulina* (4 mm. shell length) (Text-fig. 4). In the earlier stage the lophophore was circular enclosing the mouth. The region of growth of the side arms and median coil of the plectolophous lophophore differ, however, from those suggested by Williams, as shown in text-fig. 3, (Morse, 1871, pl. 2, figs. 28, 32.)



TEXT-FIG. 3.—Diagrammatic representation of the trocholophous stage of the lophophore after Williams (1956) showing crescentic shape (and not a closed circle as described by Beecher, 1895), with the stippled areas said to develop later into the side arms, and the black areas into the median coil of the plectolophous lophophore.



TEXT-FIG. 4*a*–*c*.—Trocholophous and subplectolophous stages in the development of the lophophore of *Terebratulina* (after Morse, 1871, pl. 2, figs. 27, 28, 32). (4*a*) Trocholophous stage showing the crescentic outline and erect cirri. (4*b*) Slightly later stage with cirri deflected, the mouth exposed, and showing the posterior alimentary canal. (4*c*) Early plectolophous (subplectolophous) stage showing lengthened side arms and incipient median coil. In fig. 4*a* the shell is 4 mm. in length and 5 mm. in 4*c*. In this genus according to Morse's diagrams the tips of the crescent of the trocholophe develop into the side arms while the median coil is developed from the region anterior to the mouth, unlike the regions of growth indicated in text-fig. 3. (Anterior margin above.)

Williams considers that the lophophores of all rhynchonelloids and terebratuloids have a similar early development, and that the spirolophous lophophore of rhynchonelloids is directly derived from the trocholophe as two separate spirals with their apices dorsally directed.

The trocholophe crescent is next introverted along its anterior margin (schizolophous stage), often with a median septum occupying the introversion. The antero-lateral margin of the schizolophe may become infolded in some genera to give the ptycholophous stage. The two lobes of the schizolophous stage in the terebratelloids and some terebratuloids tend to become longitudinally extended and re-curved with the formation of a median lobe (zygolophous stage). This median lobe develops into the vertical median coil of the plectolophe while the side arms extend anteriorly from the mouth into the brachial cavity. They are then doubled back on themselves and each ascending branch forms a median vertical coil. The two coils are united by a layer of the mantle. The two branches of the side arms are also attached to each other by a similar stout membrane.

The development of the lophophore in *Terebratulina* (terebratuloid) and *Terebratella* (terebratelloid) was discussed and actual specimens were figured by Elliott (1954). He pointed out the differences in the trocholophe, schizolophe and zygolophe of the two genera which in *Terebratulina retusa* (Linn.) have centrifugally arranged cirri and a rather elevated lophophore while in *Terebratella inconspicua* (G. B. Sowerby) the cirri are centripetally arranged and the early lophophore is nearly flat and disk-like. It would be of considerable interest to study the early lophophore development of other genera and species for comparison.

The lophophore was defined by Williams (1956 : 260) as a " highly muscular tubular structure covered with inner epithelium and containing a cœlomic space ". Two canals, the larger brachial canal and smaller efferent (or tentacular) canal normally extend along the length of the lophophore. The lophophore is attached to the body wall and hangs more or less freely in the brachial cavity supported to a greater or lesser extent by the brachial skeleton which in the Articulata may consist of crura (rhynchonelloid) or a long (terebratelloid) or short (terebratuloid) loop, with or without the development of a median septum.

Whether the lophophore is disc-like as in *Dyscolia* (here called dyscoliid type), schizolophous, plectolophous or coiled in two spirals, the outer margin always consists of a ciliated furrow, or food groove, formed of inner epithelium and bounded by the brachial fold on one side and by ridge bearing two rows of ciliated cirri on the other. Lashing of cilia on the cirri and mantle and in the food grooves causes a current which sweeps food particles along towards the mouth while rejecting foreign particles.

Recent spirolophous lophophores such as occur in *Leptothyris* are at present almost unknown. They are distinct from the spirolophes of the rhynchonelloids which are partly supported by the crura and have a number of whorls and their apices dorsally directed. They also differ from the elongate curved brachia of *Cryptopora* with their small anterior coil (here designated circinate type). Spirolophes also occur in the inarticulate genera *Crania*, *Lingula*, and *Discina*, but the development of these is little known. The spirolophe is certainly derived from the schizolophe, but in the case of *Leptothyris* and *Eucalathis* it is uncertain whether these spirals which are at right angles to the plane of symmetry of the valves, really constitute the adult lophophore.

VI. CONCLUSIONS

The Brachiopoda obtained by the John Murray Expedition, though consisting of a small number of individuals and mostly dried specimens proved to be of considerable interest in providing new genera and species, as well as additional information about the distribution of the genera represented.

Dyscolia johannisdavisi (Alcock), *Chlidonophora chuni* Bloch., and *Dallithyris murrayi* sp. nov. dredged from the Maldive Islands all have related forms living in the Atlantic Ocean, but not in the Mediterranean or further east off the coasts of the Malay peninsula or Australia. Species of these three genera have an almost similar discontinuous distribution in Recent seas, but *Dyscolia* and *Dallithyris* are both represented in the Pliocene of Sicily and south Italy, by *Dyscolia guiscardiana* (Seguenza) and *Dallithyris sphenoidea* (Philippi) respectively. This suggests some link between the Atlantic and Indian Oceans in Tertiary times. This was provided by the Tethyan Ocean, of which the Mediterranean is a relic, which extended from west to east possibly from America across southern Europe and Asia.

This problem of discontinuous distribution of Recent brachiopod species however, on opposite coasts of the Atlantic is one that has not yet been satisfactorily explained. The inarticulate brachiopod genera—*Lingula* and *Discinisca* have a comparatively long free-swimming larval stage lasting possibly several weeks, the larva having a functioning mouth and stomach. The larvæ of the more highly organized articulate genera such as *Terebratulina* on the other hand, have a much shorter free-swimming stage since the larva up to the cephalula stage has no mouth or functioning stomach. It, therefore, soon becomes attached to some object and henceforth is immobile. The rate of distribution of these Articulate larvæ must necessarily be slow, even assisted by winds and currents, though according to Blochmann's observations (1907) these larvæ are not found in the plankton. The depth tolerated by post-larval brachiopods seems to vary fairly considerably but is rarely more than 1000 fathoms, except in the case of a few abyssal forms. The traverse of a deep ocean except along an archipelago or coast would, therefore, be impossible.

The distribution of Recent species of *Dyscolia* and *Dallithyris* on both sides of the Atlantic and the Maldive Islands seems to point either to the former existence of land near the coasts of which the larvæ could migrate, or to the former proximity and subsequent drifting apart of the continents. Wegener's theory of continental drift as an explanation of discontinuous distribution of marine and land organisms has been the subject of much discussion and is still a greatly disputed subject. Sewell (1956) however, claims it to be the explanation of the present day discontinuous distribution of the copepoda. He considers also that the former Tethyan Ocean extended from the west Pacific across Asia, along south Europe to the Atlantic Ocean and that distribution was from west to east. Little is known about the seafloor of either ocean, but from study of the palæogeography of former geological periods there would appear to be evidence for the possible permanence of the Pacific Ocean, and the non-continuity of the Atlantic Ocean, at least in Palæozoic and Mesozoic times, and for the existence of an earlier sea, the Tethyan Ocean which seems to have extended from America across southern Europe to Asia (see palæogeographic maps in Oakley and Muir-Wood, 1959). The Tethys was presumably in open communication with the Pacific Ocean, but no trace of Tethyan fossil brachiopods has so far been found on islands of the Pacific. The Recent genus *Cryptopora* has not been found east of Australia, and *Dyscolia*, *Chlidonophora* and *Dallithyris* do not occur east of the Maldive Islands. They occur off the Antilles and east coast of North America but not on the west coast of America, or off the coasts of the Pacific island groups which would be expected if the Tethys had formerly extended westwards across what is now the Pacific Ocean.

As already stated *Dyscolia johannisdavisi* has a related species *D. wyvillei* (Davidson) off the coasts of the Antilles, an east Atlantic species *D. subquadrata* (Jeffreys) off Spain and Portugal, and probably also from the Azores, Canaries, and Cape Verde I., and a Pliocene species in S. Italy. Other probable fossil relatives are *Waisiuthyrina margineplicata* Beets from the Oligocene (= Mio-Pliocene) of Celebes, and *Terebratula diphimorpha* Stoliczka from the Cretaceous (?Cenomanian) of southern India. This indicates probably a Tethyan origin for the Dyscoliidæ. A possible relationship with the Upper Jurassic and early

Cretaceous pygopids is suggested by the remarkable similarity in outline, incurved shell margin, short loop with crural bases almost unrepresented, and much branched vascular markings, unlike those of any other known terebratuloid. The pygopids are Tethyan forms with a mainly South and Central European, and North African distribution.

Chlidonophora has no Cretaceous or Tertiary European species at present definitely recognized, but such are certainly to be expected. The present day distribution is discontinuous, and similar to that of *Dyscolia*, *i.e.* east and west Atlantic and the Maldive Islands.

Dallithyris has possible Eocene and Miocene as well as Pliocene representatives in S. Italy and like *Dyscolia* its present day species *D. cubensis* in the west Atlantic occurs off the Antilles, a subspecies in the east Atlantic off the west coast of Africa, and the Cape Verde, Azores and Canary Islands, and *D. murrayi* sp. nov. in the Indian Ocean off the Maldive Islands. A possible fourth species *D. cernica* (Crosse) has been obtained off Mauritius.

The distribution of the Recent species of *Cryptopora* is slightly more extended than that of the genera previously mentioned but the west to east pattern is similar to that of *Dyscolia* and *Dallithyris*. Fossil forms of Oligocene and Miocene age are known from Europe while the Recent species *C. gnomon* (Jeffreys) occurs in east and west Atlantic, *C. bœttgeri* Helmcke occurs off South Africa, and *C. brazieri* Crane is found off the east and south coasts of Australia.

The single young specimen of *Lingula* is the first shelled form to be obtained from near the shores of Oman and extends the distribution of the genus westwards in Asia from Karachi. *Lingula* occurs at Aden but is absent so far as is at present known from the Red Sea, and there are no records of its occurrence in the Mediterranean.

There is a remarkable absence of terebratelloid species in the Indian Ocean (ref. chapters III and IV, p. 289), and in the present collection only one species is represented. This could not be matched up with any previously described form and the three small specimens, dredged from a depth of over 1000 fathoms, either from off the coast of Somaliland, Gulf of Aden, or off Zanzibar, have been described as a new genus and species *Leptothyris ignota*. Elliott (1951) discussed the world distribution of terebratelloid species illustrated by distribution maps and for the Indian Ocean shows only the occurrence of *Mühlfeldtia* [= *Megerlia*] in the Persian Gulf and off Mauritius, *Kraussina* from off Mauritius, and the Saya de Malha Banks, *Frenulina* (?) *alcocki* from off southern India, and *Megerlina* and *Platidia* in the far south near Kerguelen I. and Prince Edward I.

These terebratelloid genera do not show the same discontinuous distribution as the three terebratuloid genera and *Cryptopora*.

Megerlia and *Platidia* are common Mediterranean and east Atlantic forms, *Platidia* occurring also off the American coasts. *Kraussina* is essentially a Southern Indian Ocean genus, occurring especially off the south and west coasts of Africa and off Tasmania (Jackson 1952). *Megerlina* is limited to the islands of the extreme south of the Indian Ocean and the south coast of Australia. *Frenulina* to which genus the species " *Kingena alcocki* " Joubin is at present assigned occurs off the Philippines, East Indies, and east Australia.

The species of these terebratelloid genera found in the Indian Ocean and Persian Gulf are listed in chapters III and IV on pp. 285–289.

This discontinuity of distribution of some of the Indian Ocean species has already been commented on by Schuchert (1911 : 275) who stated " . . . the former existence of equatorial Gondwana across the Atlantic and [as well that] its vanished Atlantic bridge still controls the distribution of living forms. We shall see that the genera of the northern

Atlantic (Poseidon) distributed themselves in one direction more or less widely throughout the northern hemisphere and in another pathway eastward into the Indian Ocean by way of the northern shore of Gondwana ".

Jackson (1921) and Thomson (1927) also remarked on the connection in Tertiary time between the Atlantic and Indian Oceans by way of the ancient Tethys, as shown by the distribution of species of *Dyscolia* and *Chlidonophora* and some species of " *Liothyrina* ". A similar discontinuous distribution is shown by other groups of marine organisms, corals, echinoids, hermit crabs, and Brachyura crustacea (crabs.).

Species previously recorded from the Persian Gulf but which are not included in the John Murray Collection are *Terebratulina retusa* var. *abbreviata* Jackson and *Mühlfeldtia* [*Megerlia*] *truncata* var. *paucistriata* Jackson. Other species which might have been dredged off the Maldive Islands are " *Hemithyris* " *sladeni* Dall and *Kraussina gardineri* Dall, both found previously off the Saya de Malha Banks, N.E. of Mauritius, and " *Kingena* " [*Frenulina*?] *alcocki* Joubin which was obtained off South India in 187 metres. It is probable that further collecting in the Indian Ocean, Persian Gulf, and off the east coast of Africa would greatly increase the number of species at present known.

SUMMARY

This report includes the description of six genera and six species from the Indian Ocean and Gulf of Oman. Of these two genera *Dallithyris* (terebratuloid) and *Leptothyris* (terebratelloid) and three species *Cryptopora maldivensis*, *Dallithyris murrayi* from off the Maldive Islands, and *Leptothyris ignota* from the Gulf of Aden and off Zanzibar are new. Related species, fossil and Recent, and their distributions are discussed. All the specimens except those of *Dallithyris murrayi* sp. nov. were dried, but some still had the lophophore preserved.

A single immature specimen of *Lingula* was obtained from the Gulf of Oman area, and two detached valves of *Dyscolia johannisdavisi* (Alcock) and two specimens of *Chlidonophora chuni* Blochmann from the Maldive Islands.

The family Cryptoporidæ is defined and internal differences from the Rhynchonellidæ emphasized. The genus *Mannia* formerly included in the Terebratelloidea has been assigned to this family with *Cryptopora*. All the known species of *Cryptopora* are listed and compared with *C. maldivensis* sp. nov.

The family Cancellothyridæ is sub-divided into two families Cancellothyrinæ with *Cancellothyris*, *Terebratulina*, and Chlidonophorinæ subfam. nov. with *Chlidonophora* and possibly also *Eucalathis*. The species of the two latter genera are compared.

The family Dyscoliidæ proposed by Fischer and Oehlert (1891) for the Recent genus *Dyscolia* is adopted and re-defined, and the fossil species *Terebratulina* [*Dyscolia*] *guiscardiana* Seguenza from the Lower Pliocene of Sicily, *Terebratula diphimorpha* Stoliczka from the Cretaceous of India, and the genus *Waisiuthyrina* from the Oligocene (= Mio-Pliocene) of the island of Celebes assigned to it.

The species ' *Gryphus* ' *cubensis* (Pourtales) and ' *G.*' *sphenoideus* (Philippi) are discussed and assigned to the new genus *Dallithyris*, the internal and external morphology of which are fully discussed.

A list of previous expeditions to the Indian Ocean is given together with a list of all brachiopod genera and species previously dredged from this area.

Additional terms introduced are *dyscoliid* stage for type of lophophore development in adult *Dyscolia*, subplectolophous (term proposed but not defined by J. A. Thomson, 1927) for type of lophophore in *Chlidonophora*, and circinate for the type of lophophore in *Cryptopora* which has two slightly curved brachia terminating in a small coil and resembling an inverted fern frond.

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EXPLANATION OF PLATES.

All specimens are natural size unless otherwise stated.

The specimens are preserved in the Department of Palæontology, British Museum (Natural History), and their individual registration numbers are quoted.

PLATE I.

Page

FIGS. 1*a–d*.—*Dyscolia johannisdavisi* (Alcock) 300

From photographs by F. Blochmann and reproduced by J. G. Helmcke, 1940, Wiss. Ergeb. deutsch, Tiefsee Exped. Valdivia, 1898–1899, **24**, heft 3, 1940, p. 264, fig. 22. For comparison with the two specimens obtained by the John Murray Exped. 1*a*. Anterior view showing marginal rims. 1*b*. Lateral view. 1*c*. Ventral view showing slight capillation. 1*d*. Interior of brachial valve showing short terebratulid type of loop. All figures are $\frac{3}{4}$ natural size.

Off the Maldive Islands in 719 fathoms. Specimen in Calcutta Museum.

FIGS. 2*a–b*.—*Dyscolia wyvillei* (Davidson) 301

Holotype for comparison with *D. johannisdavisi* (Alcock). 2*a*. Dorsal view showing slightly incurved umbo, labiate foramen and smooth shell. 2*b*. Valves opened to show mantle and much branching vascular markings. Off Culebra Island, NW. of St. Thomas, West Indies. Challenger Stn. 24 at 390 fathoms, Challenger Coll. ZB. 1356. (Figured T. Davidson, 1886, pl. 3, figs. 1, 1*a*, 2, and Challenger Rept., 1880, pl. 1, figs. 1, 2.)

FIGS. 3*a–c*.—*Dyscolia johannisdavisi* (Alcock) 300

Detached pedicle valve. 3*a*, Internal view of slightly tilted specimen to show anterior marginal rim, hinge teeth, ovarian markings anterior to teeth, and apical foramen with short pedicle collar. Slightly enlarged. 3*b*. Posterior view to show foramen and hinge teeth. 3*c*. Exterior of valve. John Murray Exped. Stn. 159, off the Maldive Islands at depth of 500–900 fathoms. ZB. 1567.

FIGS. 4*a*–b.—*Dyscolia johannisdavisi* (Alcock) 300

Datached brachial valve. 4*a*. Interior of posterior part of valve showing lobate cardinal process, shallow hinge sockets partly concealed by the inner socket ridges, and small hinge plates. Part of the crura attaching the loop is preserved but not the loop.
$\times 1\frac{1}{2}$. 4*b*. Exterior of valve. Slightly reduced.

John Murray Exped. Stn. 158, off the Maldive Islands at depth of 430–620 fathoms. ZB. 1566.

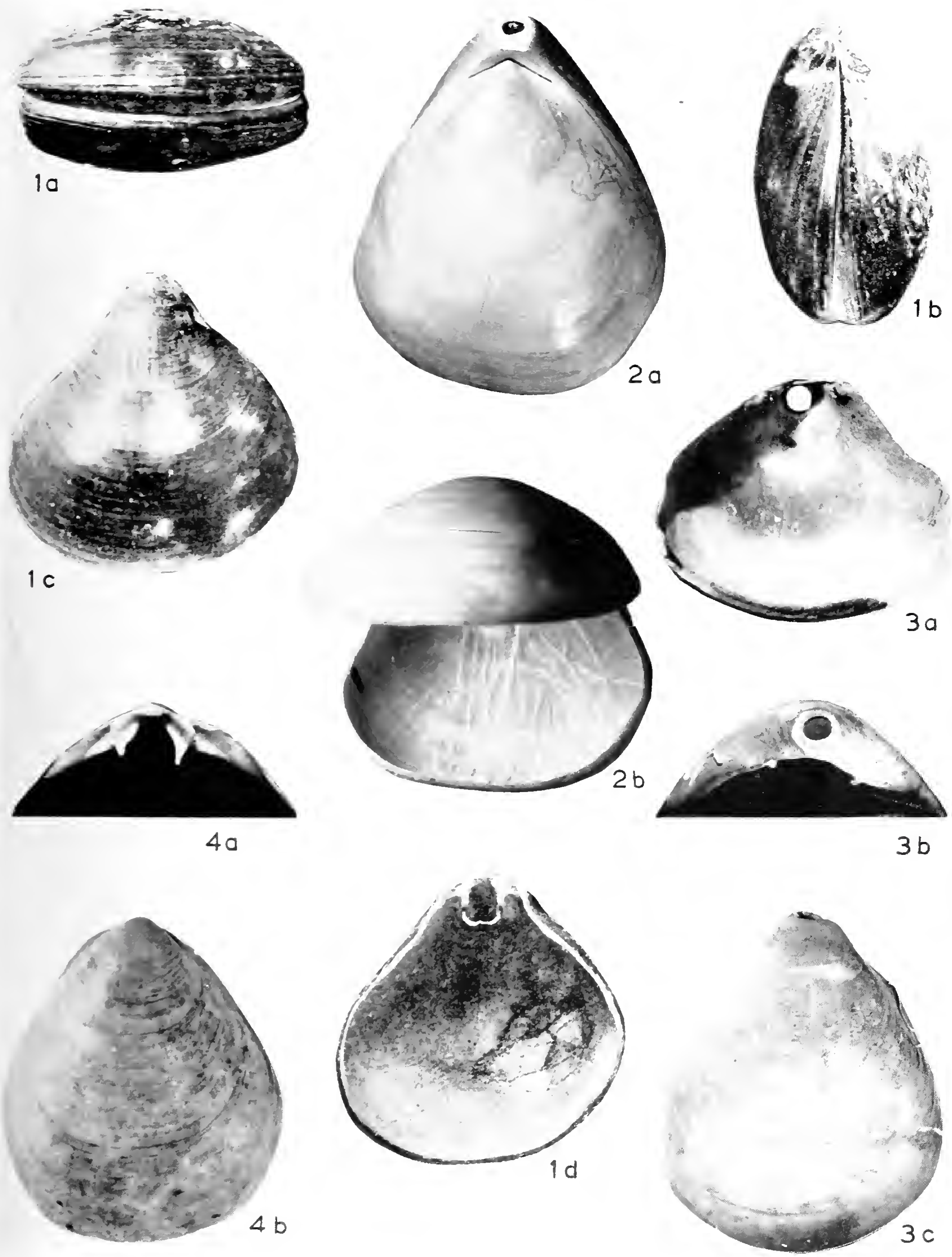

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PLATE 2.

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FIG. 1.—*Dallithyris murrayi* gen. et sp. nov. 305

Fragment of pedicle valve showing pedicle divided into a number of separate strands and attached to a coral. × 3. John Murray Exped. Stn. 157, at depth of 125 fathoms off Maldive Islands. ZB. 1575.

FIGS. 2*a*–*c*.—*Dallithyris cubensis* (Pourtales) 307

2*a*. Dorsal view. 2*b*. Lateral view for comparison with fig. 4*a* (*D. murrayi*). 2*c*. Anterior view showing an almost plane anterior comissure.

Florida Reefs or off Havana. T. Davidson Colln. ZB. 1623.

FIGS. 3*a*–*b*.—*Dallithyris cubensis* (Pourtales) 307

3*a*. Dorsal view showing marginate foramen. × approx. 1½. 3*b*. Lateral view.

Locality and collection as for fig. 2. ZB. 1626.

FIGS. 4*a*–*c*.—*Dallithyris murrayi* gen. et sp. nov. Holotype 305

4*a*. Lateral view. × approx. 1½. 4*b*. Dorsal view showing deep pedicle valve and less convex brachial valve. × approx. 1½. 4*c*. Anterior view.

Locality and collection as for fig. 1. ZB. 1570.

FIG. 5.—*Dallithyris murrayi* gen. et sp. nov. 306

Interior of brachial valve in spirit showing the plectolophous lophophore, and long cirri or filaments. × 1½.

Locality and collection as above. ZB. 1580.

FIG. 6.—*Dallithyris murrayi* gen. et sp. nov. Paratype 305

Specimen with valves still attached by the long adductor muscles, and showing traces of genital markings lateral to the muscle scars. × 1½.

Locality and collection as above. Z.B. 1571.

FIG. 7.—*Dallithyris murrayi* gen. et sp. nov. Paratype 306

Interior of brachial valve showing branching vascular sinuses and the two main vascular trunks diverging at an angle of about 40°. × 1½. Locality and collection as above. ZB. 1573.

FIG. 8.—*Dallithyris murrayi* gen. et sp. nov. Holotype 306

Interior of pedicle valve showing dendritic adductor muscle scars, the broken off diductor muscle attachments, and the fine polygonal mesh formed by the genital markings. × 1½. Locality and collection as above. ZB. 1570.

(See also figs. 4*a*–*c* and pl. 3, fig. 1.)

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Brit. Mus. (Nat. Hist.). REPORTS, VOL. X, NO. 6.

PLATE II.

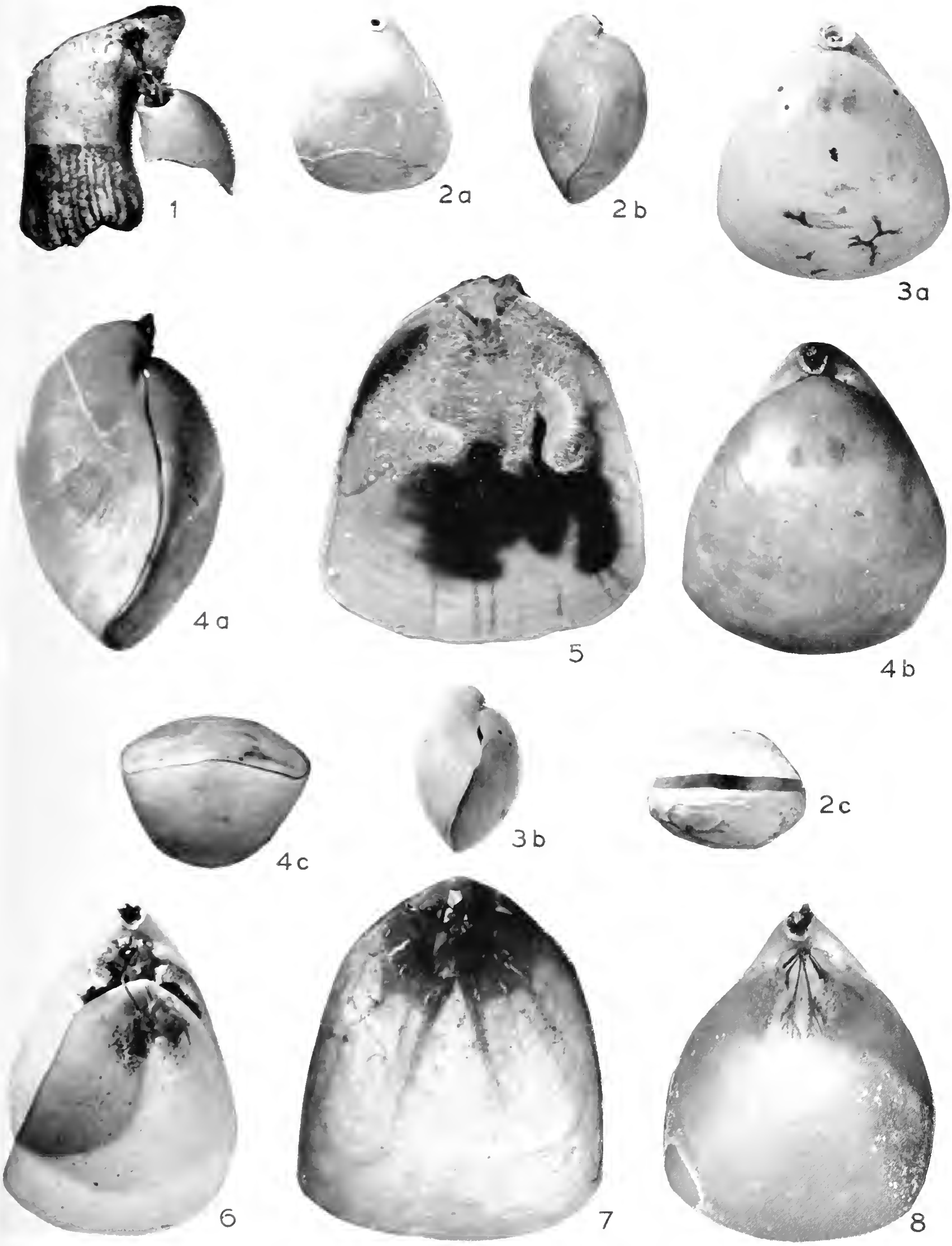

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PLATE 3.

Page

FIG. 1.—*Dallithyris murrayi* gen. et sp. nov. Holotype 306
Interior of brachial valve showing loop and broad transverse band. $\times 1\frac{1}{2}$. John Murray Exped. Stn. 157, at depth of 125 fathoms, off Maldive Islands. ZB. 1570. (See also Pl. 2, figs. 4*a–c*, 8.)

FIGS. 2*a–b*.—*Dallithyris murrayi* gen. et sp. nov. Paratype 305
2*a*. Interior of pedicle valve showing obscure muscle scars. 2*b*. Interior of brachial valve with soft parts removed by potassium hydroxide, showing perfect brachial loop with pronounced median fold and posteriorly projecting point of transverse band, cardinal process, and hinge plate. $\times 1\frac{1}{2}$. Locality and collection as above. ZB. 1572.

FIGS. 3*a–b*.—*Dallithyris murrayi* gen. et sp. nov. Paratype 305
3*a*. Interior of brachial valve with broken loop. $\times 1\frac{1}{2}$. 3*b*. Interior of pedicle valve showing labiate foramen and small teeth. Locality and collection as above. ZB. 1578.

FIGS. 4*a–b*.—*Dallithyris murrayi* gen. et sp. nov. Paratype 305
4*a*. Interior of pedicle valve showing obscure muscle scars. 4*b*. Interior of brachial valve showing cardinalia and loop. $\times 1\frac{1}{2}$. Locality and collection as above. ZB. 1574.

FIG. 5.—*Liothyrella uva* (Broderip). For comparison with *Dallithyris* 304
Brachial and pedicle valve of same specimen. $\times 2$. Off the Falkland Islands. Cuming Coll. ZB. 1319.

FIG. 6.—*Dallithyris cubensis* (Pourtales) 307
Interior of brachial valve showing narrow loop. $\times 2$. T. Davidson Coll., B.12499. (Figd. T. Davidson, 1886, pl. 2, fig. 22.)

FIG. 7.—*Gryphus vitreus* (Born). For comparison with *Dallithyris* 303
Brachial valve showing loop and unbranched vascular trunks. $\times 1\frac{1}{2}$. From the Mediterranean. T. Davidson Coll. B.12494. (Figd. T. Davidson, 1886, pl. 1, fig. 6.)

FIG. 8.—*Chlidonophora incerta* (Davidson). Syntype 296
Interior of brachial valve showing cardinalia and loop with crural points not fused as in *Terebratulina* (see Pl. 4, fig. 1). $\times 5$. From North Atlantic off west coast of Africa. T. Davidson Coll. ZB. 1421.

PLATE III.

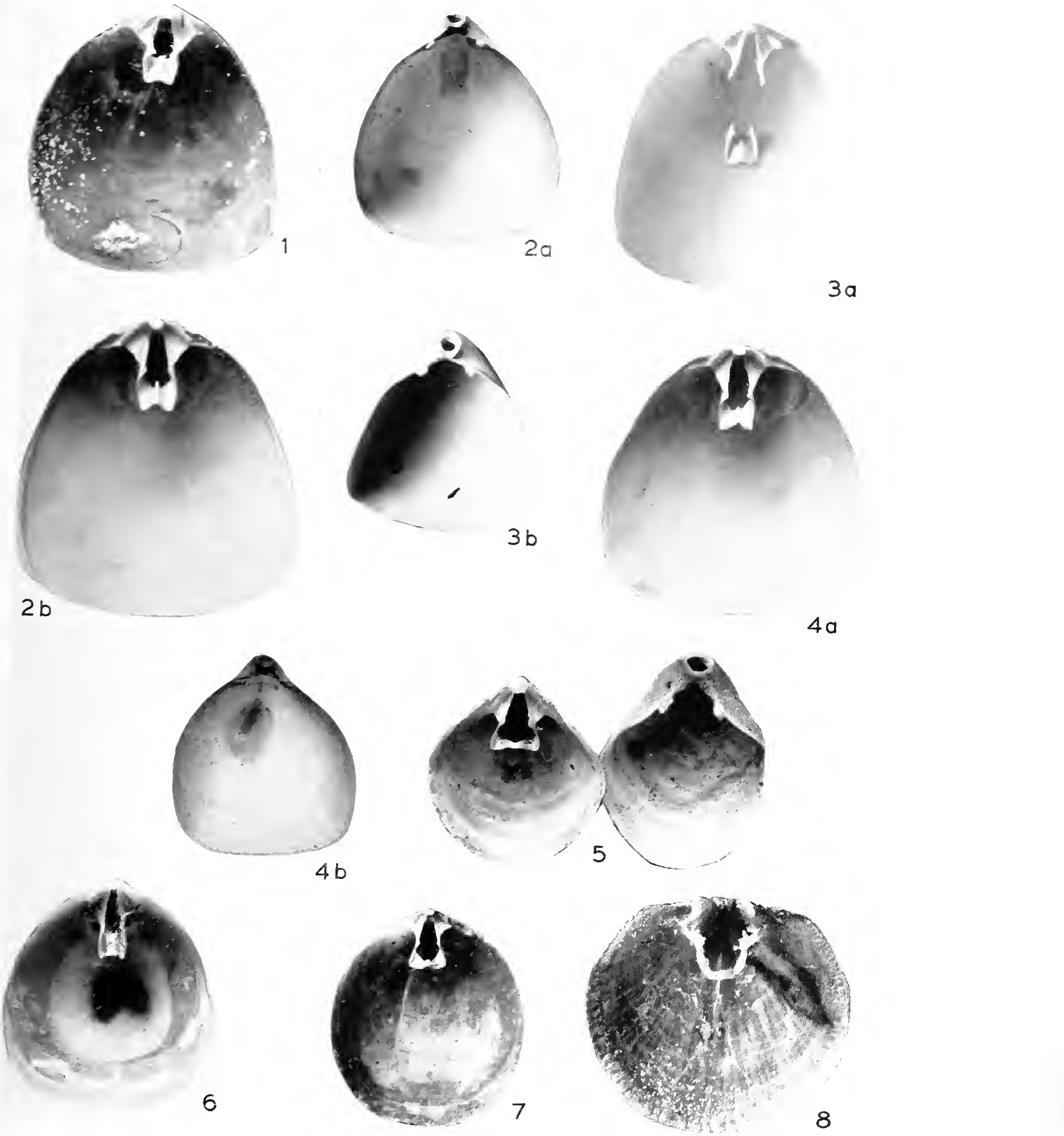

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PLATE 4.

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FIG. 1.—*Terebratulina retusa* (Linné) 296

Interior of brachial valve showing ring-like loop for comparison with that of *Eucalathis* and *Chlidonophora* (see pl. 5). The branching vascular sinuses are also seen, and laterally to the loop the genital markings. × 3. Off the Scottish coast. T. Davidson Coll. ZB. 1630.

FIGS. 2*a*, *b*.—*Eucalathis murrayi* (Davidson). Syntype 296

For comparison with *Chlidonophora*. 2*a*. Interior of brachial valve showing two spiral coils overhung by the cirri from the posterior part of the lophophore. The mouth is just visible posteriorly as a transverse slit, and part of the descending branches of the loop are seen in fig. 2*b* laterally to the mouth. × 10. 2*b*. Same. × approx. 20. Stn. 170, Challenger Exped., near the Kermadec Islands at 600 fathoms. ZB. 1200.

FIG. 3.—*Eucalathis murrayi* (Davidson). Syntype 296

Interior of brachial valve showing dried lophophore. × 10. Locality and collection as above. ZB. 1202.

FIG. 4.—*Chlidonophora incerta* (Davidson). Syntype 298

Interior of brachial valve showing dried subplectolophous lophophore. × 4. N. Atlantic, off west coast of Africa at 1850 fathoms. T. Davidson Coll. ZB. 1421.

FIG. 5.—*Chlidonophora chuni* (Blochmann). Topotype 296

Specimen with long pedicle still preserved and splitting distally into fine filaments which actually pierce the shells of the foraminifer *Globigerina*. × approx. 5. Stn. 219, S. of Suadive Islands (Maldive Islands), at 2253 metres (1283 fath.). Valdivia Coll. Z.B. 1407.

FIG. 6.—*Chlidonophora chuni* (Blochmann) 296

Valves separated showing dried subplectolophous lophophore. × 10. Stn. 162. John Murray Exped., Minikoi, Indian Ocean at 1000–1120 fathoms. ZB. 1568.

FIGS. 7*a*, *b*.—*Chlidonophora chuni* (Blochmann) 296

7*a*. Valves opened to show the subplectolophous lophophore consisting of converging side arms and incipient median coil. × 10. 7*b*. Dorsal view of specimen. × 10. Locality and collection as for fig. 6. ZB. 1569.

FIG. 8.—*Lingula* sp. 289

Immature specimen with valves attached and pedicle preserved. The body cavity outlined in white and oblique muscle scars are seen. × approx. 6. Stn. 74, John Murray Exped., Gulf of Oman at 160 metres (87 fathoms). ZB. 1554.

FIG. 9.—*Leptothyris ignota* gen. et sp. nov. Holotype 308

Interior of brachial valve showing dried lophophore consisting of two spirals. × 11. Stn. 120, John Murray Exped., off Zanzibar at 2900 metres (1585 fathoms). ZB. 1555. (See also pl. 5, fig. 13)

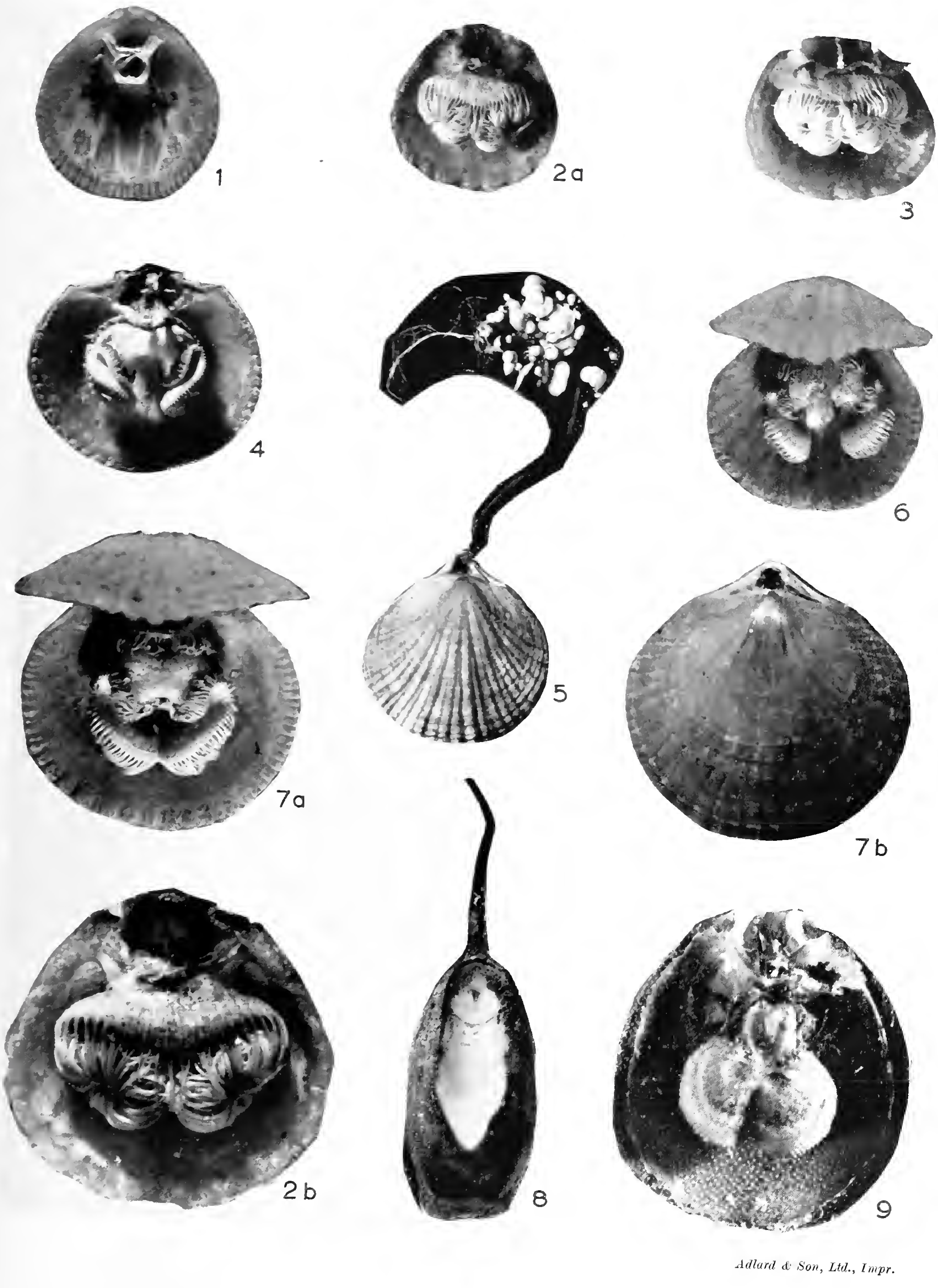

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PLATE 5.

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FIGS. 1*a*–*b*.—*Cryptopora maldivensis* sp. nov. Paratype 293
1*a*. Dorsal view showing pedicle still attached. × approx. 9. 1*b*. Same. × 5. Stn. 145, John Murray Exped., off Maldive Islands at 510 fathoms. ZB. 1559.

FIG. 2.—*Cryptopora gnomon* Jeffreys 292
Interior of brachial valve showing crura for comparison with *C. maldivensis*. × approx. 8. Off Tromso, Norway. T. Davidson Coll., B.12551.

FIGS. 3*a*–*c*.—*Cryptopora maldivensis* sp. nov. Holotype 293
3*a*. Dorsal view showing triangular foramen and narrow deltidial plates. × 8. 3*b*. Lateral view. × 8. 3*c*. Ventral view. × 5. Locality and collection as for fig. 1. ZB. 1558.

FIGS. 4*a*–*b*.—*Cryptopora maldivensis* sp. nov. Paratype 293
4*a*. Interior of dorsal valve showing hinge plates and crura, and prominent median septum. × 11. 4*b*. Posterior part of pedicle valve showing hinge teeth. × 9. Locality and collection as for fig. 1. ZB. 1562.

FIG. 5.—*Cryptopora maldivensis* sp. nov. Paratype 293
Pedicle valve with traces of the two main vascular trunks showing through transparent shell. × 4. Locality and collection as above. ZB. 1560.

FIG. 6.—*Cryptopora maldivensis* sp. nov. Paratype 293
Pedicle valve. × 4. Locality and collection as above. ZB. 1563.

FIG. 7.—*Cryptopora maldivensis* sp. nov. Paratype 293
Interior of pedicle valve. × 4. Locality and collection as above. ZB. 1564.

FIG. 8.—*Dallithyris murrayi* gen. et sp. nov. 306
Portion of mantle of pedicle valve with branching calcareous spicules. × 25. Specimen from Stn. 157, John Murray Exped., off Maldive Islands. ZB. 1579.

FIG. 9.—*Eucalathis murrayi* (T. Davidson). Syntype 298
For comparison with *Chlidonophora* on plate 3. Interior of brachial valve showing loop with narrow dorsally inclined transverse band. × approx. 7. Stn. 171, Challenger Exped., near Kermadec Islands, S. of Fiji at 600 fathoms. Challenger coll. ZB. 1199. (Figd. T. Davidson Challenger Rept., 1880, pl. 2, figs. 1*a*–*b*, and 1886, pl. 6, fig. 15.)

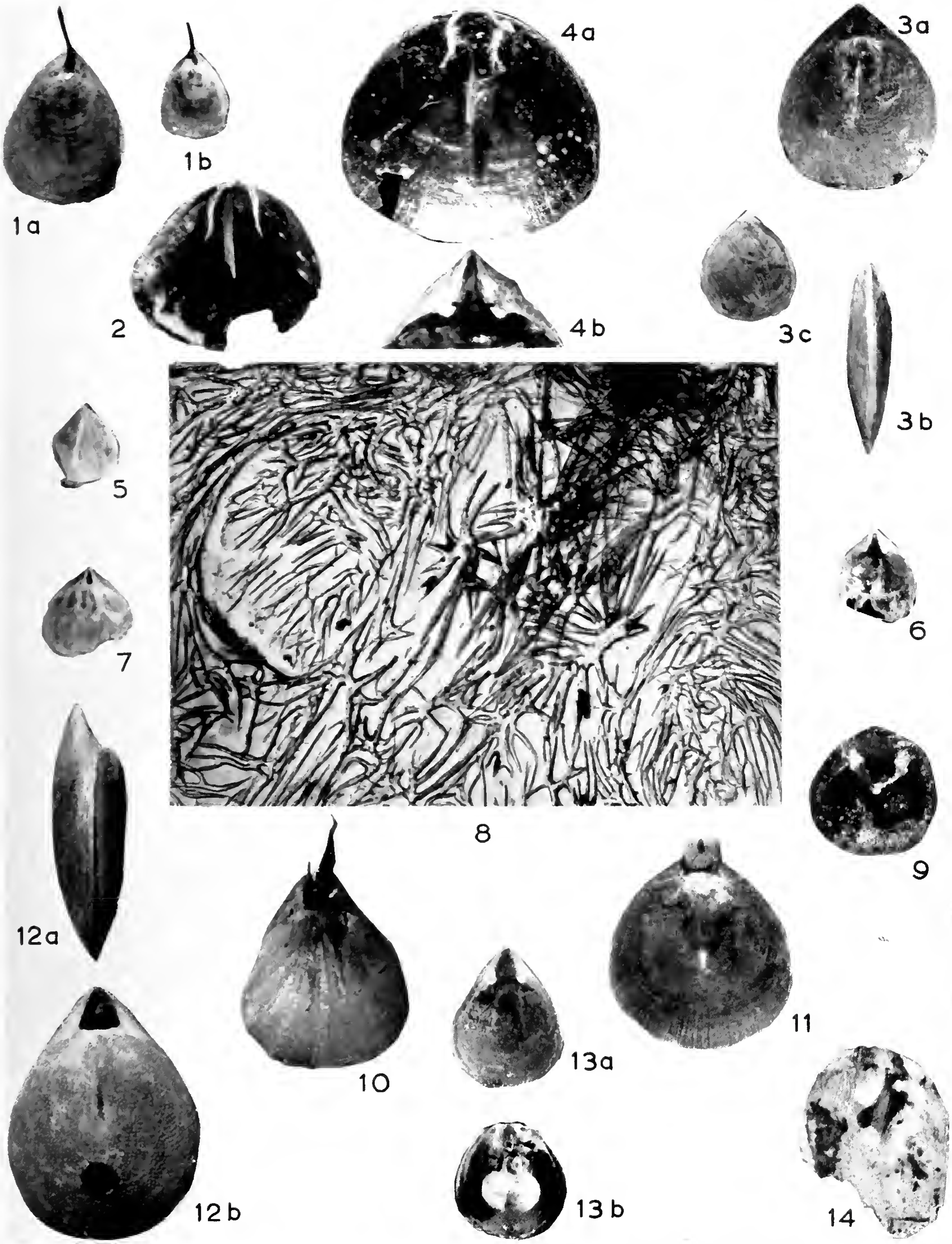
FIG. 10.—*Eucalathis murrayi* (T. Davidson). Syntype 298
For comparison with *Chlidonophora* showing costation and dried pedicle still attached. × 8. Stn. 170, Challenger Exped., near Kermadec Islands at 600 fathoms. ZB. 1203.

FIG. 11.—*Cryptopora* ? cf. *boettgeri* Helmcke 294
Dorsal view showing remarkable auriculate (cyclothyrid) expansion of deltidial plates not so far observed in other species of *Cryptopora*. × 8. Off Cape Natal, Durban, at 54 fathoms. Colld. and presented by Dr. K. H. Barnard. ZB. 1448.

FIGS. 12*a*–*b*.—*Leptothyris ignota* gen. et sp. nov. Paratype 308
12*a*. Lateral view. × 7. 12*b*. Dorsal view showing triangular foramen and narrow deltidial plates. The punctæ are clearly visible and the median septum is seen through the test. × 7. Stn. 185, John Murray Exped., Gulf of Aden, at 2000 metres (1093 fathoms). ZB. 1557.

FIGS. 13*a*–*b*.—*Leptothyris ignota* gen. et sp. nov. Holotype 308
13*a*. Interior of pedicle valve showing teeth. × 5. 13*b*. Interior of brachial valve showing cardinalia and dried lophophore. The apex of the septum can be seen posteriorly to the two spirals of the lophophore. × 5. (See enlargement pl. 4, fig. 9.) Stn. 120, John Murray Exped. Off Zanzibar at 2900 metres (1585 fathoms). ZB. 1555.

FIG. 14.—*Leptothyris ignota* gen. et sp. nov. Paratype 308
Interior of imperfect brachial valve in oblique view showing the elevated septum. The lophophore was not preserved. × approx. 10. Stn. 185, John Murray Exped. Gulf of Aden at 1093 fathoms. ZB. 1556.



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BY

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BY

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,, *crassus* n. sp.	371
Gordonella n.g.	372
,, *polyarthra* n. sp.	373
Additional note on *Gordonella* by Isabella Gordon	379
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INTRODUCTION

The "John Murray" Expedition obtained material pertaining to each of the four subfamilies into which the family Penæidæ is at present divided. Ramadan (1938) reported on all the Penæidæ with the exception of the Series Benthesicymæ of the subfamily Aristæinæ. After an interval of nearly 20 years, the small collection of Benthesicymæ was entrusted to me for study by Dr. Isabella Gordon of the British Museum (Nat. Hist.).

* Part of a thesis accepted for the degree of D.Phil. (Oxon). Mrs. Tirmizi's present address is Zoology Department, Karachi University.

The series Benthesicymæ comprises four genera: *Benthesicymus* Bate, *Gennadas* Bate, *Benthonectes* Smith and *Bentheogennema* Burkenroad. No specimens of the monotypic genus *Benthonectes* were present in the "John Murray" material, but the other three genera were represented by thirteen species of which three are described as new. In addition, there is a single female specimen which does not seem referable to any known genus of the family Penæidæ, for which a new genus is established. The systematic position of this genus *Gordonella* must for the present remain uncertain; it may belong either to the series Benthesicymæ of the subfamily Aristæinæ or to the Solenocerinæ (see p. 378). The type species of this new genus possesses a number of special characters not hitherto described in any species of the Penæidæ. The fourteen species in the present collection are listed below. The specimen on which the redescription of *Benthonectes filipes* Smith is based was sent on loan by Mons. J. Forest of the Paris Museum; it was required for comparison with *Gordonella polyarthra* which was at first thought to be perhaps referable to the genus *Benthonectes*.

The material in the "John Murray" collection will be deposited in the British Museum (Nat. Hist.).

Before proceeding with the systematic study of the material it is important to mention here that the terminology of the carapace used is after Kubo (1949, p. 14); that of the petasma is after Balss (1927, p. 250). The carapacial length is determined by measuring from the tip of the rostrum to the posterior rim of the carapace.

All drawings are original and have been prepared by the author, with the exception of Fig. 96 which was made by Dr. I. Gordon.

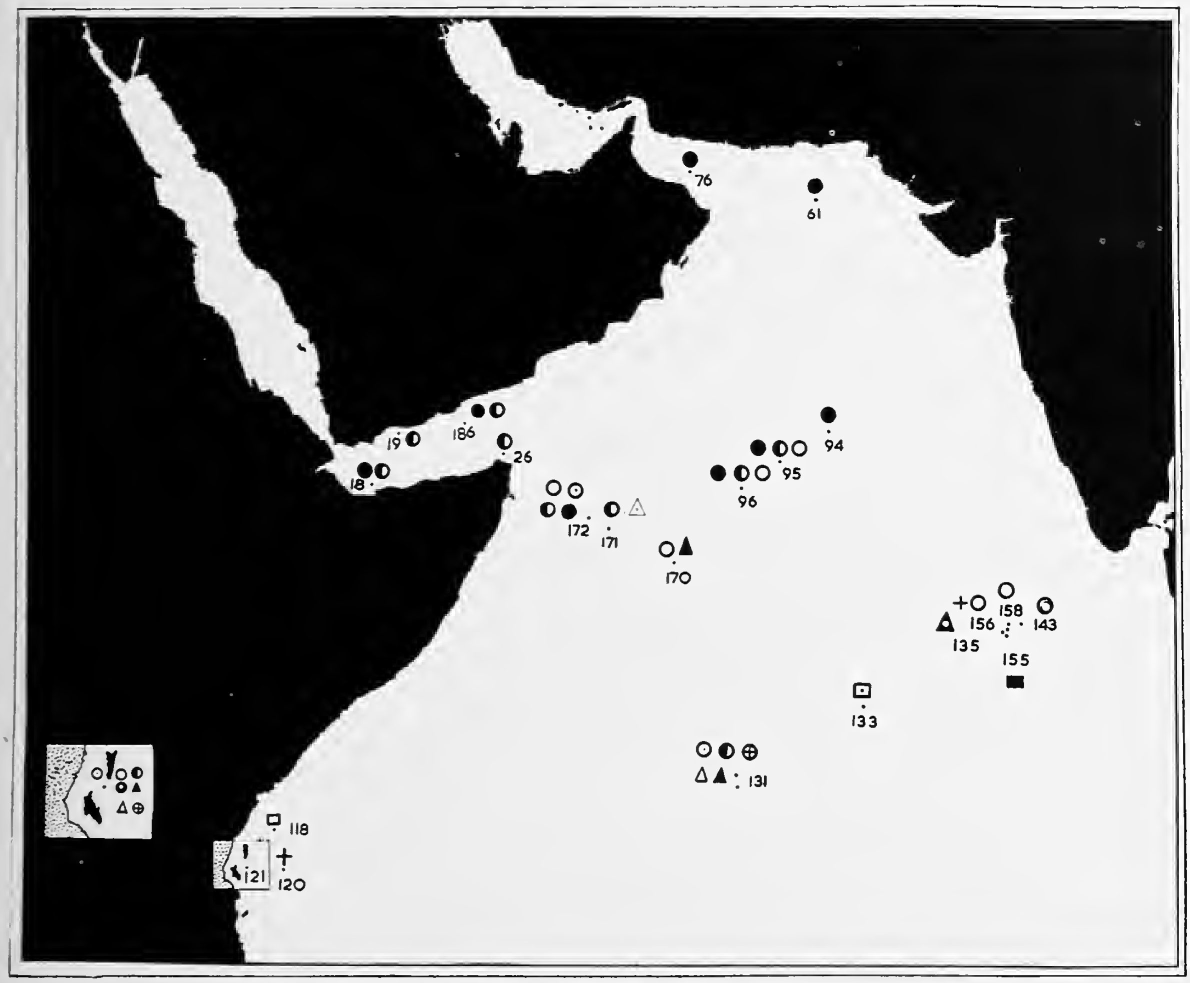
LIST OF SPECIES WITH STATIONS AT WHICH COLLECTED

Family Aristæinæ—Series Benthesicymæ:	
Benthesicymus altus Bate	133
,, *bartletti* Smith	155
,, *seymouri* n. sp.	118
Bentheogennema intermedium (Bate)	120; 156
Gennadas parvus Bate.	121; 131; 170
,, *sordidus* Kemp	18; 186; 61; 76; 94; 95; 96 and 172.
,, *clavicarpus* de Man	18; 26; 186; 193; 95; 96; 171 and 172.
,, *scutatus* Bouvier	96; 12; 131; 172
,, *bouvieri* Kemp.	95; 96; 170; 172; 121; 143; 156 and 158
,, *incertus* (Balss)	121; 131
,, *tinayrei* Bouvier	121; 131
,, *caini* n. sp.	171
,, *crassus* n. sp.	121
Systematic position uncertain:	
Gordonella polyarthra n. g. and sp.	135

Family PENÆIDÆ Bate

Subfamily Aristæinæ Alcock

No diagnosis of the subfamily Aristæinæ has been given by authors subsequent to Bouvier (1908, p. 13). Bouvier's diagnosis though quite serviceable, requires some modifications especially as regards his statement on the branchial formula. It is now definitely known that the genus *Gennadas*, belonging to this subfamily, lacks podobranchs posterior to the second maxilliped.



MAP 1.—Stations at which species of Benthesicymæ were taken.

⊡ *Benthesicymus altus* Bate.
□ *B. seymouri* n. sp.
▲ *Gennadas parvus* Bate.
⊙ *G. scutatus* Bouvier.
△ *G. incertus* (Balss).
◯ *G. crassus* n. sp.
◐ *G. clavicarpus* de Man.
⊕ *G. tinayrei* Bouvier.
■ *B. bartletti* Smith.
+ *Bentheogennema intermedium* (Bate).
● *G. sordidus* Kemp.
○ *G. bouvieri* Kemp.
△ *G. caini* n. sp.
▲ *Gordonella polyarthra* n.g. and sp.

The subfamily Aristæinæ is divided into two series, Aristæinæ and Benthesicymæ, both of which have been defined by Bouvier. Burkenroad (1936, p. 15) has rather severely criticized Bouvier's diagnosis of the series Benthesicymæ but, as he did not attempt to redefine the series, I give the following as a working definition based on all the Benthesicymæ which I have examined in the "John Murray" collection and in the British and Paris Museums.

DIAGNOSIS OF THE SERIES BENTHESICYMÆ.—Cuticle thin and rather soft. Rostrum short, not surpassing the eyes and usually with two teeth on the dorsal margin. Cervical and post-cervical grooves present, the former more pronounced than the latter. A well developed branchiostegal spine present. Post-orbital, post-antennal and supra-hepatic spines absent. Hepatic spine present or absent. Ocular peduncle with a tubercle on its median border. Both antennular flagella elongated, insertion of the upper flagellum subterminal. Proximal segment of mandibular palp wider than, and equal to, or exceeding, the distal segment in length. Telson armed with 1 to 4 pairs of lateral mobile spines; apex either truncated or with a minute point. External lobe of petasma not deeply separated from the blade. Sperm receptacles either situated on the seventh thoracic sternite or invaginated from the sulcus between sixth and seventh sternites; usually of the enclosed type. Benthonic or bathypelagic.

Key to the Determination of the Genera Examined.

I. Prosartema absent; telson with no fixed pair of lateral spines, apex truncated or with a minute point [Series Benthesicymæ].
  A. A podobranch present on each appendage from maxilliped 2 to peræopod III; telson with more than one pair of mobile lateral spines.
    i. Median carina present on a varying number of abdominal somites in addition to the sixth; apex of telson usually pointed.
      a. Hepatic spine present or absent; dactyli of paræopods IV and V normal and undivided . . . . *Benthesicymus* Bate
      b. Hepatic spine present; dactyli of peræopods IV and V flagelliform and multi-articulate . . . . *Benthonectes* Smith
    ii. Median carina present on sixth abdominal somite only; apex of telson truncated *Bentheogennema* Burkenroad
  B. No podobranch behind the second maxilliped; median carina on sixth abdominal somite only; telson with a single pair of mobile lateral spines, apex truncated . *Gennadas* Bate
II. Prosartema present; telson with a pair of fixed distal spines in addition to three mobile pairs, apex strong and pointed; no podobranchs posterior to second maxilliped; a median carina on each of the abdominal somites; third maxilliped and each peræopod with additional segments (*i.e.* some segments subdivided). [Position uncertain.] . . . *Gordonella* n.g.

Genus Benthesicymus Bate

Benthesicymus Bate, 1881, p. 190; 1888, p. 326.
Benthesicymus, Smith, 1882, p. 81; Faxon, 1895, p. 203; Alcock, 1901, p. 42; Bouvier, 1908, p. 16; de Man, 1911, p. 13; Sund, 1920, p. 29; Schmitt, 1921, p. 22; Balss, 1927, p. 247; Burkenroad, 1936, p. 23; Barnard, 1950, p. 582 in key.
Benthonectes Smith, 1884, p. 391; 1885, p. 508; 1887, p. 691.
Gennades, in part; Alcock, 1901, p. 45; Kemp, 1910*b*, p. 179; Schmitt, 1921, p. 23.

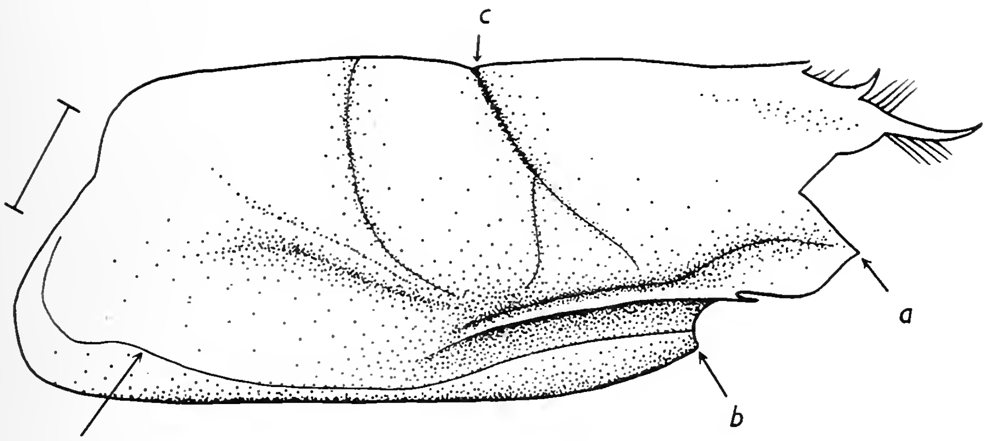
Definition of the Genus.—Benthesicymæ with a podobranch on maxilliped 2 to peræopod III inclusive. Arthrobranch of maxilliped 1 larger than pleurobranch of second maxilliped. Exopod of maxilliped 1 distally constricted and segmented. Median carina present on a varying number of abdominal somites in addition to the sixth. Telson with four pairs of mobile lateral spines; apex usually pointed. Dactyli of peræopods IV and V not divided (after Burkenroad, 1936, p. 23).

The four specimens of *Benthesicymus* trawled by the "Mabahiss" pertain to three species: *B. altus* Bate, *B. bartletti* Smith and *B. seymouri* which is described as new.

Benthesicymus altus Bate

Figs. 1–3

Benthesicymus altus Bate, 1881, p. 191; 1888, p. 336, Pl. LVIII, fig. 1.
Benthesicymus altus, Faxon, 1895, p. 203; Schmitt, 1921, p. 22.



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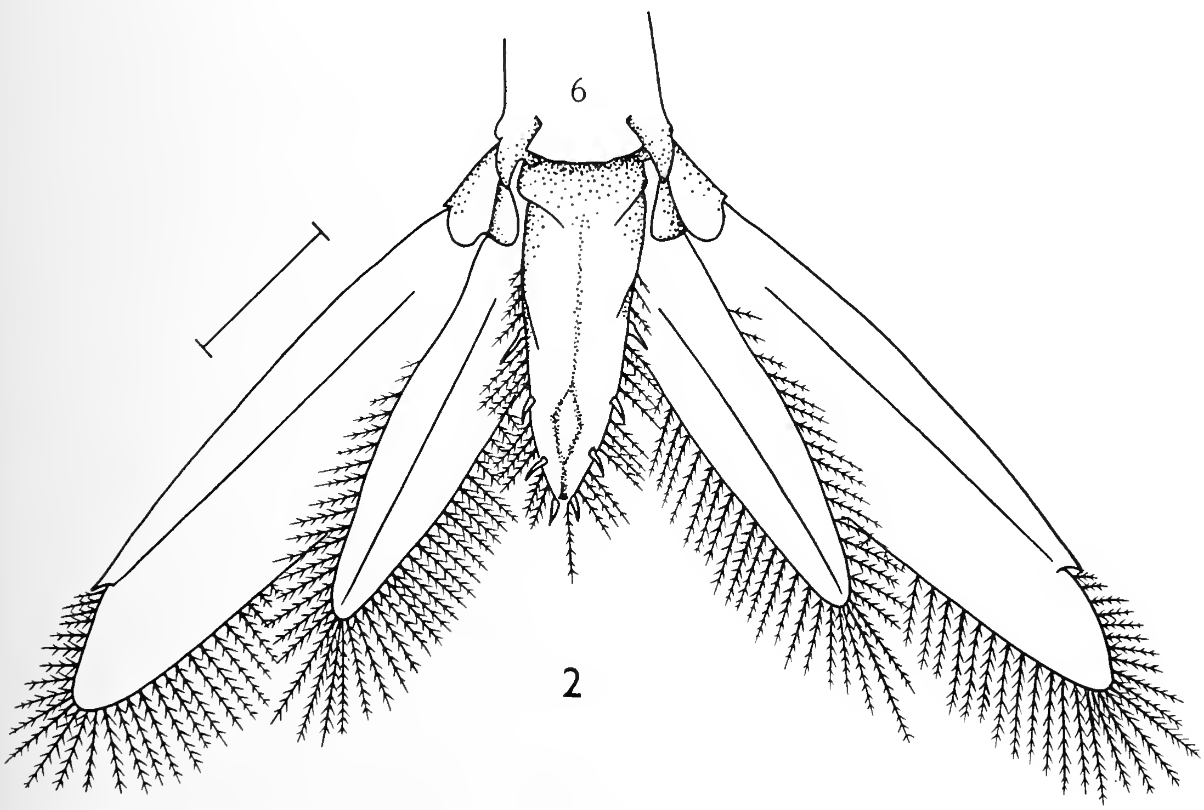

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Benthesicymus altus Bate. Fig. 1.—Carapace in lateral aspect. *a*. Antennal angle. *b*. Pterygostomian angle. *c*. Cervical groove. *d*. Pterygostomian carina. (Scale = 5 mm.) Fig. 2.—Telson and uropods in dorsal aspect. *6*. Posterior part of sixth abdominal tergite. (Scale = 5 mm.)

OCCURRENCE :

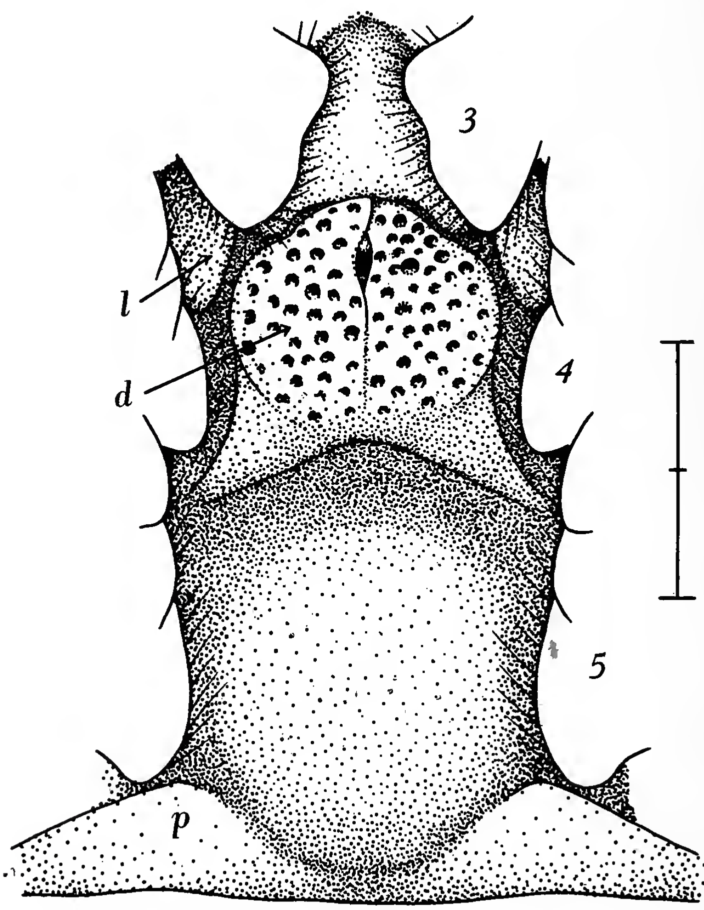
Southern area of Arabian Sea.

St. 133, trawl, 3385 m. 1 female, c.l. 35 mm.

DISTRIBUTION :

Atlantic, Indo-Pacific.

DESCRIPTIVE NOTES.—The *carapace* is soft and membranous (Fig. 1). The apex of the styliform rostrum is curved upwards and the upper margin is armed with two teeth. The post-rostral carina extends only to the cervical groove. The antennal angle is acute and pointed (*a*). The branchiostegal spine (see *B. bartletti* Fig. 4, *b*) is sharp and produced



Benthesicymus altus Bate. FIG. 3.—Thelycum. *d.* Disc-shaped plate on seventh thoracic sternite. *l.* Extreme lateral process of the plate on sixth thoracic sternite. *p.* Protuberance behind base of paræopod V. *3, 4* and *5.* Bases of peræopods III, IV and V respectively. (Scale = 2 mm.)

backwards as a distinct carina which is separated from the pterygostomian carina (*d*) by a shallow groove. The hepatic groove is deep and continuous with the orbito-antennal groove. The latter extends as far as the antennal angle. The cervical and the post-cervical grooves reach up to the dosum. The cervical groove is deep and bifurcate (*c*). The dorsal carina on the *abdomen* is distinct only on the posterior two-thirds of the fifth and the anterior two-thirds of the sixth somites The posterior dorsal margin of the sixth (pleonic) somite which is upturned, affords an excellent diagnostic character (Fig. 2, *6*). The *telson* is armed with four pairs of mobile lateral spines; its tip posterior the the distal pair is damaged (Fig. 2). The mouth-parts are similar to those of *B. bartletti* (see Figs. 6–11). Faxon (1895, p. 204) states that " In the 'Albatross' specimens there are no exopods on any of the appendages behind the third maxillipeds ". In the available female minute exopods, which can hardly be seen with the naked eye, are present on all the legs.

The thelycum of *B. altus* has not previously been figured, and is represented in Fig. 3. There is a pair of triangular projections posterior to the bases of peræopods V (*p*), separated from each other by a large, oval protuberance which occupies almost the entire space between the bases of these peræopods. Anterior to this, on the seventh thoracic sternite, is a raised disc-shaped plate (*d*) and its postero-lateral angles are produced backward and in a lateral direction. The disc is cleft in its anterior half. The antero-median tip of one half overlaps that of the other, posterior to which is a spindle-shaped slit. The surface of the disc is covered with pits, which are not setose as is the case in *B. bartletti* (c.f. Figs. 3 and 12). On the sixth thoracic sternite is a triangular plate with a narrow apex. The base of this plate has five posterior projections: the median projection can be seen through the spindle-shaped slit of the disc. The submedian projections on either side of it are small, while the extreme lateral ones are large and bulging (Fig. 3, *l*).

Benthesicymus bartletti Smith.

Figs. 4–13

Benthesicymus bartletti Smith, 1882, p. 82, pl. XIV, figs. 1–7.
Benthesicymus bartletti, Burkenroad, 1936, p. 47.
Benthesicymus pleocanthus, Bate, 1888, p. 334, pl. LVII, fig. 2.

OCCURRENCE:

Maldive area:

St. 155, trawl, 2249 m., 2 females, c.l. 17 and 31 mm.

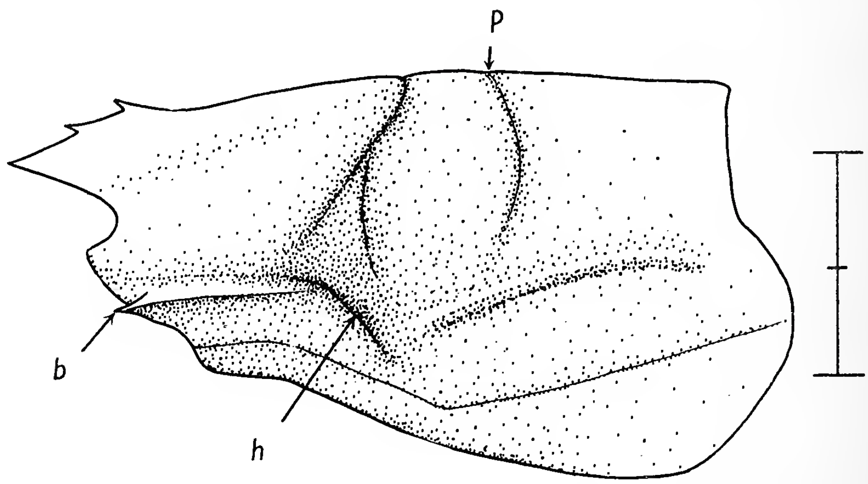
DISTRIBUTION:

Atlantic, Indo-Pacific.

DESCRIPTIVE NOTES.—The specimens agree in general with the description of the species. *B. bartletti* and the species related to it have been reviewed by Burkenroad (1936, p. 47); consequently it is sufficient to give here the differences between it and *B. altus*, and to enumerate the distinctive features of the mouth-parts.

As illustrated in Fig. 4 the *rostrum* is triangular, sharply pointed and almost horizontal. The antennal angle is bluntly rounded. The branchiostegal carina is shorter; it extends to the hepatic groove (*h*) which curves downwards posteriorly. The fifth and sixth *abdominal somites* are dorsally carinated. The carina of the fifth somite is posteriorly prolonged into a long, slender spine (Fig. 5, *5*). It is a matter of considerable interest to note that in all the males of this species, which I had an opportunity of studying in the British Museum (N.H.), the spine is produced from the middle of the fifth abdominal somite; but in both the available females, as stated above, it is a prolongation from the posterior margin of the somite in question. The tip of the *telson* is broken in both the specimens. No exopods are visible on any of the peræopods.

The *mouth-parts* illustrated in Fig. 6–11 are from the right side of the specimen, except the dactylus of the third maxiliped (Fig. 11). The mandibular palp has both its segments expanded and of about the same length (Fig. 6). The endopod of the maxillula (Fig. 7, *e*) gently diminishes in width towards the apex. The proximal gnathobasic lacinia (*g*) is bud-shaped. In the first maxilliped the exopod narrows gently to the tip ; the small, but



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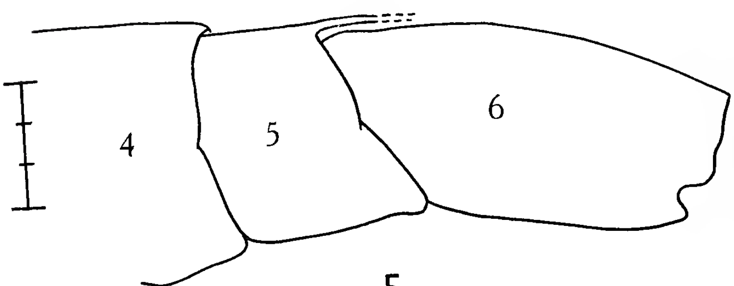

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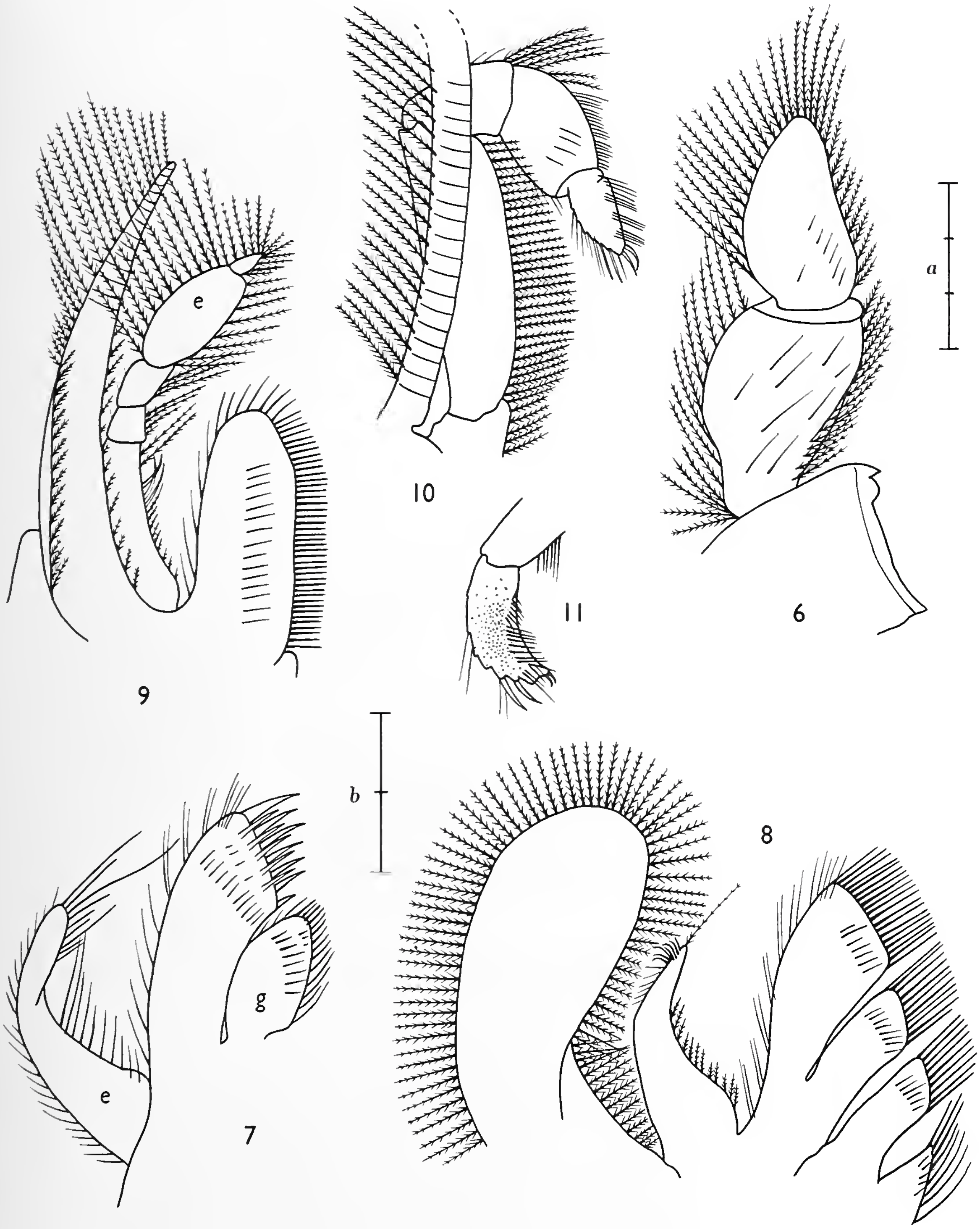
Benthesicymus bartletti Smith. Fig. 4.—Carapace in lateral aspect. *b*. Branchiostegal spine. *h*. Hepatic groove. *p*. Postcervical groove. (Scale = 10 mm.) Fig. 5.—Abdominal somites 4, 5 and 6 in lateral aspect. The fifth is prolonged into a spine. (Scale = 3 mm.)

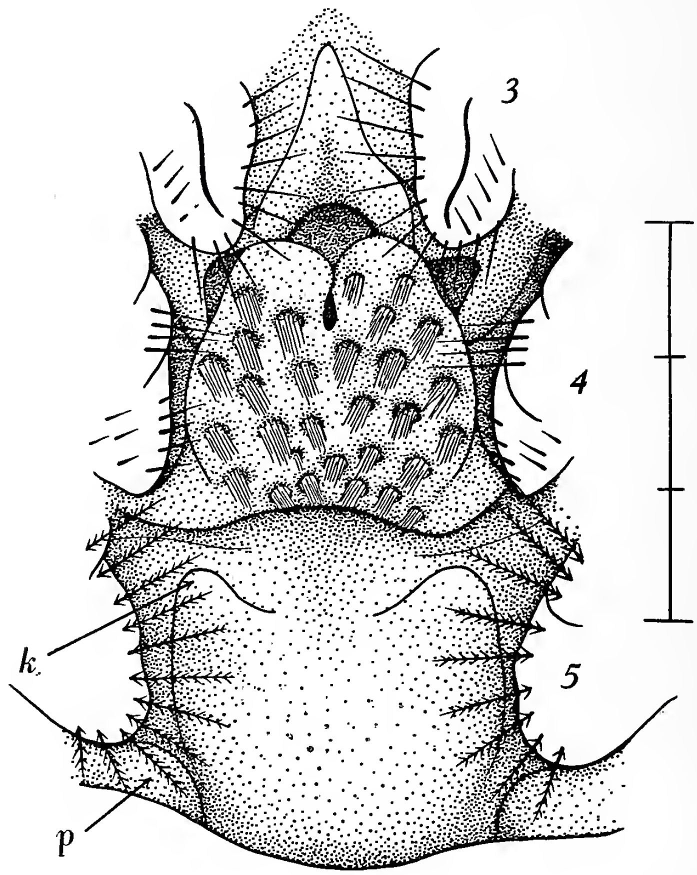
distinct, terminal segment of the five-segmented endopod (*e*) is sharply pointed (Fig. 9). The merus of the second maxilliped is unexpanded being a little more than three times as long as wide. The dactylus of the third maxilliped is sub-rectangular, with two very strong spines and truncated apex.

The *thelycum* of the adult female, which measures 31 mm. in carapace length, is represented in Fig. 12. In this species the projections (*p*), behind the bases of peræopods V, are widely separated. The antero-lateral angles of the protuberances of the eighth thoracic sternite are produced into a pair of knobs (*k*). The plate on the seventh thoracic sternite



Benthesicymus bartletti Smith. Fig. 6.—Mandible. Fig. 7.—Maxillula. *e.* Endopod. *g.* Proximal gnathobasic lacinia. Fig. 8.—Maxilla. Fig. 9.—Maxilliped 1. *e.* Endopod. Fig. 10.—Maxilliped 2 (setæ on median margin of exopod omitted). Fig. 11.—Dactylus of maxilliped 3. (Figs. 6, 9 and 10 at scale *a* = 3 mm.; Figs. 7, 8 and 11 at scale *b* = 2 mm.)

is elliptical ; its surface is covered with larger pits, from which emerge tufts of setæ. The triangular plate differs mainly in the absence of the median projection of its base ; indeed, the base is actually deeply indented in the middle.



Benthesicymus bartletti Smith. FIG. 12.—Thelycum of adult female, c.l. = 31 mm. *k*. Knob on antero-lateral angle of protuberance on eighth thoracic sternite. *p*. Projection behind base of peræopod V. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 3 mm.)

The thelycum of the younger female is shown in Fig. 13. At this stage the antero-lateral angles of the protuberance (*k*), on the eighth thoracic sternite, are only slightly projecting. The plates on the seventh and sixth thoracic sternites show only a little resemblance to those of the adult.

Benthesicymus seymouri n. sp.

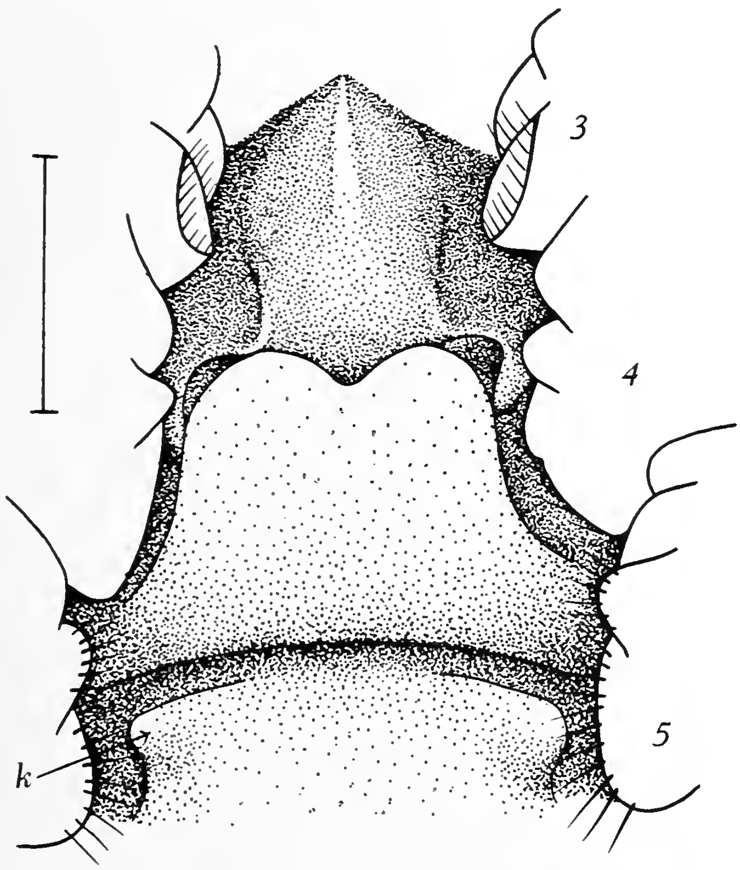
Figs. 14–23

OCCURRENCE :

Zanzibar area :

St. 118, trawl, 1789 m., 1 male, holotype, c.l. 70 mm. (Register number : 1958.6.3.133).

DESCRIPTION.—As usual in the genus the *carapace* is soft and membranous (Fig. 14). The *rostrum* is sharply pointed and directed slightly downwards ; the upper border has two small teeth. The antennal spine is prolonged posteriorly as a slight carina which is separated from the sharp gastro-orbital carina by the orbito-antennal groove (*o*). The large curved branchiostegal spine is also produced backwards as a sharp carina. The only other spine present on the carapace is the minute hepatic spine (*h*). The pterygostomian carina and groove are fairly well marked. There is a curious arrangement of carinæ behind the

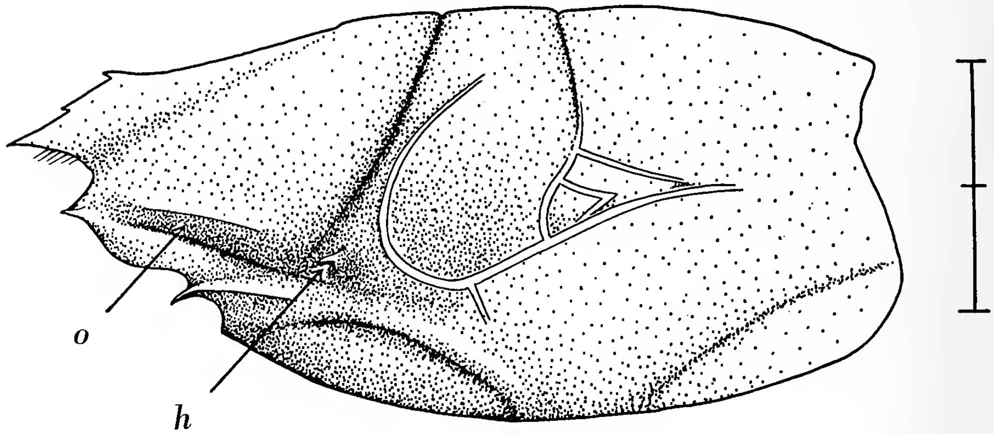


Benthesicymus bartletti Smith. FIG. 13.—Thelycum of immature female, c.l. = 17 mm. (Scale = 1 mm.) Lettering as in Fig. 12.

cervical groove, on the side of the carapace, as shown in Fig. 14. The *abdomen* has dorsal carinæ on fourth, fifth and sixth somites; that of the sixth ends in a small tooth. The *telson* has four pairs of mobile lateral spines and a strongly pointed apex (Fig. 23).

The *mouth-parts* from the left side of the specimen are illustrated in Fig. 17–22. They differ from those of *B. bartletti* in having the distal segment of the mandibular palp narrower and shorter than the proximal one (Fig. 17). The latter is one and a half times as long as the distal. The proximal gnathobasic lacinia of the maxillula is narrowly pointed at the apex (Fig. 18). The exopod of the first maxilliped narrows abruptly at the base of the distal segmented portion (Fig. 20). The merus of the second maxilliped is expanded, being more than two and a half times as long as wide (Fig. 21). The dactylus of the third maxilliped has a single apical spine (Fig. 22).

The distal margin of the petasma is divided into two distinct lobes, each of which is armed with rows of small denticles (Fig. 15 *m.l.* and *i.l.*). The spinules of the inner margin are borne on a ridge running up the anterior surface of the petasma. The outer scale of the appendix masculina (Fig. 16) is large, with the lateral margin very convex and the apex



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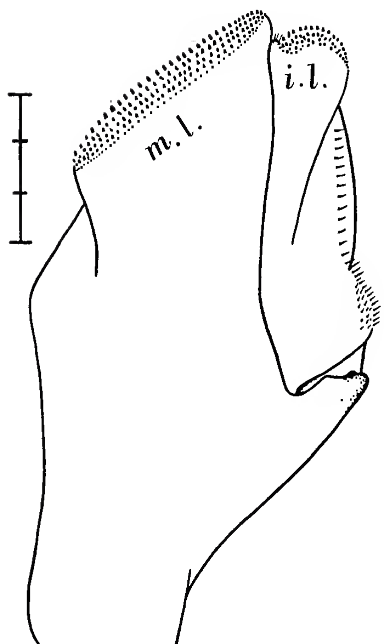

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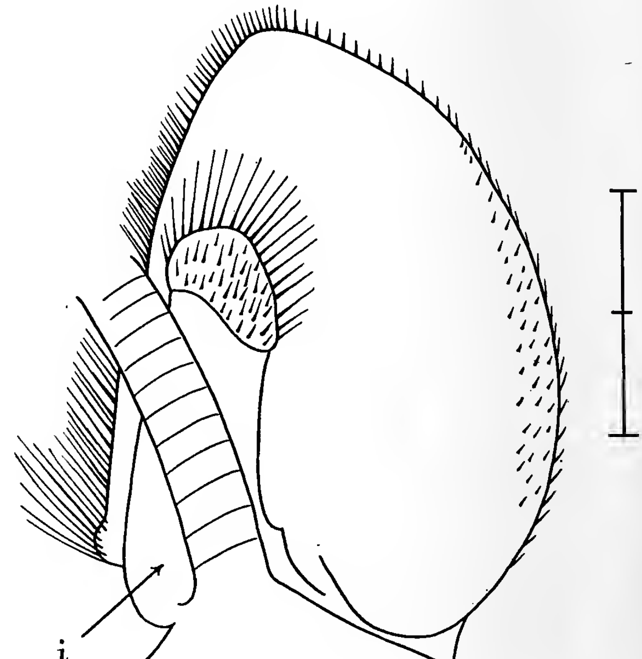


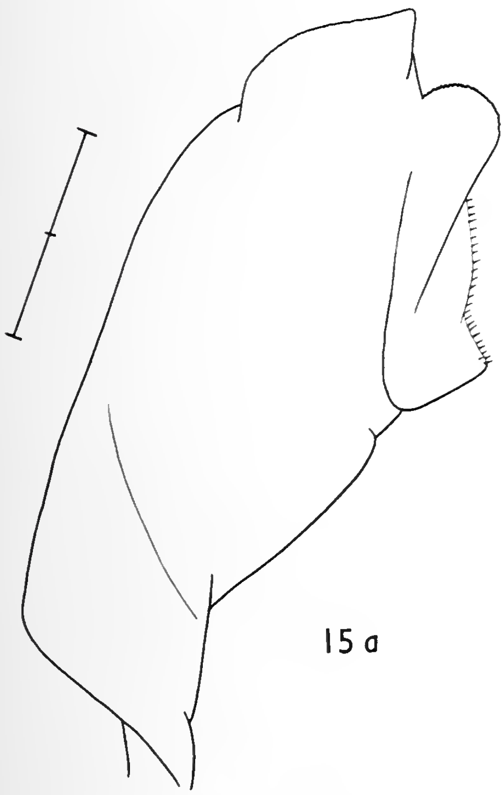
16

Benthesicymus seymouri n. sp. Holotype. Fig. 14.—Carapace in lateral aspect. *o.* Orbito-antennal groove. *h.* Hepatic spine. (Scale = 20 mm.) Fig. 15.—Petasma. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 3 mm.). Fig. 16.—Appendix maculina. *i.* Inner scale. (scale = 2 mm.)

toward the medial margin bordered with spines. The inner scale (*i*) is small and rod-like; the distal end is capped with spines, of which the marginals are greatly elongated.

Remarks.—*B. seymouri* certainly belongs to the *B. brasiliensis* complex as discussed by Burkenroad (1936, p. 30, key on p. 45). Of the five species included in this complex

(*B. brasiliensis, B. urinator, B. strabus, B. cereus* and *B. iridescens*) the present species closely resembles *B. brasiliensis*. A male specimen of *B. brasiliensis* Bate, identified as such by Burkenroad, has been made available by the courtesy of the authorities of the British Museum. On comparing *B. seymouri* with it and the literature, I notice the following differences. *B. seymouri* differs from *B. brasiliensis* in being a much larger species. Further, in *B. seymouri* the ocular peduncle exceeds the tip of the rostrum by about its distal half, while in Bate's species it extends beyond the rostrum only by the length of the cornea. The ocular tubercle, which is situated on the median margin of the peduncle, in my specimen



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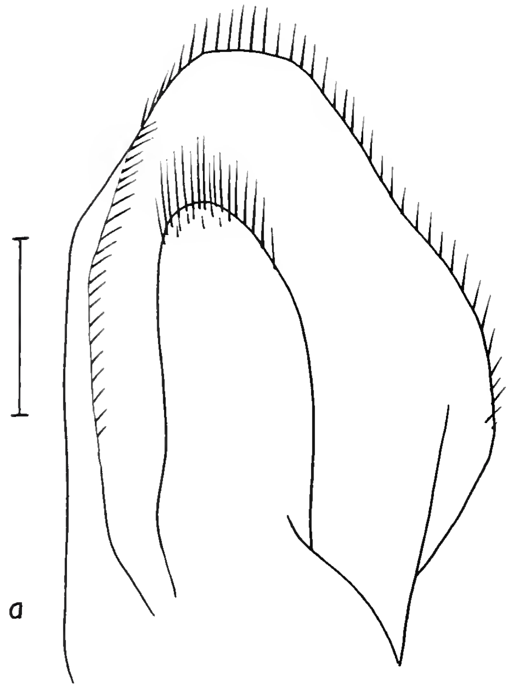
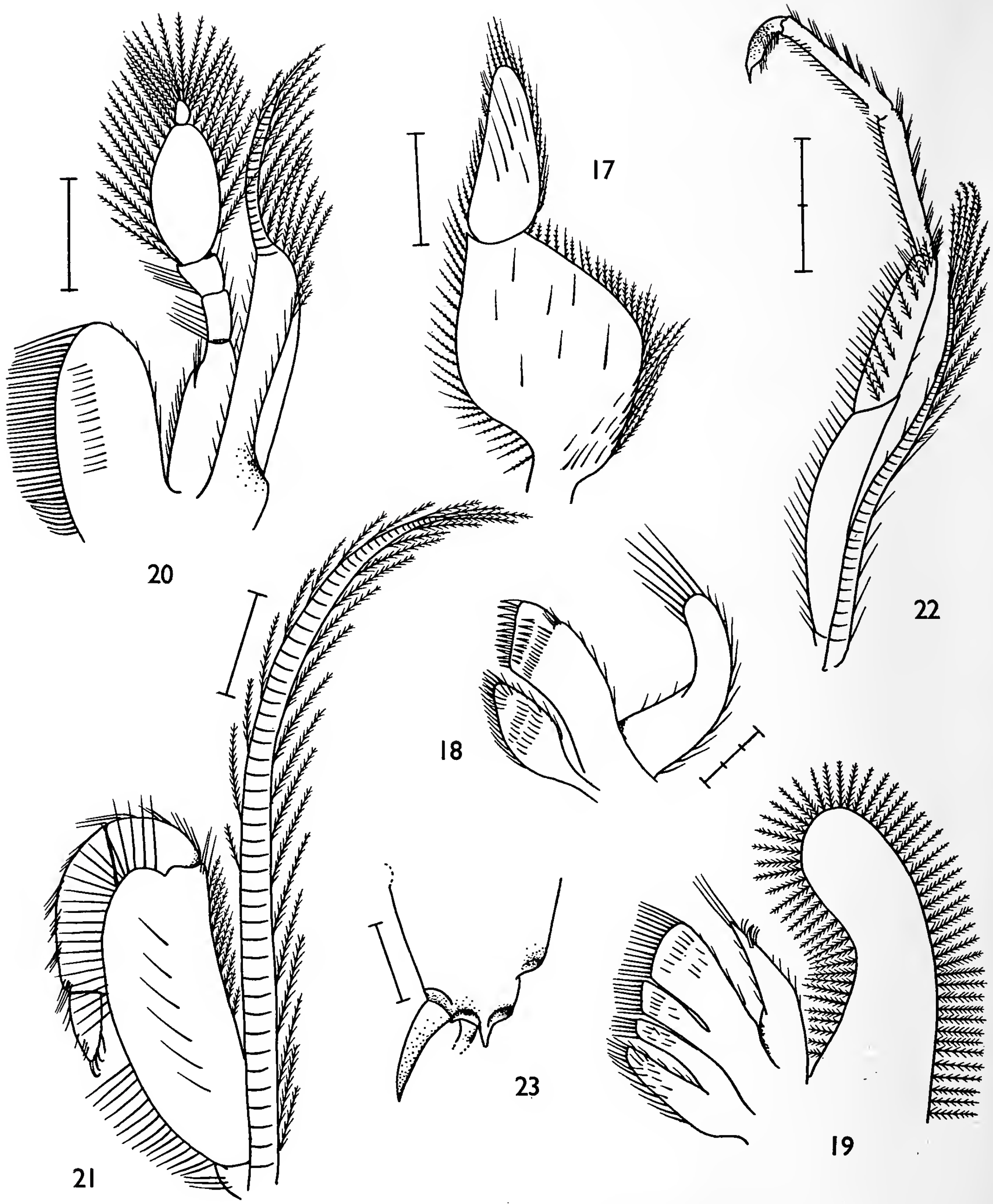


16 a

Benthesicymus brasiliensis Bate. FIG. 15*a*.—Petasma of adult male. (Scale = 2 mm.)
FIG. 16*a*.—Appendix masculina. (Scale = 0·5 mm.)

is rudimentary and near the base of the peduncle; in *B. brasiliensis* it is acute and situated near the middle. Each of the last four abdominal somites is armed with a tooth in *B. brasiliensis,* that of the third is very prominent. The abdominal somites of *B. seymouri* are unarmed except for a very minute tooth on the sixth. The distance between the ultimate and the penultimate pair of the lateral spines of the telson is much less than that between the penultimate and the antepenultimate pair. Finally, the petasma of *B. seymouri* is broad and the distal margin is furnished with rows of small denticles (*c.f.* Burkenroad, 1936, p. 40, Fig. 31 and Fig. 15*a* with Fig. 15 of the present paper). The appendix masculina of *B. seymouri* is very similar to that of *B. brasiliensis* save for the spines on the median margin of the outer scale which are appreciably elongated and thickly set in *B. seymouri.*

This species is named in honour of Lt. Col. Seymour Sewell, the leader of the "John Murray" Expedition.



Benthesicymus seymouri n. sp. Holotype. FIG. 17.—Mandibular palp. (Scale = 5 mm.) FIG. 18.—Maxillula. (Scale = 3 mm.) FIG. 19.—Maxilla. FIG. 20.—Maxilliped 1. FIG. 21.—Maxilliped 2 (all 3 figs. at scale = 5 mm.). FIG. 22.—Maxilliped 3. (Scale = 10 m.). FIG. 23.—Tip of telson. (Scale = 1 mm.)

Genus Benthonectes Smith

Benthonectes Smith, 1885, p. 509; 1886, p. 691.
Benthonectes, Burkenroad, 1936, p. 16.

Definition of the Genus.—Benthesicymæ with podobranch on somites VIII–XII. Arthrobranch of maxilliped 1 larger than pleurobranch of second maxilliped.* Exopod of maxilliped 1 distally constricted and segmented. Median carina present on abdominal somites 5 and 6. Telson with four pairs of mobile lateral spinules and a small pointed apex. Dactyli of the fourth and fifth legs very long and multiarticulate. A single species *B. filipes* Smith.

Benthonectes filipes Smith

Figs. 24–35

Benthonectes filipes Smith, 1885, p. 509.
Benthonectes filipes, Smith, 1887, p. 692, 88, pl. XVIII, fig. 1, 1*a*; pl. XIX, fig. 1, 1*a*, 1*b*; Rathbun, 1906, p. 907; Bouvier, 1922, p. 8, pl. I, fig. 1.
Benthesicymus bartletti A. Milne-Edwards, 1883. Recueil de Figures de Crustacés . . . pl. 41.

History.—Smith (1885, p. 509) described this species from four specimens (three males and one female) obtained as a result of the " Albatross " dredgings off the East coast of the United States in 1884, taken from depths between 693 and 1043 fathoms. Later on, a single male was recorded from the Hawaiian islands by Rathbun (1906, p. 907). Five specimens were taken by the Expedition of S.A.S. the Prince of Monaco, off Cape Hatteras; a coloured illustration of one of those specimens (a male) was published by Bouvier (1922, p. 8, pl. I, fig. 1). He also reported that two specimens were taken by the " Talisman " off Morocco.

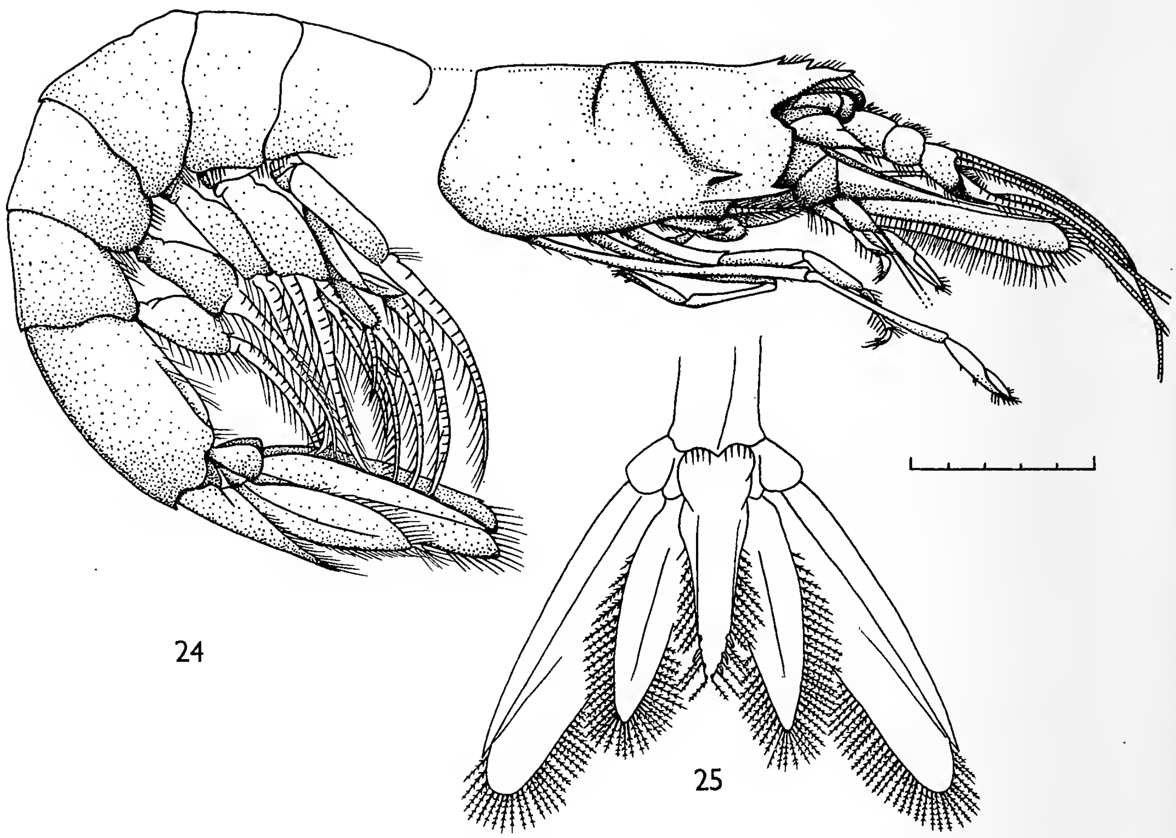
The present description is based on a male taken by the " Talisman ", locality: 32° 34 N. 12° 09 W. from a depth of 1590 m. and determined by Bouvier. It was very kindly lent by the authorities of the Paris Museum.

Description.—The *carapace*, which measures 21 mm. from the tip of the rostrum to the posterior dorsal edge, is smooth, rather soft and transparent (Fig. 24). The short rostrum is sharply pointed at the apex and nearly reaches the anterior border of the eyes; its upper border is armed with two teeth and is setose; the lower border is fringed with longe setæ. The post-rostral carina is slightly defined and extends almost to the posterior rim of the carapace. Antennal and hepatic spines are well developed. The antennal carina is sharply defined and reaches as far back as the base of the hepatic spine. The cervical groove is deep and reaches the dorsum about 13·5 mm. from the tip of the rostrum. The post-cervical groove also extends to the dorsum; it is defined only on the upper third of the carapace below which it fades out rather abruptly. The pterygostomian angle is rounded and the pterygostomian carina is totally absent.

The *abdomen*, like the carapace, is entirely smooth and dorsally carinate throughout the whole length of the sixth, and on the posterior two-thirds of the fifth, somite; in each case the carina ends posteriorly in a very small tooth. The *telson* is shorter than the sixth abdominal somite and tapers sharply towards the apex (Fig. 25). It is armed on the distal fourth of the lateral border with four pairs of mobile spines, the anterior pair being smallest; the extreme tip beyond the fourth pair of spines (which are missing) is broken.

* Branchial formula based on Smith's observations (1885, p. 510).

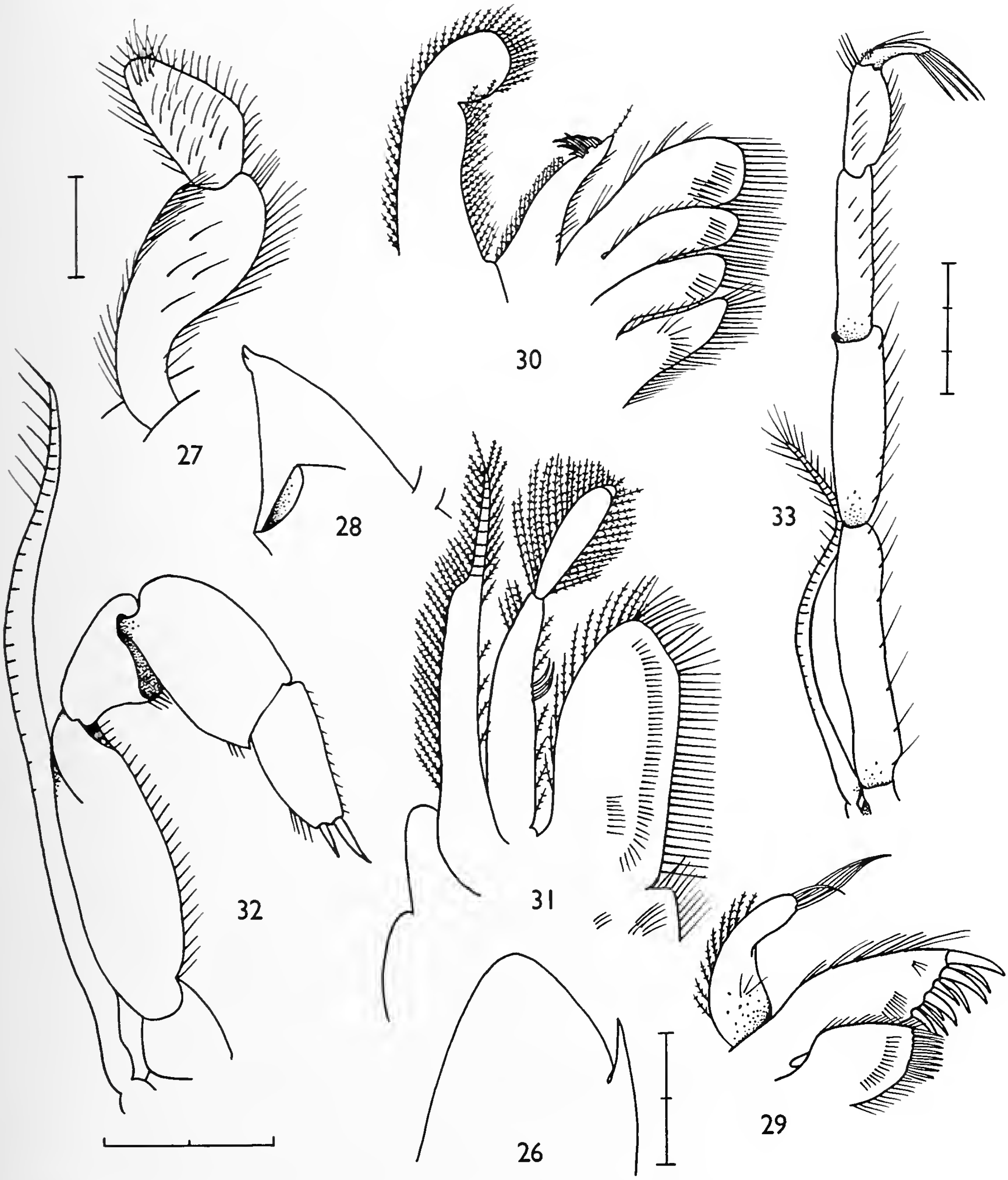
The reniform *eyes* are borne on stalks which are about twice as long as the greatest diameter of the eyes. Smith mentions " . . . a small and inconspicuous tubercle on the mesial side of the stalk just back of the edge of the eye " (1885, p. 509). I have not been able to make out this tubercle in the available specimen. The peduncle of the *antennule* is at least half as long as the carapace. The inner flagellum is inserted at the tip, the outer a little posterior to it, on the upper proximal border of the last peduncular segment. The



Benthonectes filipes Smith. FIG. 24.—Male in lateral aspect. (Scale = 10 mm.)
FIG. 25.—Telson and uropods further enlarged.

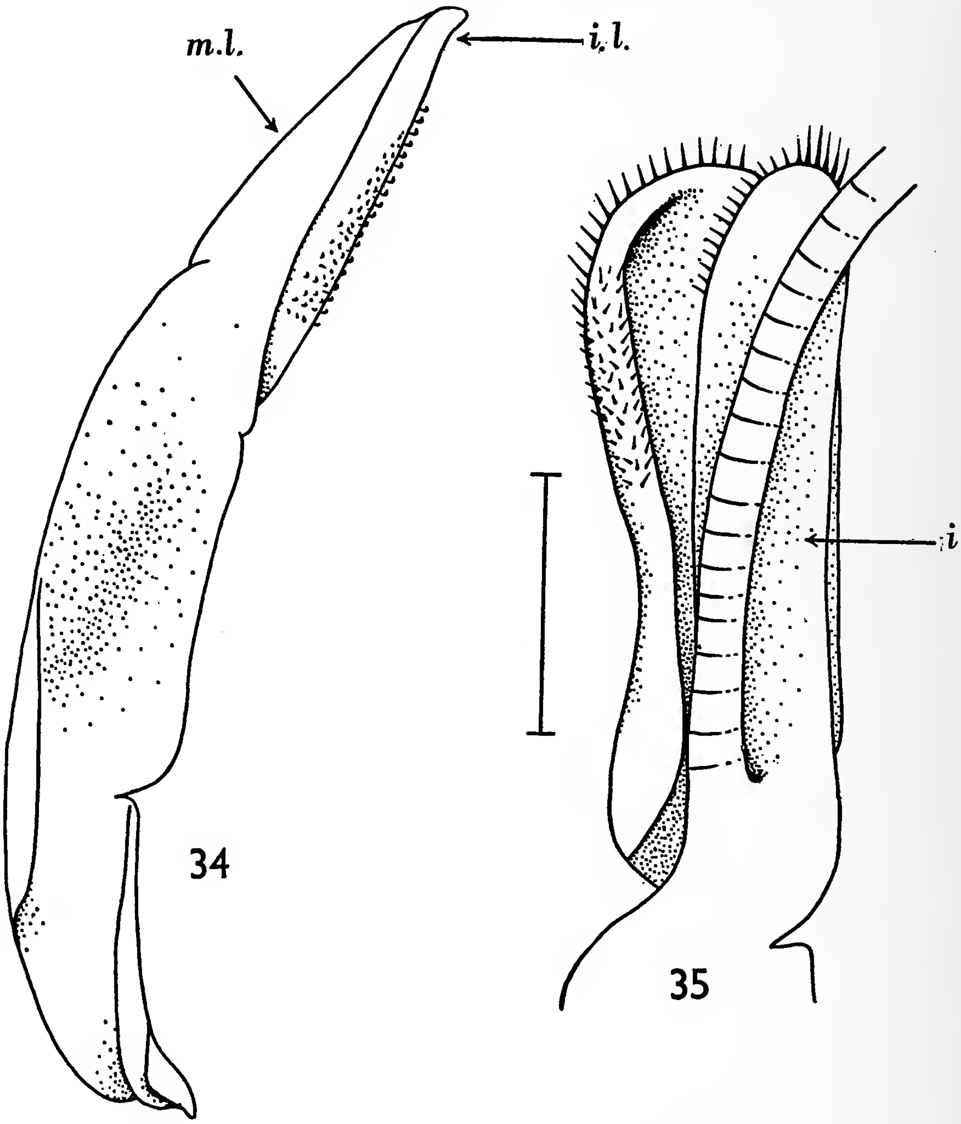
flagella are not complete in this specimen ; however, Smith said that they " are approximately equal in length, much longer than the body of the animal and very slender " (1885, p. 509). Bouvier's figure of the species shows the same. The *antennal scale* is long and narrow being about four times as long as it is broad (14 × 3.2). The apex of the blade is directed medially (Fig. 26).

The *mouth-parts* are as represented in Fig. 27–33. The *mandible*, as pointed out by Smith, is peculiar. The incisor process is greatly prolonged at the antero-median angle. The cutting edge is sharply defined and is provided with a pointed tooth at the anterior acuminate end. The palp is rather slender ; the basal segment is twice as long as it is broad ; it is anteriorly expanded and is directed inwards. The distal segment is short, being two-thirds as long as the basal one. It is slightly narrower and directed outwards; its antero-median border is truncated and the extreme tip is rounded (Figs. 27 and 28). The endopod of the *maxillula* gently diminishes in width towards the rounded tip. The proximal gnathobasic lacinia is pointed at the median angle. The *maxilla* shows only one little difference which can be observed on comparing its exopod with those of the other species of Benthesicymæ whose mouth-parts are illustrated in the present paper (Figs. 6–11, 17–22, 41–46, 89–94), being markedly narrower than in the others. With regard to



Benthonectes filipes Smith. Fig. 26.—Apex of antennal scale, setæ omitted. (Scale = 2 mm.) Fig. 27.—Mandibular palp (Scale = 5 mm.) Fig. 28.—Mandibular crown, in dorsal aspect. Fig. 29.—Maxillula. Fig. 30.—Maxilla. Fig. 31.—Maxilliped 1. Fig. 32.—Maxilliped 2. (Figs. 29–32 at scale = 2 mm.) Fig. 33.—Maxilliped 3. (Scale = 3 mm.)

the *first maxilliped* there seems to have been some doubt about the exact nature of the terminal segment of the endopod. According to Smith " . . . the small terminal segment is either wanting or very obscure " (1885, p. 510). Burkenroad (1936, p. 17), discussing the relationship of this genus to the other members of the Benthesicymæ series, says that it is completely obliterated. In the specimen at hand the endopod appears to be three segmented and the terminal segment is very small but distinct (Fig. 31). The nature of the



Benthonectes filipes Smith. FIG. 34.—Left half of petasma, in anterior aspect. *i.l.* Internal lobe. *m.l.* Median lobe. FIG. 35.—Left appendix masculina, in posterior aspect. *i.* Inner scale. (Scale = 1 mm.)

articulation of this segment with the preceding one is very different from that of *Benthesicymus bartletti* Smith, to which this species seems to be very closely related and with which Smith compared his specimen. In the form of the exopod it differs from *B. bartletti* : here the exopod narrows abruptly to a segmented distal portion. In the endopod of the *second maxilliped* the merus is three times as long as broad ; the dactylus is truncated at its distal end which bears two strong spines. The exopod is slender and seems to be slightly shorter than the endopod (Fig. 32). The endopod of the *third maxilliped* is slender and greatly elongated. The segments decrease in length from ischium to dactylus. The propodus is slightly expanded and bears a tuft of long setæ at its disto-lateral angle. The dactylus is narrow, curving medially and bears, near the proximal end of the outer margin, a tuft of minute thick spines; and at the extreme tip, which is truncated, there are four very long and slender spines. The exopod is slender and about half as long as the endopod (Fig. 33).

Most of the *peræopods* are unfortunately missing in this specimen. From those which are present it can be said that the chelate peræopods are slender. The most characteristic feature of this species is the extremely long and filiform dactylus of peræopods IV and V. There is only one complete dactylus, which is in a separate tube and it is difficult to decide whether it belongs to the fourth or the fifth pair. It measures 28 mm. in length and consists of 90–96 segments.

The poor condition of the specimen does not allow of a careful study of the branchiæ. Smith, however states that " The number and arrangement of the branchiæ and the epipods are the same as in *Benthœcetes bartletti*, but there are small rudimentary exopods at the bases of all the peræopods " (1885, p. 510). The rudimentary exopods can be seen in this specimen.

The *pleopods* are very long and slender (Fig. 24). The *petasma* has not been examined in detail by previous writers. It is very long, slender and rather thin (Fig. 34). The distal margin is divided into two lobes, internal and median (*i.l.* and *m.l.*) though not as distinctly as in *Benthesicymus seymouri* (see Fig. 16). The internal lobe is unarmed, but there are spinules on the median border of the petasma. The median lobe is separated from the rest of the petasmal blade by a notch.

The *appendix masculina*, which is represented in Fig. 35, has never been described or figured. It consists of two long slender scales, each rounded at the apex and provided with apical spines. In addition, the outer (wider) scale has numerous spinules on the distal portion of the thickened median border. The inner scale (*i*) lies in the concavity of the outer, and the flagellum in the concavity of the inner scale.

Remarks.—*Benthonectes filipes* Smith was required for comparison with *Gordonella polyarthra* (see p. 379) which I at first thought might possibly be the female of *B. filipes* or a new species belonging to that genus. On comparing the two specimens I found that they were very distinct from one another. Since the description of *B. filipes* was not very satisfactory, I took the opportunity to re-describe the specimen and figure it.

Genus Bentheogennema Burkenroad

Gennadas (in part) Bate, 1888, p. 343.
Gennadas (in part) Kemp, 1909, p. 723; 1910*b*, p. 176; de Man, 1911, p. 16; Calman, 1925, p. 3; Balss, 1927, p. 248; 1957, p. 1517.
Amalopenæus, Sund, 1920, p. 29 (in part).
Bentheogennema Burkenroad, 1936, p. 56; 1940, p. 37.
Bentheogennema, Barnard, 1950, p. 634.

The name *Bentheogennema* was given by Burkenroad to those species of *Gennadas* which possess a podobranch on the first three pairs of peræopods (for further details see p. 340).

Definition of Genus.—Benthesicymæ with a podobranch on maxilliped 2 to peræopod III inclusive; arthrobranch of maxilliped 1 large and richly plumose. Exopod of maxilliped

1 without a constricted, segmented distal portion. Dorsal carina on sixth abdominal somite only. Telson with more than a single pair of mobile lateral spinules and with a truncated apex. (After Burkenroad, 1936, p. 56).

Only four species are attributed to this genus :

*B. intermedium** Bate, 1888
B. borealis (Rathbun) 1902
B. pasithea (de Man) 1911
B. stephensi Burkenroad 1940.

In the " John Murray " collection the genus is represented by two specimens, both belonging to *B. intermedium*, the type species.

Bentheogennema intermedium (Bate)

Figs. 36–38

Gennadas intermedius Bate, 1888, p. 343, pl. lviii, fig. 3.
Gennadas intermedius, Kemp, 1909, p. 723, pl. LXXIII, figs. 7–12 and pl. LXXV, fig. 3; Calman, 1925, p. 7; Balss, 1927, p. 249 (part).
Gennadas alicei Bouvier, 1906, p. 748; 1908, p. 30, pl. I, fig. 2, pl. VI; 1922, p. 9.
Gennadas alicei, Milne-Edwards and Bouvier, 1909, p. 191; Lenz and Strunck, 1914, p. 309.
Gennadas sp., Rathbun, 1906, p. 907, fig. 62.
Amalopenæus alicei Sund, 1920, p. 29.
Bentheogennema intermedia Burkenroad, 1936, p. 56, fig. 50.
Bentheogennema intermedia, Barnard, 1950, p. 634, fig. 119, *a* and *b*.

OCCURRENCE :

Zanzibar area :

St. 120, trawl, 2926 m., 1 female, c.l. about 15 mm.

Maldive area :

St. 156, trawl (trawl never on the bottom; sounding 1317 m.), 1 female, c.l. about 14 mm.

DISTRIBUTION :

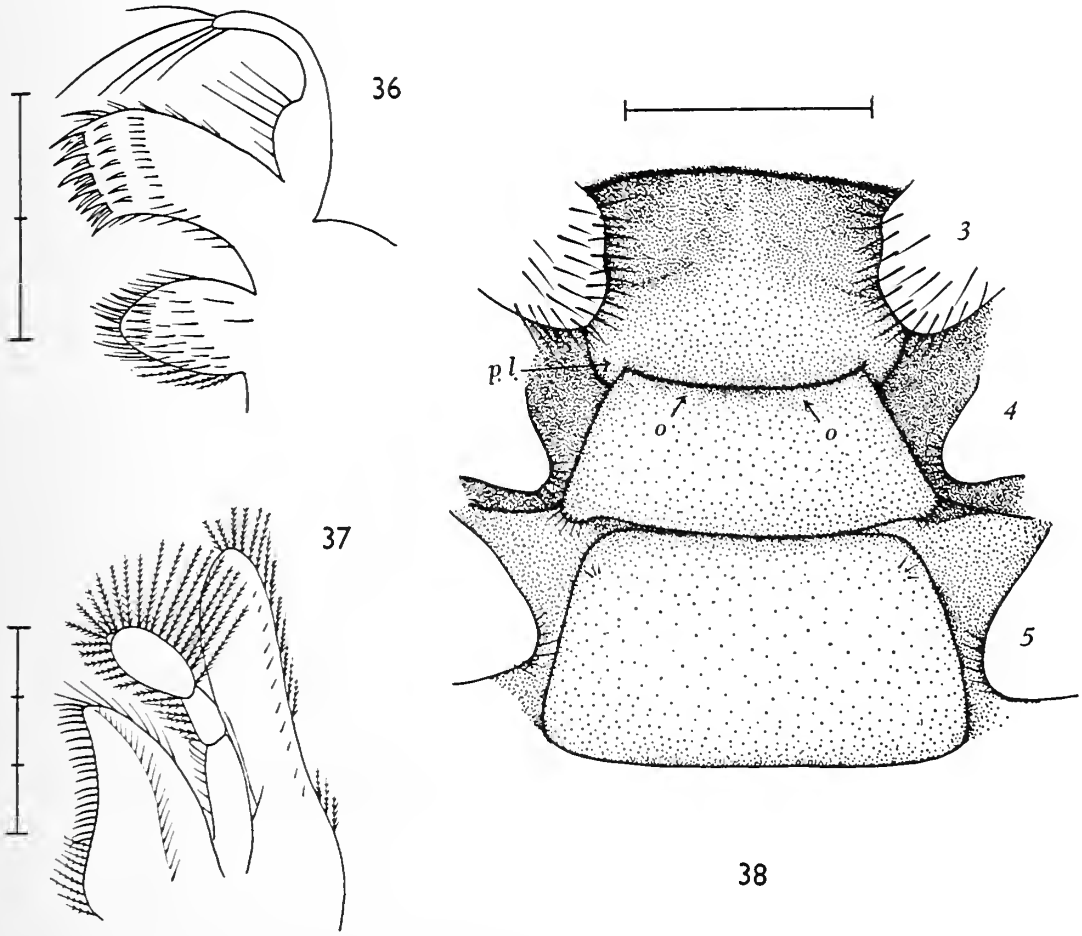
Atlantic, Pacific and now definitely recorded from the Indian Ocean.

DESCRIPTIVE NOTES.—The *carapace* in both the specimens is unfortunately in bad condition. At any rate, it can be seen that the antennal and the infra-antennal angles are bluntly rounded and obtuse as stated by Kemp (1909, p. 723). The *telson* is armed with four pairs of lateral mobile spines. The endopod of the *maxillula* narrows abruptly to a medially curved distal portion. The proximal gnathobasic lacinia is sub-oval: tapering medially (Fig. 36). The exopod of the *first maxilliped* is, as already stated above, without a constricted, segmented distal portion. The endopod is only four-segmented, and the terminal segment is extremely minute (Fig. 37).

The *thelycum* of *B. intermedium* has been illustrated by Bouvier (1908, pl. VI, fig. 17) and Burkenroad (1936, fig. 50). On comparing these figures two important differences are perceptible: in Burkenroad's figure the plate on the sixth thoracic sternite is subtriangular, its apex not reaching as far as the anterior limit of that sternite and the postero-

* The generic name *Bentheogennema* being neuter, the specific name *intermedius* had to be changed accordingly.

lateral angles of the plate are projecting backwards. According to Bouvier the apex of the triangular plate is prolonged, but how far it extends is not indicated in his figure. The postero-lateral angles are not projecting at all. In the available females the sculpture of the sixth thoracic sternite agrees with Bouvier's figure in the first point and with that of Burkenroad in the second (Fig. 38). It may be described as follows: the posterior half of the large plate, between the bases of peræopod III on the sixth thoracic sternite, is elevated



Bentheogennema intermedium (Bate). Fig. 36.—Maxillula. (Scale = 2 mm.) Fig. 37.—Maxilliped 1. (Scale = 3 mm.) Fig. 38.—Thelycum of female. *o.* Slit-like opening. *p.l.* Postero-lateral angle of plate on sixth thoracic sternite. *3*, *4* and *5*. Base of peræopod III, IV and V. (Scale = 1 mm.)

in a triangular fashion. Beneath this part lie the seminal receptacles (*c.f.* Burkenroad, 1936, fig. 50); there is a slit-like opening along the entire posterior margin of the plate (Fig. 38, *o*). The postero-lateral angles (*p. l*) are produced backwards; their function probably is to act as lateral catches or clasps. The dome-shaped appearance of the plate is due to the apical prolongation of the posterior triangular elevation, in the form of a longitudinal ridge extending to the anterior margin of the sternite in question (sixth thoracic or XII).

Genus GENNADAS Bate

Gennadas Bate, (in part), 1881, p. 191.
Gennadas (in part), Bate, 1888, p. 339 ; Alcock, 1901, p. 44 ; Bouvier, 1906, and 1908, p. 24 ; Kemp, 1909, p. 718 and 1910*b*, p. 173 ; Stephenson, 1923, p. 1 ; Calman, 1925, p. 3.
Gennadas (restricted), Burkenroad, 1936, p. 59 and 1938, p. 57 ; Barnard, 1950, p. 627.
Amalopenæus Smith, 1882, p. 86, 1884, p. 399 and 1887, p. 609 ; Kemp, 1909, p. 728 and 1910*a*, p. 13 ; Balss, 1927, p. 250 and 1957, p. 1517 ; Sund, 1920, p. 27 (part).
Gennadas (*Amalopenæus*) Bouvier, 1922, p. 9.
Not *Gennadas*, Balss, 1927, p. 248 and 1957, p. 1517.

HISTORY.—The genus was established by Bate (1881, p. 191) for *Gennadas parvus*, which was said to possess the same branchial formula as *Benthesicymus*, another new genus described in the same paper (p. 190), the important feature, in the branchial formula, being the presence of podobranchs on the first three pairs of peræopods.

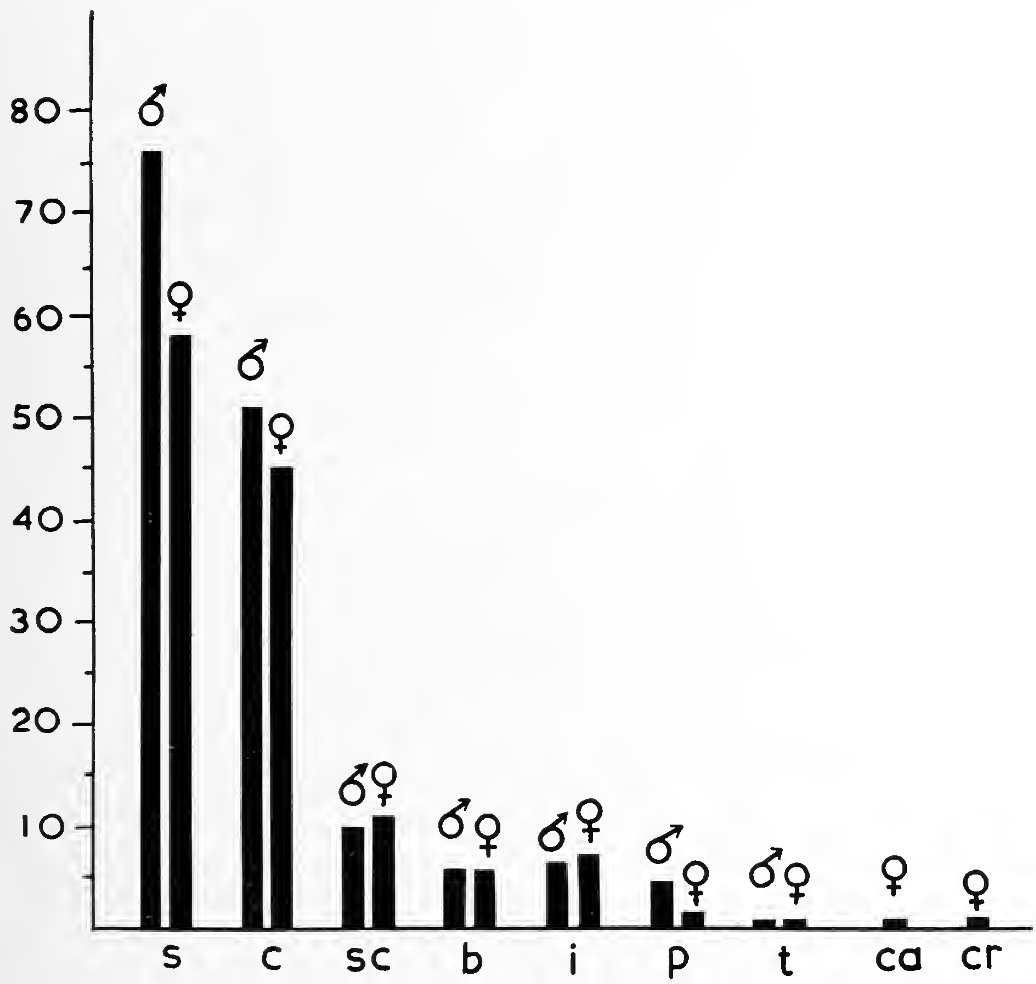
Smith (1882, p. 86) described the genus *Amalopenæus* for the reception of *Amalopenæus elegans* and later on (1884, p. 402) added *Amalopenæus valens*. This genus differed from Bate's *Gennadas* only in the absence of the podobranchs from the anterior three pairs of peræopods. Since then *Amalopenæus* Smith was variably used by subsequent workers, as discussed below.

Bouvier in 1908 (p. 24) regarded *Amalopenæus* as a synonym of *Gennades*, but later on (1922, p. 9), mainly on Kemp's observations, recognized it as a sub-genus of *Gennadas*. Kemp (1909) revised the " Challenger " material and showed that under the name *Gennadas parvus* Bate had described no less than five different species ; but unfortunately, he too, mistook the arthrobranchs for the podobranchs, and so confirmed Bate's observation. Regarding the absence of the podobranchs as a feature of great importance, Kemp retained *Amalopenæus* as a distinct genus. Calman (1925) however, showed definitely that in *Gennadas scutatus* Bouvier—a species hitherto believed to possess podobranchs on the chelipeds and so described a true *Gennadas*—there was no trace of the podobranchs attached to the epipods of the chelipeds. Balss (1927, p. 248) confirmed Calman's observation and, moreover, stated that the same held good for the type species of the genus *Gennadas parvus* Bate. Although they agreed as to the branchial formula, these two authors did not use the same nomenclature. Calman, not giving very great systematic importance to the podobranchs, described both the groups under the name *Gennadas*. Balss, on the other hand, recognized two genera—those with the podobranchs as *Gennadas*, with *Gennadas intermedius* Bate, as the type species ; and those lacking the podobranchs as *Amalopenæus*, with *Amalopenæus parvus* as the type species.

Burkenroad (1936) discussed in detail the diagnostic characters of the species of Benthesicymæ and regarded *Amalopenæus* Smith as a synonym of *Gennadas* Bate, which he restricted to include only the species without podobranchs on the anterior peræopods ; he gave a new name *Bentheogennema* to the species with podobranchs.

DEFINITION OF THE GENUS.—Benthesicymæ lacking podobranchs behind second maxilliped, with arthrobranch of maxilliped 1 reduced to a vestige. Exopod of maxilliped 1 without distal segmented prolongation. Dorsal carina present only on the sixth abdominal somite. Tip of telson truncate and with only a single pair of mobile lateral spines (after Burkenroad, 1936, p. 59).

As defined above the genus includes the following seventeen species, two of which are added here as new and the validity of only *C. propinquus* is uncertain. Of these seventeen, nine species are represented in the " John Murray " collection (see histogram). In addition to these *G. capensis*, *G. elegans*, *G. gilchristi*, *G. kempi*, and *G. valens* were made available through the great kindness of the authorities of the British Museum.

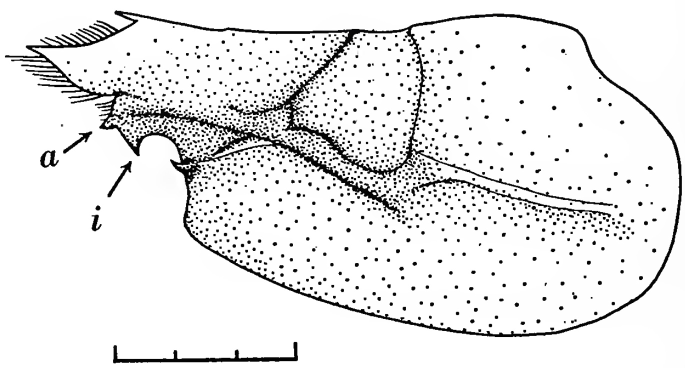


HISTOGRAM 1.—Number of specimens of males and females of the species of the genus *Gennadas* obtained by the " Mabahiss ". s. *G. sordidus* Kemp. c. *G. clavicarpus* de Man. sc. *G. scutatus* Bouvier. b. *G. bouvieri* Kemp. i. *G. incertus* (Balss). p. *G. parvus* Bate. t. *G. tinayrei* Bouvieri. ca. *G. caini* n. sp. cr. *G. crassus* n. sp.

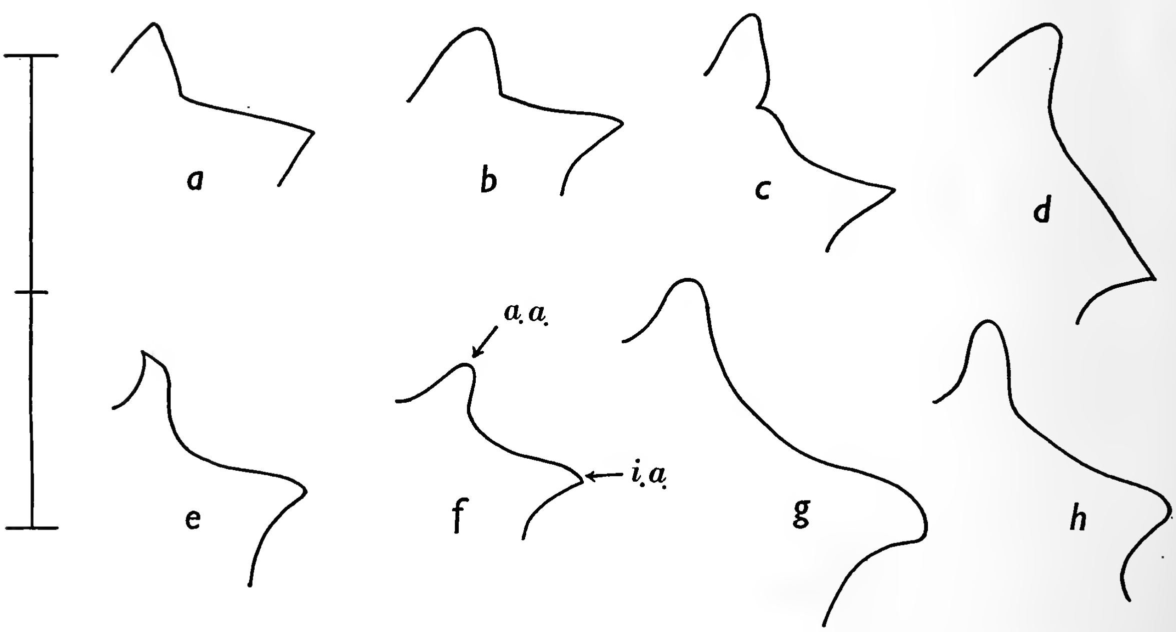
G. bouvieri Kemp 1909 . . . . Indo-Pacific
G. brevirostris Bouvier . . . . Atlantic
(Syn. *G. similis* Stephensen 1923, male ; Syn. *G. chiasmifera* Stephensen 1923, female.)
G. capensis Calman 1925 . . . . Atlantic
G. caini n. sp. . . . . Arabian Sea
G. crassus n. sp. . . . . Zanzibar area
G. clavicarpus de Man 1907 . . . . Indo-Pacific
(Syn. *G. alcocki* Kemp 1910, female ; *G. acutatus indicus* Kemp 1913, male)
G. elegans (Smith) 1882 . . . . Atlantic, Mediterranean
G. gilchristi Calman 1929 . . . . S. Atlantic, Indian Ocean
G. incertus Balss 1927 . . . . Indian Ocean
(Syn. *G. gardineri* (Balss) 1927, female ; *G.* sp? Kemp 1913, female.)

G. kempi Stebbing 1914	S. Atlantic
G. parvus Bate 1881	Indo-Pacific
G. propinquus Rathbun 1906	Hawaiian Is.
G. scutatus Bouvier 1906	Atlantic, Indo-Pacific
G. sordidus Kemp 1910	N. Atlantic, Indian Ocean
G. talismani Bouvier 1906	Atlantic
G. tinayrei Bouvier 1906	Atlantic, Indian Ocean
G. valens (Smith) 1884	Atlantic

(Syn. *G. bidentata* Stephensen 1923, female.)



Gennadas clavicarpus de Man. FIG. 39.—Carapace in lateral aspect, left side. *a.* Antennal angle. *i.* Infra-antennal angle. (Scale = 3 mm.)



Antennal region of various species of *Gennadas*, right side. FIG. 40.—*a. G. parvus* Bate. *b. G. sordidus* Kemp. *c. G. acutus* Bouvier. *d. G. bouvieri* Kemp. *e. G. incertus* (Balss). *f. G. tinayrei* Bouvier. *g. G. caini* n. sp. *h. G. crassus* n. sp. *a.a.* Antennal angle. *i.a.* Infra-antennal angle. (Scale = 2 mm.)

The genus *Gennadas* is very homogeneous; the more important generic characters are discussed below:—

Carapace.—Fig. 39 represents the carapace of *G. clavicarpus* in lateral view. The carapace of the other eight species dealt with is very similar, except for some variation in the antennal and the infra-antennal angles as can be seen in Fig. 40, *a–h*. Both the angles are acute and pointed in *G. parvus* and *G. incertus* (Fig. 40, *a* and *e*); rounded in *G. caini* and *G. crassus* (*g* and *h*), while in the remaining four species the antennal angle is more or less rounded and the infra-antennal sharply pointed (*b*, *c*, *d*, *f* and Fig. 40).

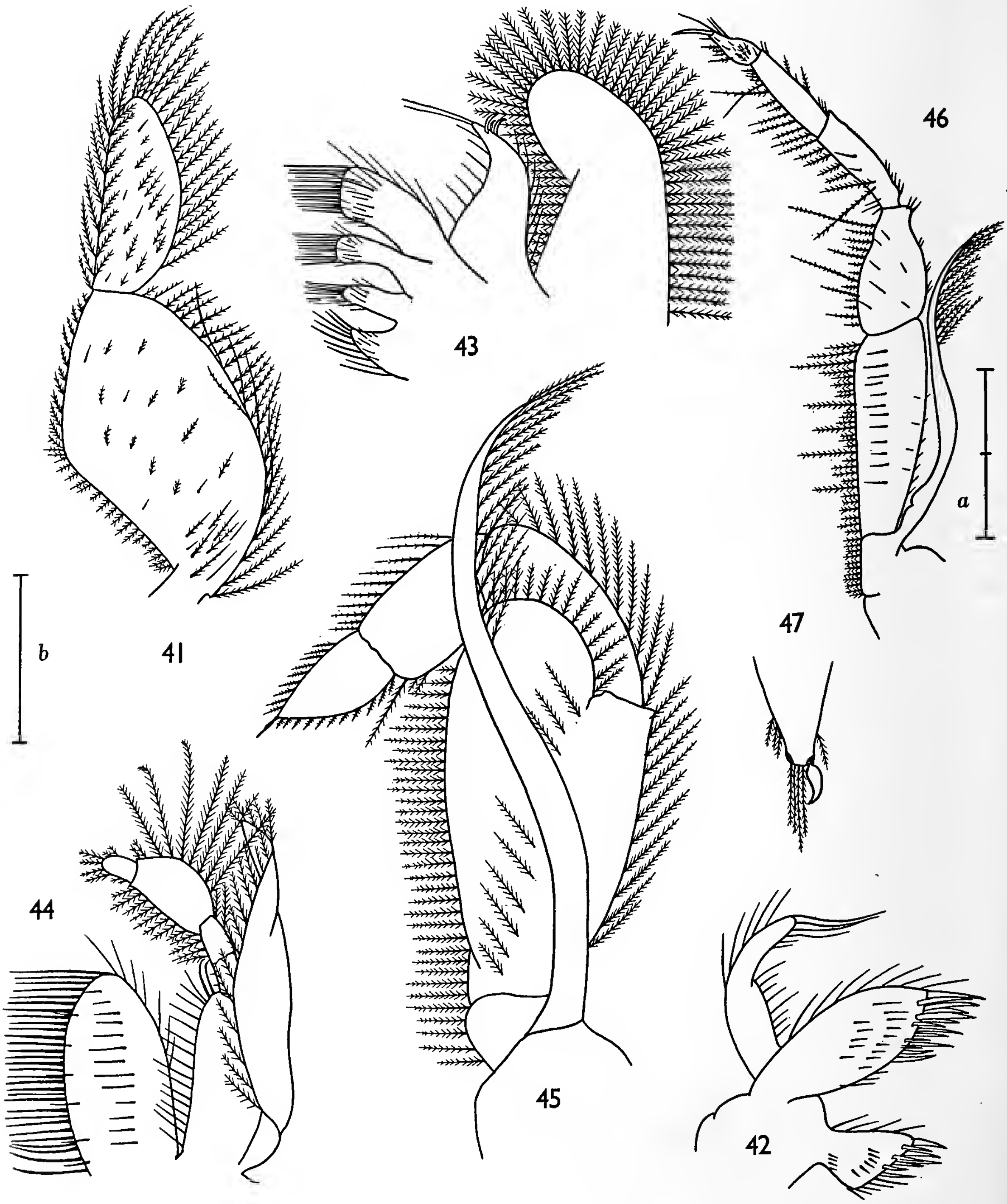
Mouth parts.—The mouth parts of all the available species are very similar to those of *G. clavicarpus* which are represented in Figs. 41–46. Their distinctive features are as follows: the distal segment of the mandibular palp is smaller and narrower than the basal segment (Fig. 41). The endopod of the maxillula gently tapers to a rounded tip; the gnathobasic lacinia is truncated distally (Fig. 42). The endopod of the maxilliped 1 is five-segmented, the fifth segment is small but distinct (Fig. 44). Its exopod, as stated in the definition of the genus, is without a distal segmented portion. The merus of the second maxilliped is greatly expanded, being generally twice as long as wide (Fig. 45). Endopod of the third maxilliped has a long slender terminal spine on the dactylus (Fig. 46).

Antennal scale.—The antennal scale of *G. crassus* and of *G. tinayrei* was unfortunately incomplete; a careful examination of the other seven species present in my material, has brought to light two other points than the one already noted by Burkenroad. Burkenroad (1936, p. 68) stated that the apex of the antennal blade in *G. kempi* is symmetrically placed in the centre of the distal margin, rather than near the lateral edge as in *G. capensis*. The two other features noticed here are: that, from species to species, the spine varies enormously in size, and also in its position relative to the apex of the lamella (Figs. 48, *a–g*). The extent of variation in the spine can be seen on comparing *G. parvus* and *G. clavicarpus* (*a* and *c*), in the former species it is present merely as a small tooth; in *G. clavicarpus*, on the other hand, it is long and stout. The external spine in some species extends beyond the apex of the scale while in others it fails to reach the apex; this is quite independent of its size, as can be seen on comparing *G. incertus* and *G. caini* (*f* and *g*). The spine in *G. incertus*, though relatively small, extends beyond the apex; in *G. caini* on the other hand, in spite of its much larger size, the spine scarcely reaches as far forward as the distal margin.

The *thelycum*, which is highly complex, is the only diagnostic character of the females on which the sub-division of the genus is based. This elaborate structure extends from the sixth to the eighth thoracic sternites; it consists of depressions and tubercles, plates, ridges and tongue-like projections of various dimensions arising from the sternites just mentioned. The great interspecific diversity can be noticed on comparing the thelyca of the nine species illustrated in Figs. 49, 52, 58, 67, 70, 76, 81, 84, and 85; and it is apparent that they cannot be deduced from a single basic plan, apart from the fact that, in most of the species examined, the simple seminal receptacles are invaginated from the sulcus between the sixth and the seventh sternites. Since the thelycum is the most important diagnostic character, I am obliged to describe two species as new. The thelyca, however, fall into various superspecific groups. The structure of the thelycum and the relationship of the various groups will be discussed in detail under each species.

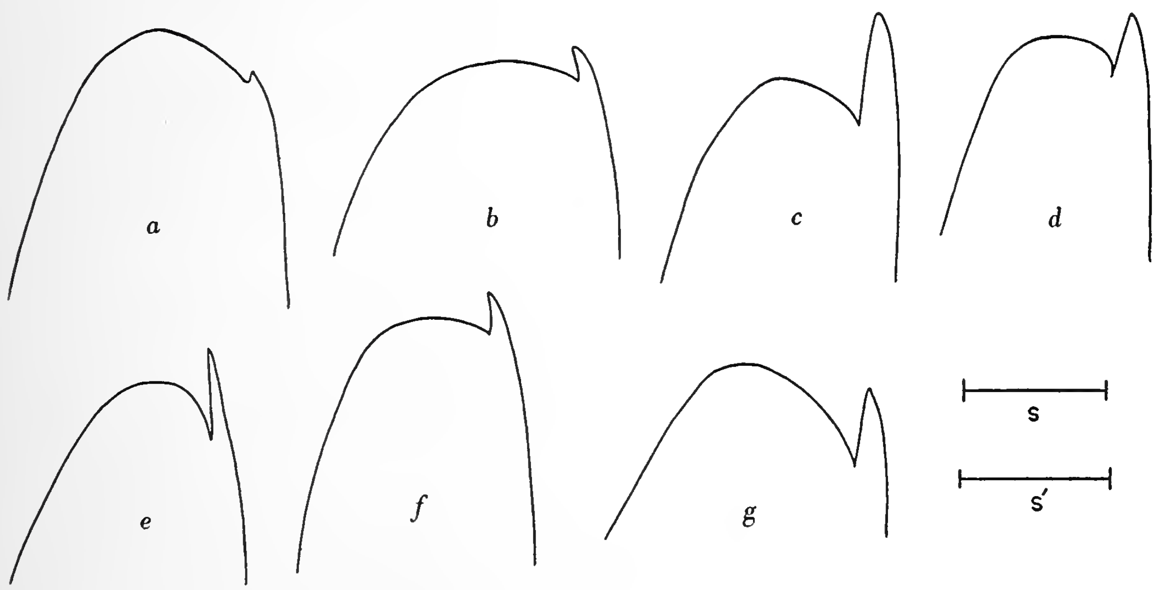
The *petasma*, like the thelycum, affords an important character in discriminating the species; but, unlike the thelycum, it shows a basic similarity throughout the genus (Figs.

50, 53, 59, 68, 73, 78, 82). The petasma of an adult male consists of a right and a left plate-like structure, each arising from the inner side of the peduncle of pleopod 1 ; the two halves are interlocked by numerous hooks borne on their median margins. The distal margin of each half is divided into three major lobes. Starting from the lateral margin of



Gennadas clavicarpus de Man. Fig. 41.—Mandibular palp. Fig. 42.—Maxillula. Fig. 43.—Maxilla. Fig. 44.—Maxilliped 1. Fig. 45.—Maxilliped 2. Fig. 46.—Maxilliped 3. Fig. 47.—Tip of telson. (Fig. 46 at scale $a = 2$ mm. ; rest all at scale $b = 1$ mm.)

the petasma, they are termed the external, median and internal lobes respectively (Fig. 50, *e.l.*, *m.l.*, *i.l.*). I have used the terminology originated by Balss which seems to be more convenient than the terms distoventral, distolateral and distomedian used by Burkenroad (1936, p. 61). These lobes in some species may be further sub-divided into lobules of different shapes and sizes. Besides the lobes already mentioned, there is invariably present another lobe—the accessory lobe, originating from the base of the median lobe on its anterior surface (*a.l.*). This lobe shows considerable variation in its degree of development. The median margin of each half of the petasma is furnished not only with hooks of different



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Apex of antennal scale of various *Gennadas* species (setæ omitted). FIG. 48.—*a. G. parvus* Bate. *b. G. sordidus* Kemp. *c. G. clavicarpus* de Man. *d. G. scutatus* Bouvier. *e. G. bouvieri* Kemp. *f. G. incertus* (Balss). (All at scale s = 0·25 mm.) *g. G. caini* n. sp. (Scale s' = 1 mm.)

shapes but also with peculiar structures of a highly interesting nature (perhaps also modified hooks). They are illustrated in the figures, as seen under an oil immersion objective. The *appendix masculina* has so far escaped the due attention of previous workers. On making a comparative study of the seven males available in the present collection, I have found it to be of considerable systematic importance, and in the present genus which exhibits an extreme homogeneity, highly useful. The appendix masculina of each of these seven males is represented in Figs. 51, 54, 59, 69, 75, 80 and 83 ; their structure and relationships, like those of the thelycum and petasma, are discussed under each species.

The following is an artificial key to the Indian Ocean species of the genus *Gennadas*. *G. gilchristi* which had been recorded from the Indian Ocean by Balss (1927, p. 261) is not represented in my material.

Keys to the Determination of the Indian Ocean Species of the Genus *Gennadas.*

Male (Petasma).

I. Median lobe undivided.
   A. Median lobe simple, not extending as far as the internal lobe; accessory lobe triangular (Fig. 82) . . . . *G. tinayrei* Bouvier
   B. Median lobe spoon-shaped and recurved, overreaching the internal lobe; accessory lobe a long narrow flap (Fig. 53) . . . . *G. sordidus* Kemp

II. Median lobe divided.
   A. Median lobe tripartite, accessory lobe a long narrow flap (Fig. 50) . . . . *G. parvus* Bate
   B. Median lobe bifurcate, accessory lobe more prominent.
      i. Inner lobule of the median lobe wider than the outer.
         a. External lobe much longer than the median lobe, deeply cleft (Fig. 79) . *G. incertus* Bate
         b. External lobe shorter than the median lobe.
            1. Inner lobule of the median lobe with the apex rounded (Fig. 68) *G. scutatus* Bouvier
            2. Inner lobule of the median lobe with the apex sharply pointed (Fig. 66) *G. clavicarpus* de Man
      ii. Lobules of the median lobe of about the same width.
         a. Lobules curved toward one another (Fig. 73) . . . . . . *G. bouvieri* Kemp
         b. Lobules not curved toward one another . *G. gilchristi* Calman (1925, pl. 1, fig. 4)

Female (Thelycum).

I. A narrow tongue-like projection directed backward from the posterior margin of the fifth thoracic sternite (Fig. 81) . . . . *G. tinayrei* Bouvier

II. No projection from the fifth thoracic sternite.
   A. Plate *p* on the eighth thoracic sternite with long narrow anterolateral process (Fig. 70) *G. bouvieri* Kemp
   B. Plate *p* on the eighth thoracic sternite without any process.
      i. Seminal orifices crescentic, situated between conspicuous projections.
         a. A pair of leaf-like processes arise from, or in front of, the bases of peræopods IV.
            1. Leaf-like processes arise from the coxæ of peræopods IV; large and directed anteromedially (Fig. 84) . . . . *G. caini* n. sp.
            2. Leaf-like processes arise in front of the coxæ of peræopods IV; small and directed medially (Fig. 49) . . . . *G. parvus* Bate
         b. No leaf-like processes (Fig. 52) . . . . *G. sordidus* Kemp
      ii. Seminal orifices not crescentic.
         a. Anterior margin of the plate *p* produced into a large free flap, reaching to the sixth thoracic sternite (Fig. 67) . . . . *G. scutatus* Bouvier
         b. Anterior margin of the plate *p* not produced into such a flap.
            1. Plate *p* anteriorly raised from the body surface.
               α. Coxæ of peræopods IV projecting medially (Fig. 85) . . . . *G. crassus* n. sp.
               β. Coxæ of peræopods IV not projecting medially . . . . . *G. incertus* Balss
            2. Plate *p* anteriorly not raised from the body surface.
               α. A triangular or sub-triangular plate on the sixth thoracic sternite (Fig. 58, *a*) . . . . *G. clavicarpus* de Man
               β. No plate on the sixth thoracic sternite . . . . . *G. gilchristi* Calman*

Gennadas parvus Bate

(Figs. 40, *a*; 48, *a*; 49–51)

Gennadas parvus Bate, 1881, p. 192; 1888, p. 340, pl. LIX (part).
Gennadas parvus, Kemp, 1909, p. 721, pl. LXXIII, figs. 1–6 and pl. LXXV, fig. 1; 1913, p. 60, pl. 7, figs. 6 (and fig. 7 unless the female is *Gennadas tinayrei*).
Gennadas parvus, Burkenroad, 1936, p. 65 (in key).
Amalopenæus parvus, Balss, 1927, p. 263, figs. 20–23.
? *G. parvus* Wood-Mason and Alcock, 1891, p. 189; Alcock, 1901, p. 46; Rathbun, 1906, p. 907, fig. 60.

* Figure of the thelycum, Burkenroad, 1936, fig. 58; Barnard, 1950, fig. 118, *h*.

Occurrence : Zanzibar area :

St. 121, trawl (sounding 925 m., net apparently not on bottom), 2 males, c.l. 7 mm.

Southern area of Arabian Sea :

St. 131, 2 m. tow net, 2500–0 m., 1 male, c.l. 5 mm., 1 female, c.l. 7 mm.

Central part of Arabian Sea :

St. 170, trawl, 3676 m., 1 male (mutilated).

Distribution : Indo-Pacific. Burkenroad (1936, p. 74) mentions the first record of this species from the Atlantic, off the Cape of Good Hope, but the statement is unaccompanied by any data whatsoever.

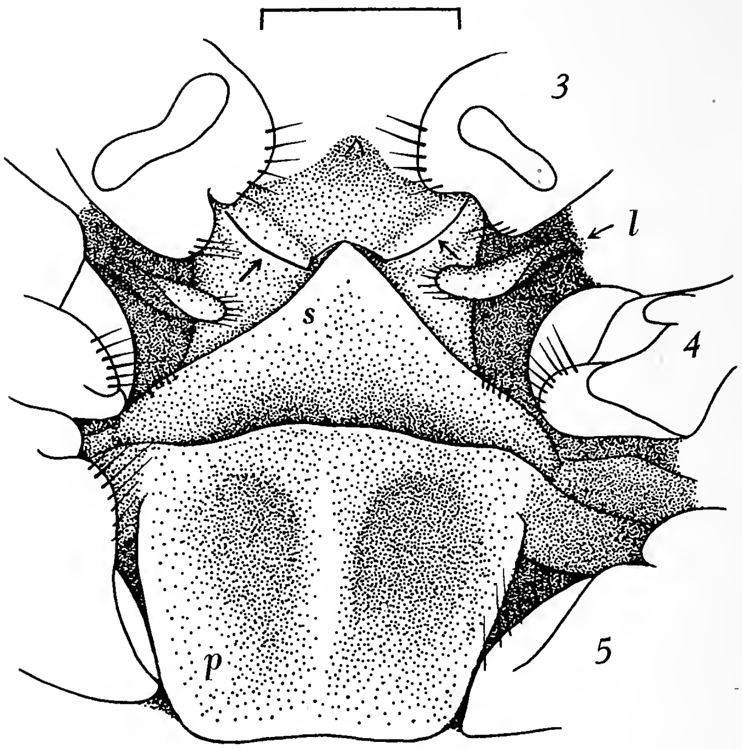
Dimensions : The specimens vary from 5–7 mm. in carapace length.

Remarks on Synonymy.—It has often been pointed out by previous authors that Bate's accounts of species were not always adequate. For the present species it was shown by Kemp (1909, p. 721) that under the name *Gennadas parvus* Bate had five different species, and Balss (1927) has since assigned them to two different genera ; moreover, the imperfect original description is responsible for the doubtful references quoted above. The identity of the males of *G. parvus* recorded by Alcock from the Indian Ocean is uncertain, but from the description of the thelycum the females can be referred to *Gennadas clavicarpus* (as pointed out by Balss, 1927, p. 265 and Kemp, 1910, p. 175). The females of *G. parvus* described by Rathbun (1906, p. 907) from the Hawaiian Islands, which were stated to have " . . . the characteristic thelycum described by Alcock " (the drawing of the thelycum represented in her Fig. 60 does not agree with the description), should also be referred to *G. clavicarpus*. Another female, attributed to the present species by Kemp, most probably belongs to *Gennadas tinayrei*, to which it was not referred because of " . . . the presence of an additional pair of tubercles between the legs of the third and fourth pairs " (Kemp, 1913, p. 61), but from Burkenroad's illustration of the thelycum of *G. tinayrei* (1936, Fig. 56) and Fig. 81 of the present paper it is quite evident that Bouvier's account was not complete.

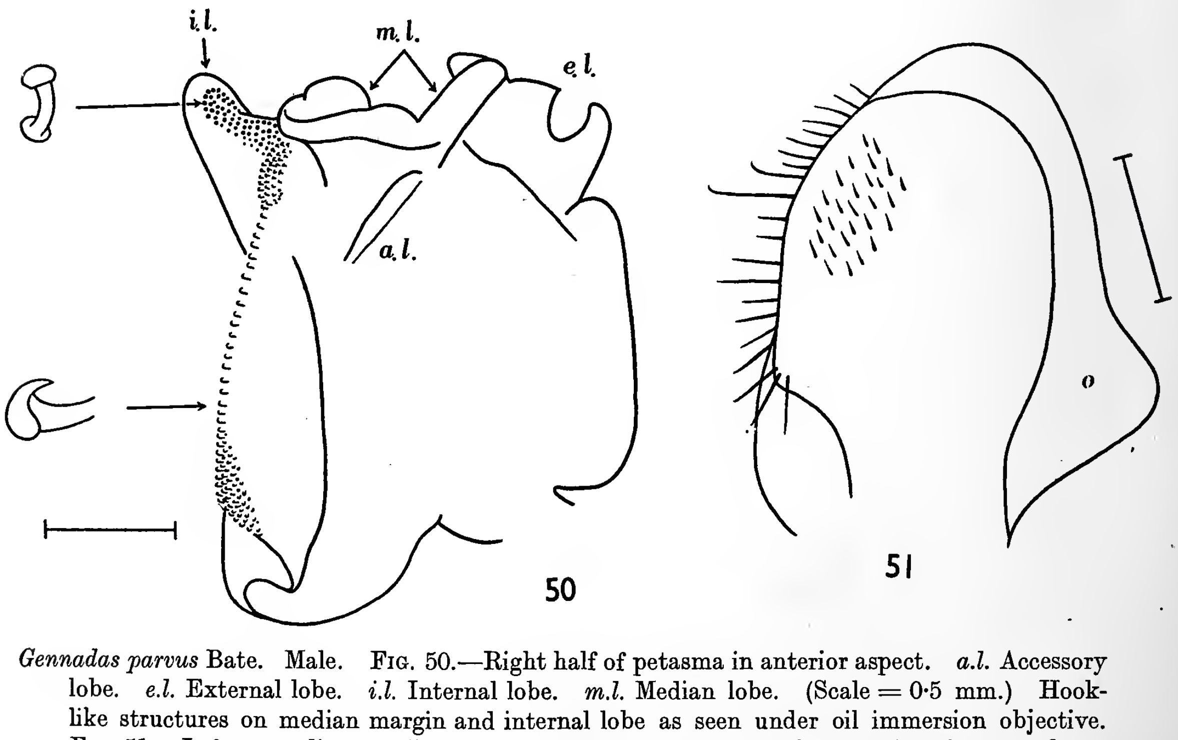
Descriptive Notes.—The *antennal scale* tapers slightly towards the rounded apex which is placed more or less in the centre of the distal margin and reaches far beyond the small spine of the outer margin (Fig. 48, *a*).

The *thelycum* of *G. parvus* has not previously been described or figured with sufficient accuracy. It consists of a large plate (Fig. 49, *p*) on the eighth thoracic sternite which occupies almost the entire space between the bases of peræopods V ; the two prominent depressions on its surface are separated by a thin carina which does not extend as far as its anterior and posterior limits. On the seventh sternite, just in front of this plate, is a triangular shield (*s*) with its base very depressed and the anterior tip pointed. The distal part of this shield is surrounded by three protuberances, one anterior and two lateral, separated by slit-like openings, the seminal orifices (indicated by arrows). Medially directed leaf-like structures (*l*) originate just posterior to the bases of peræopods III. Their apices are hairy and their function probably is to guard the openings of the seminal receptacles.

The complex nature of the *petasma* is mainly due to the median lobe (Fig. 50, *m.l.*) which is divided into a narrow, elongated outer lobule, directed upwards and forwards (as seen from the anterior surface) and an internal expanded lobule. The surface of the latter is curved so as to give it a more or less cup-like appearance. The internal lobe (*i.l.*) is also very characteristic. It is nearly as long as the external lobule of the median lobe and its surface is armed with numerous knob-like structure (modified hooks), recognizable only



Gennadas parvus Bate. Fig. 49.—Thelycum. *l.* Leaf-like structure. *p.* Plate on eighth thoracic sternite. *s.* Shield on seventh thoracic sternite. Arrows indicate the seminal orifices. *3, 4* and *5.* Bases of peræopods III, IV and V respectively. (Scale = 0·5 mm.)



Gennadas parvus Bate. Male. Fig. 50.—Right half of petasma in anterior aspect. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 0·5 mm.) Hook-like structures on median margin and internal lobe as seen under oil immersion objective. Fig. 51.—Left appendix maculina, endopod of pleopod omitted, in posterior view. *o.* Outer scale. (Scale = 0·25 mm.)

by careful scrutiny. As represented in Fig. 50 the petasma differs from Balss's illustration (1927, Fig. 20) in possessing an accessory lobe on its anterior surface. The accessory lobe in his figure is, I believe, the median lobe. Consequently the small portion between the median and the external lobe, indicated as the median lobe by the same author, cannot be given any significance.

The outer scale of the *appendix masculina* (Fig. 51) is narrowly rounded distally; its lateral margin, in the proximal half, shows a sudden widening and then tapers towards the base. The inner scale is shorter and broadly rounded distally; its external margin is slightly convex but the inner is almost straight and curves sharply inwards near the base, giving a more or less helmet shaped appearance to the inner scale. The inner scale is armed with long spines at the inner margin and with small ones on its anterior surface.

REMARKS.—The thelycum of *G. parvus* shows a very strong resemblance to that of *G. sordidus* Kemp (Figs. 49 and 52) but it can readily be distinguished by the much larger plate (*p*) on the eighth thoracic sternite with a prominent carina on its surface and marked lateral depressions; the slighter development of the apex of the triangular shield (*s*) and the more developed anterior protuberances. The most important feature is the presence of leaf-like structures (*l*) behind the bases of peræopods III. The petasmata of the two species, though more closely allied to each other than to those of any other species present in my material, differ more markedly than do the thelyca. The petasma of *G. parvus* differs from that of *G. sordidus* (Figs. 50 and 53) in the following features: the internal lobe is much more developed, the median lobe is divided and the lobules of the external lobe are differently shaped—they are separated by a deeper notch into a narrow external lobule and a much wider inner one which has a slight indication of further sub-division. The appendix masculina of *G. parvus*, as may be expected, is similar in its general outline, to that of *G. sordidus* (Figs. 51 and 54), differing mainly in possessing a larger inner scale and also in the outer scale being widest nearer the base. In spite of these differences, there can be no doubt that *G. parvus* and *G. sordidus* are very closely allied.

Gennadas sordidus Kemp

Figs. 40, *b*; 48, *b*; 52–57

Gennadas sordidus Kemp, 1910*b*, p. 177, pl. 14, figs. 1–3; Burkenroad, 1936, p. 64 (in key); 1938, p. 57.
Amalopenæus sordidus Balss, 1927, p. 262, figs. 18 and 19.

OCCURRENCE:

Gulf of Aden:
St. 18, 2 m. tow net, 900–0 m., 1 male, c.l. 6 mm. 1 female c.l. 5·5 mm.
St. 186, 2 m. tow net, 952–0 m., 4 males, c.l. 6–7 mm. 2 females, c.l. 6·5 mm.
Northern area of Arabian Sea:
St. 61 day, 1 m. tow net, 1000–0 m., 3 males, c.l. 7·5 mm.
,, ,, ,, ,, ,, ,, ,, ,, 2 males, c.l. 8·5 mm. 1 female, c.l. 8 mm.
St. 61 day, 2 m. tow net, 2000–0 m., 2 males, c.l. 7–8 mm. 3 females, c.l. 6–8 mm.
St. 61 night, 1 m. tow net, 6 males, c.l. 4–8 mm. 7 females, c.l. 7–8·5 mm.
Gulf of Oman:
St. 76, 1 m. plankton net, 600 m., 2 males, c.l. 6·5–8 mm. 1 female, c.l. 8·5 mm.
St. 76, 1 m. plankton net, 600 m., 23 males, (2 males with spermatophores c.l. 9 mm.) c.l. 6–9 mm. 20 females, c.l. 8–9·5 mm.

St. 76, 1 m. plankton net, 600 m., 1 male, c.l. 8 mm.
,, ,, ,, tow net, 1500 m., 9 males, c.l. 5–9 mm. 2 females, c.l. 7–8 mm.
St. 76, 2 m. tow net, 2500 m., 3 males, c.l. 7–9 mm. 7 females, c.l. 6–8 mm.
St. 76, 2 m. tow net, 2500 m., 1 male, about 7 mm.
Central part of Arabian Sea :
St. 94, 2 m. tow net, 984–1045 m., 2 males, c.l. 6–7 mm. 2 females, about 7 mm.
St. 95, 2 m. tow net, 430–984 m., 5 males, c.l. 4–7 mm. 3 females, 5–7 mm.
St. 95, 2 m. tow net, 430–984 m., 6 males, c.l. 5–7 mm. 2 females, c.l. 7–8 mm.
St. 96, 2 m. tow net, 400–645 m., 1 female, c.l. 6·5 mm.
,, ,, ,, ,, ,, ,, ,, 3 males, c.l. 7 mm.
,, ,, ,, ,, ,, ,, ,, 1 male, c.l. 5 mm. 1 female c.l. 4·5 mm.
St. 172, 1 m. plankton net, 850–0 m., 2 males, c.l. 5·5 mm. 4 females, c.l. 4·5–7·5 mm.
St. 172, 2 m. tow net, 2091–0 m., 1 female, c.l. 5 mm.

Distribution : Indian Ocean, Pacific off Lower California, Gulf of California.

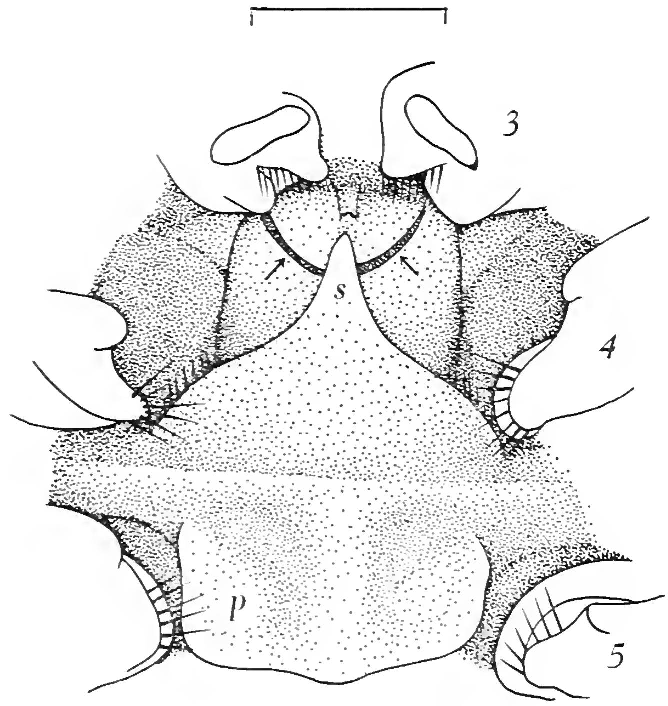
Dimensions and Sexual Conditions : The material ranges from adults of 9 mm. to juveniles of about 4 mm. in carapace length. Larger specimens 11 mm. in carapace length have been recorded from the Pacific (Burkenroad, 1938). Two males, of carapace length about 9 mm., in the present material have thin leaf-like spermatophores each of which is about the same dimensions as the corresponding half of the petasma.

Descriptive Notes.—The wide base of the *antennal scale* gradually tapers to a broadly rounded apex ; the outer margin is furnished with a short spine which extends slightly beyond the apex of the lamella (Fig. 48, *b*).

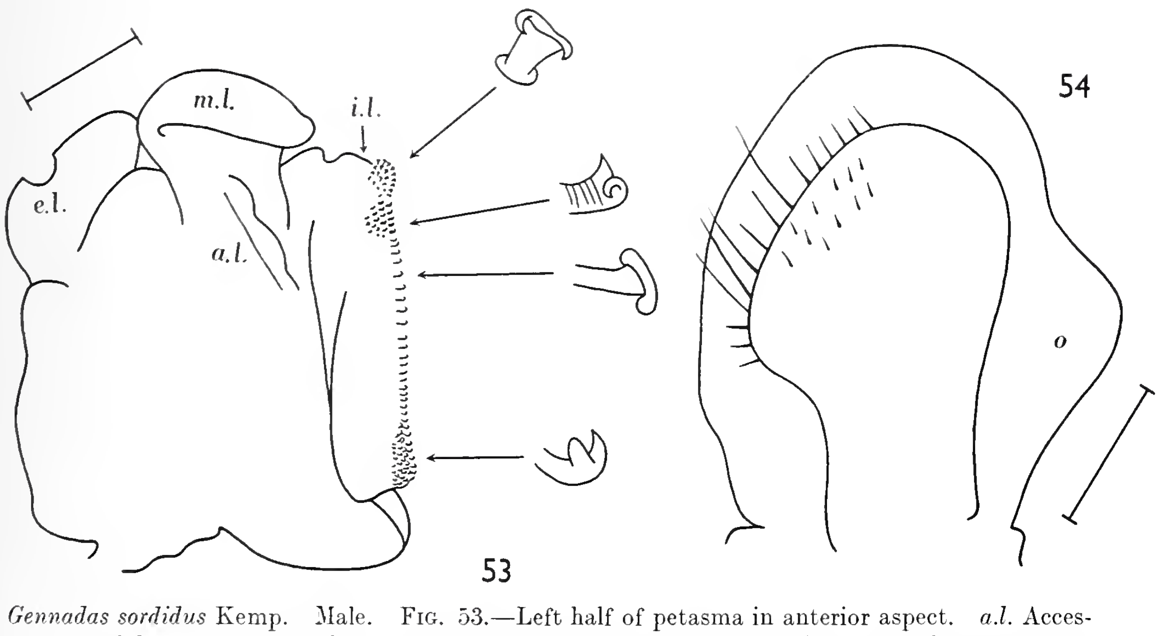
The female of this species has not previously been captured in the Indian Ocean. It was first described from the Pacific by Burkenroad (1938, p. 57). In essence, the *thelycum*, as represented in Fig. 52, agrees with Burkenroad's illustration (1938, Fig. 1). The slight differences in details are probably due to the considerable individual variation exhibited in the species. The plate (*p*) on the eighth thoracic sternite varies in the strength of its median ridge and lateral grooves from a well defined low ridge and fairly well marked grooves to an almost smooth surface. The anterior portion of the triangular shield (*s*) shows marked variation ; it may be elongated, narrow and pointed or it may be short with the apex more or less rounded. This may well be due to the body curvature in the preserved specimens. As far as I can see, there are no protuberances behind the bases of peræopods III ; in the Pacific population these are said to vary from complete absence to a low and inconspicuous weakly setose swelling and may even be a conspicuous projection (Burkenroad, 1938, p. 58).

The two figures of the *petasma*, as represented by Kemp and Balss, show some important differences. According to Kemp (1910, pl. XIV, Fig. 1) the accessory lobe is present on the dorsal surface of the petasma and the external lobe is undivided. Balss (1927, Fig. 18) on the other hand, indicates no accessory lobe on the dorsal surface (what he calls an accessory lobe is the median lobe), and the external lobe is, though rather imperfectly, divided. Fig. 53 of the present paper agrees with Kemp in the position of the accessory lobe. The base of this lobe is much wider here than figured by Kemp. It agrees with Balss's figure in the sub-division of the external lobe ; the lobules in the present case are well separated by a notch.

Some early stages in the development of the petasma are illustrated in Figs. 55–57. In a male of about 4 mm. in carapace length the petasma is simple and unfolded. It gradually



Gennadas sordidus Kemp. FIG. 52.—Thelycum. *p.* Plate on eighth thoracic sternite. *s.* Apex of shield on seventh thoracic sternite. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 0·5 mm.)



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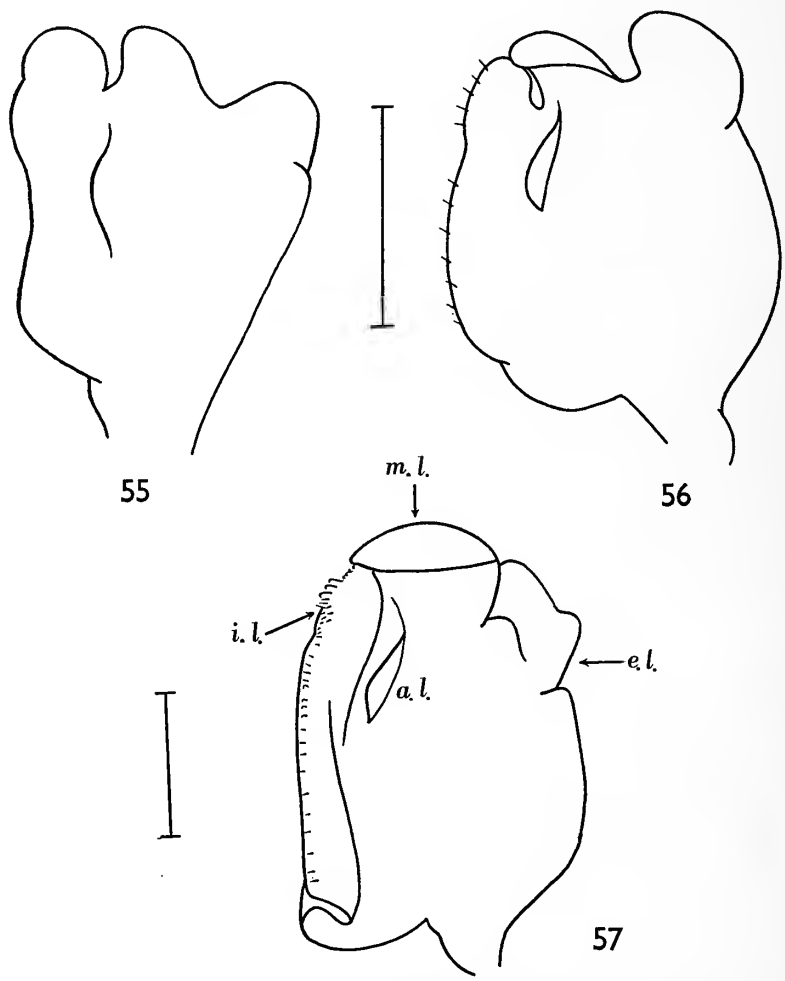
Gennadas sordidus Kemp. Male. FIG. 53.—Left half of petasma in anterior aspect. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 0·5 mm.) Hook-like structures on median margin and internal lobe as seen under oil immersion objective. FIG. 54.—Left appendix masculina, endopod of pleopod omitted, in posterior aspect. *o.* Outer scale. (Scale = 0·25 mm.)

widens towards the distal border which, moreover, is divided into three subequal lobes and the accessory lobe, at this stage, is represented by a low ridge (the lobes are labelled in Fig. 57). In a slightly larger specimen (carapace length 5 mm.) the median lobe shows the beginning of the anteriorly curved spoon-shaped appearance which is the most distinctive feature of the petasma ; the accessory lobe is now well differentiated. The petasma of a male measuring 6·5 mm. in carapace length has the characteristic shape but not the full size (Fig. 56) of that of the adult. The petasma of a juvenile male ascribed to this species



Gennadas sordidus Kemp. Figs. 55–57.—Three developmental stages of the petasma from specimens of carapace length 4·5 mm. (Fig. 55), 5 mm. (Fig. 56) and 6·5 mm. (Fig. 57). Lettering as in previous figure. (Upper scale 0·25 mm. ; lower scale 0·5 mm.)

by Balss (1927, Fig. 19), certainly does not belong here ; as can be seen from his figure the distal margin is divided into three lobes, the external lobe is indicated by a broken line, and besides these there is another lobe projecting above the external lobe and reaching almost as far distal as the median lobe. Consequently this specimen should be referred to some other species with a large accessory lobe projecting far above the distal margin of the external lobe, but my material is insufficient for me to hazard a guess.

The *appendix masculina* of *G. sordidus* (Fig. 54) closely resembles that of *G. parvus* ; the distinguishing features have already been stated under that species (p. 349).

Gennadas clavicarpus de Man

Figs. 40, *c*; 48, *c*; 58–66.

Gennadas clavicarpus de Man, 1907, p. 144 (female); 1911 (part), p. 19, pl. II, figs. 3*h* and 3*j*; 1922, p. 3, pl. 1, fig. 1 (male); Boone, 1930, p. 129 (female only).
Gennadas alcocki Kemp, 1910*b*, p. 174, pl. XIII, fig. 8 (female): 1913, p. 62, pl. 7, fig. 8 (female).
Gennadas scutatus, Kemp, 1910*b*, p. 178, pl. XIII, figs. 9 and 10 (male).
Gennadas scutatus indicus Kemp, 1913, p. 62 (male only).
Gennadas propinquus, Burkenroad, 1936, p. 66, 83–85; *nec* Rathbun, 1906, p. 907, fig. 61*a* and *b*.
Amalopenæus clavicarpus Balss, 1927, p. 267 (female).
Amalopenæus scutatus indicus Balss, 1927, p. 259, fig. 13 (male).
? *Gennadas parvus*, Alcock, 1901, p. 46 (female); Rathbun, 1906, p. 907, fig. 60 (female).

Occurrence:

Gulf of Aden:

St. 18, 2 m. tow net, 900–0 m., 2 males, c.l. 6·5–8 mm.; 2 females, c.l. 8–9 mm.

St. 26, trawl, 2312 m., 1 male, c.l. 8 mm.

St. 186, 2 m. tow net, 952–0 m., 1 male, 6·5 mm. 16 males, 3–9 mm. 20 females, c.l. 4–8·5 mm.

St. 193, trawl, 1061–1080 m., 1 female, c.l. 7·5 mm.

Central part of Arabian Sea:

St. 95, 2 m. tow net, 430–984, m., 2 males, c.l. 6–7 mm.; 4 females, 6–8 mm.

St. 95, 2 m. tow net, 430–984 m., 1 male, c.l. 6 mm. 16 males, c.l. 6–10 mm.; 5 females, c.l. 6·5–9 mm.

St. 95, 1 m. tow net, 1 male, c.l. 5·5 mm.

St. 96, 2 m. tow net, 400·645 m., 2 males, c.l. 7–8 mm.; 3 females, c.l. 5–8 mm.

St. 171, trawl, 3840–3872 m., 1 female, c.o. 8·5 mm.

St. 172, 1 m. plankton net, 850–0 m., 1 female, c.l. 9 mm. 1 female, c.l. 5·5 mm.

Zanzibar area:

St. 121, trawl (sounding 925 mm., net apparently not on bottom), 8 males, c.l. 6·5–8 mm.; 7 females, c.l. 5·5–9 mm.

Southern area of Arabian Sea:

St. 131*c*, 2 m. plankton net, 600–0 m., 1 male, c.l. 7·5 mm.

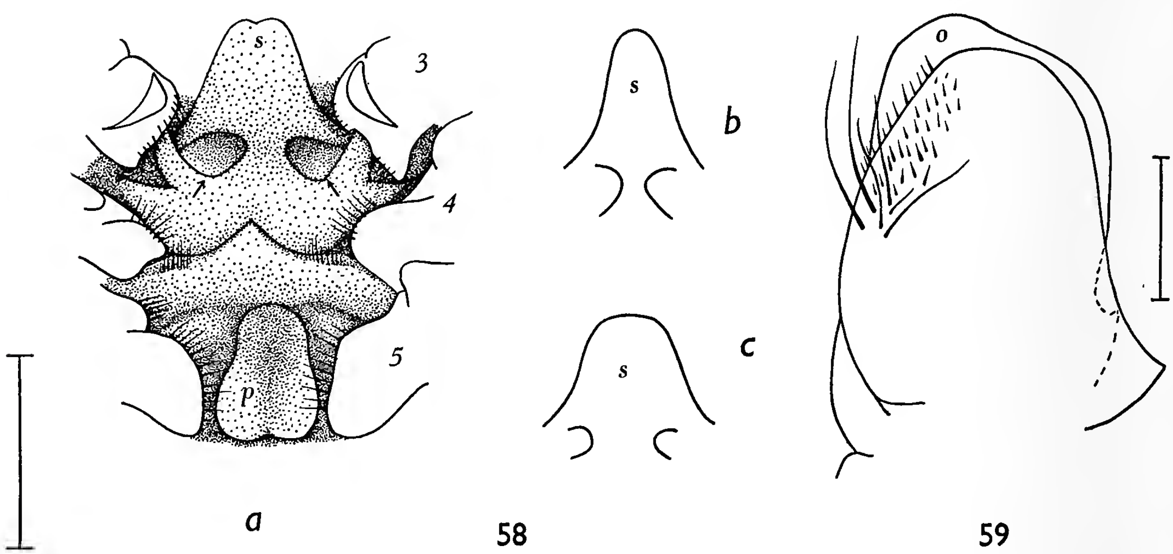
Distribution: Indo-Pacific.

Dimensions: The material ranges from adults of 9 mm. to very young specimens of about 4 m. in carapace length.

Descriptive Notes.—The narrowly rounded apex of the *antennal scale* is placed nearer to the inner than to the outer margin. The spine on the outer margin is highly developed and extends far beyond the apex of the lamella (Fig. 48, *c*).

In Fig. 58*a* the *thelycum* is represented in detail. To the existing descriptions of the thelycum it is sufficient to add that the triangular shield (*s*), on the sixth thoracic sternite, exhibits considerable variation. It may be elongated and narrow, with its apex either smoothly rounded (Fig. 58, *b*) or notched; or short and broad with its apex, as in the previous case, either smoothly rounded or notched (Fig. 58, *c*). Furthermore, the ventral surface of the shield in some specimens is flat, in others concave.

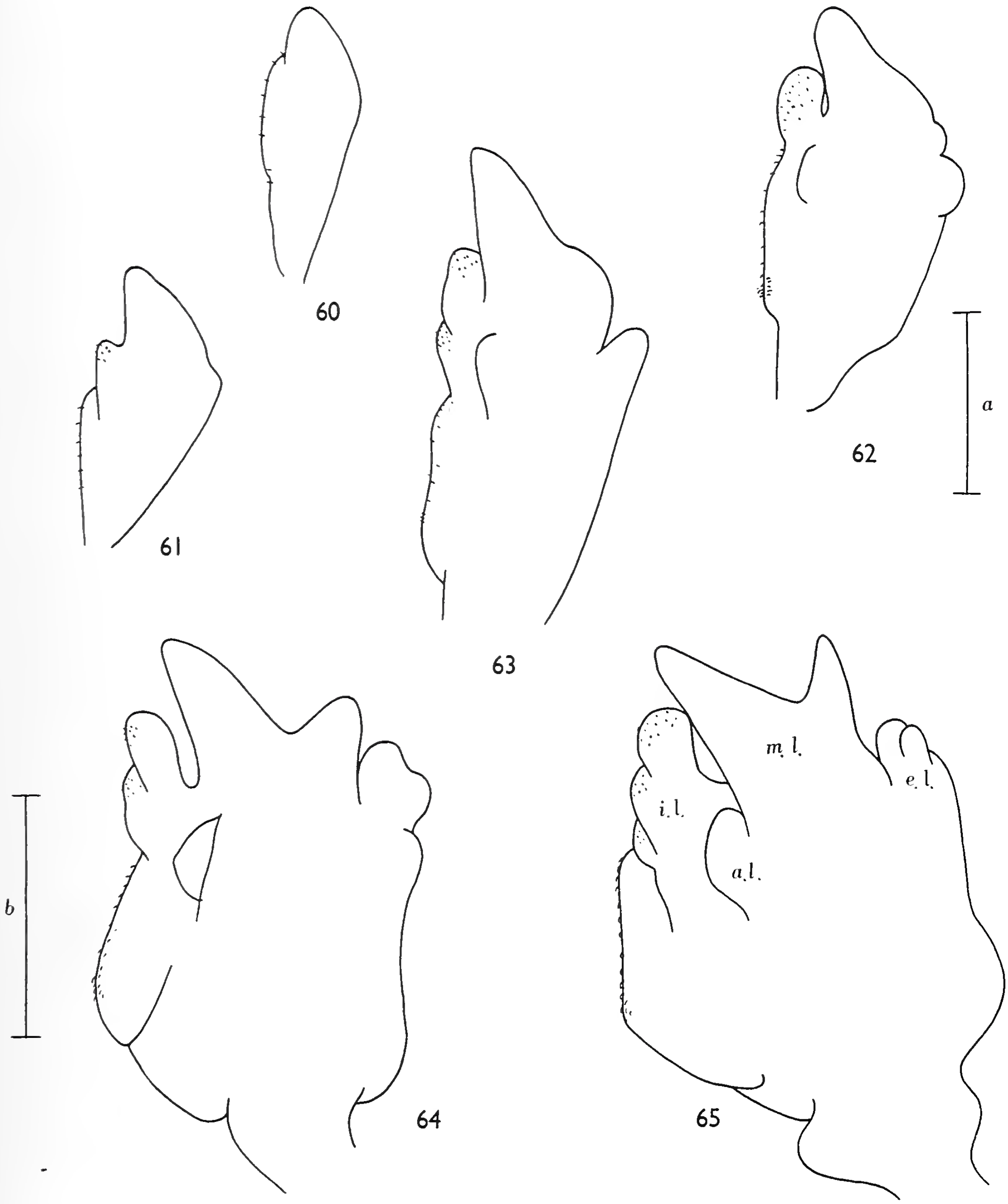
The adult *petasma*, represented in Fig. 66, has been quite well figured and described by previous writers. The abundant material at my disposal has enabled me to trace the development of the petasma in considerable detail (Figs. 60–65). In a very young specimen measuring 3 mm. in carapace length, the petasma is present as a small bud and the median margin is already differentiated (Fig. 60). Fig. 61 represents a somewhat more advanced developmental stage (carapace of the specimen is mutilated, probably 3–4 mm.). In this specimen the apex of the petasma is elongated and directed medially. The internal lobe and the median margin are well marked, but the external lobe is as yet indistinct. Figs. 62 and 63 are taken from two specimens each measuring 4·5 in carapace length, although in one (63) the petasma is certainly more advanced than in the other. The distal margin of the petasma in both these specimens is divided into the three major lobes ; the internal, the median and the external lobes, and at this stage the accessory lobe can also be seen (*c.f.* Fig. 65). The commencement of the further sub-division of internal and median lobes is clearly indicated in Fig. 63.



Gennadas clavicarpus de Man. Fig. 58.—*a*. Thelycum. *p*. Plate on eighth thoracic sternite. *s*. Shield on sixth sternite. Arrows indicate the openings to the seminal receptacles. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. b. and c. Variations in the form of the shield on sixth sternite. (Scale = 1 mm.) Fig. 59.—Left appendix masculina, endopod of pleopod omitted, in posterior aspect. *o*. Outer scale. (Scale = 0·25 mm.)

The petasma of a specimen measuring 5·5 mm. in carapace length already shows a certain resemblance to that of an adult (*c.f.* Figs. 64 and 66). All three distal lobes are now sub-divided, the external lobe only very slightly. In a specimen of 6·5 mm. carapace length the petasma, though more like that of an adult, shows one very striking difference and that is in the relative lengths of the lobules of the external lobe (Fig. 65, *e.l.*). At this stage the inner lobule is slightly bigger than the outer one but in the fully grown petasma this condition is reversed. Moreover, the tip of the outer lobule of the external lobe (*e.l.*) and of both the lobules of the median lobe (*m.l.*), in the adult petasma, are curved posteriorly as illustrated separately in Fig. 66, *a–c*. The median margin of the adult petasma and the three lobules of the internal lobes are furnished with curious structures (modified hooks), whose shape and distribution is represented in the figure. Also, the external margin is armed proximally with a few curved spines.

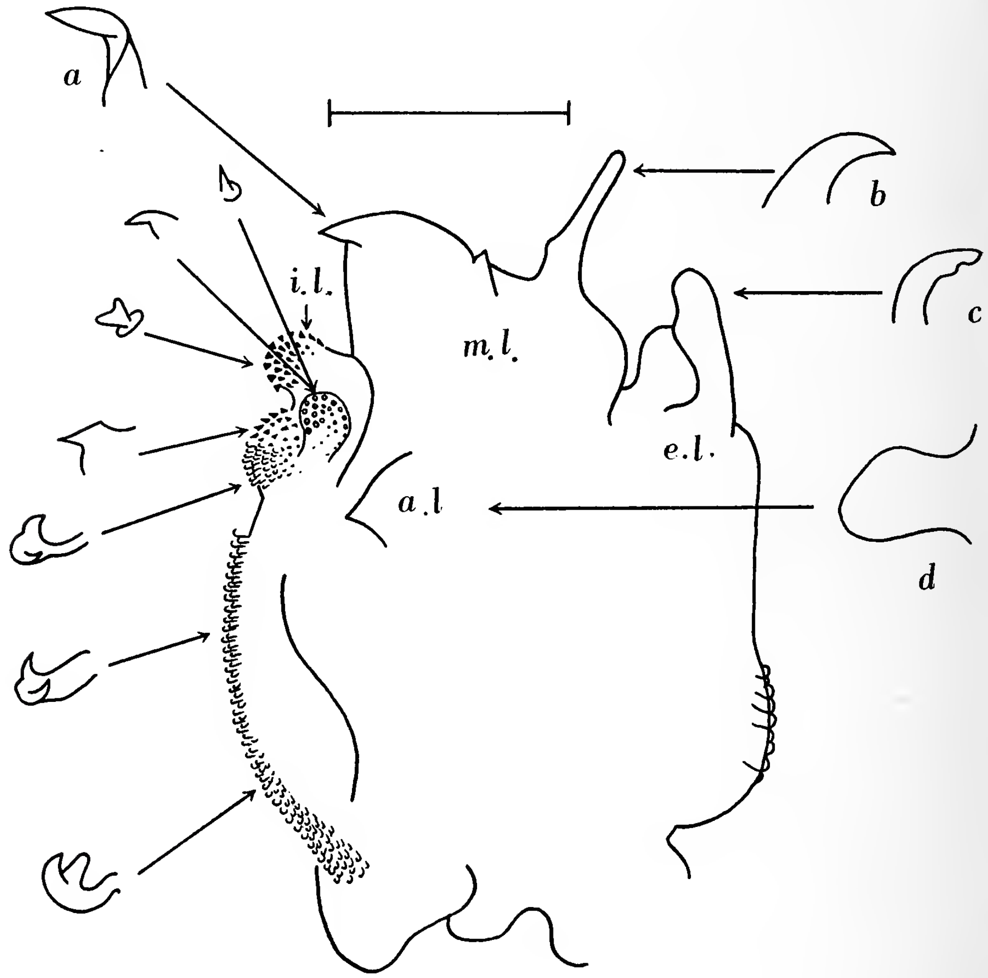
The inner scale of the *appendix masculina* is widest at the base and slightly narrows towards the rounded apex. Medially it is armed with spines, of which the posterior ones are greatly elongated. The outer scale is larger than the inner one and has its distolateral margin somewhat truncated (Fig. 59). The appendix masculina of *G. clavicarpus* differs



Gennadas clavicarpus de Man. Figs. 60–65.—Developmental stages of the petasma (right half) from specimens of carapace length measuring 3 mm. (Fig. 60); about 4 mm. (Fig. 61); 4·5 mm. (Figs. 62 and 63); 5·5 mm. (Fig. 64) and 6·5 mm. (Fig. 65). Lettering as in next Fig. (Figs. 60–63 at scale $a = 0{\cdot}25$ mm.; Figs. 64 and 65 at scale $b = 1$ mm.)

from that of *G. scutatus* in having the inner scale more rounded apically and the outer scale not so markedly truncated at the distolateral margin.

Synonymy.—The highly complicated synonymy needs to be discussed in detail. Rathbun (1906, p. 907) described a new species from the Pacific as *Gennadas propinquus*; though the description of the species is insufficient, the distinctive features of the thelycum



Gennadas clavicarpus de Man. Fig. 66.—Right half of petasma of an adult male, anterior aspect. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. *a, b, c* and *d.* The tips of inner and outer lobules of median lobe, outer lobule of external lobe and accessory lobe respectively. (Scale = 1 mm.) Hook-like structures on median margin and internal lobe as seen under oil immersion objective.

and the petasma can be clearly made out in her accompanying figures which are, on the whole, rather well drawn. The petasma (Rathbun, 1906, Fig. 61 *a*) may be interpreted as having, on its distal margin, an acuminate external lobe which is separated from the median lobe by a wide gap; the median lobe is divided into a distally narrow and pointed outer lobule and a much larger and broader, apically truncated inner lobule; the inner lobe is divided into three lobules placed one behind the other. The thelycum (Rathbun, 1906,

Fig. 61*b*) can be described as follows: on the eighth thoracic sternite there is an oval median plate; anterior to this (probably on the seventh sternite) is a narrow transverse plate in front of which is another much larger plate, or shield, with the anterior margin tridentate. The structure anterior to this shield is neither mentioned by her nor is evident from the figure. From the foregoing account it is clear that the thelycum and the petasma of *G. propinquus* Rathbun differ from those of both *G. clavicarpus* de Man (Figs. 58 and 66) and *G. scutatus* Bouvier (Figs. 67 and 68), with which species it is otherwise very closely allied.

In 1907 (p. 144) de Man gave a preliminary description of a new species *Gennadas clavicarpus* from the Pacific. In 1911 (p. 19) de Man gave a full description with illustrations of his *G. clavicarpus*, which really included both sexes of *G. scutatus* Bouvier and both sexes of his new species. Kemp (1910, p. 174) described a new species *Gennadas alcocki* from the Indian Ocean; the females of Kemp's supposed new species really belonged to *G. clavicarpus* de Man while the males pertain to *Gennadas bouvieri* Kemp, 1909, (c.f. Kemp 1910*b*, pl. XIII, fig. 5 and fig. 73 of the present paper). Balss (1926, p. 267) recognized that the females of *G. alcocki* Kemp were referable to *G. clavicarpus* de Man (which he called *Amalopenæus clavicarpus*); the males he called *A. alcocki* (Kemp). Males belonging to *G. clavicarpus* de Man were assigned to *G. scutatus* Bouvier by Kemp (1910*b*, p. 174, pl. xiii, fig. 10) and later to *G. scutatus indicus* (Kemp, 1913) and to *Amalopenæus scutatus indicus* by Balss (1927). Burkenroad (1936, p. 66 and p. 83–84), on the assumption that the thelyca of *G. clavicarpus* de Man and *G. propinquus* Rathbun are identical, used the latter name since it had priority. But, as stated above, the thelycum and the petasma of *G. propinquus* Rathbun are not the same as those of *G. clavicarpus* de Man. It is to be hoped that someone in the near future will give a careful redescription of the original material of *G. propinquus* Rathbun, and a better figure of the thelycum.

G. propinquus, *G. clavicarpus* and *G. scutatus* bear a closer resemblance to one another than they do to any other member of the genus. But they can easily be distinguished by the points given in the following table.

	G. propinquus.	*G. clavicarpus.*	*G. scutatus.*
THELYCUM			
Plate on eighth thoracic sternite	Subcordate (Rathbun, 1906, Fig. 61*b*)	As represented in Fig. 58*a*; rather longer than wide, lateral margin constricted in anterior half, posterior margin with median notch	As represented in Fig. 67. A large oval flap arises from the widest part and extends freely forwards reaching the sixth sternite.
Posterior plate on seventh thoracic sternite	Narrow, anterior margin slightly convex	Narrow; anterior margin with a triangular median projection	Relatively much longer and triangular (only the postero-lateral parts visible beyond flap).
Anterior plate on seventh thoracic sternite	Twice as long though narrower than posterior plate, anterior margin tridentate (Rathbun's Fig. too small to show details in front of this margin)	As long as posterior plate; anterior margin produced between the seminal orifices and apparently continuous with large shield between bases of peræopod III	Much shorter than the posterior plate, anterior margin almost three-pronged.

	G. propinquus.	*G. clavicarpus.*	*G. scutatus.*
PETASMA			
External lobe .	Acuminate (Rathbun, 1906, Fig. 61*a*) .	Bilobulate ; outer lobule longer than inner, apex recurved (Fig. 66) .	Bilobulate ; apex of each lobule recurved (Fig. 68).
Outer lobule of median lobe .	Narrowing abruptly, distal half slender .	Long and slender, apex recurved .	Long, tapering to a point in distal half.
Inner lobule of median lobe .	Extending well beyond outer lobule, broad, apex truncated .	Falling far short of outer lobule, broadly triangular with recurved apex .	Almost as long as outer lobule, apex broadly rounded.

Gennadas scutatus Bouvier

Figs. 40, *c* ; 48, *d* ; 67–69

Gennadas scutatus Bouvier, 1906, p. 9, figs. 8 and 13 ; 1908, p. 42, pl. VIII.
Gennadas scutatus, Milne-Edwards and Bouvier, 1909, p. 193, figs. 10–12 ; Kemp, 1909, p. 727, pl. lxxv, fig. 2 ; 1913, p. 62, female only ; Lenz and Strunck, 1914, p. 310 ; Calman, 1925, p. 4 ; Burkenroad, 1936, p. 83, fig. 59 ; 1938, p. 59 ; Barnard, 1950, p. 634, fig. 118, *o, p*.
Amalopenæus scutatus Balss, 1927, p. 258, figs. 11 and 12.
Gennadas clavicarpus, part, de Man, 1907, p. 144 (male) ; 1911, p. 19, pl. 1, figs. 3*f*, 3*g* ; pl. II, fig. 3*j* ; Boone, 1930, p. 129 (male only).

Occurrence :

Central part of Arabian Sea :

St. 96, 2 m. tow net, 400–645 m., 2 females, c.l. 7 mm.

Zanzibar area :

St. 121, trawl (sounding 925 m., net apparently not on bottom), 6 males, 7 females, c.l. 5–6 mm.

Southern area of Arabian Sea :

St. 131, 2 m. tow net, 2500–0 m., 1 male, c.l. 5½ mm.

Central part of Arabian Sea :

St. 172, 2 m. tow net, 2091–0 m., 3 males, c.l. 5 mm. 1 female (damaged).

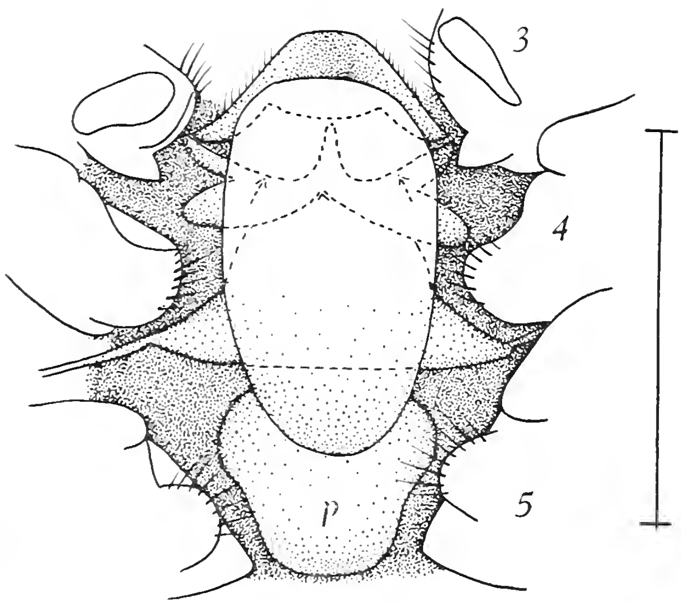
St. 172, 1 m. plankton net, 850–0 m., 2 males, c.l. 5 mm. 1 female, c.l. 7 mm.

Distribution : Cosmopolitan.

Dimensions : The largest specimen is recorded from the Pacific coast of America and measures 9 mm. in carapace length (Burkenroad, 1938, p. 59). In the present material the specimens do not exceed 7 mm. in carapace length.

Descriptive Notes.—The *antennal scale* tapers sharply to a narrow, rounded apex. The outer margin of the scale is furnished with a well developed spine, which extends beyond the apex of the lamella by its distal half (Fig. 48, *d*).

The *thelycum* of *G. scutatus* as illustrated in Fig. 67 is essentially the same as that figured and described by Burkenroad (1936, p. 84, fig. 59) from a North Atlantic specimen. The detailed structure as observed here may be described as follows ; the plate (*p*) on the eighth thoracic sternite is narrow at the base but widens towards the anterior margin where it is almost twice the width of the base. Moreover, from its anterior margin (or third) a large, free flap arises and extends as far forwards as the sixth thoracic sternite. The flap is broad, being one and a half or one and three-quarters as long as wide (measured from the dorsal surface). The rounded tip of the flap may be broad in some specimens, in others narrow or even pointed. The line of demarcation between the plate and the flap can be observed by slightly lifting up the flap. When the flap is turned back other structures, constituting the rest of the thelycum, can be studied. On the seventh thoracic sternite are two plates—a large triangular posterior plate and a much shorter anterior one. The triangular plate is raised posteriorly in the form of a low transverse ridge ; anteriorly its surface is depressed and fills the notch of the plate just in front. The anterior plate is constricted in the middle where its posterior margin is notched and the anterior produced into a longitudinal ridge. This narrow ridge, on careful examination, can be seen (in some specimens at least) to reach as far as the shield on the sixth thoracic sternite. In some it is

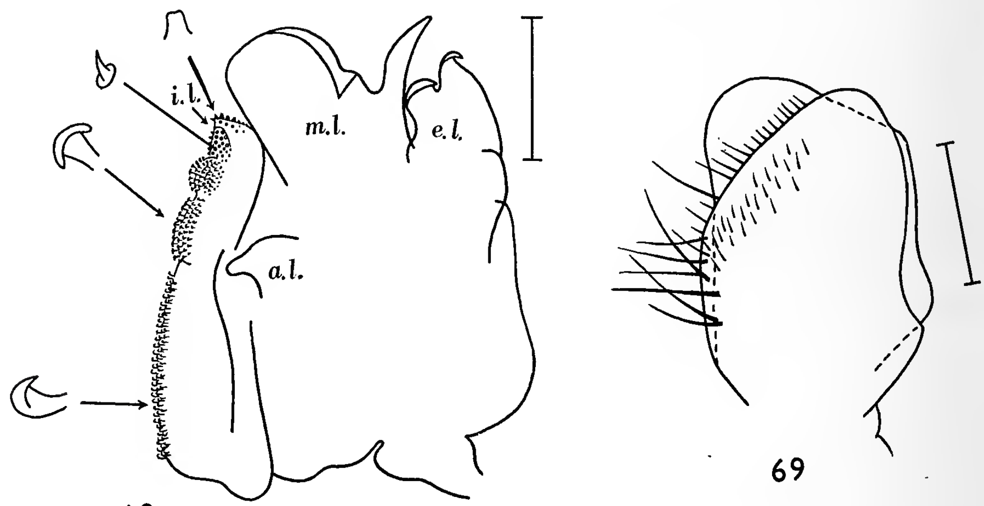


Gennadas scutatus Bouvier. Fig. 67.—Thelycum. *p*. Plate on eighth thoracic sternite. Arrows indicate openings of the seminal receptacles. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 1 mm.)

difficult to see the ridge clearly. The expanded lateral margins of the anterior plate are bifurcated into narrow anterior and broader posterior processes. The shield on the sixth thoracic sternite has its anterior and posterior margins convex and its surface very depressed; it is postero-laterally produced into processes which nearly abut against the narrow processes of the anterior plate of the seventh sternite. In the depressions on either side of the longitudinal ridge lie the seminal orifices.

The knob-like structure shown in Burkenroad's figure 59 (1936), on either side of the flap (which is turned back) are not mentioned in his text. However, in one specimen I have been able to see a low protuberance at the same place, in the rest the surface of the sternite is smooth. Another feature noted by the same author is the presence of a pair of setose prominences just median to the bases of the fourth legs. These prominences, which are conspicuous and setose in the American Pacific population, very inconspicuous and weakly setose in the Atlantic females according to Burkenroad, are totally absent in the present Indian Ocean population. It may be added here that the thelycum of *G. scutatus* is somewhat difficult to study, in the first place because of the very small size of the specimens and in the second because of the presence of the large flap of the eighth thoracic sternite which masks most of the genital sculpture.

A comparison of the drawings of the *petasma* by Bouvier (1906, fig. 13), Kemp (1909, Pl. LXXV, Fig. 2) and Balss (1927, Fig. 11) shows some differences. The distal margin of the inner lobule of the median lobe is more or less truncated in Bouvier's and Balss's figures, rounded in Kemp's. The accessory lobe seems to be more variable. It is shown to be narrow and elongated by Bouvier ; long but with a broad base by Kemp ; broad and short by Balss. The petasma of the present males agrees with Kemp's figure in the first point (Fig. 68). The accessory lobe is slightly different and may be described as roughly triangular in shape—attached to the petasmal plate by the broad base. The distal margin of the accessory lobe is convex, the proximal concave, so that the narrow apex is directed proxo-medially. These differences may well be due to slight differences in viewpoint of this very small lobe.



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Gennadas scutatus Bouvier. Male. Fig. 68.—Right half of petasma, anterior aspect. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 0·5 mm.) Hook-like structures on median margin and internal lobe as seen under oil immersion objective. Fig. 69.—Left appendix masculina, endopod of pleopod omitted, in posterior aspect. (Scale = 0·25 mm.)

The *appendix masculina* (Fig. 69) of *G. scutatus* is strikingly similar to that of *G. clavicarpus*. The disto-lateral margin of the outer scale is sharply truncated. The inner scale is almost as big as the outer one and has the narrowly pointed apex placed nearer to the lateral margin.

Gennadas bouvieri Kemp

Figs. 40, *d* ; 48, *e* ; 70–75

Gennadas bouvieri Kemp, 1909, p. 726, pl. lxxiv, figs. 1–4, pl. lxxv, figs. 6 and 7 ; 1910*b*, p. 179.
Gennadas bouvieri, Burkenroad, 1936, p. 80.
Amalopenæus bouvieri, Balss, 1927, p. 267.
Gennadas alcocki, Kemp, 1910*b*, p. 174, pl. xiii, figs. 5, ? 6 (male only).
Amalopenæus alcocki, Balss, 1927, p. 266, fig. 30.

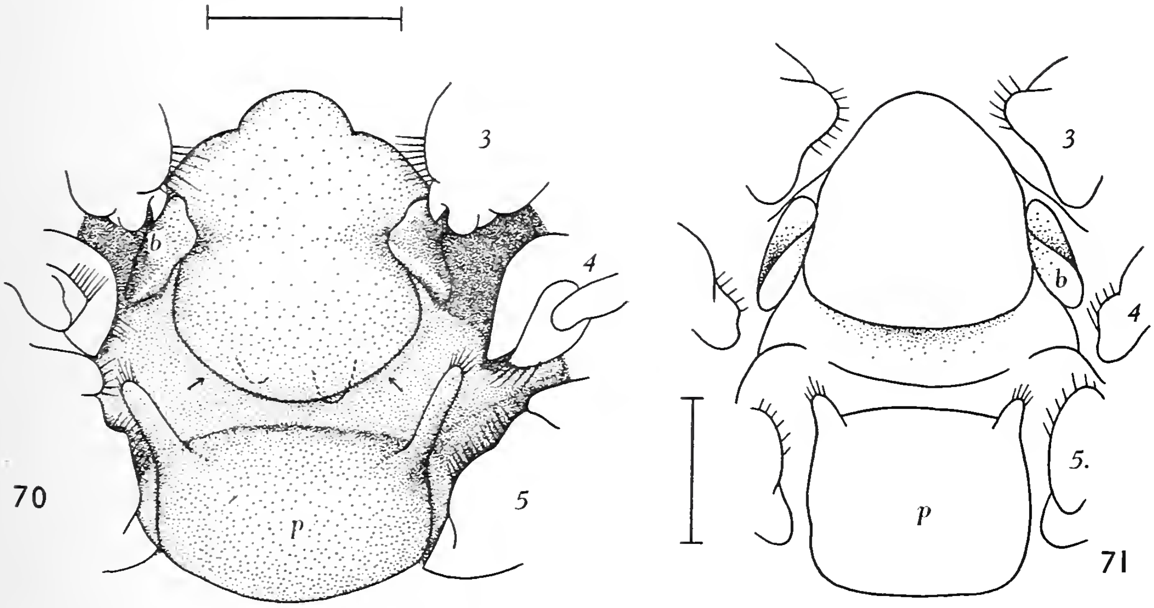
Gennadas elegans, part, Lenz and Strunck, 1914, p. 310.
Gennadas parvus, part, Bate, 1881, p. 192 ; 1888, p. 340.
NOT *Gennadas alcocki*, Kemp, 1910*b*, p. 174, pl. 8, fig. 8, and 1913, p. 62, pl. 7, fig. 8 (part female).

OCCURRENCE :

Central part of Arabian Sea :
St. 95, 2 m. tow net, 430–984, m., 1 female, c.l. 10 mm. (with spermatophores).
St. 96, 2 m. tow net, 400–645 m., 1 female (mutilated).
St. 170, trawl, 3676 m., 2 males, c.l. 9–10 mm.
St. 172, 1 m. plankton net, 850–0 m., 1 male, c.l. 9 mm.

Zanzibar area :
St. 121, trawl (sounding 925 m., net apparently not on bottom). 1 male c.l. 7 mm., 3 females, c.l. 6–7 mm.

Maldive area :
St. 143, trawl, 797 m., 1 male (mutilated).
St. 156, trawl (sounding 1317 m., trawl never on the bottom) 1 male, c.l. 11 mm.
St. 158, trawl, 786-1170 m., 1 female, c.l. 14 mm., with spermatophores.



Gennadas bouvieri Kemp. Female. FIG. 70.—Thelycum of adult. *p.* Plate on eighth thoracic sternite. *b.* lateral projections on seventh sternite. *3, 4* and *5.* Bases of peræopods III, IV and V respectively. (Scale = 1 mm.) FIG. 71.—Thelycum of immature specimen of carapace length = 6 mm. (Scale = 0·5 mm.)

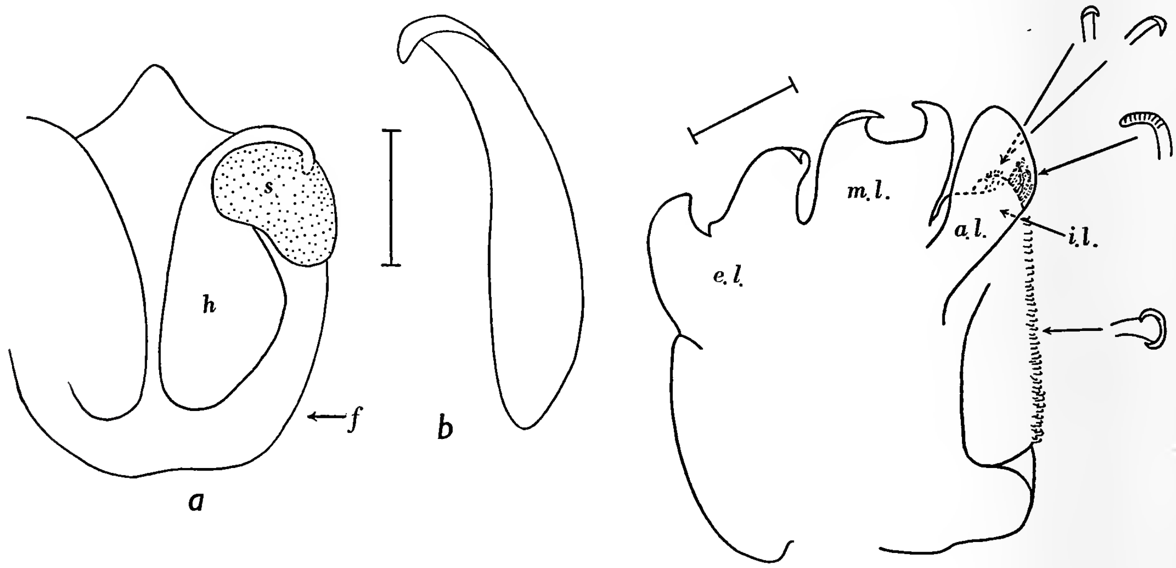
DISTRIBUTION : Indian Ocean, East Pacific, Bahamas, Bermudas, Caribbean, South Atlantic (one male only).

DIMENSIONS : My material varies from 6–14 mm. in carapace length. Two females of carapace length 10 and 14 mm. respectively bear spermatophores.

DESCRIPTIVE NOTES.—The males of this species (see p. 357) were known as *Gennadas clavicarpus* de Man until 1936 when, for the first time, the two sexes were taken together in the same haul (Burkenroad, 1936, p. 81). They were taken in the Bahaman and Bermudan waters. Both the sexes are here recorded as captured together in the Indian Ocean by the " Mabahiss " (Station 121).

The apex of the *antennal scale* is narrowly rounded and placed nearer to the outer margin, which is furnished with a long and slender spine exceeding the apex by its distal third (Fig. 48, *e*).

Fig. 70 of the *thelycum* of *G. bouvieri* differs from Kemp's illustration of the same (1909, Pl. lxxv, Fig. 6 and 7), mainly in two features; these have already been observed by Burkenroad (1936, p. 82) in the North Atlantic specimens. The differences as noted by me on comparing Fig. 70 of the present paper with Kemp's Fig. 6, are as follows: the antero-lateral processes of the plate (*p*) on the eighth thoracic sternite are much longer, directed more anteriorly and the tips are setose. The lateral projections (*b*) on the seventh sternite are considerably larger (in the present specimen) and their median margins are sinuous. The size of the processes of the eighth sternite, as shown by Kemp, corre-



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Gennadas bouvieri Kemp. Fig. 72.—*a*. Position of right spermatophore in the thelycum, dorsal aspect. *f*. Flap. *h*. Hook of spermatophore. *s*. Seminal receptacle filled with sperm mass. *b*. Hook removed from thelycum. (Scale = 0·5 mm.) Fig. 73.—Left half of petasma of adult male, anterior view. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 0·5 mm.) Hook-like structures on median margin and internal lobe as seen under oil immersion objective.

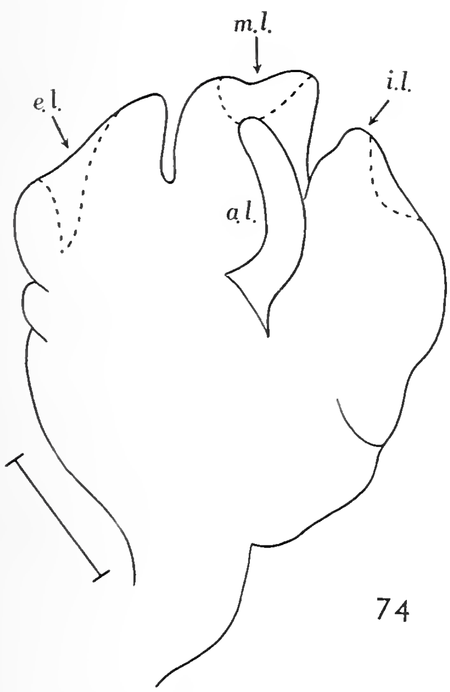
sponds to that seen in a juvenile female (measuring 6 mm. in carapace length) as illustrated in Fig. 71. But, even at this stage, the tips of the processes are hairy and the lateral projections (*b*) of the seventh thoracic sternite are much larger.

Two of the six females at my disposal are impregnated each with a pair of dark brown spermatophores. *On removing the left half of the flap, which hangs from the sixth thoracic sternite and is kept in position by the lateral projections (*b*) of the seventh sternite, a single spermatophore could be examined (Fig. 72). It is more or less like a cone with a pointed apex, curved laterally—giving a hooked appearance to the spermatophore. Consequently, the two spermatophores, which are placed very near to each other posteriorly, diverge anteriorly. The tip of the hook is inserted in the seminal receptacle, which is an invagina-

* This study is based on the female taken from St. 95.

tion from the sulcus between the sixth and the seventh thoracic sternites, and in this case filled with a mass of sperm. In Fig. 72, *a* and *b*, the hook and the seminal receptacle (from the right side of the specimen) are represented as seen from the dorsal side. The hook can easily be detached from the surface of the sternum and is shown in Fig. 72, *b*, after removing the substance which envelopes most of its posterior half.

The *petasma* as represented in Fig. 73 is in full agreement with Burkenroad's observations (1936, p. 81) in differing from its illustrations given by Kemp (1910*b*, Pl. XIII, Fig. 5) and Balss (1927, Fig. 30). Therefore, it is necessary to give some account of its important features. The external lobe (Fig. 73, *e.l.*) is divided into a shorter outer and a longer inner lobule. The tips of both the lobules are accuminate. The median lobe (*m.l.*) extends much beyond the external lobe. It is sub-divided into two lobules of almost equal width and their



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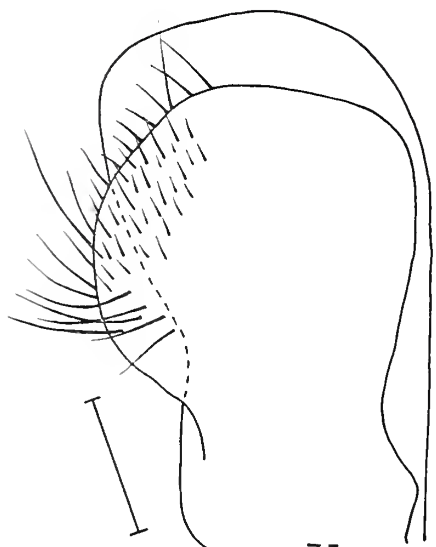

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Gennadas bouvieri Kemp. Male. Fig. 74.—Left half of petasma of an immature specimen of carapace length = 7 mm. Lettering as in Fig. 73. Broken line indicates outline of future petasma as seen through the cuticle. (Scale = 0·25 mm.) Fig. 75.—Left appendix masculine of adult male, in posterior aspect, endopod of pleopod omitted. (Scale = 0·25 mm.)

pointed tips are directed towards one another but the tips do not touch, in any of the males present, whereas they overlap in Balss's figure. The internal lobe (*i.l.*) has been illustrated by Kemp and Balss as reaching beyond the median lobe, but as figured here it can be seen that it is half the length of the median lobe. It is armed with long hooks which are apically ringed. On the other hand, the accessory lobe (*a.l.*) shown to be much smaller by the same authors, is here seen to be very large and as long as the median lobe.

A juvenile male, measuring 7 mm. in carapace length, certainly belongs to this species. The external and the median lobes of the petasma (Fig. 74) have no apparent sign of subdivision, but one can see the future outline of the petasma through the cuticle (shown by a broken line in the figure). Moreover, the accessory lobe is very well developed, which is a distinctive feature of the petasma of *G. bouvieri*.

The *appendix masculina* of *G. bouvieri* shows no great resemblance to that of any other species illustrated in this paper. Both the scales are broad and rounded distally (Fig. 75).

Gennadas incertus (Balss)

Figs. 40, *e*; 48, *f*; 76–80

Amalopenæus incertus Balss, 1927, p. 265, figs. 24–29.
Gennadas incertus, Burkenroad, 1936, p. 66 (in key).
Gennadas sp. Kemp, 1913, p. 62, pl. 7, fig. 9.
Amalopenæus gardineri Balss, 1927, fig. 31.

OCCURRENCE:

Zanzibar area:

St. 121, trawl (sounding 925 m., net apparently not on bottom), 4 males, c.l. 4·5–8 mm.; 4 females, c.l. 7–8 mm., 1 female, c.l. 8 mm. with spermatophores.

Southern area of Arabian Sea:

St. 131, 2 m. tow net, 2500–0 m., 3 females (2 juv. c.l. 5 mm.; 1 adult with spermatophores, c.l. 10 mm.)

St. 131*c*, 2 m. plankton net, 600–0 m., 1 male, c.l. 8 mm.

St. 131 night, 2 m. tow net, ,, ,, c.l. 6 mm.

DISTRIBUTION: Indian Ocean.

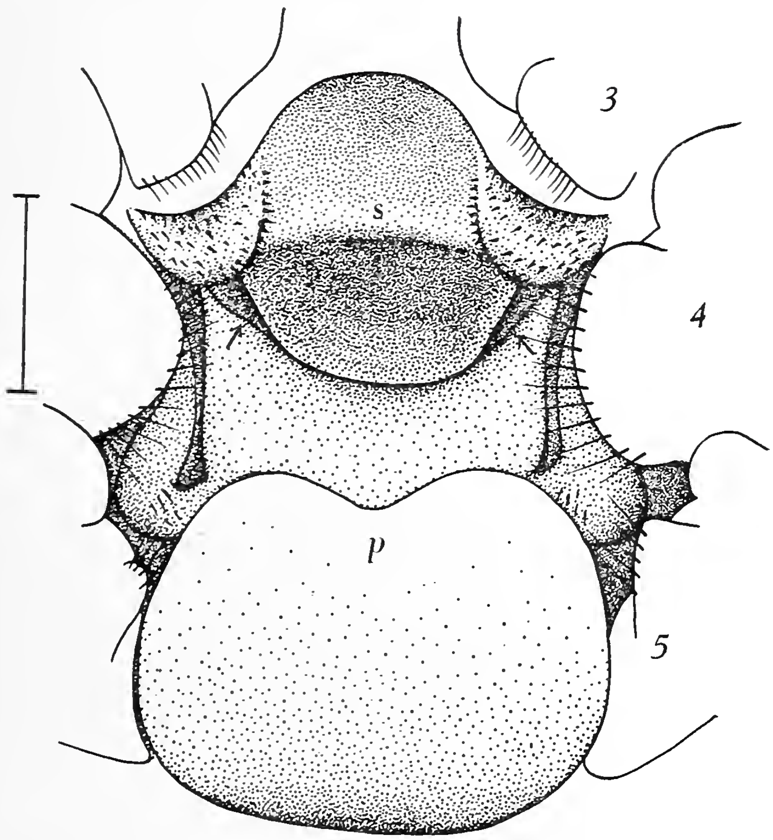
DIMENSIONS AND SEXUAL CONDITIONS: My specimens range from 4·5 to 10 mm. in carapace length. Two females, of carapace lengths 8 and 10 mm. respectively are impregnated with spermatophores. The male from Station 131*c*, measuring 8 mm. in carapace length, has large protruding spermatophores.

REMARKS.—Only three specimens of this species have heretofore been captured, a single male and two females, all from the Indian Ocean. No females were assigned to *G. incertus* by Balss (1927, p. 265). The two females mentioned above were described under different names, the first female as *Gennadas* sp. by Kemp (1919, p. 62); the second specimen taken by the " Valdivia " was named *Amalopenæus gardineri* by Balss (1927, p. 267). Burkenroad in 1936 (p. 85) suggested the possibility of *G. gardineri* representing the female of *G. incertus*. His suggestion is now confirmed from the catch by the " Mebahiss " at Station 121 where both the sexes were taken in the same haul.

DESCRIPTIVE NOTES.—The small spine on the outer margin of the *antennal scale* exceeds the narrowly rounded apex of the lamella by almost its entire length (Fig. 48, *f*).

The *thelycum* of an adult female is represented in Fig. 76. It consists of a large plate (*p*), on the eighth thoracic sternite, which covers the entire space between the bases of peræopods V. The anterior margin of the plate *p* is notched in the middle and is considerably raised from the body surface. On the seventh thoracic sternite is another plate of a curious shape. Its postero-lateral corners, partially concealed by the anterior margin of the plate *p*, are produced into processes which may be described as roughly L-shaped. The antero-lateral corners of the same plate are prolonged into distally pointed processes. The surface of the sternum in front of this plate is markedly concave. On either side of this concave surface are seen the openings of the seminal receptacles which are, as is usual in the genus, simple pocket-like invaginations. On the sixth thoracic sternite is a shield (*s*) the surface of which is concave in the centre but much accentuated laterally where it is armed with small spines. In the impregnated females a large, brown mass is seen attached to the thelycum. It is placed just in front of the plate on the seventh thoracic sternite and extends forwards to cover a great part of the shield. It is to be expected that a further portion of this brown mass—the spermatophores—is tucked into the seminal receptacles. And it is likely that the purpose of the spines on the lateral angles of the shield *s* is to help in the attachment of the spermatophores.

A comparison of the present illustration of the thelycum of *G. incertus* with figures by Kemp (1913, pl. 7, fig. 9) and Balss (1927, fig. 31) shows some differences which are as

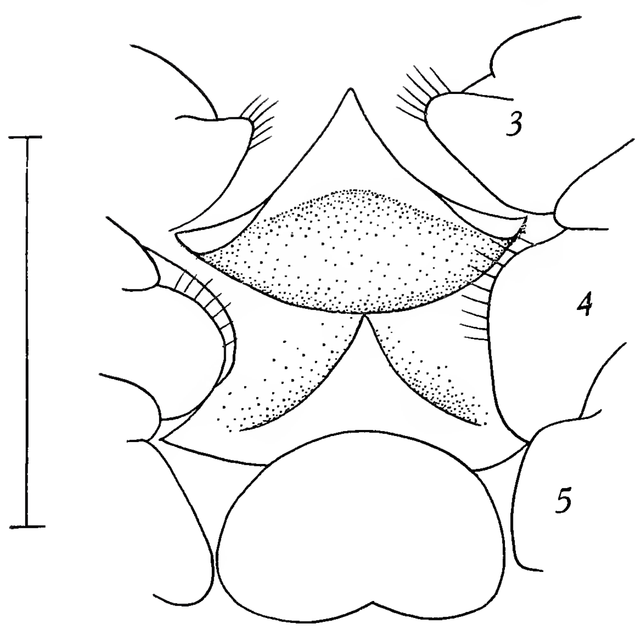


Gennadas incertus (Balss). Fig. 76.—Thelycum of adult female. p. Plate on eighth thoracic sternite. *s*. Shield on sixth sternite. Arrows indicate seminal orifices. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 0·5 mm.)

follows: from Kemp's figure it differs strikingly since in his drawing, the plate between the bases of peræopods V is heart-shaped, and in front of it is a narrow, crescentic, transverse plate. The shield, between the bases of peræopods III, is greatly elongated. From Balss' figure, my material differs only in the more complicated nature of the plate between the bases of peræopods IV.

Fig. 77 is drawn from a juvenile female measuring 5 mm. in carapace length. Though the thelycum is still in an early developmental stage, one can see enough similarity between it and that of an adult to attribute this specimen to *G. incertus*.

The *petasma* (Fig. 79) agrees with Balss's figure and description (1927, p. 265, Fig. 24)



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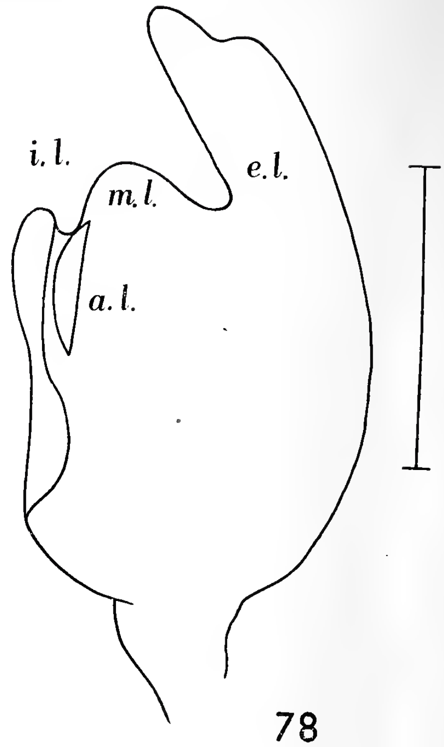

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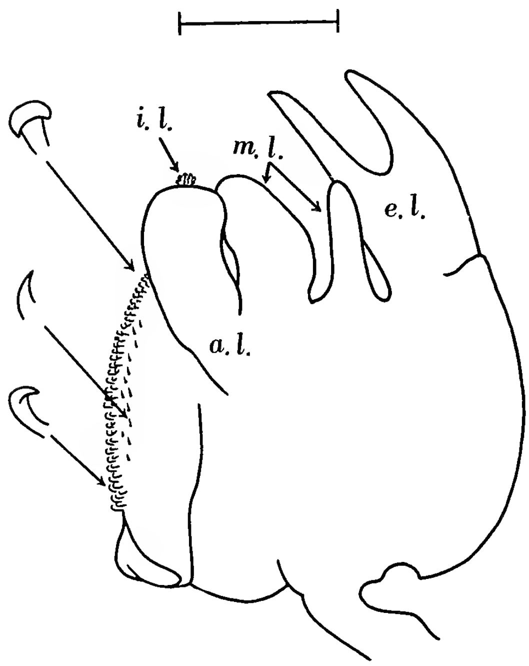
Gennadas incertus (Balss). Fig. 77.—Thelycum of immature female of 5 mm. carapace length. (Scale = 1 mm.) Fig. 78.—Right half of petasma of immature male of carapace length = 4·5 mm. Lettering as in next figure. (Scale = 0·25 mm.)



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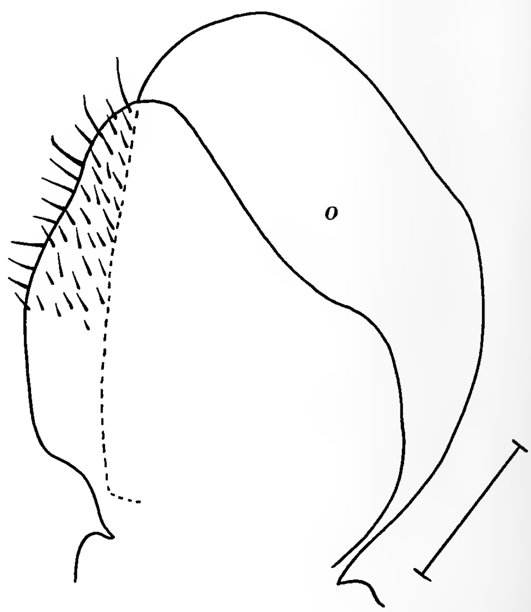

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Gennadas incertus (Balss). Adult male. Fig. 79.—Right half of petasma, anterior aspect. *a.l.* Accessory lobe. *e.l.* External lobe. *i.l.* Internal lobe. *m.l.* Median lobe. (Scale = 0·5 mm.) Hooks on median margin as seen under oil immersion objective. Fig. 80.—Left appendix masculina, endopod of pleopod omitted, posterior aspect. *o.* Outer scale. (Scale = 0·25 mm.)

except his statement that " Die Häkchen am Innenrande sind in der ganzen Länge desselben gleich ausgebildet " since the hooks are variable in their structure as represented in the present figure. The petasma of a very young male is shown in Fig. 78. At this stage the median lobe is undivided and the accessory lobe is just making its appearance. But from the size and shape of the external lobe it is possible to identify the specimen, with some confidence, as *G. incertus*.

The outer scale (*o*) of the *appendix masculina* has its inner margin straight, its outer convex and the apex rounded. The inner scale is broad at the base but is narrowly rounded at the apex (Fig. 80).

REMARKS: The thelycum of this species shows no great resemblance to that of any other available female, except some likeness, in the anterior shield which is situated between the bases of peræopods III, with *G. caini* (*c.f.* Fig. 84). The petasma, on the other hand, shares the enormous size of the accessory lobe with that of *G. bouvieri* (*c.f.* Fig. 73).

Gennadas tinayrei Bouvier

Figs. 40, *f*; 81–83

Gennadas tinayrei Bouvier, 1906, p. 10, figs. 2–4 and 14; 1908, p. 48, pl. 1, fig. 4, pl. 10; 1922, p. 10.
Gennadas tinayrei, Lenz and Strunck, 1914, p. 313; Stephensen, 1923, p. 11; Burkenroad, 1936, p. 73, fig. 56.
Amalopenæus tinayrei, Sund, 1920, p. 29; Balss, 1927, p. 252, fig. 2.
? *Gennadas parvus*, part, Kemp, 1913, p. 60, pl. 7, fig. 7 (thelycum).

OCCURRENCE:

Zanzibar area:

St. 121, trawl (sounding 925 m., net apparently not on bottom), 1 male, c.l. 5·5 mm.

Southern area of Arabian Sea:

St. 131, 2 m. tow net, 2500–0 m., 1 female, c.l. 6·5 mm.

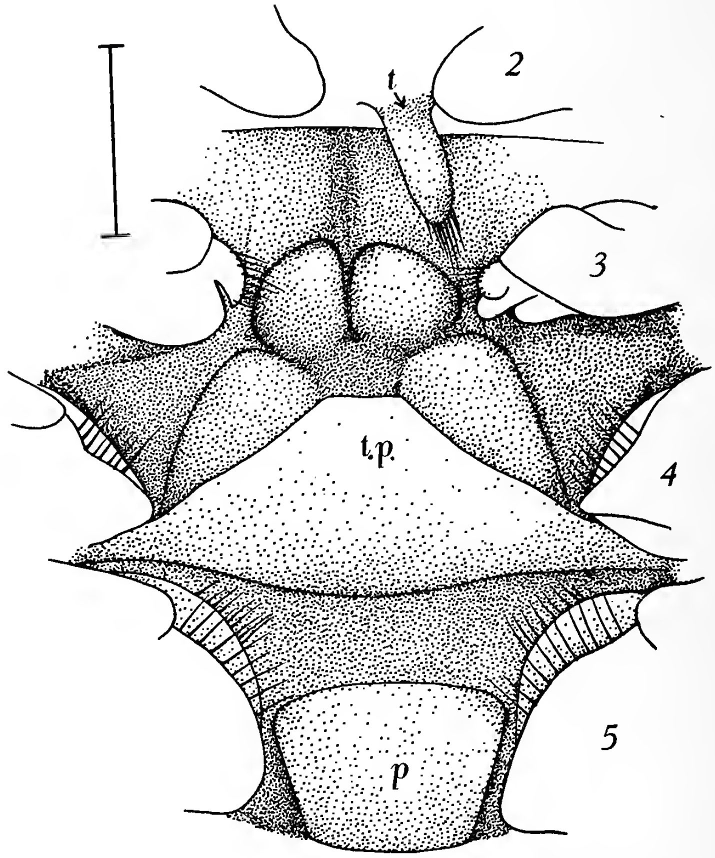
DISTRIBUTION: Atlantic, chiefly in the North; Indian Ocean.

DESCRIPTIVE NOTES.—The species is represented in the present collection by a single male and a female. It is the first female taken from the Indian Ocean. The previous record of the species from the Indian Ocean is based on two males captured by the " Valdivia " (Balss, 1927).

The *thelycum* (Fig. 81) of the female from St. 131 differs from that of a Bahaman female illustrated by Burkenroad (1936, Fig. 56) in the points enumerated below. The plate (*p*), on the eighth thoracic sternite, tapers posteriorly so that its base is narrower than its anterior margin. The triangular plate (*t.p.*) anterior to it, on the seventh thoracic sternite, is truncated at the apex and not produced into a knob-like process as in the Atlantic female. The four projections anterior to this plate are better defined. Lastly, the tongue-like projection *t* (slightly displaced in my specimen), which hangs from the posterior margin of the fifth thoracic sternite, is not setose on the lateral margins, the setæ being confined to the apex.

Two very slight differences are observed on comparing Fig. 82 of the *petasma* with Balss's figure 2. The internal lobe (*i.l.*) is rounded medially and is heavily armed. The distal margin of the accessory lobe (*a.l.*) is not convex, and so the lobe here has a more or less pointed appearance.

The outer scale of the *appendix masculina* has a straight inner margin and a rounded apex ; the inner scale is bud-shaped in outline, and armed with a few long spines (Fig. 83).



Gennadas tinayrei Bouvier. Fig. 81.—Thelycum. *p.* Plate on eighth thoracic sternite. *t.* Tongue-like projection. *t.p.* Triangular plate on seventh sternite. *3, 4* and *5.* Bases of peræopods III, IV and V respectively. (Scale = 0·5 mm.)

Gennadas caini n. sp.

Figs. 40, *g* ; 48, *g* and 84

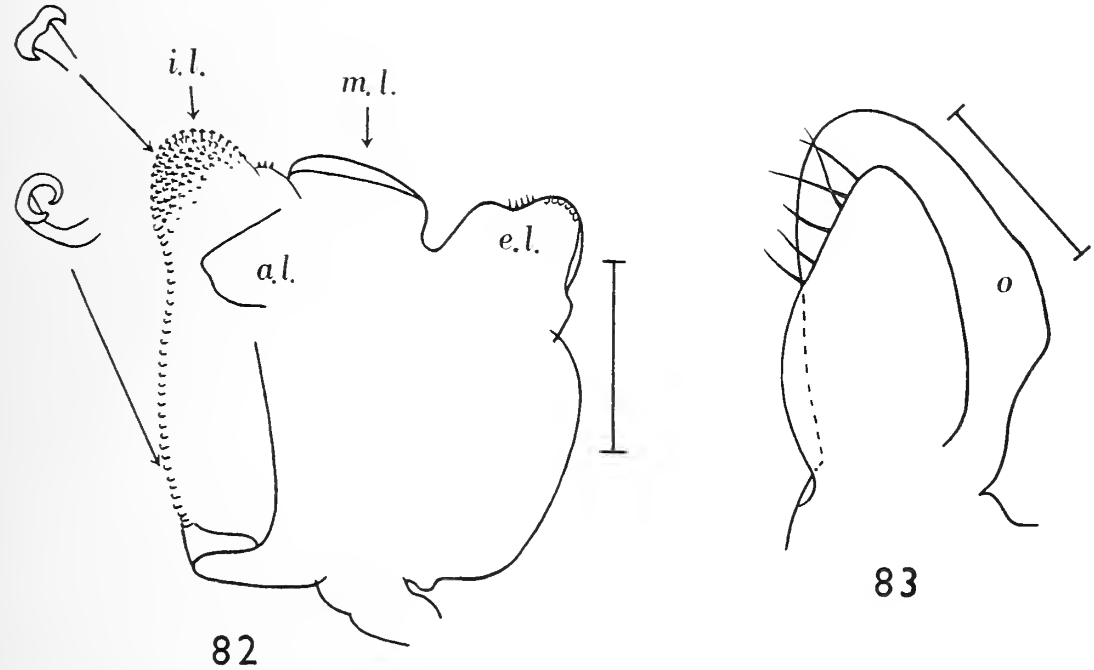
Occurrence :

Central part of Arabian Sea :

St. 171, trawl, 3840–3872 m., 1 female, the holotype, c.l. 9 mm. (Register number 1958.6.3.11).

Description.—The specimen is in rather poor condition, the carapace is slightly damaged and most of the appendages are missing. Therefore a complete description of the holotype cannot be given. As stated earlier in this paper (p. 343) the thelycum is the most important diagnostic feature for the females of the genus *Gennadas*, and the thelycum of *G. caini* does not correspond to that of any species which has been previously described. The species is, however, closely allied to *G. capensis* Calman as discussed below.

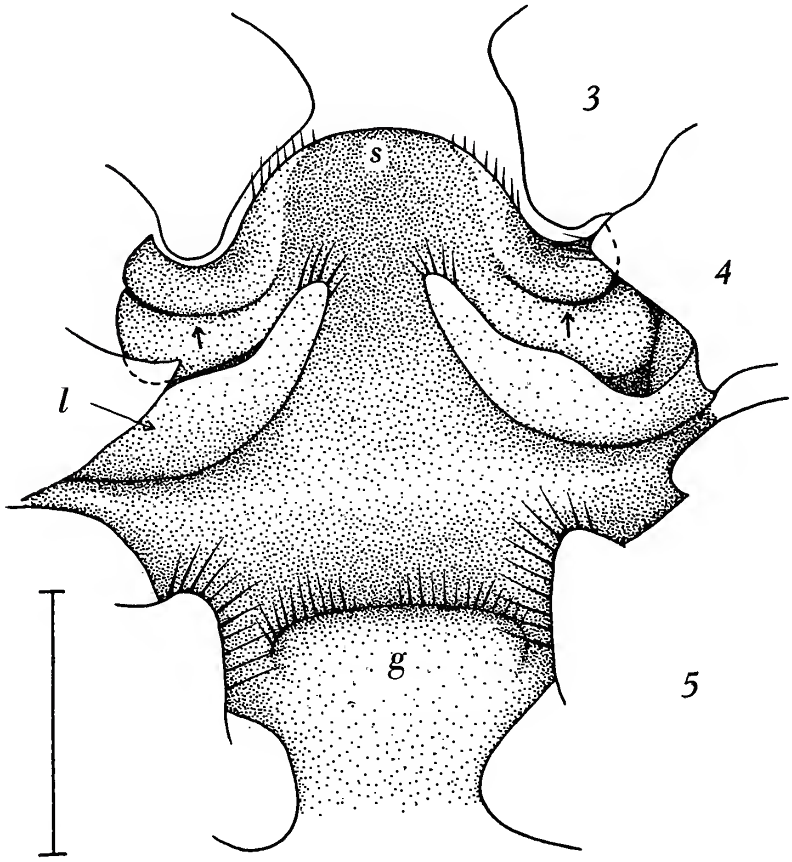
Both the antennal and the infra-antennal angles of *G. caini* are rounded (Fig. 40, *g*) The apex of the lamella of the *antennal scale*, as in *G. capensis*. (Burkenroad, 1936, fig. 51), is placed nearer to the median margin (*i.e.* its outer edge is oblique) and exceeds the spine of the external margin (Fig. 48. *g*).



Gennadas tinayrei Bouvier. Adult male. FIG. 82.—Right half of petasma, anterior aspect. Lettering as in previous figures. (Scale = 0·5 mm.) Hooks on median margin and internal lobe as seen under oil immersion objective. FIG. 83.—Left appendix masculina, endopod of pleopod omitted, posterior aspect. *o*. Outer scale. (Scale = 0·25 mm.)

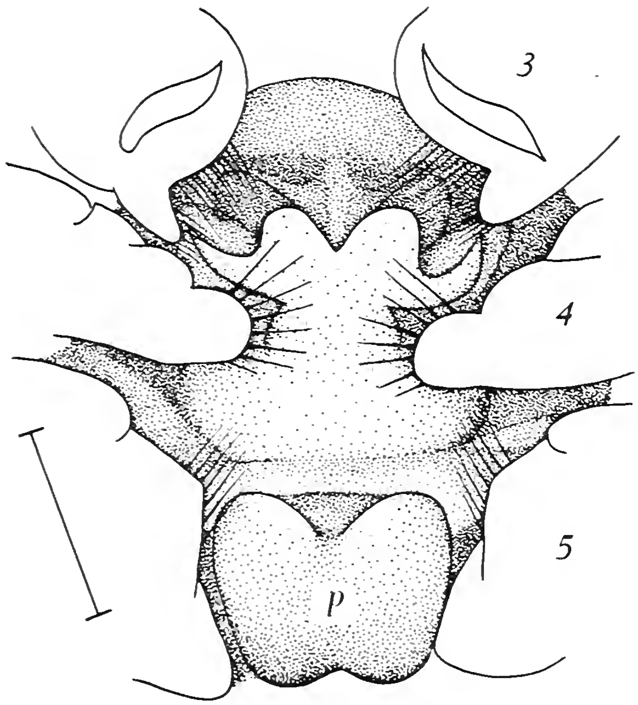
The *thelycum* of *G. caini*, as illustrated in Fig. 84, consists of a prominent transverse ridge (*g*) on the eighth thoracic sternite, the anterior margin of which is fringed with setæ. In front of this ridge the sternal surface is concave, save for a low ridge running transversely between the bases of peræopods IV and V. This probably marks the limits between the eighth and the seventh thoracic sternites. Between the bases of peræopods III, on the sixth thoracic sternite, is a shield (*s*) with its anterior convex margin reaching as far as the anterior limit of that sternite. The surface of the shield which is concave in the middle is bulging at the lateral edges. Moreover, these bulging lateral edges are separated by a pair of crescent-shaped slits—the seminal orifices—from another pair of prominences, situated posterior to them, which are of about the same strength and roughly the same shape. Since it is usual in the genus that the seminal orifices are situated between the sixth and the seventh thoracic sternites, it can be assumed that the shield which is anterior to the seminal orifices is placed on the sixth thoracic sternite and the pair of prominences, posterior to the orifices, on the seventh. The coxa of peræopod V is bilobed; the proximal lobe is rounded and devoid of setæ, the distal one is pointed and setose. From the coxa of peræopod IV arises a large leaf-like process (*l*) which is directed medially and then curved anteriorly.

REMARKS.—For comparison with *G. caini*, I obtained two females of *G. capensis* Calman on loan from the British Museum. One of them is an Atlantic specimen determined and recorded by Burkenroad from St. 1478 (1936, p. 68). The other is from the Pacific, determined by the same author, from the " Challenger " material (taken at St. 171, Kermadec Is.). As stated above, *G. caini* bears a very close resemblance to *G. capensis* but the two species can readily be distinguished by the form of their thelyca.



Gennadas caini n. sp. FIG. 84.—Thelycum of holotype. *g*. Ridge on eighth thoracic sternite. *l*. Leaf-like structure. *s*. Shield on sixth sternite. Arrows indicate the seminal orifices. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 1 mm.)

The thelycum of *G. capensis* Calman is rather well represented by Burkenroad (1936 fig. 53, p. 70). I have not been able to see the " . . . ill-marked rectangular plate on the fourteenth sternite ", mentioned by him (p. 69), probably because of the poor condition of the available specimens. The thelycum of *G. caini* differs from that of *G. capensis* in possessing, on the eighth thoracic sternite, a transverse ridge. According to Burkenroad the anterior part of the thelycum in *G. capensis* consists of " . . . a strong w-shaped ridge on the thirteenth sternite ; and a pair of setose knobs anterior to the ridge, on the twelfth sternite. The boundary between the twelfth and the thirteenth sternites is not marked, save at the lateral edges of the outer legs of the w. At this point at either side a notch is perceptible in which lies the aperture of a small bilobed sperm-receptacle." As can be seen, in *G. caini* this part of the thelycum is quite different, since on the sixth thoracic sternite is a shield with its anterior margin convex. The pair of setose knobs mentioned by Burkenroad are absent in my specimen. The homologue of the proximal rounded lobe of peræopod V, in *G. capensis* is subrectangular and setose. In *G. capensis* the slender leaf-like projection of the coxa of peræopod IV is small and directed medially. Burkenroad's statement that it " . . . nearly meets its fellow of the opposite side " is borne out neither by his figure nor by the specimens available to me.



Gennadas crassus n. sp. Fig. 85.—Thelycum of holotype. *p*. Plate on eighth thoracic sternite. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 0·5 mm.)

Gennadas crassus n. sp.

Figs. 40, *h* and 85

Occurrence :

Zanzibar area :

St. 121, trawl (sounding 925 m., net apparently not on bottom), 1 female, the holotype, c.l. 6 mm. (Register number 1958.6.3.12).

Description.—The holotype is in quite good condition, but, as usual, many of the peræopods are missing. The antennal and the infra-antennal angles are rounded, the former is acute (Fig. 40, *h*). The antennal scale is damaged.

As represented in Fig. 85 the *thelycum* can be described as follows : On the eighth thoracic sternite, between the bases of peræopods V, is a large plate (*p*), the anterior margin of which is considerably raised, giving it a more or less cushioned appearance—hence the name of the species (crassus–thick). Anterior to the plate *p* is another plate which is on the seventh thoracic sternite. This plate has two lateral depressions in which lie the proximal lobes of the bilobed coxæ of peræopods IV. Moreover, the anterior margin of this plate is divided by a v-shaped notch and each half is again sub-divided by a notch even deeper than the median one. Since *G. crassus* is represented only by a single specimen no attempt was made to dissect the thelycum and study the structure which is visible in front of and partly covered by the plate of the seventh thoracic sternite. What can be seen without removing the plate may be described as a pair of low protuberances, mostly visible through the lateral notches. As the anterior margin of the plate, on the seventh thoracic sternite, is raised, a cup-like depression is formed between it and the pair of low protuberances—probably for the reception of the spermatophores in the same manner as in *G. gilchristi* (Balss, 1927, fig. 17). The coxæ of peræopods IV, as stated above, are distinctly bilobed, the proximal lobes being very prominent and fringed with long setæ which just fail to meet in the centre.

REMARKS.—The thelycum of *G. crassus* shows a certain resemblance to that of *G. gilchristi* Calman as figured by Balss (1927, fig. 17). Burkenroad (1936, p. 79) stated that the figure of the thelycum given by Balss " . . . is incomplete and misleading ", and he gave a description and an illustration of the thelycum of *G. gilchristi* from a specimen determined and recorded by Balss from St. 91 (D.T.E.). I had an opportunity of studying a female of *G. gilchristi* which was sent on loan by the British Museum. It was determined by Burkenroad from the undetermined material recorded by Calman from St. 87 (1925, p. 7).

I have also examined an impregnated female of *G. gilchristi* sent on loan from the Zoologisches Museum der Universität, Berlin, determined and recorded by Balss (1927, p. 261, D.T.E. St. 91). My observations on the thelycum are in accordance with Burkenroad's, who has well illustrated the anterior and the median part of the thelycum. The thelycum of *G. crassus* differs from that of *G. gilchristi* in the following particulars: the anterior margin of the plate (*p*) is raised. The lateral depressions on the plate of the seventh thoracic sternite are more marked. In *G. gilchristi* the anterior margin of this plate is divided by a bud-shaped notch and each half is then continued as a sinuous border. The corresponding margin in *G. crassus* is separated by a wider notch and each half is again deeply notched. Another important difference is in the coxæ of the peræopods IV which are more projecting medially in *G. crassus*.

Genus GORDONELLA n.g.

Definition.—Cuticle soft and finely pubescent. Rostrum short and thin, upper margin concave and armed with two teeth. Carapace deep, armed with antennal, post-antennal, hepatic, supra-hepatic, branchiostegal and five post-rostral (or epigastric) spines. Hepatic, orbito-antennal, cervical and branchio-cardiac grooves well marked; post-cervical groove absent. Post-rostral, antennal, branchio-cardiac and pterygostonian carinæ present. A mid-dorsal carina present on each of the six abdominal somites. Telson with three pairs of mobile lateral spines anterior to the distal fixed pair, apex strong and sharply pointed. Cornea rudimentary, a minute tubercle on ocular peduncle. Prosartema present as a rigid scale fringed with long setæ. Mandibular palp long and slender. Endopod of first maxilliped five segmented and greatly elongated. Second maxilliped with the exopod smaller than the endopod. Third maxilliped with additional segments in the endopod, exopod rudimentary. Peræopods I, II, IV and V with additional segments (the third pair is missing, but they also presumably have additional segments, perhaps the same number as in II). A podobranch present on second maxilliped only, arthrobranch of maxilliped 1 reduced.

The genus is named in honour of Dr. Isabella Gordon. Gender : feminine. Type species : *Gordonella polyarthra* n. sp. The branchial formula is tabulated below :—

Gills.	Thoracic segment. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	Total.
Pleurobranchiæ	–	–	1	1	1	1	1	1	6
Arthrobranchiæ	r	2	2	2	2	2	2	–	12+r
Podobranchiæ	–	1	–	–	–	–	–	–	1
Mastigobranchiæ	1	1	1	1	1	1	1	–	7

Gordonella polyarthra n. sp.

Figs. 86–96

Definition of the species as for the genus.

OCCURRENCE :

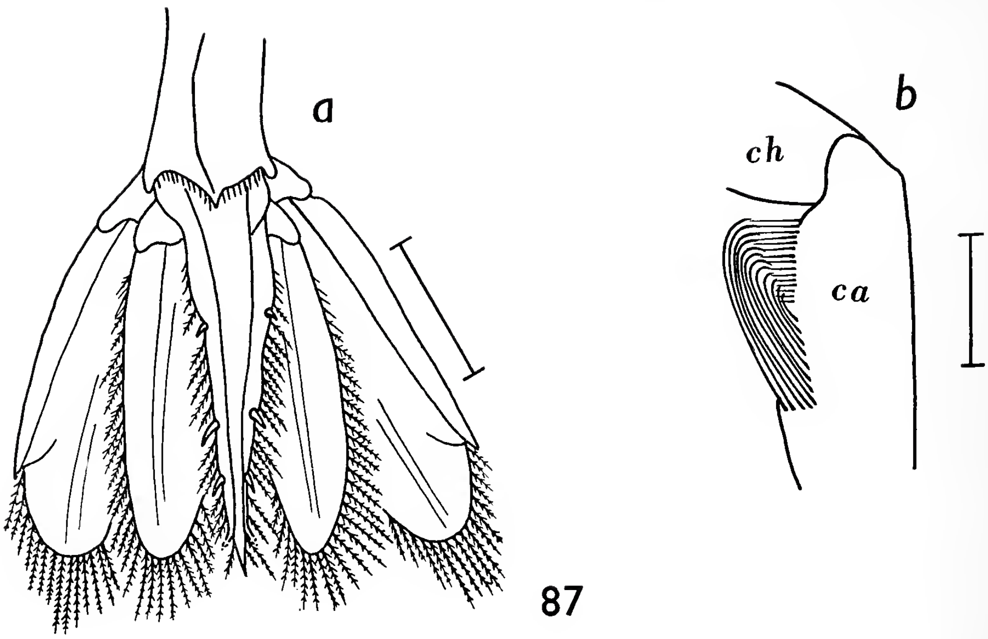
Southern area of Arabian Sea :

St. 135, trawl, 2727 m., 1 female, holotype, c.l. 58 mm. (Register number 1958.6.3.134).

DESCRIPTION.—The *carapace* is finely pubescent and soft ; it measures 58 mm. in length, the rostrum included (Fig. 86). The slender, narrowly triangular rostrum reaches beyond the first segment of the antennular peduncle ; its upper border is armed with two teeth followed by a series of five teeth on the carapace. The post-rostral carina is prominent, interrupted only by the cervical groove and extending along the whole length of the carapace, at the level of the hepatic spine it is continued anteriorly as far as the post-antennal spine. The cervical groove is deep and, as already mentioned, extends to the dorsum. The orbito-antennal groove is rather shallow anteriorly, The hepatic groove is very deep ; anteriorly it is directed obliquely upwards towards the orbito-antennal groove. The hepatic carina anteriorly runs towards the branchio stegal carina. The antennal spine is small and blunt and posteriorly prolonged as a carina which extends to the post-antennal spine (*a*). The post-antennal spine is small but pointed ; it is prolonged backwards in the form of a carina which is interrupted by the small, acute hepatic spine behind which it is well defined and extends, above the branchio-cardiac groove, almost to the posterior border of the carapace. The branchio-cardiac carina (*c*) posteriorly divides into two branches. The supra-hepatic spine (*b*) is small and blunt. Another carina runs from this spine in a backward and downward direction. The branchiostegal spine is well developed ; its carina at the level of the pterygostomian angle runs downwards as far as the pterygostomian carina. The pterygostomian angle is rounded and infolded, as is most of the lower border of the carapace.

The *abdomen*, like the carapace, is soft and pubescent. It is rather slender. All the abdominal segments are dorsally carinated. The carina of the fifth and of the sixth segment ends posteriorly in a small tooth, that of the fifth being the smaller. A distinct lateral carina is present on the posterior three segments. The *telson* is almost twice as long as the sixth abdominal segment. It is provided with three pairs of mobile lateral spines, in addition to a fixed distal pair. The dorsal surface of the telson is flat (*i.e.* without a groove) and terminates in a strong pointed apex (Fig. 87, *a*).

The rudimentary *eyes* are borne on long slender stalks. The distal segment of the peduncle is greatly elongated and at the middle of its median margin provided with a tubercle. The small cornea is only as wide as the stalk. The first segment of the peduncle of the



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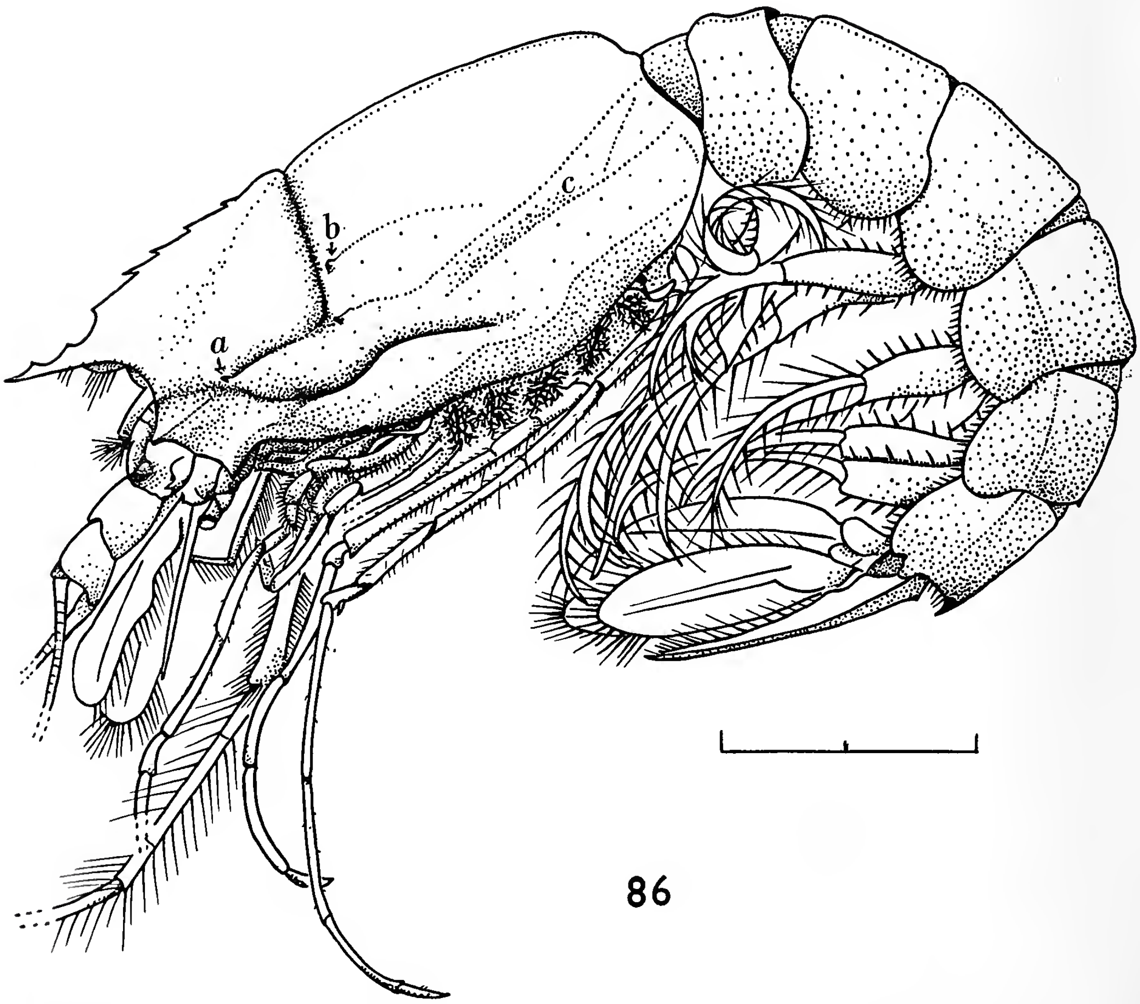


86

Gordonella polyarthra n. g. and sp. Fig. 86.—Holotype in lateral aspect. *a*. Post-antenanl spine. *b*. Supra-hepatic spine. *c*. Branchiocardiac carina. (Scale = 20 mm.) Fig. 87.—a. Telson and uropods in dorsal aspect. (Scale = 10 mm.) b. Setiferous organ on peræopod I. *ca*. Carpus. *ch*. Chela, proximal part. (Scale = 1 mm.)

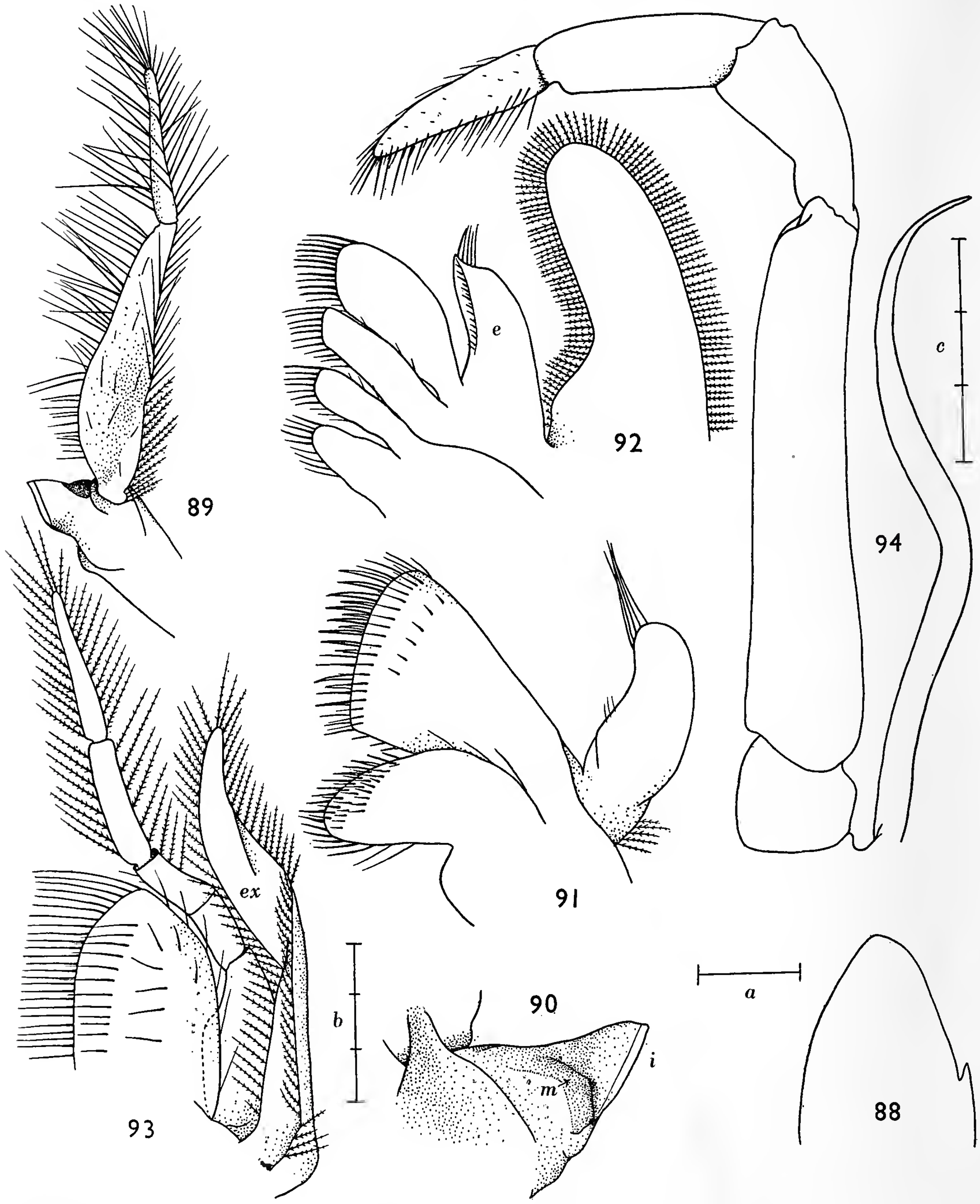
antennule is not the longest, being equal to the second segment; this is very unusual in the Penæids (see Kubo, 1949, p. 28). It is provided with a prosartema in the form of a rigid scale fringed with long hairs. On the disto-lateral margin of the segment is a small stylocerite and, behind this, another small spine. The third segment is rather shorter than the second; the inferior flagellum is inserted at its apex while the superior one is slightly posterior to it. Both the flagella are unfortunately incomplete. The *antennal scale* is large and broad being a little less than three times as long as wide. The apex is symmetrically placed in the centre; the minute spine on the external margin is situated far behind the apex, (Fig. 88). The flagellum is missing in the holotype.

The *mouth parts* from the left side of the specimen are represented in Figs. 89–94 and 95*a*. The mandibular palp is very long and narrow, extending as far as the second segment of the antennular peduncle. The distal segment of the palp is shorter and narrower than the basal (Fig. 89); both segments are provided with long, thickly set setæ. The molar process of the crown is *pyramidal* is shape (Fig. 90*m*); the incisor (*i*) has a sharply defined edge. The endopod of the maxillula hardly diminishes in width towards the rounded apex which, on its antero-median angle, is provided with long setæ (Fig. 91). The proximal gnathobasic lacinia is thumb-shaped in outline. The endopod of the maxilla (*e*) is broad; the inner margin is somewhat concave. The outer suddenly curves inward distally where it is provided with long setæ. Near the median border, on the ventral surface, there is a row of small spines (Fig. 92). The five-segmented endopod of maxilliped 1 stretches much beyond the tip of the exopod (Fig. 93). The ultimate segment of the endopod is longer than the penultimate. As already mentioned, the exopod (*ex*) is without a distal segmented portion—it gently narrows towards the tip. The second maxilliped (Fig. 94) is pediform and greatly elongated. The merus of its endopod (by far the largest segment) is unexpanded and the exopod is much shorter than the endopod. The third maxilliped of one side is missing and, that of the other is incomplete (Fig. 96*a*). The latter, in spite of being incomplete, is amazingly elongated and extends much beyond the tip of the antennal scale; It consists of seven distinct segments, beyond which it is broken. The exopod is rudimentary and incomplete distally (but see p. 379).

Peræopods III are missing; the rest are interesting in that each possesses extra segments. The left first peræopod is apparently seven segmented and it seems that the carpus is subdivided into a short proximal and a long distal segment. The merus, *i.e.* the segment behind it, is undivided, and the ischium has two segments. That of the right side differs from it in having the proximal segment of the carpus longer and with a faint indication of sub-segmentation in the merus (Fig. 96, *b*). The setiferous organ present on this cheliped is shown in Fig. 87, *b*. The second peræopod from the left side is missing; that of the right is illustrated in Fig. 96, *c*. If it is assumed that the carpus is sub-divided, it will be seen that the proximal segment is very small. The merus is divided into two distinct segments (one in front and one behind the bend of the leg in the figure),* and the ischium also has two segments. Alternatively, the ischium may be considered as being undivided and the merus as having two distinct and one (or two) false sub-segments. The latter suggestion appears to be more probable. Unfortunately my material is inadequate to state the exact number of segments in the chelipeds. The fingers of the chela of peræopods I and II are longer than the palm. From the right side of the specimen peræopod IV and the terminal segment of V are missing. On the left side both the peræopods IV and V are nine-segmented;

* See additional note, p. 381. In Fig. 96 *c*, merus lies between *1* and *4*.

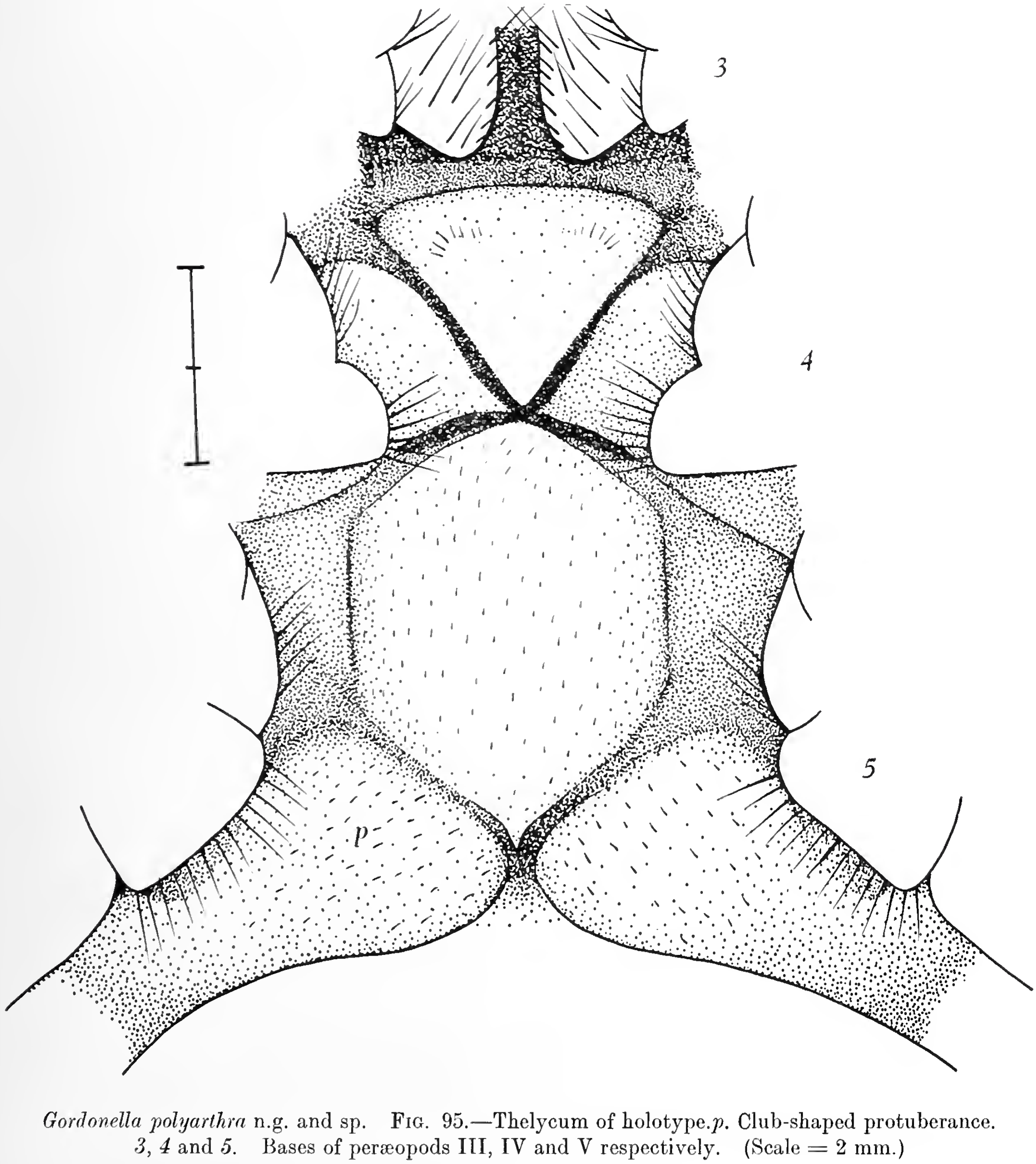
as far as I can judge it is the dactylus which is elongated and composed of four subsegments. [But see additional note by Dr. I Gordon, p. 381]. All the legs of *G. polyarthra* are slender and elongated. The fifth, which measures 75 mm. in length, exceeds the carapace by at least



Gordonella polyarthra n.g. and sp. Holotype. Fig. 88.—Apex of antennal scale, setæ omitted. Fig. 89.—Mandible. Fig. 90.—Mandibular crown in dorsal aspect. *i*. Incisor, *m*. molar, process. Fig. 91.—Maxillula. Fig. 92.—Maxilla; *e*. endopod. Fig. 93.—Maxilliped 1; *ex*. exopod. Fig. 94.—Maxilliped 2 (most of setæ omitted). (Figs. 88 and 89 at scale $a = 5$ mm.; Figs. 90–93 at scale $b = 3$ mm.; Fig. 94 at scale $c = 3$ mm.)

its three distal segments. Minute exopods are present on all the legs. The *pleopods* are very long and hairy as can be seen in Fig. 86.

The *thelycum* is illustrated in Fig. 95 and may be described as follows: posterior to the bases of peræopods V is a pair of club-shaped protuberances (*p*), directed antero-medially,



Gordonella polyarthra n.g. and sp. FIG. 95.—Thelycum of holotype.*p*. Club-shaped protuberance. *3*, *4* and *5*. Bases of peræopods III, IV and V respectively. (Scale = 2 mm.)

and not quite meeting in the midline. Between the bases of peræopods V, on the eighth thoracic sternite, is a plate which is somewhat hexagonal in shape, with its postero-lateral margins meeting at a sharp point. The surface of the plate and of the club-shaped protuberances is covered with a fine pubescence. On the seventh thoracic sternite are three protuberances, one median triangular and two laterals which are pear-shaped. The tip of the triangular protuberance is directed posteriorly, and those of the pear-shaped ones medially. The surface of these protuberances is smooth save for a few hairs near the anterior margin of the median protuberance. The postero-median angle of the coxæ of peræopods IV form large lobes.

RELATIONSHIPS :—In the absence of podobranchs behind the second maxilliped (body somite 8) *Gordonella* agrees with *Gennadas* amongst the Aristæinæ and with the majority of the Solenocerinæ and Penæinæ (Balss, 1957, p. 1516—here the two latter subfamilies are united under Penæinæ). As only a single female of *Gordonella polyarthra* is known, it is difficult to determine the systematic position of the genus. Burkenroad (1936, p. 100) states that " in the males of all known Aristæinæ and Solenocerinæ the appendix masculina is composed of two blades, whereas it seems to be single in all Penæinæ and Eusicyoninæ."

In the softness of the cuticle, small size of the rostrum and the possession of a tubercle on the ocular peduncle *Gordonella* resembles the Benthesicymæ. Of the genera included in this series, *Gordonella* agrees with *Gennadas* in the form of the exopod of the first maxilliped ; with *Benthonectes* and the *Benthesicymus brasiliensis* group (see Burkenroad, 1936) in possessing a hepatic spine and in the degree of development of the exopods of the peræopods.

On the other hand, it differs from all the Benthesicymæ and approaches certain Solenocerinæ in having a post-antennal, a supra-hepatic and epigastric spines on the carapace. These spines are present in *Parahaliporus sibogæ* (de Man) and certain other Solenocerinæ. It may be mentioned here that Burkenroad's statement that the Solenocerinæ " are peculiar in their possession of a post-orbital spine, which is reported lacking in *Solenocera maldiviensis* Borradaile " (1936, p. 65—see also Burkenroad 1936, p. 102) is incorrect, since according to Kubo (1949, p. 207 in key) it is absent in *Parahaliporus*, *Haliporus* and *Hymenopenæus*. I can confirm that the post-orbital spine is absent in *Parahaliporus sibogæ* and in *Haliporus curvirostris*. The telsonic armature of *Gordonella polyarthra* is similar to that of *Haliporus thetis* Faxon and *H. curvirostris* Bate which, according to Burkenroad (1936, p. 101), are the only adult Solenocerinæ with several pairs of mobile lateral spines anterior to the distal fixed pair. The prosartema in these two species, is unlike that of other Solenocerinæ, a rigid short projection fringed with long setæ—much the same as in *Gordonella polyarthra* where it is slightly more developed and scale-like. A careful re-examination of the type specimen of *H. curvirostris* in the British Museum Collection revealed other similarities. The cornea of *H. curvirostris* is very reduced, unlike that of many other Solenocerinæ. The carapace is soft and pubescent and sculptured with many grooves and carinæ ; it has the following spines : antennal, post-antennal, branchiostegal, hepatic and a few epigastric—the same as in *Gordonella* apart from the supra-hepatic spine. The post-rostral carina extends to the posterior margin of the carapace, and all the abdominal somites are dorsally carinated.

The long slender mandibular palp of *Gordonella polyarthra* is strikingly similar to that of *Parahaliporus sibogæ* (*c.f.* Kubo, 1949 Fig. 8*c* with Fig. 89 of this paper), and of *H. curvirostris*. On removing the mandible from *Haliporus curvirostris* the incisor process proved to be tridentate and the molar process flat ; in *G. polyarthra* the incisor process is sharp and smooth and the molar process is pyramidal (Figs. 89 and 90). The first maxilliped of *Gordonella* deviates from that of the Benthesicymæ and approaches the form typical of the Penæinæ and Solenocerinæ since the endopod is slender and the ultimate is longer than the penultimate segment.

In the possession of long slender peræopods IV and V with subdivided dactyli* *Gordonella* is paralleled by *Benthonectes* and *Xiphopenæus* (littoral Penæinæ). At first sight the elongated legs and the extra segments of peræopods IV and V suggested that the "John Murray" specimen probably belonged to the genus *Benthonectes*. When I compared a specimen of *B. filipes* with *G. polyarthra* I found that the two specimens were quite different, as already mentioned (p. 337). In *B. filipes* the dactyli of peræopods VI and V are flagelliform and composed of 90 to 96 subsegments.

With regard to the thelycum, unless an impregnated female is captured, or by careful dissection of further material the presence of sperm receptacles is demonstrated, it is not possible to say whether the thelycum is of the open or the enclosed type. However, it is of interest to note that the thelycum of *Gordonella polyarthra* shows some resemblance to that of a young female of *Hymenopenæus aphoticus* Burkenroad (1936—compare his Fig. 66 with Fig. 95 of this paper). According to Burkenroad (1934, p. 65) the thelycum of the Solenocerinæ is of the open type.

Gordonella is unique in the family Penæidæ (i) in having the basal segment of the antennular peduncle short (see Kubo, 1945, p. 28) and (ii) in possessing additional segments in the third maxilliped and in the chelipeds.

Additional Note on *Gordonella polyarthra* Tirmizi

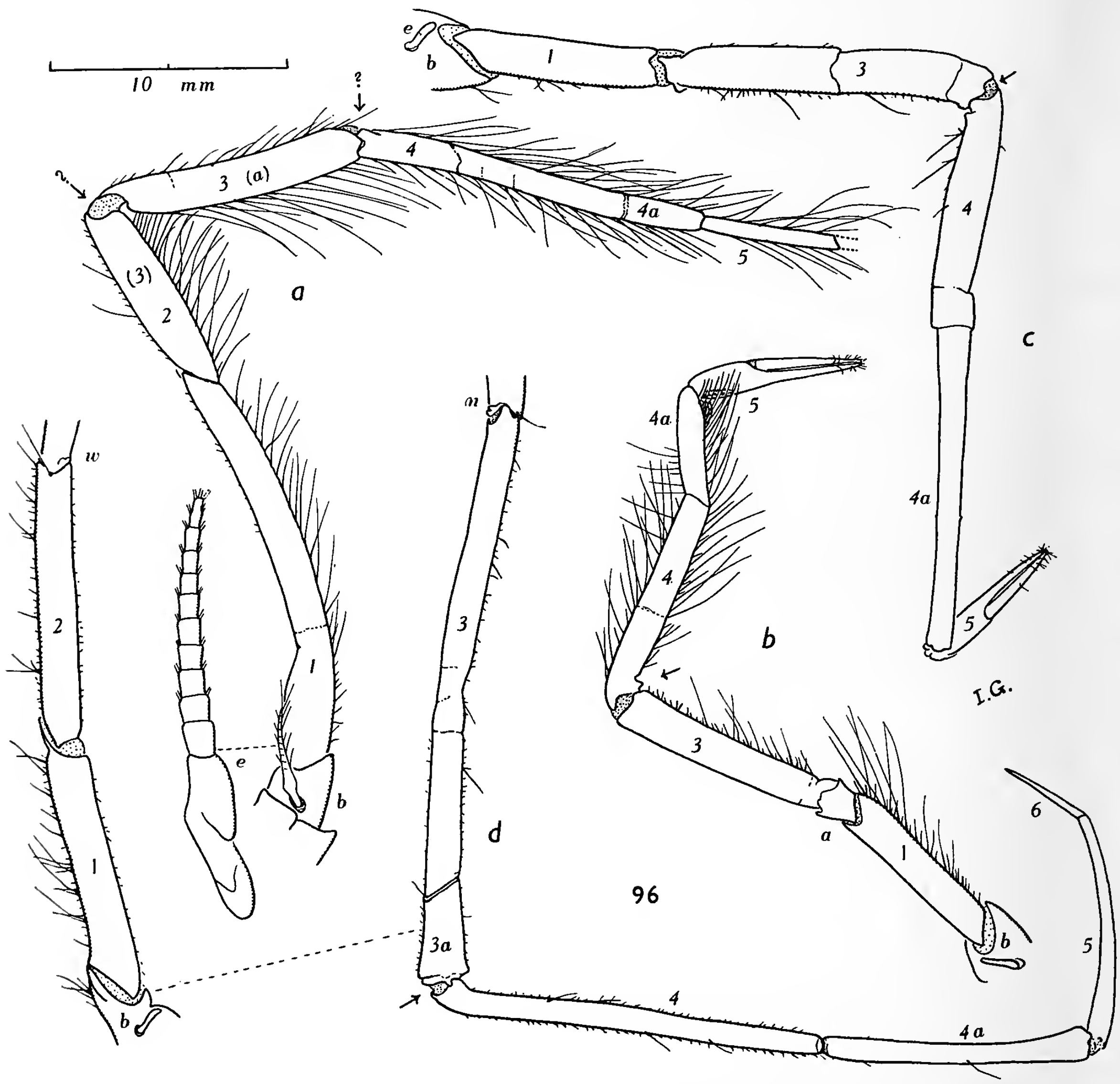
Dr. Tirmizi had returned to Karachi before I was able to prepare her manuscript for publication. The holotype of *Gordonella polyarthra* is very fragile and it is by no means easy to determine precisely how many additional subsegments there are and which of the principal segments are subdivided. Moreover, the specimen has been preserved for about 25 years and, while it was lying undetermined, some of the long limbs have probably been bent in unusual places, causing folds which may be mistaken for suture lines. But some of the segments do undergo subdivision, which may not be identical in left and right partners. Mrs. Tirmizi's figures of the appendages were rather too small to show the details adequately and, as my interpretation of the segments differs from hers, I have made camera lucida drawings to replace her Fig. 96.

I have studied the thoracic appendages 3 to 8 (maxilliped 3 and peræopods I to V) rather carefully and have tried to make out the principal segments of the endopod in each appendage. These are ischium (or fused preischium + ischium), merus, carpus, propodus and dactylus. In peræopod V there are two distinct long segments (or subsegments with a very good articulation) proximal to the merus which I have designated as *3* in the drawings. Since segment (or subsegment) *2* is wanting in peræopod IV and in the chelate peræopods which are present (I and II), I have omitted that number in Figs. 96*b* and 96*c*. Since the merus has been designated *3*, 4 is the carpus, *5* the propodus and *6* the dactylus in my interpretation of the segments.

The third maxilliped is very long and heavily setose ; the exopod is small, though better developed than that of each peræopod (*e* in Figs. 96*a* and 96*c*). I think, however, that it is complete, or nearly so, since there seem to be 2 terminal setæ with a third one missing ; if any of the segments are wanting (as Dr. Tirmizi thought) then it would be only one or two. The very long proximal segment of the endopod (*1*) is bent about one-third of the way

* See, however, additional note, p. 381. I do not think that it is the dactylus which is subdivided in *Gordonella*, I. G.

along (indicated by a transverse dotted line) and it is difficult to decide whether or not there is a subdivision at this point—I think there is no true subdivision. The next two segments may be interpreted as representing *2* and *3*, or, since *2* is wanting in most peræopods other than V, as *3* and *3a*. The " knee " joint is indicated by an arrow in the figures ; it should



Gordonella polyarthra n.g. and sp. Fig. 96.—a. Right maxilliped 3 (tip missing), and exopod more highly magnified. b. Right peræopod I. c. Right peræopod II. d. Left peræopod V (the part marked *w* fits on to the part with *w* inverted). *b*. Basis with minute exopod. *e*. Exopod. *1* and *3* to *6*. The principal segments of the appendage. The arrow indicates the probable " knee " joint.

lie between *3* or *3a* and *4* (between merus and carpus), but in the case of the third maxilliped it would be at either of the two points indicated, according to the way in which the segments are interpreted. Since there is a tendency for the merus to subdivide in the peræopods, I am inclined to favour the *3*, *3a* interpretation, although there is a very long arthrodial membrane between the two (these articular membranes are dotted in the figures). Segment

4 appears to have two suture lines, the distal one being the more distinct. The tip is missing beyond *5*, which may not be complete although the break is at a suture line.

The right peræopod I is represented in Fig. 96*b*. Segment *3*, the merus, is bent proximally and it is not certain whether *a* is a true subsegment or whether the cuticle has been damaged at this place at some time and healed to give this subdivided effect. (In the left partner the rather indistinct subdivision is apparently at the distal end of segment *1*). Subsegment *4* has been bent across the dotted line, which does not indicate a suture ; *4* and *4a* probably represent the subdivided carpus since, in the left partner, the relative lengths of the subsegments is reversed. These peræopods are also heavily setose.

Peræopod II shows a tendency to subdivision of segment *3* which is presumably the merus (Dr. Tirmizi is mistaken in thinking that the " knee " joint could lie *within* the merus—see p. 375). Divisions *4* and *4a* probably represent a divided carpus, but the limb has been slightly damaged at the distal end of *4* (Fig. 96*c*).

The left peræopod V is represented in Fig. 96*d* (the two parts of the limb join so that *w* fits over the inverted *w*). As already mentioned, segment *2* is difficult to interpret, since it seems to be missing from peræopods I, II and IV ; it does not appear to be a subdivision of the merus (*3* and *3a*) so perhaps the ischium (*1*) has subdivided or preischium has become distinct from the ischium in this appendage. The merus is very long and, in addition to the distinct suture line at the base of *3a*, there appears to be an indistinct suture line distal to the median kink in the major portion (*3*). I regard *4* and *4a* as representing a divided carpus since there is the characteristic terminal expansion at the distal end of *4a*. The propodus in this instance is undivided (*5*) and is followed by a short dactylus (*6*). The right partner differs somewhat from the one figured : i). Segment *1* is slightly shorter, *2* is considerably longer. (ii). Segment *3* is about one-third shorter than $3 + 3a$ and has only one suture near the middle. (iii). Subsegment *4* is shorter than *4a* and the latter is again subdivided at its distal third. Segment *5* has a median suture line and the dactylus is missing.

Peræopod IV (left—right missing), though quite similar to V, differs in detail as follows: Segment *2* appears to be wanting and the merus is rather indistinctly subdivided into three subsegments of which the distal equals the sum of the other two. Subsegment *4* is longer than *4a* and comprises a very short proximal, and a long distal, part ; the carpus thus has three subsegments. Segment *5* is also subdivided just beyond the middle.

Secondary subdivision of the carpus of peræopod II is quite common in Decapoda Natantia (Hippolytidæ, Alphæidæ, Pandalidæ, Processidæ) and in *Thaumastocaris* (Palæmonidæ) the carpus of peræopod I is also subdivided. In the Stenopidea the carpus and propodus of the non-chelate limbs (IV and V) may be subdivided (*Stenopus*, *Richardina*). Occasionally other segments may also be subdivided ; in the Hippolytid *Ligur uveæ* (Borradaile) I found that carpus, merus and ischium (distal end only) of peræopod II are subdivided as also is the propodus of peræopods III, IV and V (Gordon, 1936, *Proc. Linn. Soc. London* 148 : 104–106). In the Penæid genera *Benthonectes* and *Xiphopenæus*, as mentioned by Mrs. Tirmizi (see p. 379), the dactylus alone is subdivided in peræopods IV and V. *Gordonella* is unique in that all the peræopods and the third maxilliped are affected to a certain extent. It is to be hoped that additional specimens may one day be available for examination, for the holotype of *G. polyarthra* lacks peræopods III and is in poor condition, although it has withstood a considerable amount of handling quite well.

Isabella Gordon.
18.vi.58.

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CRUSTACEA : CHIROSTYLIDAE
(Galatheidea)

BY

NASIMA M. TIRMIZI, D.Phil.(Oxon.)

WITH FORTY-THREE TEXT-FIGURES

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INTRODUCTION

THE Galatheidea obtained by the " John Murray " Expedition belong to two families : Chirostylidae Ortman and Galatheidae Dana. The present paper is based on the material pertaining to Chirostylidae and it is hoped that a report on the " John Murray " Galatheidae will be completed in the near future.

The family Chirostylidae comprises two subfamilies: Uroptychinae Doflein and Balss and Eumunidinae Milne-Edwards; the latter is not represented in this collection. The subfamily Uroptychinae is at present divided into two genera: *Chirostylus* Ortman and *Uroptychus* Henderson, which are represented in this collection by thirteen species, two belonging to *Chirostylus* and eleven to *Uroptychus*. Seven species of the genus *Uroptychus* are described as new to science: *U. gordonae*, *U. murrayi*, *U. brachydactylus*, *U. sternospinosus*, *U. spinimanus*, *U. onychodactylus* and *U. siraji*. *Chirostylus hendersoni* Alcock is recorded for the second time and *Uroptychus gracilimanus* Henderson for the first time from the Indian Ocean.

Through the kindness of the authorities, I have been able to study type and other named material in the collections of the British Museum (Nat. Hist.); the Muséum National d'Histoire Naturelle, Paris; the Rijksmuseum van Natuurlijke Historie, Leiden; the Zoölogisch Museum, Amsterdam and the U.S. National Museum.

I would like to mention here that I have followed Balss in using " plastron " for the ventral plate formed by the sterna of the third to seventh thoracic segments. The " penduncle " is used for the protopod and the basal segments of the endopod of the antenna. The following abbreviations have been used: *c.l.* = carapace length measured from the orbital border to the posterior margin of the carapace; *c.l.* + *r.* = carapace length from the tip of the rostrum to the posterior margin of the carapace; *c.b.* = the breadth of carapace determined by measuring the widest part across the branchial regions; *ch.l.* = length of chelipeds.

The material in the " John Murray " collection will be deposited in the British Museum (Nat. Hist.).

LIST OF SPECIES WITH STATIONS AT WHICH COLLECTED

Family Chirostylidae—Subfamily Uroptychinae.

Genus *Chirostylus* :	
Chirostylus investigatoris Alcock and Anderson	159
hendersoni Alcock	42
Genus *Uroptychus* :	
Uroptychus nigricapillis Alcock	50, 119, 159
gracilimanus Henderson	108, 122
australis var indicus Alcock	124
gordonae n. sp.	158
murrayi n. sp.	Not known
brachydactylus n. sp.	42
sternospinosus n. sp.	159
spinimanus n. sp.	54
cavirostris Alcock and Anderson	157
onychodactylus n. sp.	158, 159
siraji n. sp.	159

Family Chirostylidae Ortmann

Subfamily UROPTYCHINAE Doflein and Balss

Key to the Determination of the genera of the subfamily Uroptychinae

I. Lateral margins of the carapace not sharply defined, rostrum spiniform, antennal acicle wanting — Genus *Chirostylus* Ortmann

II. Lateral margins sharply defined, rostrum triangular, antennal acicle present — Genus *Uroptychus* Henderson

Genus *CHIROSTYLUS* Ortman

Miss van Dam (1933, pp. 16 and 38) listed all the species of *Chirostylus* known to her, eleven in all. Since then, as far as I know, only one Atlantic species, *Ch. affinis* Chace (1942, p. 6) has been described. The " John Murray " Expedition obtained specimens of each of the two species previously recorded from the Indian Ocean.

Key to the determination of Indian Ocean species of the Genus Chirostylus

I. Chelipeds stout, fifth abdominal tergum with a longitudinal row of spines or tubercles at the junction with either pleuron . . . *investigatoris* Alcock

II. Chelipeds very slender, fifth tergum with two transverse rows of spines . . . *hendersoni* Alcock

Chirostylus investigatoris Alcock & Anderson

(Figs. 1 and 2.)

Ptychogaster investigatoris Alcock & Anderson, 1899, p. 24.

Ptychogaster investigatoris, Alcock, 1901, p. 281 ; Ill. Zool. Investigator, Crust., pl. XLV, Fig. 1 ; Kemp & Sewell, 1912, p. 25.

Chirostylus investigatoris Doflein & Balss, 1913, p. 132, fig. 1, 2.

OCCURRENCE :

Maldive Area :

St. 159, monagésque trawl, 914–1463 metres, 1 male (*c.l.* + *r.* = 25 mm., *ch.l.* = 113 mm.) ; 1 mutilated female (*c.l.* = 12·5 mm. tip of rostrum broken, no chelipeds).

DISTRIBUTION : Indian Ocean.

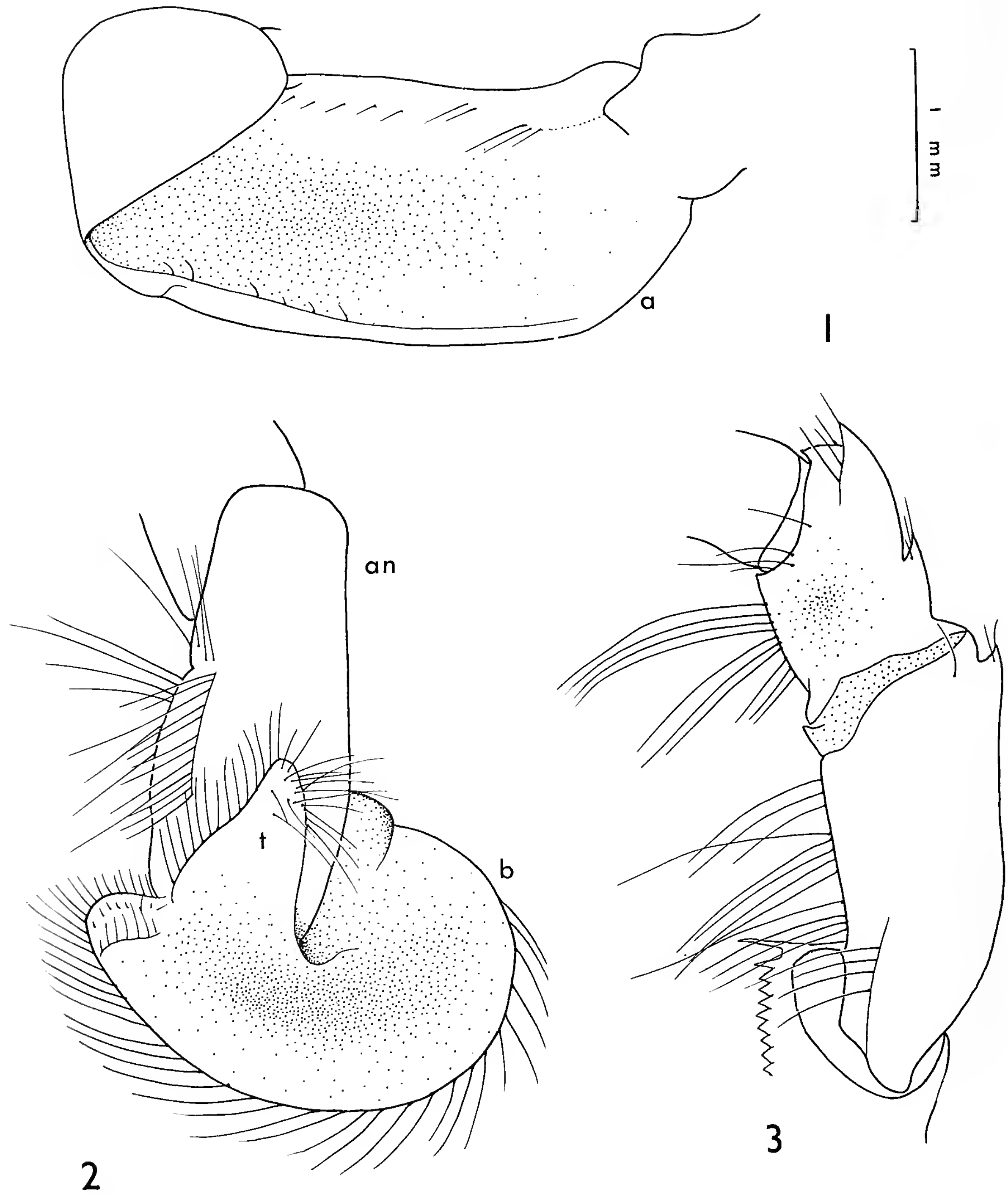
DESCRIPTIVE REMARKS : Doflein and Balss described the first male of *Ch. investigatoris* in 1913 (p. 132) and pointed out that their specimen differed from the type in the spinosity of the second and third abdominal segments. It seems that the spines of the abdominal segments are liable to some individual variations, since both " John Murray " specimens, a male and a female, differ slightly from the previous descriptions and also from each other. The female agrees more closely with the original description except that the third abdominal tergum, which according to Alcock " . . . is perfectly free from spines " (p. 281), has one or two rather weak spines on either lateral margin of the tergum exactly in the same position as in the following two segments. In the male the spines of the second segment are small and blunt and not only the third but the fourth tergum is also free from spines. The fifth tergum, in both the specimens, has spines as described in the type.

The sternum of the segment corresponding to the third maxillipeds has a median groove which is continuous over the following sternites. Immediately behind the anterior margin and on either side of the median groove, this sternum has a spine. The fourth thoracic sternum has two large spines on each lateral border and on either side of the median groove is a longitudinal row of three spines. Each of the next three sterna has a strong, setose transverse ridge. Since the female is imperfect the above observations are based entirely on the male.

The chelipeds are wanting in the female. In the male they are stout, spiny and nearly twice the length of the fully extended body.

The third maxilliped has been figured by Doflein & Balss (1913, Fig. 1). In the " John Murray " specimens the spine on the distal outer border of the merus is small and the tubercle on the same border of the carpus is simple and not bidentate, somewhat better developed in the female than in the male.

The first and second pleopods of the male have also been figured by the same authors (Doflein & Balss 1913, Fig. 2). A closer examination, however, showed that the endopod of the first pleopod is thin, elongate and deeply concave for the greater part of its dorsal surface. The posteriorly directed apex is rounded and curved over the concave surface as shown in Fig. 1. The anterior margin (*a*) is also curled inwards, towards the same surface, and has a few small spines. The endopod of the second pleopod is rather complicated (Fig. 2). It consists of a slender, stalk-like proximal part and a much broadened and rounded distal part. The surface of this rounded part is concave and, as represented in the figure, a tongue-like projection (*t*) arises from it. The tongue-like projection is curved and bears long setae at its apex. When the specimen is viewed from above, the margin labelled *an* is anterior in position, the projection *t* is directed medially and the margin *b* is directed upwards.



Chirostylus investigatoris Alcock & Anderson. Male. FIG. 1.—Endopod of left first pleopod, dorsal view. *a.* Anterior margin. FIG. 2.—Endopod of left second pleopod. *an.* Anterior margin. *b.* Margin directed upwards. *t.* Tongue-like projection.

Chirostylus hendersoni Alcock. Female. FIG. 3.—Median portion of endopod of third maxilliped.

Chirostylus hendersoni Alcock & Anderson

(Fig. 3.)

Ptychogaster hendersoni Alcock & Anderson, 1899, p. 23.
Ptychogaster hendersoni, Alcock, 1901, p. 280 ; Ill. Zool. Investigator, Crust., pl. XLV, fig. 2.

OCCURRENCE :

South Arabian coast :

St. 42, Triangular dredge, 1415 metres, 1 female (*c.l.* + *r.* = 17·5 mm., *ch.l.* = 95 mm.)

DISTRIBUTION : Indian Ocean.

DESCRIPTIVE REMARKS : The " John Murray " specimen of *Ch. hendersoni* is the second female and the only other known specimen of the species besides the holotype. It is slightly bigger than the holotype with which it agrees except in the following details :

Alcock described the carapace as being " . . . covered with spinules and spines, in which a definite serial arrangement of the larger spines is hardly manifest " (1901, p. 280). In this specimen, however, the spines anterior to the cervical groove are large and sparse, with a very few small spines in between them. Posterior to the cervical groove are four longitudinal rows of large spines separated by smaller spines which, more or less, form a double row in between those of the large spines.

The first abdominal tergum has " . . . a transverse spiny carina continuous with a similar carina on the anterior edge of the second pleura ; the second has two such carinae ; the third has a longitudinal row of spines at the junction with either pleura but is otherwise smooth ; . . . " (Alcock, 1901, p. 280). In this specimen, however, there are some additional spinules on the third tergum suggesting traces of two carinae. The armature of the following terga is as in the type specimen.

The armature of the thoracic sterna is much the same as that of *Ch. investigator*, only somewhat weaker.

According to Alcock the third maxillipeds are unarmed (p. 280). But in the " John Murray " specimen, as represented in Fig. 3, the merus is armed with a small distal spine on its outer border. The same border of the carpus has a spine near the centre and another at the anterior margin.

The chelipeds, which are long, spiny and very slender, are just a little less than two and three-quarter times the length of the fully extended body. They are said to be more than two and three-quarter times in the type.

Genus *UROPTYCHUS* Henderson

Miss van Dam listed all the known species of the genus *Uroptychus*, with their distribution, in 1933, pp. 36 and 40 ; her total was forty three species and four varieties. Since then, as far as I know, the following additional species and varieties have been described :

U. aguayi Chace, 1939
U. crassipes van Dam, 1939
U. fornicatus Chace, 1942
U. grandirostris Yokoya, 1933
U. joloensis van Dam, 1939
U. mortenseni van Dam, 1939
U. nitidus var. A Chace, 1942
U. nitidus var. B Chace, 1942
U. nitidus var. C Chace, 1942
U. spinuliferus van Dam, 1940
U. latirostris Yokoya, 1933.

Key to the Determination of Indian Ocean Species of the Genus *Uroptychus*

I. Carapace, excluding rostrum, as long as, or longer than broad.
- A. Rostrum acutely triangular.
  - i. Carapace almost smooth, no granules or spinules.
    - A. Gastric area with a pair of spines . . . . . *U. nigricapillis* Alcock
    - B. No gastric spines.
      - a. Lateral margins of carapace nearly smooth or denticulate.
        - i. Lateral margins smooth or obscurely crenulate, chelipeds much more than twice the length of carapace.
          - a. Chelipeds slender, four to five times the length of carapace *U. gracilimanus* Hend.
          - b. Chelipeds moderate, about three and a half times the length of carapace . . . . *U. australis var indicus* Alcock
        - ii. Lateral margins denticulate; chelipeds about twice as long as carapace . . . . *U. gordonae* n. sp.
      - b. Lateral margins of carapace and the pterygostomial region spinose *U. murrayi* n. sp.
  - ii. Carapace and chelipeds covered with granules or spinules.
    - A. Carapace and chelipeds covered with granules.
      - a. No gastric spines, chelipeds stout, three and a half times as long as carapace . . . . *U. brachydactylus* n. sp.
      - b. A pair of large gastric spines, chelipeds slender, more than five times as long as carapace . . . . *U. sternospinosus* n. sp.
    - B. Carapace and chelipeds covered with spinules . . . . *U. spinimanus* n. sp.
- B. Rostrum broadly triangular, upper surface concave . . . . *U. cavirostris* Alc. & And.

II. Carapace, excluding rostrum, broader than long.
- A. Lateral margins of the carapace smooth, dactyli of ambulatory legs hook-like *U. onychodactylus* n. sp.
- B. Lateral margins crenulated, dactyli normal . . . . *U. siraji* n. sp.

Uroptychus nigricapillis Alcock

(Figs. 4, 5.)

Uroptychus nigricapillis Alcock, 1901, p. 283, pl. 3, fig. 3; Ill. Zool. Investigator Crust., pl. LVI, fig. 3.
Uroptychys nigricapillis, Laurie, 1926, p. 123; van Dam, 1933, p. 26; 1940, p. 98, fig. 2.

Occurrence:

South Arabian coast:

St. 50, triangular dredge 4, 1536–1939 metres, 1 male (*c.l.* + *r.* = 15 mm., *ch.l.* = 47 mm.).

Zanzibar area:

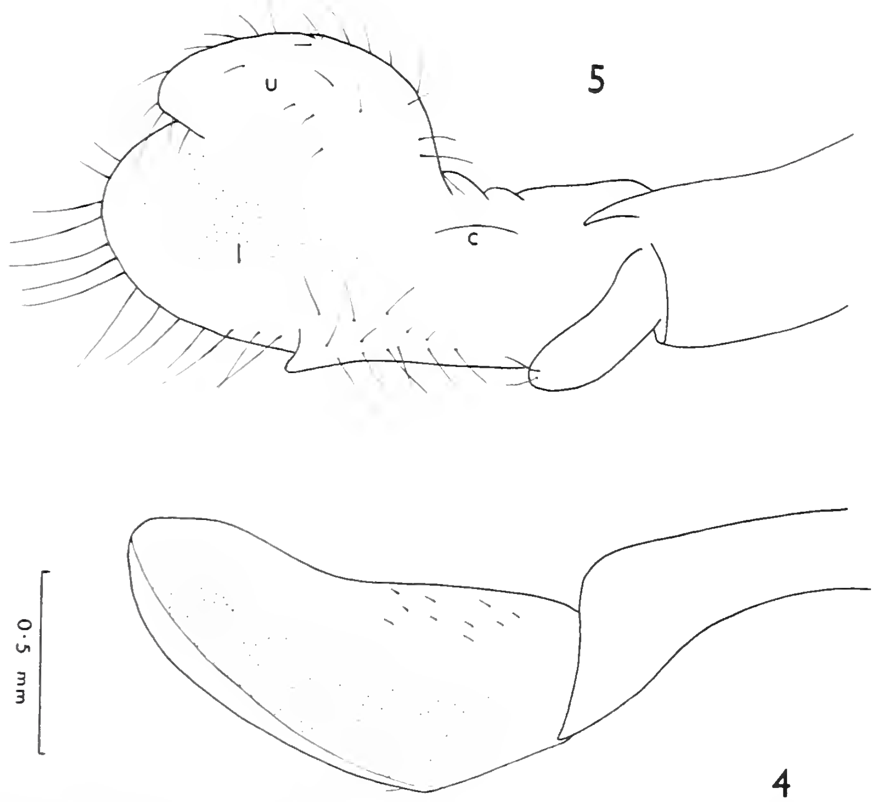
St. 119, Agassiz trawl, 1207–1463 metres, 2 males (*c.l.* + *r.* = 9–11 mm.); 2 females (*c.l.* + *r.* = 10·5–11 mm., *ch.l.* = 30–36 mm. larger female ovig. all chelip. detached).

Maldive area:

St. 159, monagésque trawl, 914–1463 metres, 2 ovig. females (*c.l.* + *r.* = 12–13 mm., *ch.l.* = 40–45 mm.).

Distribution: Indo-Pacific.

Descriptive Notes: Alcock in 1901 established *U. nigricapillis* as a new species for a single female collected from the Indian Ocean. The first male of the species was described by Laurie (1926), another male was reported by van Dam in 1933 and later the same author described an ovigerous female (1940). The "John Murray" Expedition collected, for the first time, a number of specimens belonging to this species. From the literature consulted it is evident that the specimens exhibit a noticeable individual variation particularly in the number of spines on the carapace. On studying the material at hand, I find that the specimens show differences in the spinosity of the dorsum, in the size and shape of the rostrum, in the relative lengths of the peduncle and acicle of the antenna and also in the armature of the thoracic sterna.



Uroptychus nigricapillis Alcock. Male. Fig. 4.—Left first pleopod, dorsal view. Fig. 5.—Left second pleopod, ventral view *c*. Crest-like lobe. *l*. Lower lobe. *u*. Upper lobe.

Only in one specimen are the gastric spines large, their tips exceeding the frontal margin of the carapace as is shown in the holotype (Alcock, pl. LVI, Fig. 3), in all the others these spines are rather small. In nearly all specimens a median spine or a tubercle is present on the gastric region. The lateral spines mentioned by van Dam (1933, p. 27) could be observed in two or three individuals only. In one of the two females taken from St. 159 there are two to three tubercles on the carapace median to the first post-cervical tooth. In the same female the lateral margins of the carapace, behind the cervical groove, are strongly serrated. In other individuals they are either weakly serrated or may be nearly smooth save for one or two rather obscure crenulations. The rostrum is highly variable in length, it may be short and hardly outreaching the eyes or rather long extending beyond the cornea by about a third or more of its entire length. The apex of the rostrum is rather depressed in some specimens, horizontal in others and directed upwards in three specimens from St. 119.

The antennal acicle is either as long as the peduncle or it may be considerably shorter.

The thoracic sternites have been described and illustrated by van Dam (1940, Fig. 2) and as already pointed out above, the specimens are rather variable in their sternal armature. In the " John Murray " specimens the sternum belonging to the third maxillipeds has a deep notch medially, so that the two median teeth shown by van Dam (1940, Fig. 2) are separated from each other. Furthermore, the anterolateral angles of the same sternite are either unarmed or furnished with 1–3 teeth. Occasionally a tooth may be present, on the anterior margin, between the anterior tooth and the antero-lateral angle. The fourth thoracic sternum of only one specimen is in agreement with that of van Dam's specimen. In others the second row of teeth is either represented by a few weak teeth or tubercles or they may even be wanting. The teeth of the first row also show similar variations but are never totally absent. Finally, the transverse ridge on the following sternum is conspicuously granulated in some individuals, smooth in others.

The inner margin of the ischium and merus of the chelipeds may be serrated for their entire lengths or only for a short distance proximally. A few small tubercles can be seen on the lower surface of the carpus distally.

The first and second pleopods of the male have never been described or figured before. The endopod of the first pleopod is thin, elongate and concave as represented in Fig. 4. The endopod of the second pleopod is cushion-like and partially divided into an upper (*u*) and a lower (*l*) lobe (Fig. 5). The upper surface of the lobe *l* is slightly concave, whereas that of the upper lobe is somewhat swollen and provided with a few stiff setae. An obscure crest-like projection is also present at the base of the upper lobe and is labelled *c*. On the opposite surface the endopod has a median keel-like projection which extends over its basal two-thirds.

Uroptychus gracilimanus Henderson

(Figs. 6–9.)

Diptychus gracilimanus Henderson, 1885, p. 420.
Uroptychus gracilimanus, Henderson, 1888, p. 181, pl. xxi, fig. 5 ; Doflein & Balss, 1913, p. 134 ; Parisi, 1917, p. 3.

Occurrence :

Zanzibar Area :

St. 108, Agassiz trawl, 421–457 metres, 2 males (*c.l.* + *r.* = 5·5 and 9 mm., *ch.l.* = 21·5 and 42 mm. respectively) ; 2 ovig. females (*c.l.* + *r.* = 8 and 8·5 mm., *ch.l.* = 40 and 38 mm. respectively.).

St. 122, otter trawl, 732 metres, 1 male (*c.l.* + *r.* = 8 mm., *ch.l.* = 35 mm.).

Distribution : Indo-Pacific.

Descriptive Remarks : This species can be easily recognized by its long and slender chelipeds, which are even more slender in females and in the youngest male (St. 108) than in adult males.

The eyes and the anterior part of the carapace of the largest male are shown in Fig. 6. Only the tip of the rostrum lies beyond the eyes, whereas in the description of the type Henderson says that the rostrum " . . . extends for about one-third of its length beyond the ends if the eye-stalk " (p. 181). I had the opportunity to examine the type and I find

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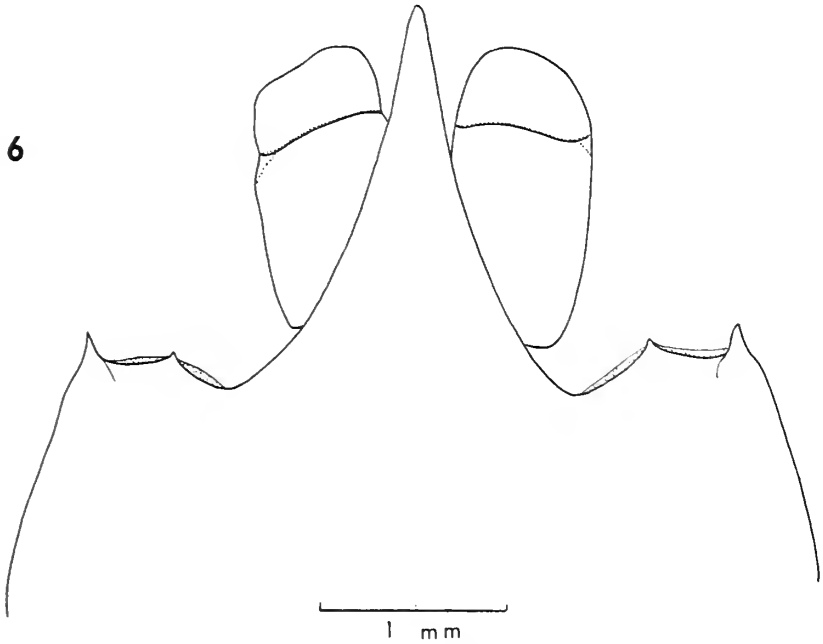

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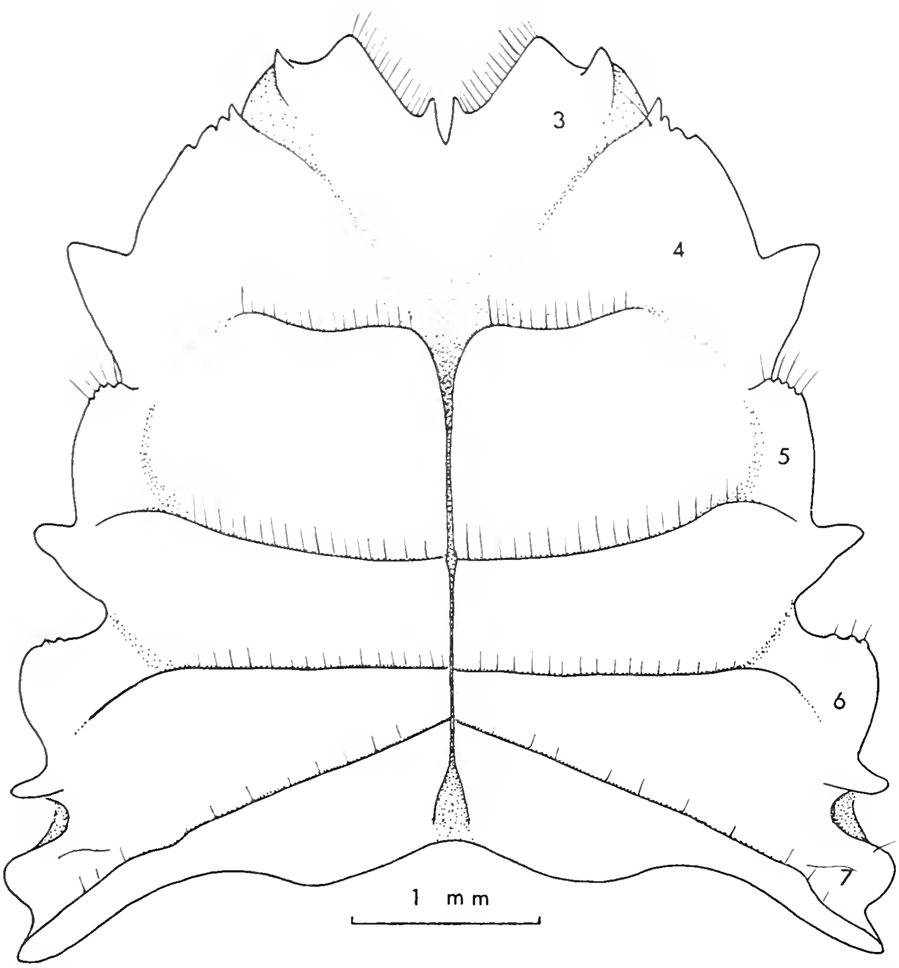


Uroptychus gracilimanus Henderson. Male. Fig. 6.—Anterior part of carapace. Fig. 7.—Plastron. *3* to *7*. Thoracic sternites 3 to 7.

that the lateral margins of the carapace are microscopically crenulated with very fine hairs sticking out. In the " John Murray " specimens the lateral margins are either as in the type or are more strongly crenulated. A spine is present on each antero-lateral angle of the carapace. The outer orbital margin is also produced into a minute spine.

The plastron of the same male is represented in Fig. 7. The anterior margin of the sternum bearing the third maxillipeds is setose and has a pair of median teeth and a deep notch in the centre. The postero-lateral angles of the same sternite are produced into sharp spines. The following sternum has its antero-lateral angles denticulated and a short transverse ridge extends over its surface. This transverse ridge is separated, in the middle, by a groove which extends posteriorly over the following sterna. The transverse ridges of the fifth and sixth sterna extend almost to the lateral sternal margins. Each half of the ridge of the seventh sternum is directed obliquely backwards.

The antennal acicle varies in length, being either as long as the peduncle or somewhat shorter. It is shorter in the type.

The ischium of the cheliped has a small spine on its outer distal angle. Henderson said that the palm of the cheliped " . . . is only about three-fourths the length of the carpus " (1888, p. 181). In the " John Murray " specimens the palm is longer, being nearly as long as the carpus. The fingers of the chela are in contact with each other for the greater part of their lengths (Fig. 8). Only in the left chela of the largest male do the fingers gape proximally (Fig. 9). A compound tooth is present on the dactylus, which can easily be seen in the left chela of the male where it projects into the hiatus formed by the gaping fingers. In others, when the chela is closed, this tooth lies below the toothed margin of the fixed finger.

The first and second pleopods of the male are very similar to those of *U. nigricapillis*, except that the endopod of the first pleopod is perhaps more deeply concave in *U. gracilimanus* and that the endopod of the second pleopod is not cushion-like, being rather thin, with the crest-like lobe fairly conspicuous (c.f. Fig. 5*c*, of *U. nigricapillis*).

Uroptychus australis Henderson var. *indicus* Alcock

Uroptychus australis Henderson var. *indicus* Alcock, 1901, p. 284.
Uroptychus australis Henderson var. *indicus* l.c., van Dam, 1933, p. 19, figs. 24–28 ; 1937, p. 101.

Occurrence :

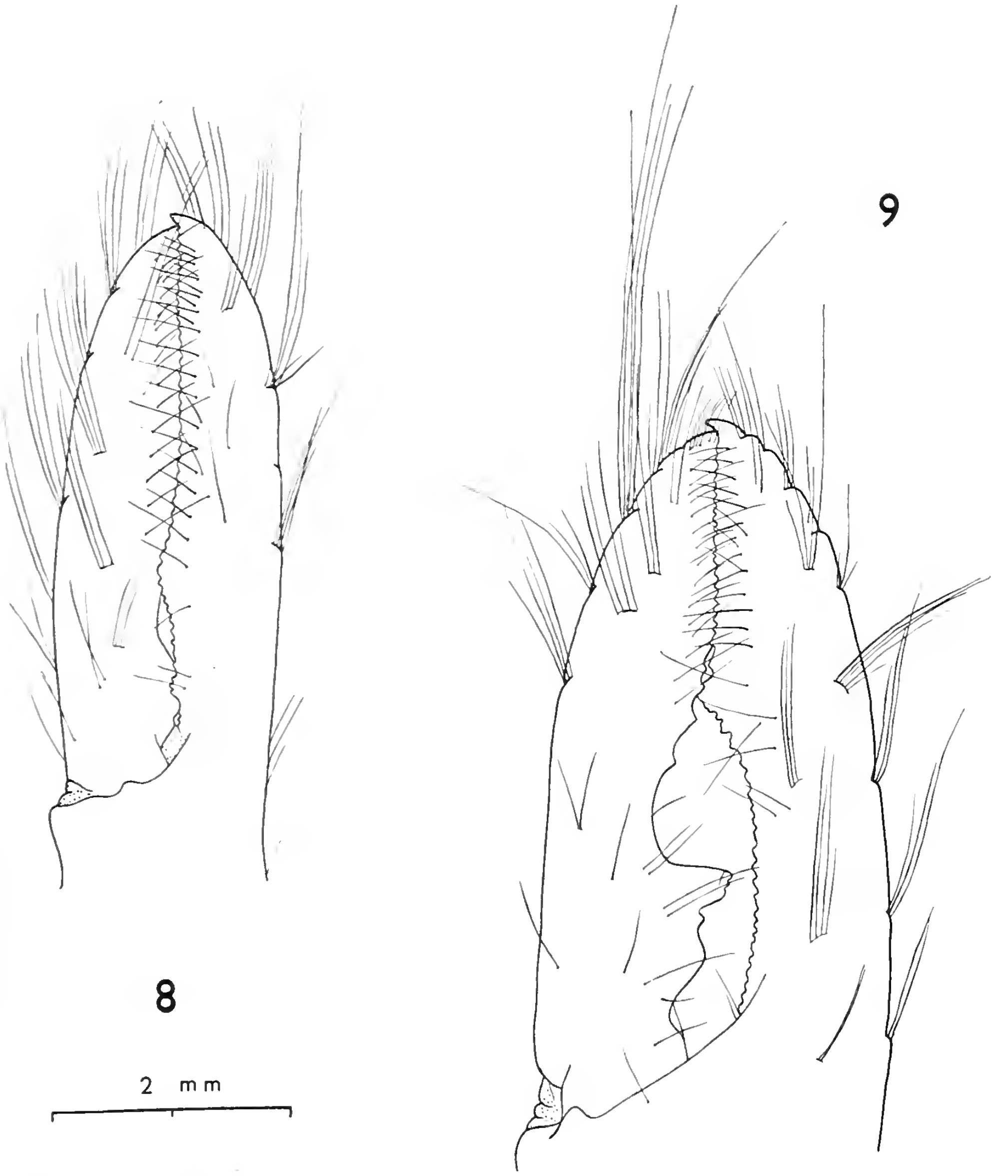
Zanzibar Area :

St. 124, monagésque trawl, 914 metres, 1 male (*c.l.* + *r* = 8 mm., *ch.l.* = 29 mm.) ; 1 female (*c.l.* + *r.* = 11 mm., *ch.l.* = 39 mm.).

Distribution : Indian Ocean.

Descriptive Remarks : The " John Murray " specimens agree rather well with Alcock's description of *U. australis* var. *indicus* except in having a shorter rostrum and antennal acicle and stronger armature of the ambulatory legs. The rostrum exceeds the eyes only by its tip. The antennal acicle instead of reaching nearly to the end of the peduncle extends to about two-thirds the length of the distal segment of the peduncle.

To Alcock's brief description of the thoracic sterna, I would like to add that a notch separates the median pair of teeth, situated on the anterior margin of the sternum corresponding to the third maxilliped (third thoracic sternum). The antero-lateral angles of this sternum are unarmed in the male, but have two small teeth in the female. The antero-

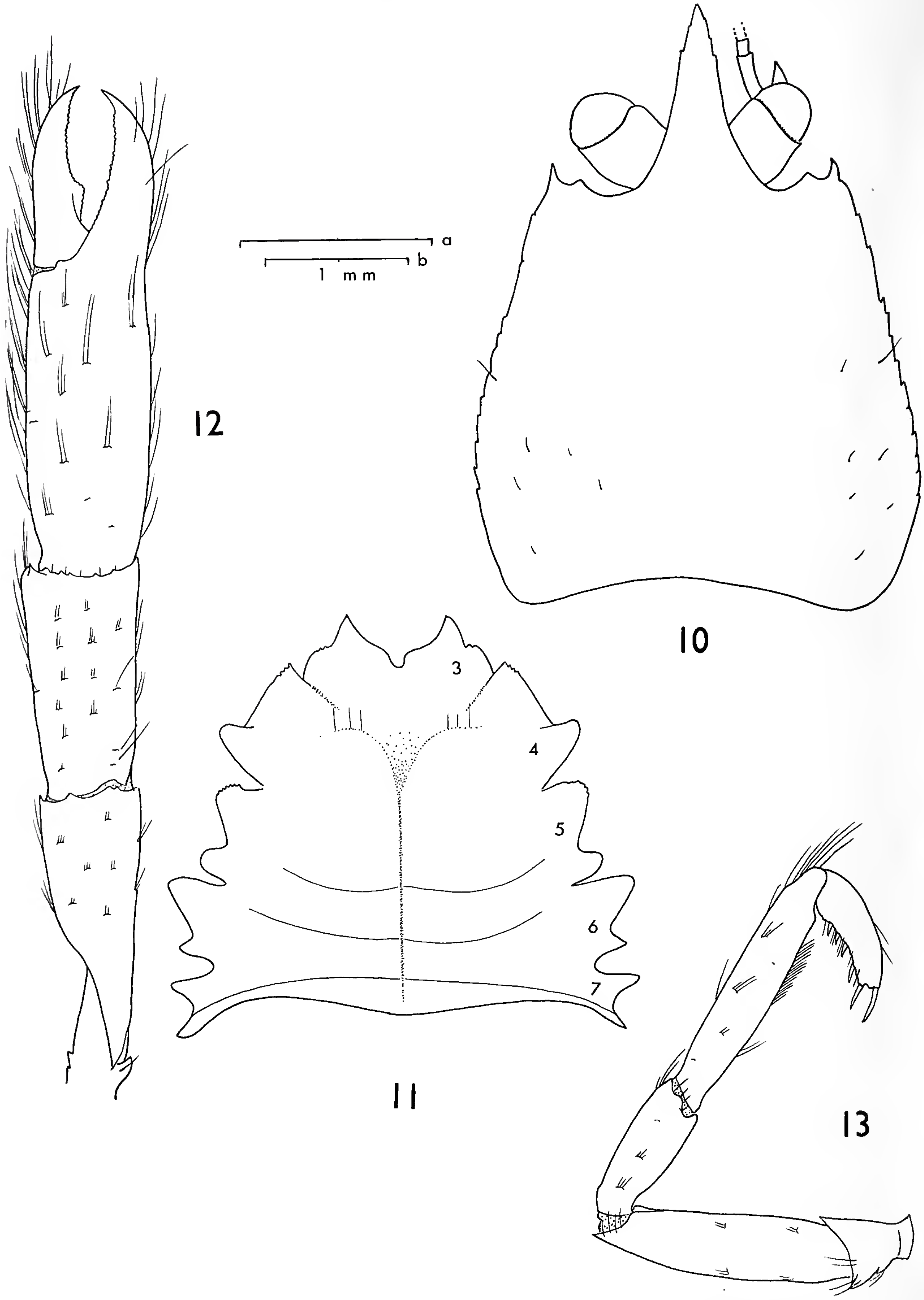


Uroptychus gracillimanus Henderson. Fig. 8.—Left chela of female. Fig. 9.—Left chela of male.

lateral angles of the fourth sternum are furnished with three to four teeth which successively diminish in size posteriorly. The same angles of the following sterna are minutely serrated. In all the thoracic sterna each postero-lateral angle has a tooth-like projection. A median groove separates the fourth and the following sterna into a right and left half. Furthermore, a short setose ridge is present on the fourth sternum, and each of the next three sterna has setose ridges which extend from the median groove to the lateral borders. These transverse ridges are densely setose in the female, only sparingly so in the male.

The chelipeds agree with those of Alcock's specimens. The posterior margin of the propodus of each ambulatory leg is spinose on a little more than its distal half. Strong spines are also present on the posterior margin of the dactylus.

The first and second pleopods of the male in the " John Murray " collection show a striking resemblance to those of *U. gracilimanus* Henderson.



Uroptychus gordonae n. sp. Male. Fig. 10.—Carapace, dorsal view. Fig. 11.—Thoracic sternites 3 to 7. Fig. 12.—Cheliped. Fig. 13.—Ambulatory leg. (Figs. 10, 12 and 13 all at scale *b*).

Uroptychus gordonae n. sp.

(Figs. 10–13.)

OCCURRENCE :

Maldive Area :

St. 158, Agassiz trawl, 786–1170 metres, 1 male, the holotype (*c.l.* + *r.* = about 4·5 mm.) ; 1 female (*c.l.* + *r.* = 4 mm., 2 detached chelipeds 7·5 and 8·5 mm.).

DESCRIPTION : The carapace of the male is represented in Fig. 10, its lateral margins are denticulate, and terminate anteriorly in a small but sharp spine. When the carapace is slightly dry a fine pitting and a few short hairs can be seen on its surface. The rostrum is pointed at the tip and its lateral margins are serrated anteriorly ; it extends beyond the eyes by rather less than half of its length. The eye-stalks are short and rather stout ; the cornea tapers slightly towards the distal end.

The anterior margin of the sternum that carries the third maxillipeds is deeply invaginated in the middle and has acute lateral angles (Fig. 11). The postero-lateral angles of this sternite and the antero-lateral angles of the following two sternites are serrated. The transverse ridge of the fourth sternum, which is rather obscure, has a few hairs. The ridges of the remaining sterna appear to be smooth.

The antennal acicle is shorter than the peduncle. The third maxillipeds are unarmed.

The chelipeds are short and fairly stout, the smaller cheliped is shown in Fig. 12. The ischium has a small spine on its outer distal angle. Merus, carpus and palm all have tufts of hairs. The inner margins of the fingers are finely serrated, whereas the outer ones are furnished with long hairs. A small tooth-like projection is present on the basal half of the dactylus. None of the ambulatory legs are attached to the specimens, there are, however, a few present in the same tube and one of them is shown in Fig. 13. The posterior margin of the dactylus is spinose ; but the same margin of the propodus has a thick row of hairs, especially on its distal half and, as far as I can see, no spines are present.

The first two pleopods of the male show a close resemblance to those of *U. brachydactylus* n.sp.

RELATIONSHIP : This species appears to be closely related to *U. sulucnsis* van Dam, in having the lateral margins of the carapace serrated, short chelipeds and unarmed propodi of the ambulatory legs. But it can easily be distinguished by the long, pointed rostrum, the short eye-stalks and the presence of hairs on the palm of the chela and also on the posterior margin of the propodi of the ambulatory legs.

Uroptychus murrayi n. sp.

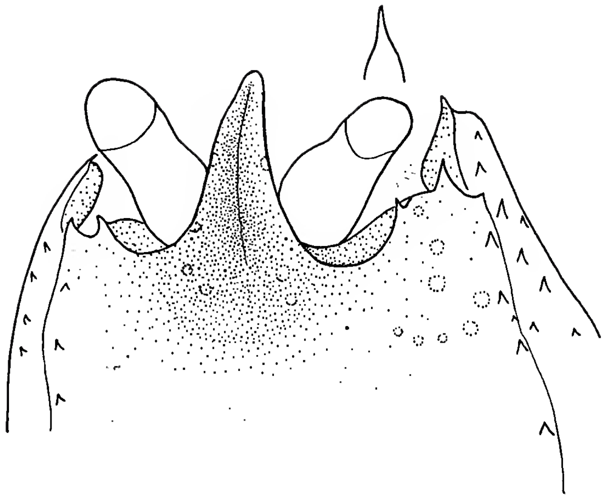
(Figs. 14–18.)

OCCURRENCE :

St. not known.

1 female, the holotype (*c.l.* + *r.* = 5 mm., *ch.l.* = 14 mm.).

DESCRIPTION : The single "John Murray" specimen, which is a female, is not in very good condition. However, the anterior part of the carapace is as represented in Fig. 14. The lateral margins of the carapace are provided with 4–5 spines, and besides the spine on the antero-lateral angle there is another smaller spine on the outer orbital margin. The pterygostomial region is also provided with small spines. The rostrum, which hardly



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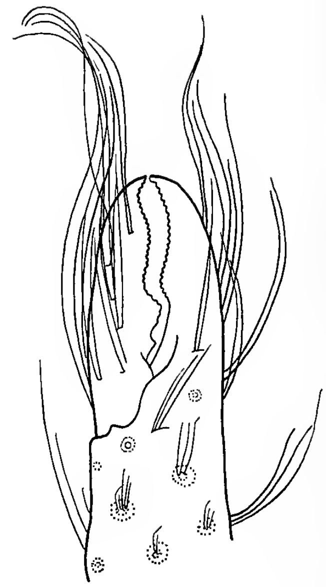

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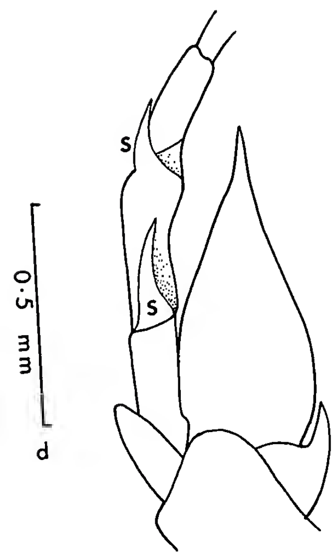

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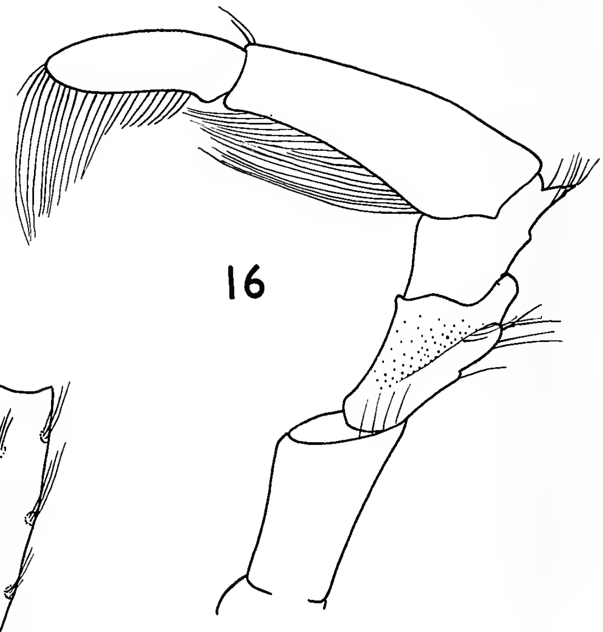

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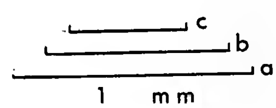


Uroptychus murrayi n. sp. Female. Fig. 14.—Frontal region of carapace (Scale *b*). Fig. 15. —Left antenna, ventral view. (Scale *d*). *s*. Spine. Fig. 16.—Endopod of left third maxilliped (Scale. *a*). Fig. 17.—Ischium and merus of cheliped. Fig. 18.—Distal part of chela (Both at scale *c*).

exceeds the eyes, is deeply concave and trough-like. The eyes are rather characteristic in being somewhat conical, tapering gradually from the base of the ocular peduncle to the distal margin of the cornea. Scattered over the surface of the carapace are a few circular patches, which do not appear to be setose.

The condition of the specimen does not allow of a detailed study of the sternum. But, from what could be seen, a close resemblance with that of *U. gordonae* is evident.

The antenna is also characteristic (Fig. 15). The antennal acicle is broad at the base but distally it tapers to a sharp point. The last two segments of the peduncle are each provided with a long, curved spine (*s*) on the ventral surface of the distal margin.

The merus of the third maxilliped has three rounded lobes on its outer margin, while the same margin of the carpus has a conspicuous conical projection near its distal border (Fig. 16).

Only one cheliped is present ; it is long and slender. The ischium has a spine on its inner and outer distal angles (Fig. 17) ; moreover there is a row of about six spines near the inner margin and another row of three to four still smaller spines on the median line. The merus has five fairly large spines on its inner border. All the segments of the cheliped, including the palm, are covered with circular patches from the centres of which arise tufts of hairs. The fingers, which are about half the length of the palm, are furnished with exceptionally long hairs (Fig. 18). The inner margin of the dactylus has a broad prominence near its base.

The ambulatory legs are likewise covered with setose circular patches. The posterior margins of dactylus and propodus are spinose.

Relationship : *U. murrayi* resembles *U. tridentatus* Henderson in having spines on the pterygostomial region and also in the form of the eyes, antenna, and the third maxilliped. But it differs from *U. tridentatus* mainly in having a simple and not a tridentate rostrum and much weaker spines on the lateral margin of the carapace. I had the opportunity to compare the " John Murray " specimen with the holotype which is present in the British Museum (Nat. Hist.). The chelipeds are missing in the holotype, but they have been described and illustrated by van Dam (1933, p. 32, Figs. 45, 46) ; it can be seen that the chelipeds are not so hairy in that species.

Uroptychus brachydactylus n. sp.

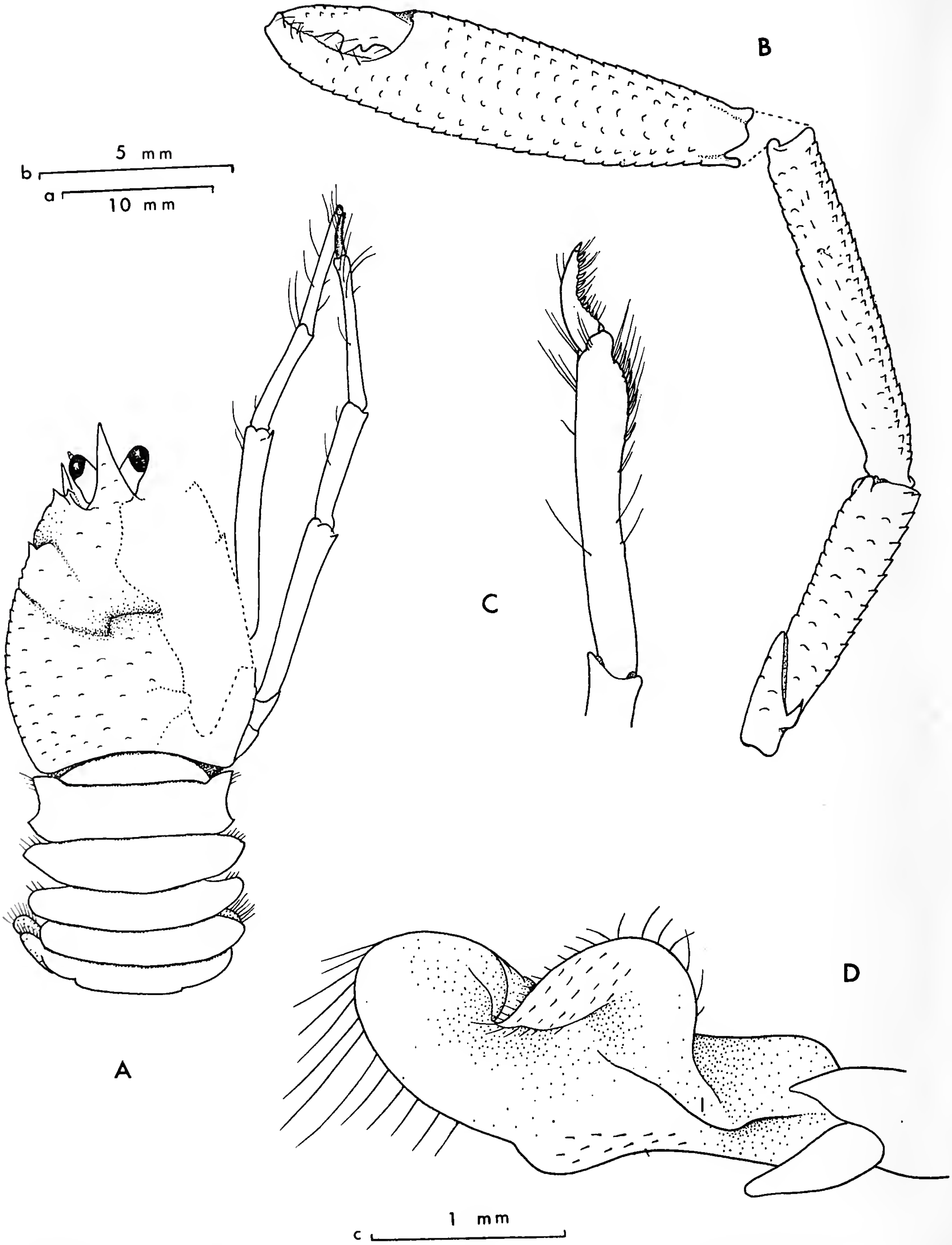
(Fig. 19.)

Occurrence :—

South Arabian coast :

St. 42, triangular dredge 4, 1415 metres, 1 male holotype (*c.l.* + *r* = 21 mm., *ch.l.* = 72 mm.).

Description : A dorsal view of the holotype is illustrated in Fig. 19a ; unfortunately, the specimen is damaged and the right half of the carapace is missing while the rostrum is somewhat displaced. The chelipeds are detached and all the ambulatories are missing except the first and third on the right side. The triangular rostrum exceeds the eyes by about a third of its length. The lateral margin of the carapace is serrated and terminates anteriorly in a small spine ; another spine of about the same size is present at the level of the anterior branch of the cervical groove. The surface of the carapace is covered with large, well separated granules with microscopically crenate anterior margins and at least



Uroptychus brachydactylus n. sp. Holotype. FIG. 19.—A. Specimen in dorsal aspect B. Cheliped. (Both at scale *a*). C. Propodus and dactylus of right third ambulatory leg. (Scale *b*). D. Distal portion of left second pleopod, ventral view. (Scale *c*). *l*. Crest-like lobe.

some of them have fine short hairs. A few rather obscure granules are also present on the rostrum. The abdominal terga are smooth and polished.

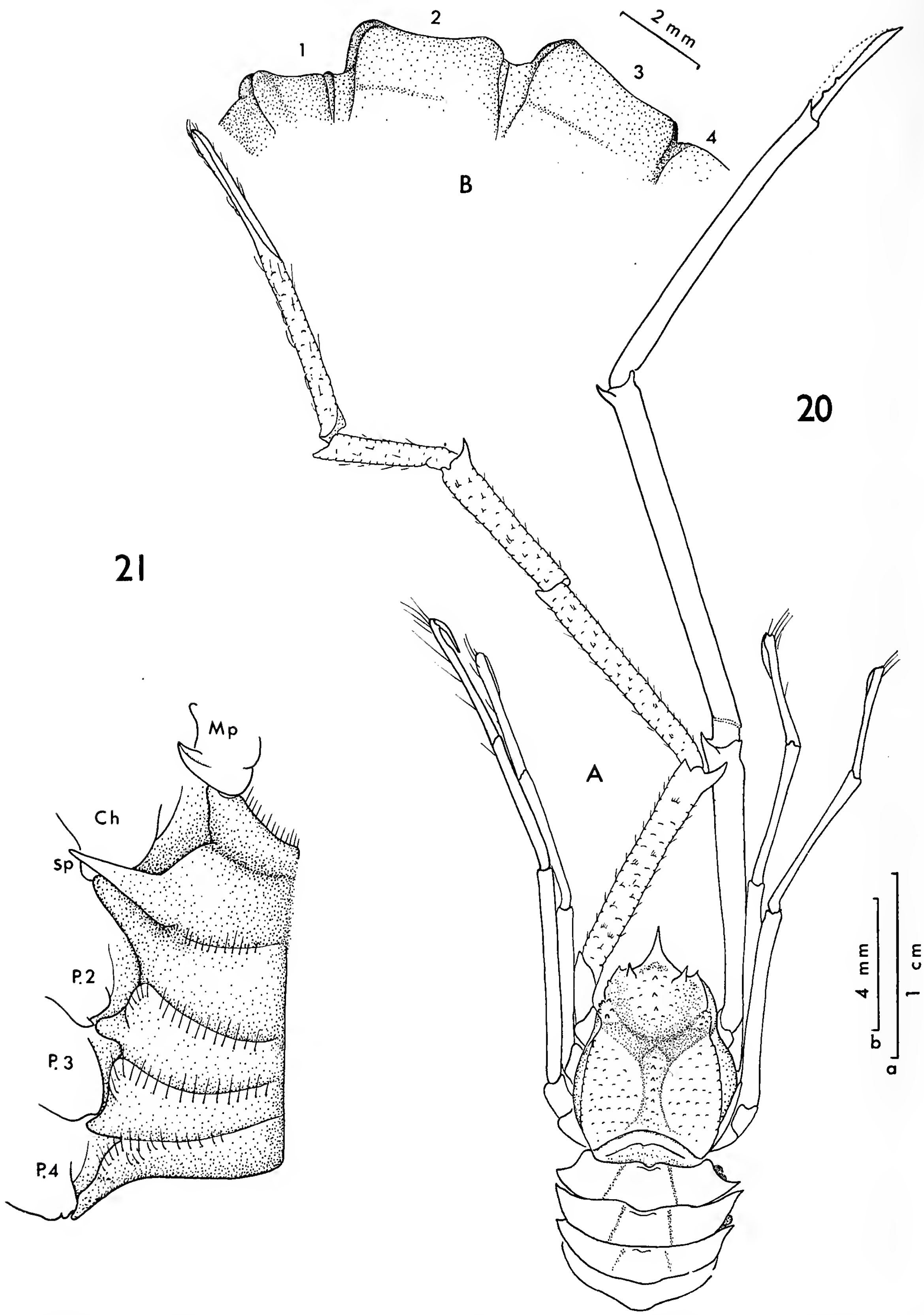
The anterior margin of the third thoracic sternum is setose : the tips of the two median teeth overlap and are separated posteriorly by a deep notch. The right half of the anterior margin bears another small tooth, a short distance from the median one. The antero-lateral angles are rounded, whereas the postero-lateral ones are each armed with a spine. The lateral margins of the fourth sternum are produced into a small spine anteriorly and a blunt tooth-like projection posteriorly. Moreover, the surface of this sternum bears numerous large setose tubercles, which are arranged more or less in transverse rows. The next three sternites have each a setose transverse ridge. The third sternum is separated from the fourth by a U-shaped depression and a very deep median groove separates the remaining sterna into right and left halves.

The antennal acicle is about as long as the peduncle. The third maxillipeds are unarmed.

The granules on the chelipeds are large and numerous, those on merus and carpus becoming squamose with fairly long setae (Fig. 19B). The ischium has a curved spine at the distal end of its inner margin ; inner and outer margins of merus and carpus end in a distal knob-like projection. The cheliped gradually widens towards the palm, the distal half of which is considerably broadened and inflated. The fingers, which are less than half the length of the palm, are in contact only along their distal third ; the hiatus formed by the gaping fingers is filled with the projecting bicuspid tooth of the dactylus. The ambulatories that are present are long and almost smooth ; the propodus is expanded distally where the posterior border bears six to nine spines (Fig. 19C). The short curved dactylus measures less than one-third of the propodus, and the posterior margin is spinose.

The first pleopod resembles that of *U. nigricapillis*. The distal portion of the second pleopod is represented in Fig. 19D ; the anterior margin is curved in a curious manner characteristic of the species and a thin crest-like lobe (1) is present near the base. On the basal half, or more, of the side opposite to that figured is a strong median keel-like projection.

RELATIONSHIP : In having granules on the carapace and chelipeds *U. brachydactylus* appears to be related to *U. granulatus* Benedict, of which only three females, including the holotype, were taken by the " Albatross " at the Galapagos Islands. I was able to examine Benedict's material at the Smithsonian Institution, Washington and later a paratype was sent on loan for comparison with the " John Murray " specimen. Although the chelipeds and all the ambulatories except the third pair are missing, it is evident that the " John Murray " specimen is not referable to *U. granulatus*. In *granulatus* the rostrum is longer, about half the length of the carapace, with serrated lateral margins and a concave upper surface. In *brachydactylus* the rostrum is shorter with smooth lateral margins and a flat dorsal surface. Moreover, in *U. granulatus* the lateral margins of the carapace are conspicuously serrated and rather spiny. The third ambulatory of *U. granulatus* has the propodus unarmed, apart from one pair of ventral spines at the distal end, and the dactylus, which exceeds half the length of the propodus, is armed on the posterior border. In *U. brachydactylus* the curved dactylus is less than one-third of the propodus, which is armed distally as shown in Fig. 19C. Although the chelipeds are missing from the paratype sent on loan, (*c.l.* + *r.* = 14 mm.), they are present in the largest female (*c.l.* + *r.* = 16 mm.) but the palm is not inflated—perhaps this is only a sexual difference, since the " John Murray " specimen is a male.



Uroptychus sternospinosus n. sp. Fig. 20.—A. Female, dorsal view (Scale *a*). B. First four abdominal segments in profile. Fig. 21.—Right half of plastron of male. *Mp*, *Ch*, *p2*, *p3*, and *p4* = coxa of third maxilliped, cheliped and peraeopods 2 to 4. *sp*. Spine on sternite 4. (Scale *b*).

Uroptychus sternospinosus n. sp.

(Figs. 20–27.)

Occurrence :

Maldive Area.

St. 159, monagésque trawl, 914–1463 metres, 1 male (*c.l.* about 17 mm., tip of rostrum broken, *ch.l.* = 90 mm.) ; 1 ovig. female (*c.l.* + *r.* = 15·5 mm., *ch.l.* = 85 mm.).

Description : The carapace, which is longer than broad, has the various regions well marked (Figs. 20a, 22). The branchial region is inflated where the carapace is widest. The gastric region is furnished with a pair of large spines which are directed upwards and forwards. A mid-dorsal carina extends from the anterior limit of the gastric region to the hind margin of the carapace, interrupted only by the wide cervical groove. The spines at the antero-lateral angles of the carapace are rather small. The rostrum is triangular and ends in a sharp, uptilted point, and is slightly longer than the eyes. The entire surface of the carapace is covered with large, well separated granules, at least some of which have fine hairs.

The tergum of the first abdominal segment has a sharp median carina with a slight dent in the middle (Figs. 20a and 20b). Anteriorly, the terga of the following two segments are raised into median humps or projections, which are hollowed out in front. The tergum of the fourth segment has only a slight projection, faintly hollowed in front (Fig. 20b).

The sternum corresponding to the third maxilliped is U-shaped and has a short anterior median groove. Furthermore, it is separated from the following sternum by a very wide groove. The fourth sternum is characterized by the presence of a pair of lateral spines which are of enormous size, sharply pointed and directed downwards and slightly outwards (*sp.* Fig. 21). A setose transverse groove runs from the base of these spines to the median line where it is separated from its fellow by a midventral groove which extends posteriorly over the remaining sterna. The fifth, sixth and seventh sterna have strong and setose transverse ridges which end at the base of tooth-like projections situated near the lateral margins of the sterna.

The eye-stalks are short but the cornea are large and globular (Fig. 22).

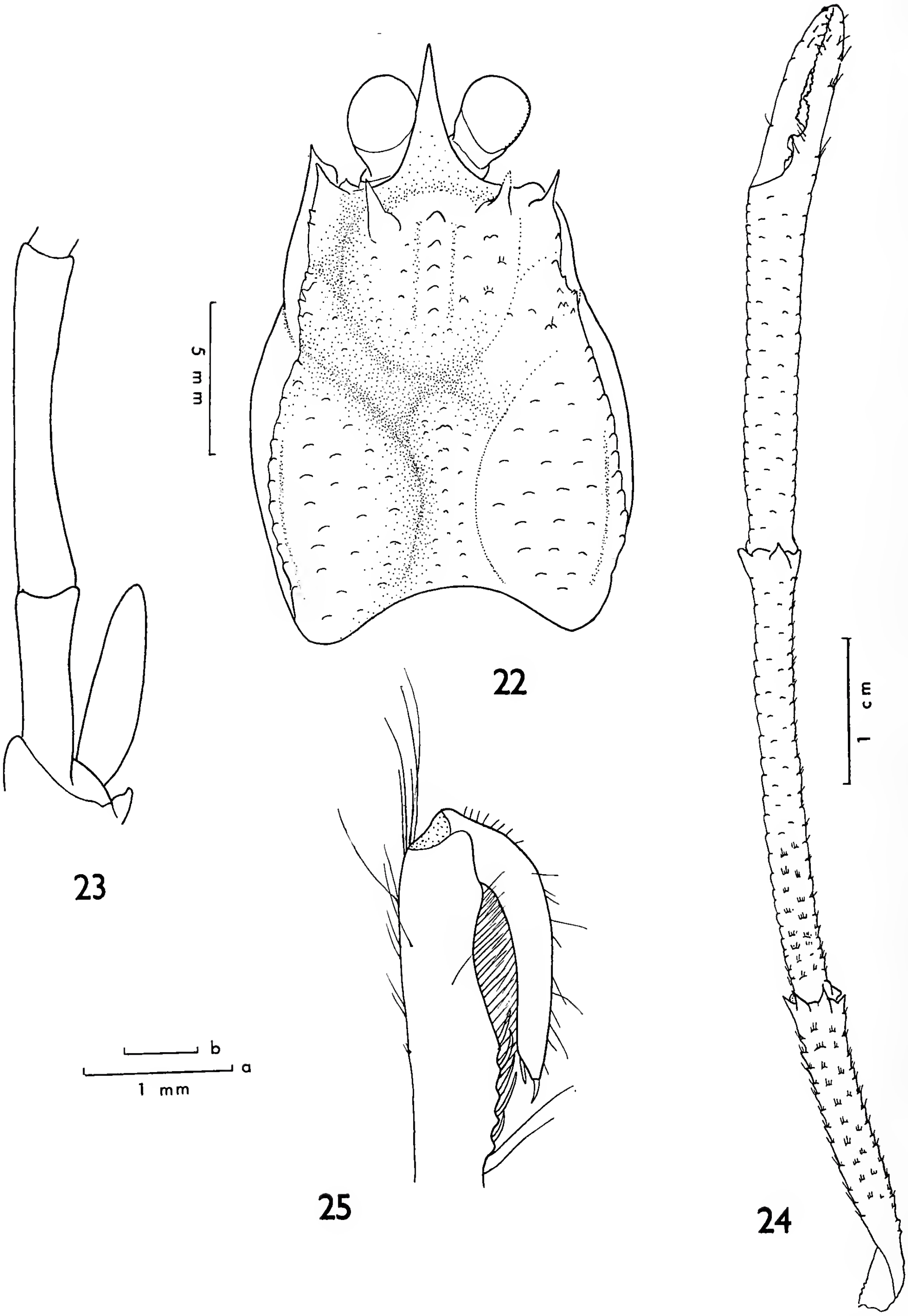
The antennae are rather peculiar in having greatly elongated proximal segments of the endopod (= distal segments of the peduncle). The antennal acicle, as illustrated in Fig. 23, is short, extending only to the base of the second segment.

The third maxillipeds are long and unarmed except for a spine on the coxa.

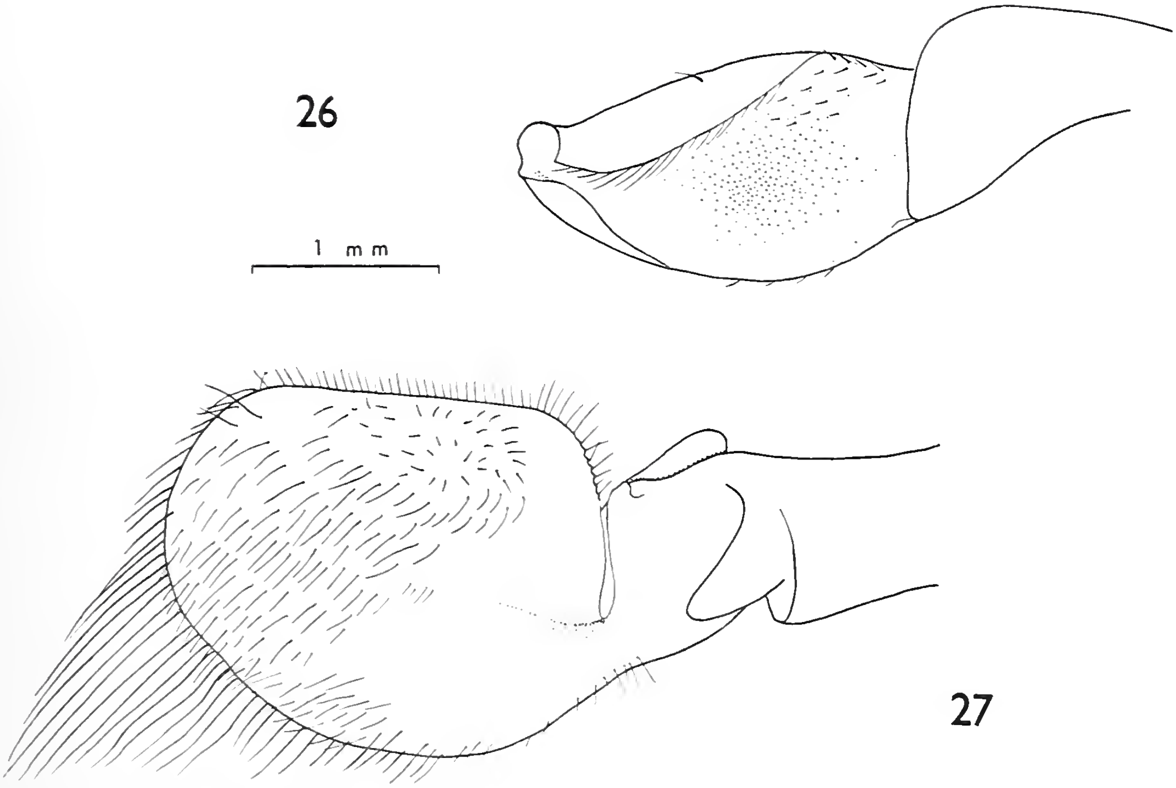
The chelipeds are more than five times as long as the carapace and are very slender in the female. A spine is present on the inner distal angle of the coxa. The ischium is relatively smooth, all the other segments are covered with setose granules. The distal margins of merus and carpus are spiny as shown in the figure (Fig. 24).

The ambulatory legs are nearly smooth and end in subchelae. The dactylus is strongly bent and its posterior margin is fringed with setae, only one spine may be present just behind the terminal one, the claw (Fig. 25). The propodus is expanded at a short distance from its distal margin, where the posterior border is provided with hairs and a few strong spines.

The first two pleopods of the male are represented in Figs. 26, 27. The endopod of the first pleopod is thin and concave dorsally ; the anterior and posterior margins are bent



Uroptychus sternospinosus n. sp. FIG. 22.—Carapace of male. FIG. 23.—Left antenna, ventral view. (Scale *a*). FIG. 24.—Cheliped of male. FIG. 25.—Distal part of propodus, and dactylus of ambulatory leg. (Scale *b*).



Uroptychus sternospinosus n. sp. Male. Fig. 26.—Dorsal view of left first pleopod. Fig. 27.—Ventral view of left second pleopod.

inwards. The endopod of the second pleopod is paddle shaped, rather soft and cushion-like, and its ventral surface is furnished with numerous setae. On the opposite surface a median keel-like projection extends for a short length near the base of the endopod.

Relationship : In having granules on the carapace and chelipeds, this species resembles *U. brachydactylus*, from which it can readily be separated by its long and slender chelipeds, the subchelate nature of the ambulatory legs and the entirely different type of pleopods of the male.

Uroptychus spinimanus n. sp.

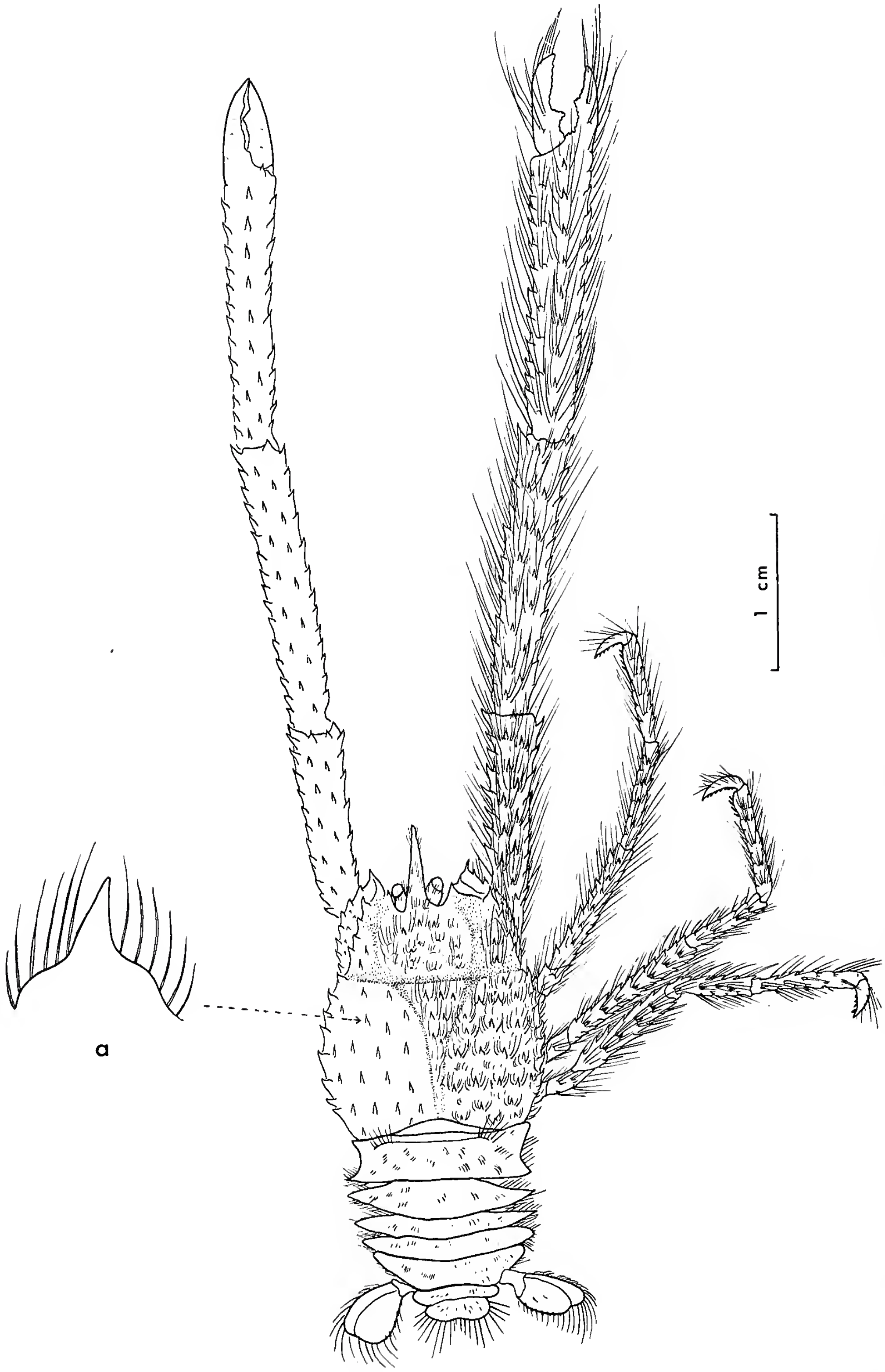
(Figs. 28–33.)

Occurrence :

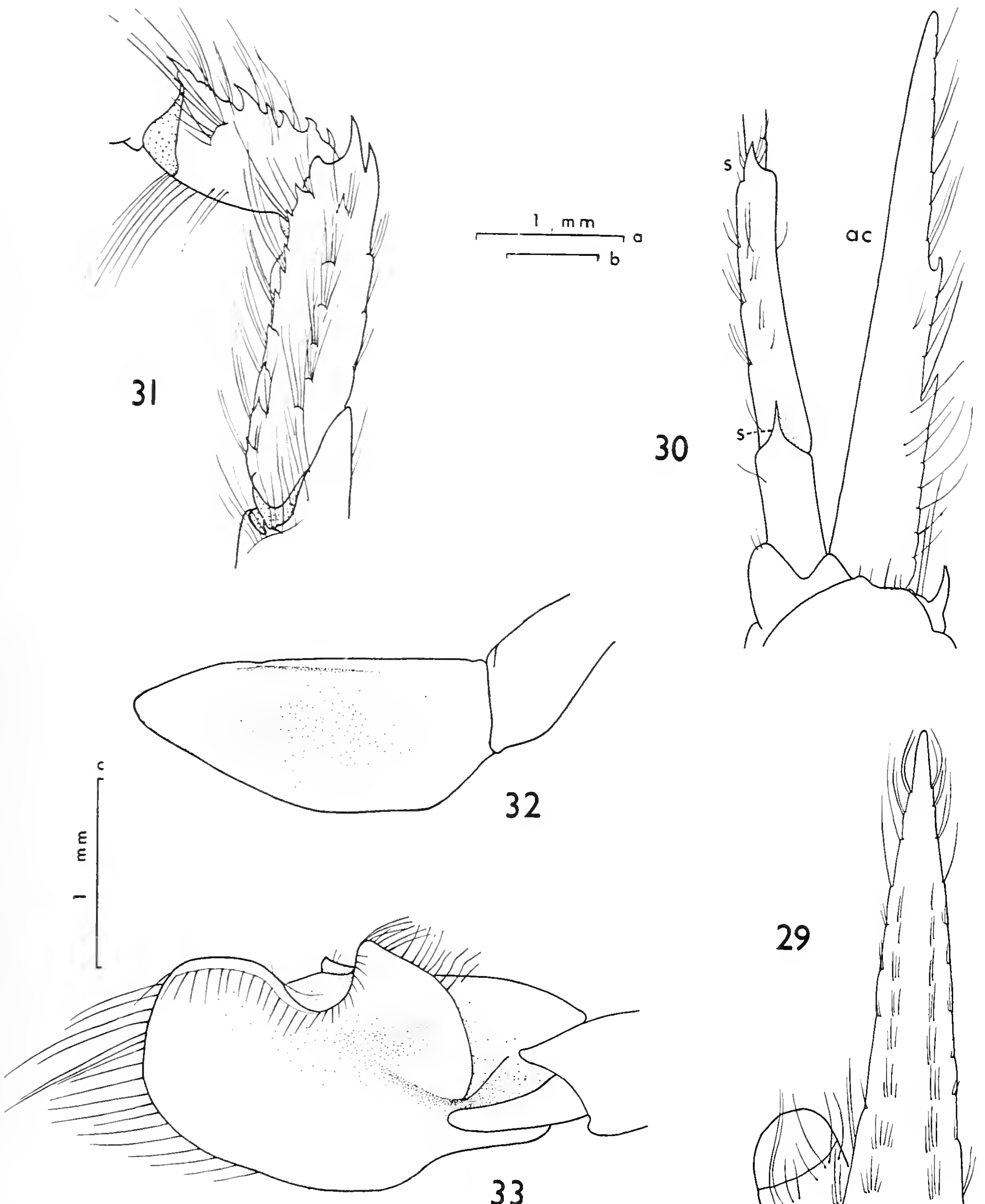
South Arabian Coast.

St. 54, Agassiz trawl, 1046 metres, 2 males (*c.l.* + *r.* = 19 and 20 mm., *ch.l.* = 61 and 59 mm. respectively) ; 2 ovig. females (*c.l.* + *r.* = 16 and 20 mm., *ch.l.* = 42·5 and 55 mm. respectively).

Description : The carapace, without rostrum, is as long as broad (Fig. 28). It is broadest across the branchial regions and considerably narrower in front. Only the cervical groove is well defined, the others are rather obscure. The rostrum is long and slender, the lateral margins are weakly serrate and hairy, tufts of setae are also present on the dorsal surface (Fig. 29). The carapace and the pterygostomian regions are studded with numerous spines. Each spine is situated on a tubercular projection and is flanked



Uroptychus spinimanus n. sp. Fig. 28.—Male, dorsal view. *a.* A single spine, greatly enlarged.



Uroptychus spinimanus n. sp. Male. Fig. 29.—Rostrum and left eye. (Scale *b*). Fig. 30.—Left antenna, ventral view. (Scale *a*). *ac.* Acicle *s.* Spine. Fig. 31.—Merus and carpus of left third maxilliped. (Scale *b*). Fig. 32.—Left first pleopod, dorsal view. Fig. 33.—Distal part of left second pleopod, ventral view. (Both at scale *c*).

by long hairs (Fig. 28*a*). Scattered amongst the spines are a few squamiform tubercles which are also fringed with long hairs and are more numerous on the gastric region.

The abdominal segments have tufts of hairs on their dorsal surfaces.

The anterior margin of the sternum corresponding to the third maxillipeds has a pair of median teeth which are separated by a V-shaped notch. The antero-lateral angles of this sternum are provided with three to four teeth and some hairs; each postero-lateral angle has a spine. The lateral margins and the anterior angles of the fourth sternum are furnished with many spines and hairs; the surface is beset with numerous, setose, squamiform tubercles. The fifth sternum has the lateral margins and anterior angles serrated, they are weakly so in the following sternum and are entire in the seventh; they are, however, hairy in all. The postero-lateral angle of the fourth and each of the following sterna is produced into a small rounded projection. Each of the last three sterna has a setose, transverse ridge. A mid-ventral groove separates the fourth and the following sterna into right and left halves. The sternal armature of the smaller female is weaker than that of the other specimens.

The eye-stalks are short and slender, the cornea is overhung by long hairs arising from the stalk (Fig. 29).

The antenna is characteristic in having a long, acuminate acicle, which is longer than the peduncle (Fig. 30, *ac*); the outer margin of the acicle is setose and has two spines. A mid-ventral spine is present on the distal margin of the last two segments of the peduncle (Fig. 30, *s.*).

The inner margin of the merus of the third maxilliped has a row of small spines, and there are two rather big spines on the outer distal angle (Fig. 31). The outer margin of the carpus is spiny and all the segments are furnished with long hairs.

The chelipeds are long and slender. They are longer in males and in the younger male the single cheliped present exceeds three times the carapace length. All the segments of the cheliped, including the palm, are spiny and with long hairs. The spinosity of the chelipeds and the ambulatory legs is shown in Fig. 28.

The endopod of the first pleopod of the male is thin and somewhat pointed at the apex, it is concave on the dorsal surface (Fig. 32). The anterior margin of the endopod of the second pleopod is curiously curved as represented in Fig. 33 and shows a striking resemblance to that of *U. brachydactylus*.

Relationship: *U. spinimanus* is very closely related to *U. fusimanus* Alcock, but unlike that species it has spines on the palm which is slender and not swollen. It also differs from Alcock's species in having spines on the ambulatory legs and hairs on the dorsal surface of abdominal segments.

Uroptychus cavirostris Alcock & Anderson

(Figs. 34–39.)

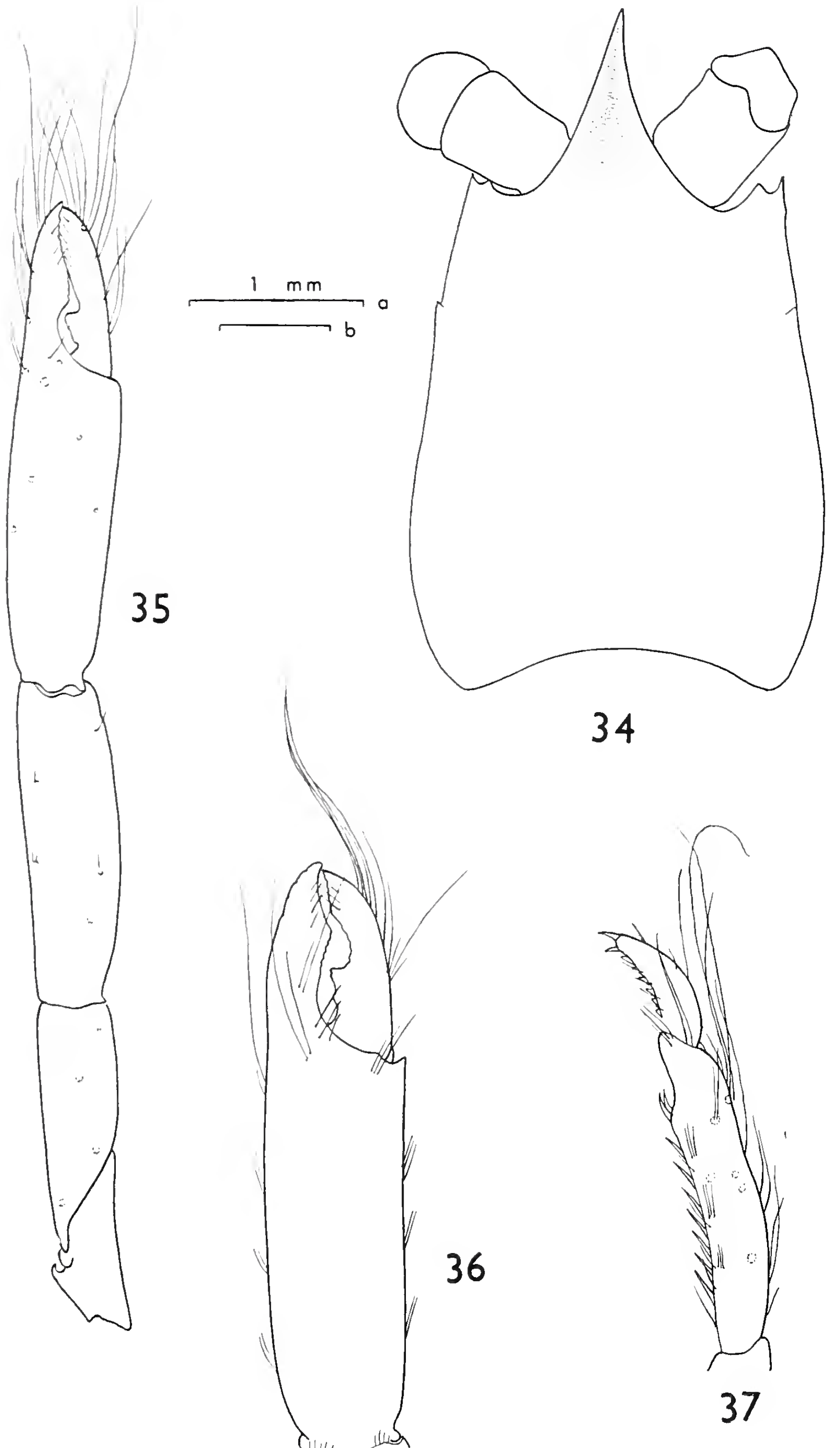
Uroptychus cavirostris Alcock & Anderson, 1899, p. 26; Ill. Zool. Investigator Crust., pl. XLIV, fig. 3.
Uroptychus cavirostris, van Dam, 1933, p. 22, fig. 33.

Occurrence:

Maldive area.

St. 157, triangular dredge 4, 229 metres, 14 specimens.

Distribution: Indian Ocean.



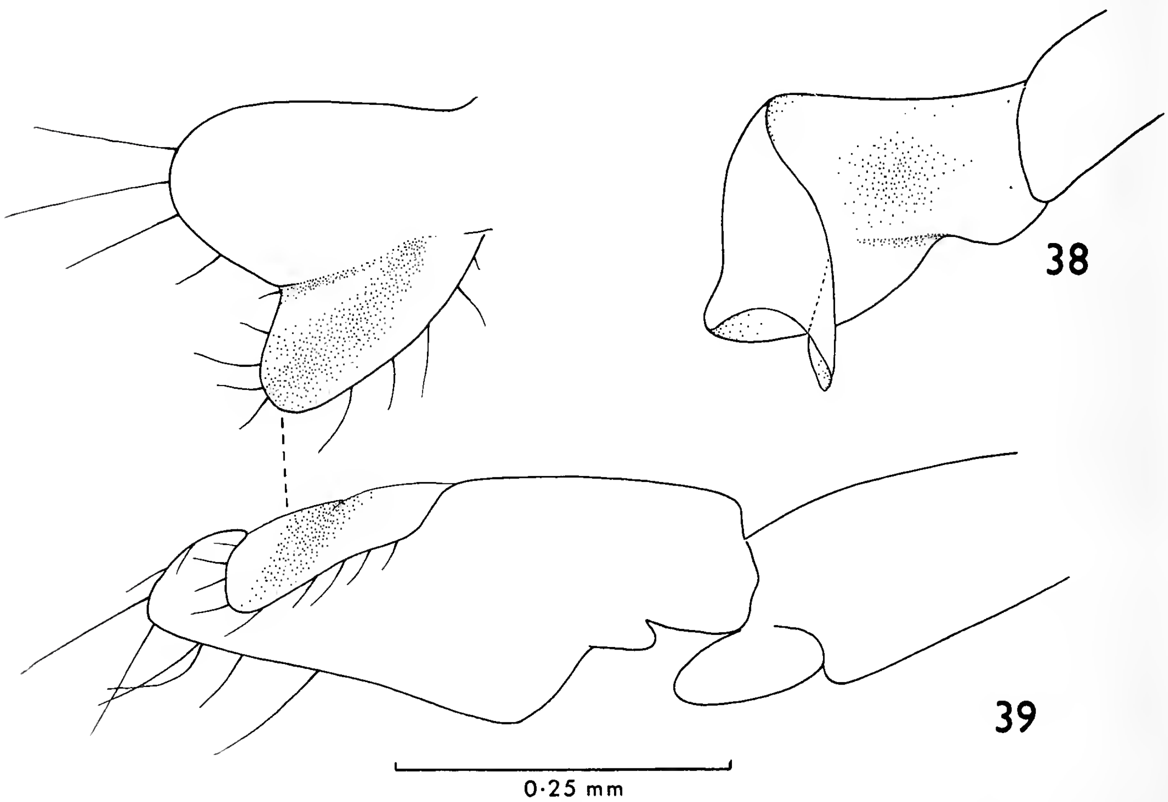
Uroptychus cavirostris Alcock & Anderson. Fig. 34.—Carapace of female, dorsal view. (Scale *a*). Fig. 35.—Cheliped of same. (Scale *b*). Fig. 36.—Chela of male. (Scale *b*). Fig. 37. —Propodus and dactylus of ambulatory leg. (Scale *a*).

Remarks on Material: There are four males and ten females measuring 2·5 to 5 mm. in carapace length including the rostrum. Females measuring 4 mm. in carapace length are ovigerous. Most specimens have the chelipeds detached; the measurements of those which had the chelipeds attached are given below.

Males: *c.l.* + *r.* = 3 mm. and 4·5 mm., *ch.l.* = 9·5 and 15 mm. respectively.

Female: *c.l.* + *r.* = 4 mm., *ch.l.* = 13 mm.

Descriptive Remarks: Hitherto *U. cavirostris* was known only from the holotype and a single " Siboga " specimen; both were ovigerous females of about the same size.



Uroptychus cavirostris Alcock & Anderson. Male. Fig. 38.—Endopod of left first pleopod, dorsal view. Fig. 39.—Distal part of left second pleopod, anterior view.

All the " John Murray " specimens are much smaller, the ovigerous females being about half as long as those recorded by Alcock and by van Dam. However, Alcock's description of the holotype applies rather well to the " John Murray " specimens except that the tooth on the lateral border of the carapace is not very distinct (Fig. 34). It may be added here that the " John Murray " specimens are poorly calcified and are not in very good condition. Furthermore, some specimens have circular patches on the carapace, similar to those present on the limbs.

The cheliped of a female is shown in Fig. 35; it agrees perfectly well with that of the holotype except that it is only one and a half times as long as the body whereas Alcock has described them as being " . . . not much less than twice the length of the fully extended body " (1899, p. 26). It is interesting to note that in the " John Murray " specimens the chelipeds are about three times as long as the carapace, as in van Dam's specimens. The chela of the male is heavier than that of the female (Fig. 36). The ambulatory legs are slender, hairy and in nearly all of them there are circular patches on the surface. The posterior margins of the dactylus and the propodus are spinose (Fig. 37).

In the male the endopod of the first pleopod is thin, leaf-like and rolled apically (Fig. 38). The endopod of the second pleopod is produced into an incurved lobe on the margin which is dorsal in natural position. In Fig. 39 the detached pleopod is represented as nearly as possible in anterior aspect, it may be slightly to one side ; in the upper figure the apex is seen from the opposite side.

Uroptychus onychodactylus n. sp.

(Figs. 40–42.)

Occurence :

Maldive area.

St. 158, Agassiz trawl, 786–1170 metres, 1 ovig. female, the holotype (*c.l.* + *r.* = 11 mm., *c.l.* = 7·5 mm., *c.b.* = 10 mm., *ch.l.* = 29 mm.).

St. 159, monagésque trawl, 914–1463 metres, 1 male (*c.l.* + *r.* = 8 mm., *c.l.* = 5·5 mm., *c.b.* = 7 mm., *ch.l.* = 24 mm.).

Description : The carapace, without the rostrum, is broader than long (Fig. 40). It has a small spine on each antero-lateral angle and is finely pubescent especially near the lateral margins. The rostrum is long and pointed, the dorsal surface and the lateral margins are furnished with soft hairs. The abdominal terga are quite smooth.

The anterior margin of the sternum corresponding to the third maxillipeds is concave in the female, almost V-shaped in the male. In both specimens the lateral angles of all the sterna are unarmed. The female differs from the male in having bunches of fairly long, silky hairs on the surface of the fourth sternum and also in having the lateral margins of all the sterna densely covered with long hairs, similar to those of the fourth sternum.

The eye-stalks are very small, the cornea round and not any wider than the stalk.

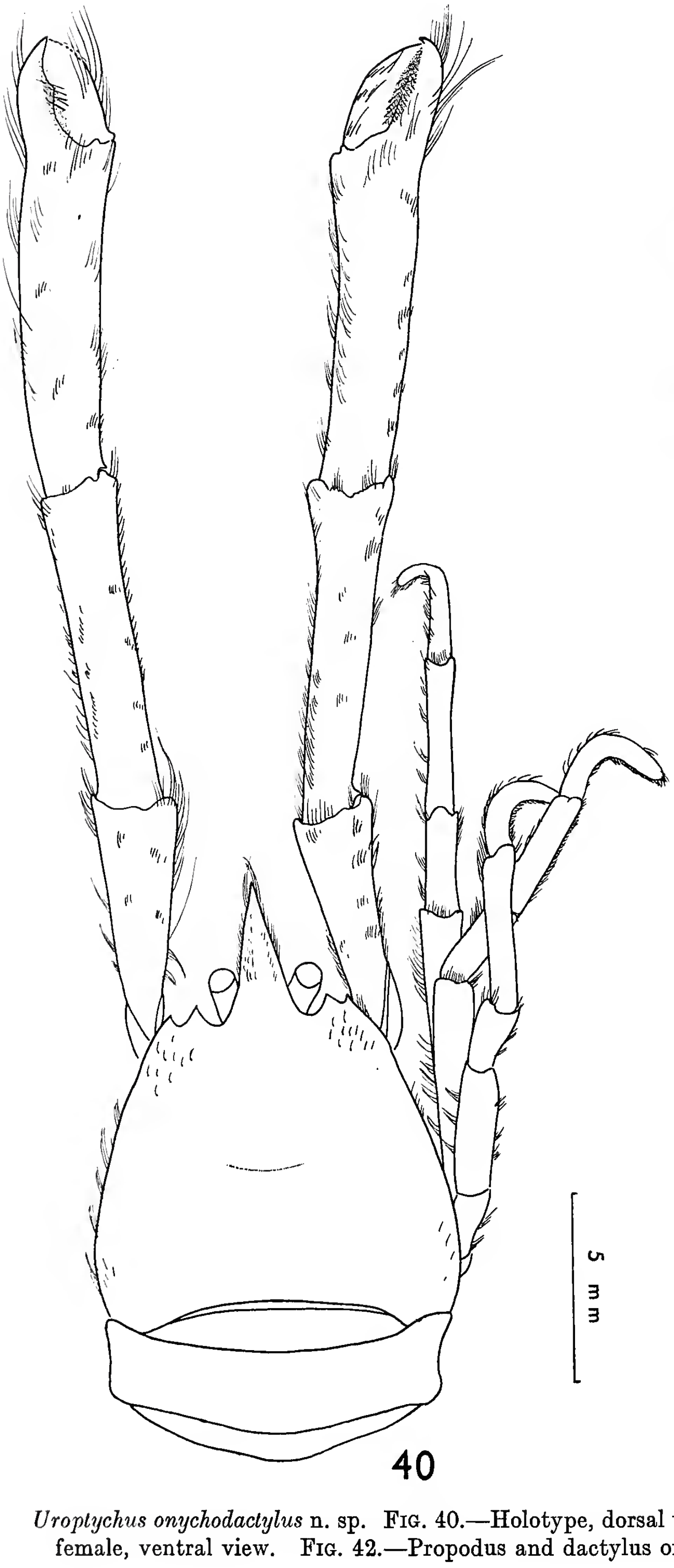
The antennal acicle is shorter than the peduncle, but the bunch of soft hairs on the apex are so matted together that on a casual glance they give a false impression of an acuminate apex which is as long as the peduncle (Fig. 41). The distal margins of the two proximal endopod segments (= distal segments of the peduncle) are also provided with silky hairs.

The third maxillipeds are unarmed, but the merus and carpus are noticeably feathery.

The chelipeds are symmetrical in the female, sub-symmetrical in the male, where the left chela is heavier and a little longer than the right. The chelipeds are three times as long as the carapace and are stout, gradually widening towards the palm which is two and a half times as long as the fingers. A spine is present on the outer distal angle of the coxa.

The ambulatory legs are characteristic in having long and strongly curved dactyli which, when bent backwards, become hook-like as illustrated in Fig. 42. The posterior margin of the propodus and of the dactylus are thickly fringed with short soft hairs. Moreover, on that of the dactylus there are horny teeth which gradually become smaller proximally, so that the proximal margin is merely serrated. These teeth are normally concealed in the fringe of hairs.

The first and second pleopods of the male are very similar to those of *U. spinimanus*,



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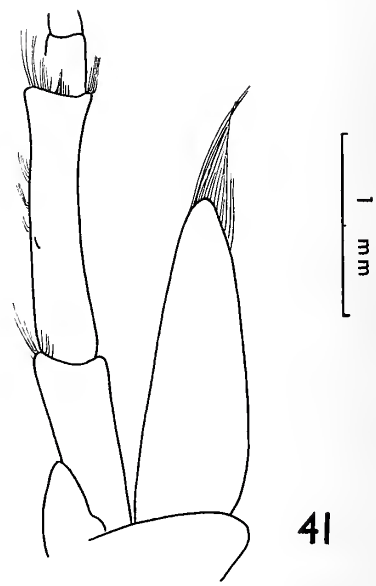

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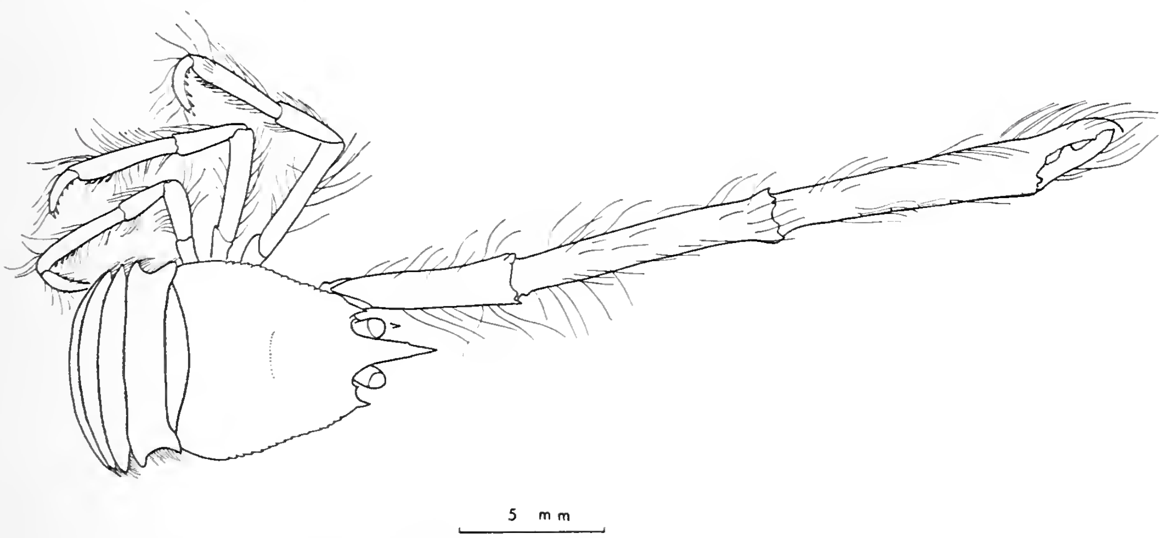
Uroptychus onychodactylus n. sp. Fig. 40.—Holotype, dorsal view. Fig. 41.—Left antenna of female, ventral view. Fig. 42.—Propodus and dactylus of third ambulatory leg of male.

except that in the second pleopod the apex of the endopod is narrower and not so broadly rounded, and the exopod has a few very long hairs on the tip.

RELATIONSHIP : In having a broad carapace, small eyes and hook-like dactyli of ambulatory legs this species is very near to *U. scambus* Benedict (= *U. glyphodactylus* McGilchrist). However, it differs in having a much longer rostrum and the fingers of the chelae are not curved nor is the inner margin of each toothed in the very characteristic fashion illustrated in Pl. LXX, Fig. 4 of the " Illustrations . . . " Investigator " where a male of *U. glyphodactylus* MacGilchrist is depicted.



Uroptychus siraji n. sp. FIG. 43.—Holotype, dorsal view.

Uroptychus siraji n. sp.

(Fig. 43.)

OCCURRENCE :

Maldive Area.

St. 159, monagésque trawl, 914–1463 metres, 1 ovig. female (*c.l.* + *r.* = 9 mm., *c.l.* = 6 mm., *c.b.* = 7 mm., *ch.l.* = 30 mm.).

DESCRIPTION : This species is so similar to *U. onychodactylus* that in the first sorting I had placed them together. On a closer examination, however, I find that *U. siraji* differs from *U. onychodactylus* in the following details :

The lateral margins of the carapace are crenulate and the spine on the antero-lateral angles is much stronger (Fig. 43).

The plastron differs from that of the female of *U. onychodactylus* in being less hairy ; in having the anterior margin of the sternum corresponding to the third maxilliped very deeply concave, almost V-shaped ; the antero-lateral angles of the fourth sternum have each 2–3 denticles.

The antennal acicle has no terminal bunch of hairs.

The hairs on the limbs are much longer but are rather scanty and not grouped in bunches.

Only the left cheliped is present, it is slender and is more than three times the length of the carapace. The fingers of the chela are also longer than those of *U. onychodactylus*, being just a little less than half the length of the palm. In addition to the spine on the coxa there is another spine on the ventral side of the disto-median angle of the merus.

The dactyli of the ambulatory legs are not strongly bent and hook-like, but resemble those of most species of the genus.

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