

THE BATHYAL AND ABYSSAL SIPUNCULA

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ABSTRACT

The 43 species of Sipuncula collected by the "Gala-
thea" from depths greater than 400 meters are dis-
cussed. Interesting or atypical morphological fea-
tures are noted and both their vertical and horizon-
tal distribution patterns are summarized. Twenty-
six species showed marked downward extensions of

their known vertical range and 15 showed signifi-
cant extension of their horizontal range.

The large number of shallow water species
occurring here for the first time at great depths is
surprising and may be questioned. This possibly can
be attributed to the large number of grab samples
taken.

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INTRODUCTION

As is the case with many groups of marine invertebrates, our knowledge of the deep-sea sipunculans is very incomplete. Only recently have extensive and careful collections been made employing collecting gear with small mesh size and a washing-sorting procedure which retains organisms of small size. The sipunculans collected by the "Galathea" contained only one new species which is somewhat surprising, but even more surprising are the large number of species recorded herein for the first time from sub-littoral depths. Twenty-six out of 43 species or 60% were previously known only from shallow, warm water habitats (Table 1, p. 154). There were also a few species typically restricted to cold water habitats occurring in warm, tropical areas.

These facts have caused me great concern and it must be stated that for one whose intellectual nourishment has been within the G. E. Hutchinson family, believing in the niche concept, it has been very difficult to write this report. For a species which has been collected repeatedly from warm, tropical seas to suddenly appear at 3000-5000 m is hard to justify or accept as real. However, what is reported herein is what I have been given. I do not take responsibility for the accuracy of the station information, but only for the identification of the specimens and the recording of the locality as it has been given to me. Most of the specimens had already been dissected by the time I saw them, and a few were impossible to identify to species level. Some had been damaged in the collection process, but this is not unusual. In the

following taxonomic section, complete descriptions are not given to conserve space, but interested persons should refer to the recent monograph by Stephen & Edmonds (1972) where descriptions can be found. If there is any deviation from the published descriptions, this is mentioned. The sequence in which the species are discussed follows the arrangement of Stephen & Edmonds (1972).

This report contains only those species found at depths exceeding 400 m. Many other sipunculans were taken at shallower depths. These records are included here only if the species was also found below 400 m. Those only occurring at shallow depths will be reported on elsewhere.

Acknowledgments

I am grateful to Dr. Torben Wolff for the opportunity to examine this striking collection. The material was initially being processed by Dr. Elise Wesenberg-Lund, but unfortunately she passed away before being able to complete the work. Dr. Galena Murina has been of assistance in offering her opinions on some difficult specimens, and this is gratefully acknowledged. The preceding article by Murina describes the sole new species found in the collections and is not included here. Mrs. Norma Cutler has provided valuable technical assistance at various points throughout the project. The drawings were made by the Danish artist P. Winther. The completion of the manuscript was aided by a grant from Utica College of Syracuse University.

SYSTEMATIC PART

Sipunculus sp. (cf. *aequibilis* Sluiter, 1902)

Material:

- St. 30. Bay of Guinea (0°42'N, 5°59'W), 5160 m, 18 Nov. 1950, trawl, clay, c. 2.2°C. - 1 specimen.
St. 324. Malacca Strait (6°38'N, 96°00'E), 1140 m, 9 May 1951, trawl, brownish globigerina ooze. - 1 specimen.

These are the most poorly preserved, damaged specimens of this genus, but from what could be observed they seem to fit most closely this species. There are 20-21 longitudinal muscle bands; the ven-

tral retractor muscles originate from bands 2-3 and the dorsals from 8-9. The nephridia open between bands 4 and 5. The posterior part of the trunk is torn off one, and it is difficult to ascertain several features on either.

Distribution: Earlier records show *S. aequibilis* present in the Java Sea, the Indian Ocean and the Mediterranean at depths of 26-1200 m. Based on the uncertainties regarding the identity of this material, I suggest these records not be incorporated into the known distribution range.

Sipunculus natans W. K. Fisher, 1954

Material:

St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m,
20 Jan. 1952, grab, globigerina ooze, c. 7.5°C.
- 1 specimen.

This specimen has 47-49 longitudinal muscle bands and the anus lies between the origins of the dorsal retractor muscles. Using the nephridiopore as the anterior end of the trunk, the specimen is 6 cm long and the introvert, if extended, around 2.5 cm. The anus is 1 cm posterior to the nephridiopore. The broadly based, but thin, wing muscles occupy the space between the origin of the dorsal and ventral retractor muscles; the latter originating from longitudinal muscle bands 1-7 and 2-7 (see Stephen & Edmonds 1972, fig. 3B).

Fisher's type material came from Baja California and was swimming at the surface of the water - a very different life style from this one, but the morphology seems essentially the same so it is referred to this species with some reservation.

Distribution: Only the two records are known: surface off California and now the Tasman Sea.

Sipunculus norvegicus Danielssen, 1869

Material:

St. 491. Makassar Strait (4°56'S, 117°39'E), 1560 m,
14 Sep. 1951, trawl, muddy clay. - 8 specimens.
St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m,
20 Jan. 1952, grab, globigerina ooze, c. 7.5°C.
- 1 specimen.

Despite the poor condition of several specimens, it is possible to assign these animals to this species. The number of longitudinal muscle bands varies from 21 to 24 and the retractors' origins extend over two or three longitudinal muscle bands. The morphology agrees well with published descriptions. Two individuals contain large nematodes within their coelomic spaces.

Stephen & Edmonds (1972: 31) erected a separate subspecies for Gerould's (1913) forms. It is difficult to understand their reasoning on this point and it seems to us to be unnecessary.

Distribution: These two records reinforce and extend the records of this species in the western Pacific Ocean. It is quite widespread in the Atlantic

Ocean through the Mediterranean into the Suez Canal and Red Sea, but was previously reported only from Hawaii and the Loyalty Islands in the Pacific. The Makassar Strait record is the first from the Indonesian Archipelago area. The depths of these records fall into the normal vertical range for this species.

Sipunculus robustus Keferstein, 1865

Material:

St. 190. Off S.E. Africa (29°42'S, 33°19'E), 2720 m,
3 Feb. 1951, trawl, globigerina ooze, c. 2.4°C. -
2 specimens.
St. 324. Malacca Strait (6°38'N, 96°00'E), 1140 m,
9 May 1951, trawl, brownish globigerina ooze.
- 9 specimens.

All of the specimens from St. 324 are small and probably immature. All but one are damaged with ruptured body wall and intestine partially missing. There are 26-28 longitudinal muscle bands. The totally free nephridia open at the level of the anus.

In the specimens from St. 190 there are 30-32 longitudinal muscle bands, and the presence of racemose glands is characteristic of this species. The free nephridia open just anterior to the anus; the spindle muscle is present and seems to attach to the posterior end. These specimens have been somewhat disarranged by previous dissection, and it is not possible to satisfactorily confirm all of the details. It is with some hesitation that I assign these here.

Distribution: Common in the Indo-Pacific and also occurring in the West Indies, but usually at very shallow depths. These stations greatly extend the vertical range.

Sipunculus titubans

Selenka, de Man & Bülow, 1883

Material:

St. 63. Bay of Guinea (2°00'N, 9°14'E), 1500 m,
2 Dec. 1950, trawl, bluish clay, c. 3.8°C. -
3 specimens.

The specimens are not well preserved. There are 23-28 longitudinal muscle bands; the intestine is free posteriorly; the nephridia are between muscle bands 4 and 5 and almost entirely free. The dorsal retractor muscles originate across bands 8 and 9; the

ventrals across 3 and 4. Externally the glans region is very distinct.

There is some confusion in the literature on the nature of this species, and due to the state of preservation, there is some hesitation about assigning these specimens to this species.

Distribution: Found off the east and west coasts of Africa, in the Caribbean, the Pacific coast of Central America, and a single record from Thailand. Depths previously have been in the littoral zone. This record is unique for its depth.

Xenosiphon mundanus
(Selenka, de Man & Bülow, 1883)

Material:

St. 554. Great Australian Bight (37°28'S, 138°55'E), 1320-1340 m, 5 Dec. 1951, dredge, globigerina ooze, c. 3.5°C. - 2 specimens.

These specimens are small, 60 and 65 mm, and possibly immature. They are slender (5-7 mm), translucent with a short introvert, bearing the characteristic triangular lappets - in many ways resembling the genus *Sipunculus*. Longitudinal musculature is divided into 28-30 bands. The unique pair of protractor muscles is difficult to see being very thin and much like the large nerves coming off the plexus in the same region. There is a long rectum with a small caecum. The anus is far anterior to the nephridiopores.

Distribution: Found off eastern, southeastern and western Australia and off New Zealand and New Britain. This record is unique because of its great depth.

Siphonosoma (Damosiphon) cumanense
(Keferstein, 1867)

Fig. 1

Material:

St. 423. East of Cebu, Philippines (10°27'N, 124°18'E), 810 m, 25 Jul. 1951, grab, green mud. - 1 specimen.

This specimen Wesenberg-Lund had identified as *S. formosa* Sato, but we here follow the suggestion of Stephen & Edmonds (1972) to consider this a junior synonym of *S. cumanense*. Eighteen to 20 longitu-

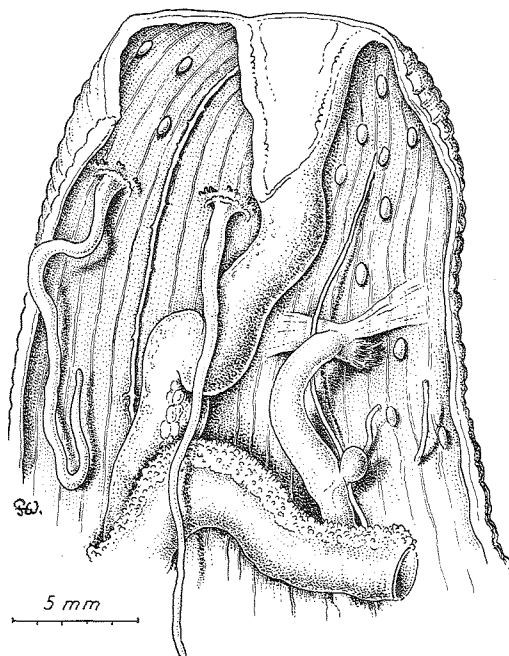


Fig. 1. *Siphonosoma cumanense*. A portion of the internal anatomy.

dinal muscle bands are visible through the skin; contractile vessel with villi and oviform coelomic vesicles (Keferstein bodies) are present. The gonads are well developed and the coelom filled with eggs. Two or three fixing muscles, spindle muscle, and broad wing muscles exist as well as the crescentric dissepiments (Fig. 1)*.

Stephen & Edmonds (1972) retain six subspecies for this rather plastic and variable species. These forms are distinguished on the bases of external characters e.g., color, roughness or smoothness, minor variations in skin, body size or distribution, and relative transparency of skin. The necessity or value of retaining these names is questioned. I doubt the biological meaningfulness of this subjective segregation and suggest they are not truly subspecies but simply illustrate the morphological variations which may exist within this species population.

Distribution: Widespread in tropical Indian Ocean, south to Capetown and into the Red Sea and West Pacific Ocean, and north to North Japan. It is rare in the western Atlantic Ocean and usually is found in intertidal and shallow water. This depth is unusual.

* This drawing was marked "St. 404", but I have not seen the specimen. The data for St. 404 are: South China Sea (5°09'N, 106°47'E), 63 m, 30 Jun. 1951, grab, clay.

Siphonosoma (Siphonosoma) australe
(Keferstein, 1865)

Material:

St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m,
20 Jan. 1952, trawl, globigerina ooze, c. 7.5°C.
- 1 specimen.

The specimen has its introvert retracted and the posterior half of the trunk is missing. It is pale colored and the 20 anastomosing longitudinal muscle bands are visible through the body wall. No genuine hooks are on the introvert but instead there are long, soft, cylindrical papillae in rings much like the figure in Shipley (1899). The ventral retractors originate from longitudinal muscle bands three and four, slightly behind the dorsals. In other respects it compares well with published descriptions.

Distribution: Common in the warm water Indo-West Pacific but generally from shallow water. This depth is unique.

Siphonosoma (Siphonosoma) novaepommeraniae
(W. Fischer, 1926)

Material:

St. 549. Coral Sea (30°05'S, 154°33'E), 1560 m,
11 Nov. 1951, grab. - 3 specimens.

The longest individual is about 110 mm, with the introvert one-third to one-fourth the length of the trunk. Eighteen or 19 longitudinal muscle bands are visible through the body wall. The anal region and posterior end have dark, dense, flattened papillae. Hooks are absent but soft introvert papillae are present.

Distribution: Previously recorded from Guam, New Britain, Mauritius, and Cuba, so this is not a new area, but the great depth is unique.

Golfingia (Golfingia) capensis
(Teuscher, 1874)

Material:

St. 196. Off S. E. Africa (29°55'S, 31°20'E), 430 m,
14 Feb. 1951, dredge, sandy mud with stones. -
42 specimens.

Most animals have trunks about 20 mm long. The morphology compares well with the literature,

except that the typical bulbous, orange vesicles on the contractile vessel are very small and without pigmentation - almost like large grains of sand.

Distribution: Reported from shallow water (down to 300 m) around South Africa and in the southern Indian Ocean off Kerguelen and St. Paul's Islands. This record is a modest extension of its depth range.

Golfingia (Golfingia) appendiculata
(Sato, 1934)

Material:

St. 602. Tasman Sea (43°58'S, 165°24'E), 4510 m,
15 Jan. 1952, dredge, bluish clay, c. 1.1°C. -
2 specimens.

The specimens were in good condition with trunks measuring 30 and 35 mm. The smaller of the two was missing its posterior end, but the other had the characteristic tail appendage. Otherwise they fit the criteria nicely.

Distribution: The two previous records are from the N. W. Pacific (Japan and Bering Sea). Stephen & Edmonds (1972: 86) list Japan and North Africa, Murina 1964, but that is an error as the only record in that (or any other of her papers) is well north of Japan in the Bering Sea. The depth range is from 288-4811 m so this record is not unusual for its depth but is a significant southerly extension of its range.

Golfingia (Golfingia) margaritacea
(Sars, 1851)

Material:

St. 334. Keppel Harbour, Singapore, tidal zone,
16 May 1951. - 9 specimens.
St. 566. Great Australian Bight (36°02'S, 138°27'E),
52 m, 6 Dec. 1951, grab, sand. - 1 specimen.
St. 576. Cooks Strait (40°31'S, 173°20'E), 60 m,
21 Dec. 1951, grab, clay and sand. - 2 specimens.
St. 619. Entrance of Milford Sound, New Zealand,
136 m, 19 Jan. 1952, grab. - 1 specimen.
St. 638. New Zealand (37°33'S, 175°57'E), 660 m,
26 Jan. 1952, grab, clay with a little sand. -
1 specimen.
St. 661. Kermadec Trench (36°07'S, 178°23'W),
5285 m, 23 Feb. 1952, dredge, abundant pumice,
1.1°C. - 2 specimens.

The specimens are small (possibly immature), with trunk 6-8 mm long and have the characteristic form of this well-known species.

Distribution: Wide-spread in cold water in the Atlantic Ocean, with a few records from both sides of the Pacific, ranging in depth from the littoral to 2900 m. These records extend the vertical range.

The record from St. 334 is almost impossible for me to believe. The idea of this species which is common in subpolar and cold temperate seas living in the tidal zone near Singapore is very difficult to accept.

Golfingia (Golfingia) muricaudata
Southern, 1913

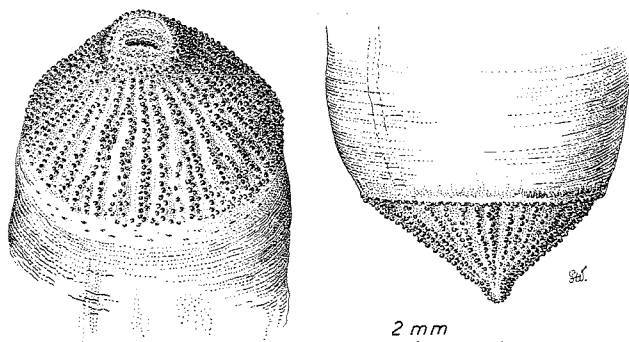
Material:

St. 193. Off S. E. Africa (32°34'S, 31°52'E), 3680 m, 6 Feb. 1951, trawl, globigerina ooze, 1.1°C. - 2 specimens.

St. 663. Kermadec Trench (36°31'S, 178°38'W), 4410 m, 24 Feb. 1952, trawl, brown, sandy clay with pumice, 1.2°C. - 3 specimens.

The specimens are in many ways similar to *margaritacea*. Both Wesenberg-Lund and Murina have described *G. margaritacea* with tail-like appendages. It is my opinion that to expand the definition of *G. margaritacea* to include tailed specimens is a mistake. While there is variation within a population, this phenotypic feature is of an order of magnitude which I consider to exceed reasonable limits of variation for a particular genotype. Therefore, I am considering these to belong to the species *G. muricaudata*.

The largest specimen is 50 mm long with a 5 mm tail. The skin is yellowish-grey and smooth with very small, white papillae. These specimens coincide well with Southern's description of the species.



Distribution: Found in cold water in Hudson Bay, along the east coast of North America, in the eastern Atlantic from Ireland, from Bouvet Island in the South Atlantic, the Indian Ocean, Japan and the North Pacific. The depth range is 450-3000 m. These two records modestly increase its depth range.

Golfingia (Golfingia) n.sp.
(Fig. 2)

Material:

St. 214. Off S. E. Africa (20°12'S, 35°15'E), 380 m, 24 Feb. 1951, grab, clay. - 1 specimen.

The specimen is pale, 18 mm long by 3-4 mm wide, with a completely retracted introvert. There are black, randomly distributed, sharp hooks 0.13 mm high. At the anterior and posterior ends there are densely packed, pigmented, finger-shaped to spheroid papillae (Fig. 2).

Internally there are four retractors of normal configuration originating about 60% of the distance to the posterior end. The nephridia are long, slender and about half the trunk length. The spindle muscle is present but unattached posteriorly. The contractile vessel is simple.

The decision to leave this organism unnamed is consistent with my philosophy that in order to adequately describe a species, one must have more than a single specimen.

Golfingia (Mitosiphon) trichocephala
(Sluiter, 1902) sensu Cutler, 1973

Material:

St. 358. 2 km S. of Tg.Gul., Singapore Island, 15 m, 31 May 1951, grab, muddy sand. - 1 specimen.

St. 539. Coral Sea (26°33'S, 153°31'E), 55 m, 5 Nov. 1951, grab, gravel. - 4 specimens.

Fig. 2. *Golfingia (Golfingia) n. sp.* External view of anterior and posterior ends of trunk.

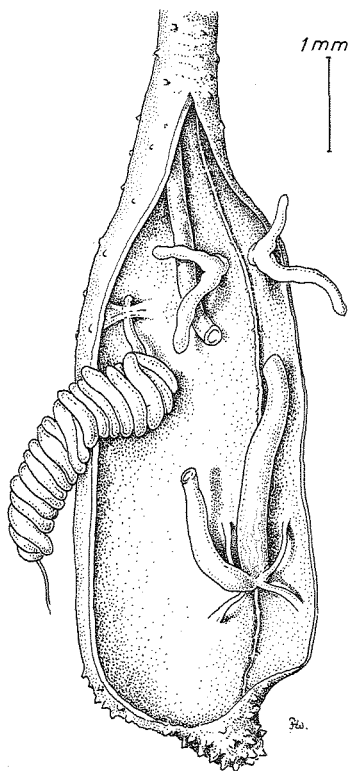


Fig. 3. *Golfingia* (*Mitosiphon*) sp.
Internal organs.

St. 616. Milford Sound (44°37'S, 167°53'E), 290 m,
19 Jan. 1952, dredge, mud. - 1 specimen.

St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m,
20 Jan. 1952, trawl, globigerina ooze, c. 7.5°C.
- 1 specimen.

These specimens are damaged and poorly preserved
but easily referred to this species as redescribed by
Cutler (1967, 1973), with bilobed nephridia,
four retractors and posteriorly attached spindle muscle.

Distribution: Reported from shallow water off
Indonesia, South Africa, West Africa and the east
coast of U.S.A. These records spread the species
into the southwestern Pacific Ocean and modestly
increase the vertical distribution.

Golfingia (*Mitosiphon*) sp.

Fig. 3

Material:

St. 476. S. of Bali (9°04'S, 114°43'E), 1555 m,
11 Sep. 1951, grab, clay with fine sand. -
1 specimen.

The specimen has the proper bilobed nephridia and
characteristic retractor origins for this subgenus

(Fig. 3). Unfortunately, its introvert is missing and,
therefore, it is impossible to refer it to a species.

The trunk is about 5 mm long and yellowish-white
in color. The nephridiopores are a little anterior to
the anus and one lobe of the nephridia is longer than
the other. This is similar to *G. hespera* and *G.*
misakiana in some ways.

Golfingia (*Golfingiella*) *murinae murinae*

Cutler, 1969

Figs 4 and 5

Material:

St. 239. Off Kenya (3°59'S, 42°03'E), 3290 m,
14 Mar. 1951, grab, globigerina ooze, c. 2.3°C. -
3 specimens.

St. 281. E. of the Seychelles (3°38'N, 78°15'E),
3310 m, 10 Apr. 1951, trawl, globigerina ooze. -
2 specimens.

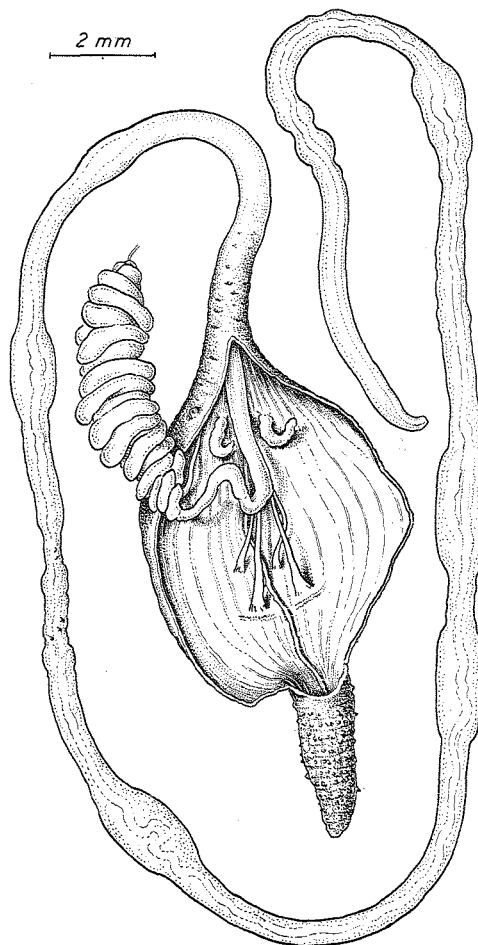


Fig. 4. *Golfingia murinae murinae*. Combination of two dissected
specimens from Sts. 239 and 281. Vague suggestion of longitudinal
musculature being divided into bundles, possibly due to poor
preservation.

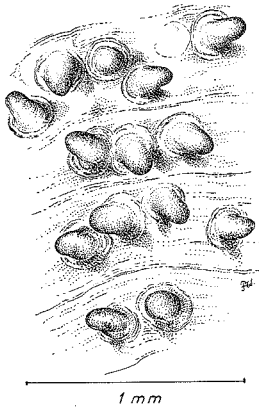


Fig. 5. *Golfingia murinae murinae*.
Papillae from posterior end.

- St. 421. W. of Philippine Trench (10°26'N, 126°05'E), 1000 m, 24 Jul. 1951, grab, clay. - 1 specimen.
- St. 471. Sunda Trench (10°26'S, 114°15'E), 2810-2990 m, 10 Sep. 1951, dredge, clay and volcanic tuff, 1.7°C. - 2 specimens.
- St. 477. S. of Bali (9°01'S, 114°48'E), 780 m, 11 Sep. 1951, grab, sandy clay, c. 6°C. - 1 specimen.
- St. 550. Tasman Sea (31°27'S, 153°33'E), 4530 m, 12 Nov. 1951, dredge, very stiff clay, c. 1°C. - 6 specimens.

The state of preservation is rather poor. The circular muscles are strongly contracted in narrow bands giving a "beaded" appearance to the worms. The introvert is about six times the length of the trunk. The color is greyish brown, darker at both ends of the trunk. The posterior papillae are large and bluntly mammiform. Small, slender hooks are present, but as none of the animals was fully protruded, no comment on the tentacles can be made.

The longitudinal musculature appeared to be split into bands near each end of the trunk but continuous in the central part. This was probably due to its poor preservation. The internal morphology is consistent with the published description of this subspecies, the nephridia being single lobed (Figs 4 and 5).

Distribution: A deep water species (1000-4750 m) in the northwestern Atlantic and in the northwestern Pacific Ocean (3950 m). These are the first Indian Ocean and southern Pacific records.

Golfingia (Golfingiella) sp.

Fig. 6

Material:

St. 423. E. of Cebu, Philippines (10°27'N, 124°18'E), 750 m, 25 Jul. 1951, dredge, green mud. - 1 specimen.

This small (20 mm) specimen is brownish with a rusty red coating which rubs off easily. The two retractor muscles are long and separated from each other, fastening near the posterior end of the trunk. Hooks are absent; the anus and nephridiopore are at the same level. The gut has about 20 coils and the rectum is fastened to the body wall by a connective tissue (Fig. 6). Three fixing muscles are present and the spindle muscle seems to have been fastened to the posterior of the trunk prior to dissection. The contractile vessel has numerous vesicular outpouchings but not villi as in the subgenus *Thysanocardia*. There is only a single, reddish nephridium present; the other might have been destroyed during dissection.

Golfingia (Phascaloides) flagrifera
(Selenka, 1885)

Material:

St. 30. Bay of Guinea (0°42'N, 5°59'W), 5160 m, 18 Nov. 1950, dredge, clay, c. 2.2°C. - 1 specimen.

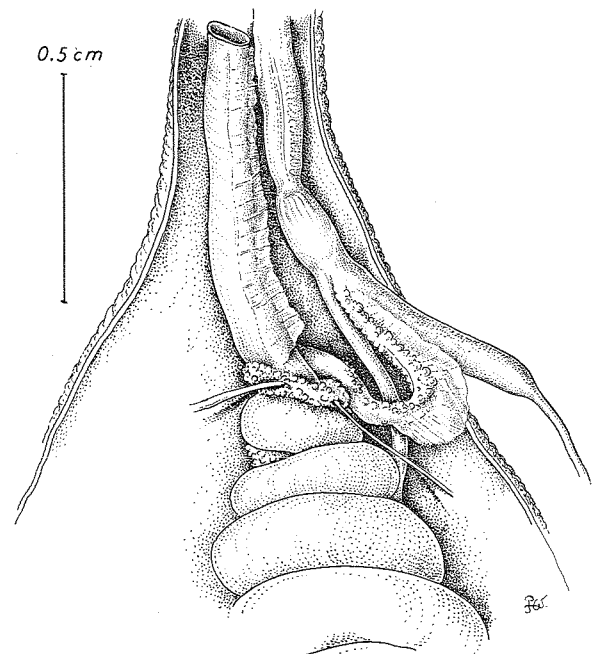


Fig. 6. *Golfingia (Golfingiella) sp.* Anterior portion of digestive system.

- St. 212. Off S. E. Africa (20°08'S, 35°33'E), 200 m, 24 Feb. 1951, grab, gravel with shells and coral. - 1 specimen.
- St. 408. South China Sea (12°47'N, 116°24'E), 4330 m, 4 Jul. 1951, dredge, globigerina ooze. - 3 specimens.
- St. 450. Celebes Sea (1°50'N, 119°20'E), 4890 m, 21 Aug. 1951, grab, bluish clay with fragments of plants. - 75 specimens.
- St. 771. Gulf of Biscay (47°48'N, 8°26'W), 1920 m, 18 Jun. 1952, grab, stiff clay, c. 1°C. - 1 specimen.

Many of the Celebes Sea specimens are damaged and poorly preserved, but still referable to this species. This haul of 75 individuals from a single grab sample (0.2 m²) is noteworthy in terms of population density. Many are small (about 2 cm). The posterior end has the characteristic filiform tail and large, vesicular papillae, some measuring 0.5 mm high.

The specimen from St. 212 is very small, its trunk being only 8 mm long with a 2 mm tail. The posterior papillae were not enlarged but as pointed out in Cutler (1973: 155) the small worms have small papillae. This individual contained no gametes.

Distribution: Previously recorded from deep water in the northern Atlantic and Pacific Oceans. These are the first records from tropical areas and the southern hemisphere. The shallow record from off Mozambique is the first one from the Indian Ocean, remarkable for that and its shallow depth. Whether or not this represents a breeding population or an accidental fringe situation is debatable.

Golfingia (Phascoloides) minuta
(Keferstein, 1863)

Material:

- St. 24. Bay of Guinea (3°54'N, 8°22'W), 3200 m, 15 Nov. 1950, dredge, clay, c. 2.7°C. - 6 specimens.

These specimens were found in straight, rusty-red tubes, probably constructed by a foraminiferan. They are elongate and have noticeably large papillae around the posterior end and might be referred to the species *G. improvisum* by some authors.

Distribution: Common in the colder water of the Atlantic and Antarctic. There is a report from the

N. W. Pacific Ocean also. This is only the second record from off West Africa, but it is present off South Africa.

Golfingia (Phascoloides) sp. (cf. pellucida)
(Keferstein, 1865)

Material:

- St. 476. S. of Bali (9°04'S, 114°43'E), 1555 m, 11 Sep. 1951, grab, clay with fine sand. - 1 specimen.
- St. 638. New Zealand (37°33'S, 175°57'E), 660 m, 26 Jan. 1952, grab, clay with a little sand. - 1 specimen.

The specimen from St. 476 is 6 mm long, has two or three rows of small hooks, measuring 0.03 mm high. It has small, sparsely distributed, finger-shaped papillae and numerous tentacles. The two retractors originate from near the posterior end. It is possibly an immature.

The specimen from St. 638 is in a poor state of preservation, has no eye spots and a sparseness of papillae in the central region of the trunk. The introvert carries a few rows of long, cylindrical papillae with dark, chitinous tips - not really hooks.

It is with reservation that these specimens are referred to the specific name *pellucida*.

Distribution: Recorded from the Caribbean as far north as Cape Hatteras and there are several reports from the Indonesian-Australian-West Pacific area extending into subtropical regions, usually in shallow water. An exception is a report from the Antarctic between 110-750 m. The depth of these records is unusual.

Golfingia (Phascoloides) rutilofusca
(W. Fischer, 1916)

Fig. 7

Material:

- St. 214. Off S. E. Africa (20°10'S, 35°15'E), 380 m, 24 Feb. 1951, grab, clay. - 1 specimen.

This small, red specimen exhibited the characteristic external features of this unusual species. The trunk is 5 mm long and the introvert is at least twice that. The posterior end of the trunk has alternating grooves and ridges but is indistinctly set off from the

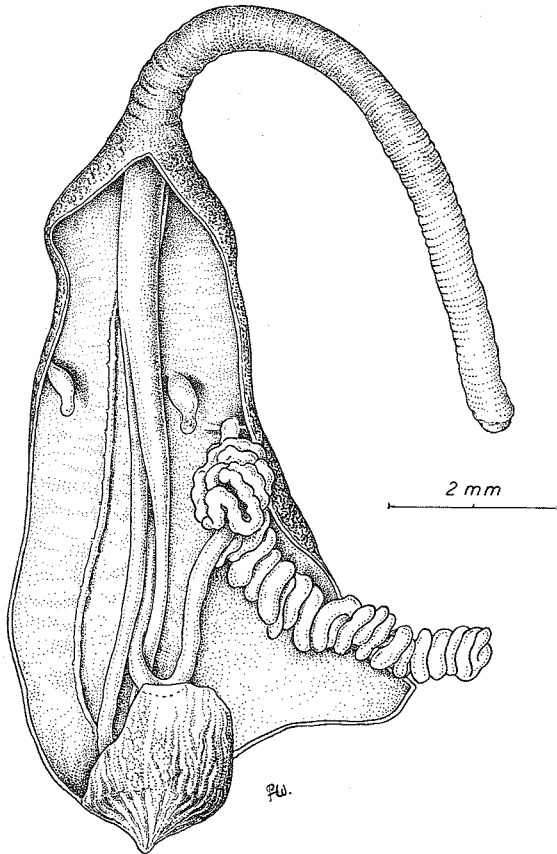


Fig. 7. *Golfingia rutilofusca*. Dissected specimen.

rest of the body. It only vaguely resembles a posterior shield of *Aspidosiphon*. The two retractor muscles originate near the posterior end. The spindle muscle is not attached posteriorly. The two very short, vesicular nephridia open just anterior to the anus (Fig. 7).

Distribution: The only previous record of this species is from 1362 m off Zanzibar.

Golfingia (Phascoloides) sp.

Material:

St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m, 20 Jan. 1952, dredge, globigerina ooze, c. 7.5°C. - 1 specimen.

This single, 3 mm specimen was unfortunately allowed to dry up at some point in its history and was impossible to identify to species. There was a single pair of retractor muscles and the spindle muscle was unattached posteriorly.

***Onchnesoma steenstrupi* Koren & Danielssen, 1875**

Material:

St. 96. Off Congo River (7°00'S, 11°10'E), 1435 m, 10 Dec. 1951, grab, mud. - 2 specimens.
St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m, 20 Jan. 1952, dredge, globigerina ooze, c. 7.5°C. - 6 specimens.

These specimens agree well with published descriptions and are distinctive enough to be easily identified. The single retractor muscle, single nephridium, and irregularly coiled gut, as well as their peculiar shape facilitate this process.

Distribution: Generally a deep water form, it is common on both sides of the North Atlantic; has been found in the Mediterranean, off West and South Africa, and S. E. Australia. This Tasman Sea record is startling, not for depth, but as the first indication that this might be a cosmopolitan species. The West African record is a modest extension of its vertical range.

***Phascolion collare* Selenka, de Man & Bülow, 1883**

Material:

St. 452. Makassar Strait (3°37'S, 118°34'E), 2000 m, 24 Aug. 1951, grab, greenish clay. - 2 specimens.
St. 490. Bali Sea (5°25'S, 117°03'E), 545-570 m, 14 Sep. 1951, dredge, sand and clay, c. 6.5°C. - 3 specimens.

The specimens from St. 452 are from twisted prosobranch shells, therefore, also twisted. Those from St. 490 are from very long scaphopod shells and are in a bad state of preservation. Both have the intestine pushed out through ruptures in the body wall. It is de facto impossible to study the internal anatomy. The holdfasts are, however, in close agreement with Selenka's drawings (1883, pl. VI, figs 72-74). The chitinized rim of the holdfasts from the dorsal side is about three quarters of a circle or an ellipse. From the middle of the horseshoe a high cone rises up, and to each side of it a long straight or curved "arm" runs backwards. The holdfasts of the ventral (concave) side are by far not so strongly chitinized and they are much smaller too. It is with some hesitation that the five specimens are referred to this species. The only features which point to it

are the shape of the holdfasts and the blunt, slightly curved hooks of the introvert which measure about 0.03 mm high. The color is a light brown with a darker girdle at the base of the introvert. From this area and into that where the horseshoes are, the skin is set with numerous irregularly arranged, rather large vesicles or papillae. Only one retractor with two very short roots is present which anchors at the very tip of the trunk, just as in Selenka's drawing.

Distribution: Reported twice before, from the Philippines at 7-25 m, and off Zanzibar at 465 m. These records greatly increase its vertical range.

Phascolion denticolum Sato, 1937

Fig. 8

Material:

St. 554. Great Australian Bight (37°28'S, 138°55'E), 1360 m, 5 Dec. 1951, dredge, globigerina ooze, c. 3.5°C. - 18 specimens.

St. 575. Tasman Sea (40°11'S, 163°35'E), 3710 m, 19 Dec. 1951, trawl, pteropod ooze, c. 1.1°C. - 1 specimen.

St. 602. Tasman Sea (43°58'S, 165°24'E), 4510 m, 15 Jan. 1952, dredge, bluish clay, c. 1.1°C. - 1 specimen.

The specimens from St. 554 were poorly preserved and came from small, twisted gastropod shells; most of them with protruded introvert. Some Kamptozoa (Entoprocts) at both ends. The color is greyish-brown, the posterior end with transparent, thin skin. Behind the tentacular crown (Fig. 8 A) which surrounds the mouth, the introvert is vesiculous and has irregularly arranged hooks only visible by strong magnification (Fig. 8 B). They have a rather broad base, are slightly curved, and have a blunt tip.

At the base of the introvert the papillae form a broad girdle and increase slightly in size but are shorter than the spines; they are low, blunt cones. In the middle of the trunk there is a girdle of holdfasts (Fig. 8 C) with a semicircular brown horseshoe-shaped rim, much larger and closer set at the exterior side of the convolutions of the trunk than at the inner side. In some specimens the hindmost tip is darkly pigmented. The longitudinal muscles are continuous. There are two retractor muscles separated in their whole length and anchored with broad roots close to the nerve cord at the posterior tip of the trunk. The nephridiopore is situated far behind the anus. The nephridium is short; the rectum long, straight and has a small diverticulum. In one specimen a Syllid polychaete was found following the convolutions of the trunk of the sipunculan.

It is with hesitation that we have referred the present specimens to Sato's species. They closely agree with his figure and description of the internal anatomy, but the skin organs seem to us not quite alike; and furthermore, his specimens come from shallow water in a Japanese bay.

Distribution: Not recorded since the first find in Japan from shallow waters. These records greatly increase both its vertical and horizontal ranges.

Phascolion lutense Selenka, 1885

Material:

St. 663. Kermadec Trench (36°31'S, 178°38'W), 4410 m, 24 Feb. 1952, trawl, brown, sandy clay with pumice, 1.2°C. - 2 specimens.

These worms were found in lumps of clay along with some *Golfingia margaritacea*. They have the characteristic wide retractor muscle with three origins and small hooks, 0.06 mm high.

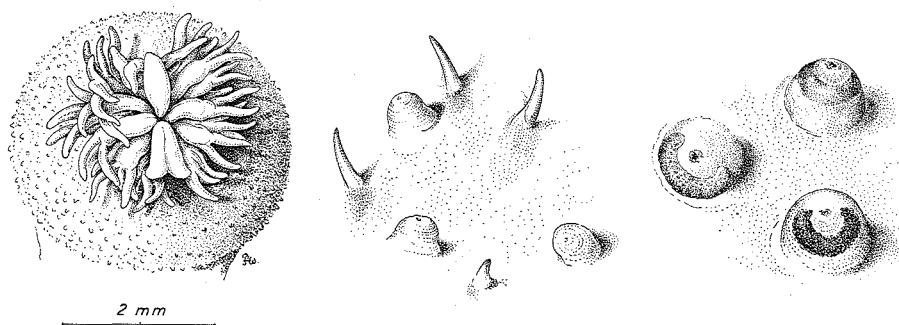


Fig. 8. *Phascolion denticolum*. A, tentacular crown and bulbous tip of introvert. B, spinelike hooks and papillae from introvert. C, "holdfasts" or chitinized papillae from mid region of trunk.

Distribution: A deep-water species having been found previously in the South Pacific, the Aleutian, Kurile-Kamchatka and Japanese Trenches in the N.W. Pacific and in the Bering Sea, at depths greater than 3500 m. It has also been reported from the South Sandwich Islands in the South Atlantic at depths greater than 1820 m.

Phascolion pacificum Murina, 1957

Material:

St. 554. Great Australian Bight (37°28'S, 138°55'E), 1320-1340 m, 15 Oct. 1951, dredge, globigerina ooze, c. 3.5°C. - 1 specimen.

The trunk measures about 1 x 5 mm with a transparent body wall. It had been living in an empty gastropod shell. The identification of this was verified by the original describer of this species.

Distribution: Reported six times by Murina from the N. W. Pacific, the Peru-Chile Trench, the far southern Atlantic, Pacific, and Indian Oceans, at depths between 2965 and 6860 m. Thus this is the shallowest record for this species.

Phascolion strombi (Montagu, 1804)

Material:

St. 17. Off N. W. Africa (7°17'N, 13°28'W), 1260 m, 10 Nov. 1950, dredge, mud. - 3 specimens.

Two of the three worms were incomplete and the third, with a 17 mm trunk, was damaged. All had been living in *Dentalium* shells.

The species *P. africanum* was originally described by Fischer (1923) from a single specimen. Wesenberg-Lund (1963) placed three more individuals in this taxon but noted that they were "... in a very bad state of preservation, ruptured and damaged to a high degree ...". One way it supposedly differs from *P. strombi* is that the ventral retractors originate anteriorly to the dorsal. However, this is also true for *P. strombi* and the issue of how great a distance there is between these two points is not clear. This may be a reflection of animal size/age or type of living quarters they inhabited. Also, in Stephen & Edmonds' (1972) key to the genus (p. 167) they separate these two species at point 18 wherein *P. strombi*'s presumably "hardened rim of adhesive papillae

bear one or more points or teeth". This is not universally true (see Gerould 1913 or Cutler 1973).

The holdfasts in the "Galathea" animals are rounded and the ventral retractors originate slightly anterior to the dorsal but the form, in my opinion, is within the range exhibited by *P. strombi*. I seriously question the validity of Fischer's *P. africanum*.

Distribution: Perhaps the most common sipunculan in the North Atlantic. There are numerous records from the Arctic, North Sea, and eastern Atlantic as well as along the eastern coast of North America. There are additional records from the Antarctic waters in southern Atlantic, Indian, and Pacific Oceans. It also extends into the Mediterranean, the Red Sea and the Gulf of Aden. The only previous West African record was much further south at 32° S off South Africa.

Its vertical distribution is broad but generally at shelf and slope depths in cold and temperate waters.

Stephen & Edmonds (1972: 189) list, under distribution: West Indies, ten Broeke, 1928. As far as I can determine ten Broeke did not publish in 1928. Her West Indies paper was published in 1925, and there is no reference in that paper to any member of the genus *Phascolion*.

Themiste huttoni (Benham, 1904)

Material:

St. 625. Tasman Sea (42°08'S, 170°20'E), 610 m, 20 Jan. 1952, core sampler, globigerina ooze. - 6 specimens.

St. 638. New Zealand (37°33'S, 175°57'E), 660 m, 26 Jan. 1952, grab, clay with a little sand. - 5 specimens.

These straw colored worms are between 25 and 31 mm long. The tentacle branches do not show the brownish pigmentation. The posterior end shows a reticulate pattern. The sparsely scattered blunt hooks lie behind a brown girdle and their bases are circular. Internally the only variation is the presence of two, not three fixing muscles. As noted later this species is similar to *T. lageniformis*, but possesses hooks.

Distribution: Seems to be restricted to the New Zealand region. These records are deeper than earlier ones.

Themiste lageniformis Baird, 1868

[= *Themiste signifer*

(Selenka, de Man & Bülow, 1883)]

Fig. 9

Material:

- St. 203. Off S. E. Africa (25°36'S, 35°21'E), 730 m, 21 Feb. 1951, trawl. - 8 specimens.
- St. 259. West of Mombasa (4°06'S, 39°43'E), 40 m, 22 Mar. 1951, grab, coralline sand and gravel. - 1 specimen.
- St. 545. Coral Sea (29°57'S, 153°24'E), 75 m, 11 Nov. 1952, grab. - 25 specimens.
- St. 597. Otago Harbour, N. Z. (45°47'S, 169°30'E), tidal zone, 9 Jan. 1952. - 4 specimens.
- St. 598. Dunedin Harbour, N. Z., just below tidal zone, 9 Jan. 1952. - 1 specimen.
- St. 624. Entrance of Milford Sound, N. Z. (44°34'S, 167°49'E), tidal zone, 19 Jan. 1952. - 10 specimens.
- St. 643. Manakau Harbour, Auckland, N. Z., tidal flat, 29 Jan. 1952. - 10 specimens.
- St. 667. Takopuna Bay near Auckland, N. Z., tidal zone, 27 Feb. 1952, sand. - 5 specimens.

The greyish brown trunks measure between 10 and 16 mm. The white branched tentacles have brown pigment on their ventral surfaces of the main branches. Hooks are absent, but spinelike papillae are visible. The internal morphology agrees with the literature (Stephen & Edmonds 1972: 205). The long, free nephridia open at the same level as the anus and near the ventral nerve cord. One specimen had a strongly deformed nephridium (Fig. 9). The contractile vessel villi increase in size posteriorad and also become bifurcated, some ending in spherical brown vesicles. One specimen is packed with ripe ova.

This species is part of a complex of closely related forms, as discussed in Stephen & Edmonds (1972: 205). Like in the genus *Golfingia* we find species being differentiated on the basis of whether or not hooks are present. While acknowledging the danger of this, we continue in the practice. For example, this form is very much like the preceding *T. huttoni*, except that it lacks hooks.

This species name is one that Rice & Stephen

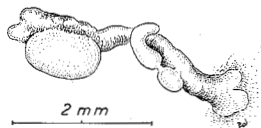


Fig. 9. *Themiste lageniformis*.
Strangely deformed nephridium.

(1970) recently resurrected after being unused for over 100 years. It used to be called *T. signifer* and this particular case is one of the more unfortunate examples of excessively legalistic interpretation causing more confusion than clarity, as *T. signifer* is a name widely spread in sipunculan literature.

Distribution: Recorded from West Africa around South Africa, Red Sea, Madagascar, through Indonesia to Japan, Australia, and western Pacific. The South African record (St. 203) is not surprising but it is deeper than earlier littoral records.

Themiste minor (Ikeda, 1904)

Material:

- St. 602. Tasman Sea (43°58'S, 165°24'E), 4510 m, 15 Jan. 1952, dredge, bluish clay, c.1.1°C. - 1 specimen.
- St. 620. Off Milford Sound, N. Z. (44°36'S, 167°47'E), 126 m, 19 Jan. 1952, grab. - 5 specimens.
- St. 638. New Zealand (37°33'S, 175°57'E), 660 m, 26 Jan. 1952, grab, clay with a little sand. - 1 specimen.

The size ranges from 1 to 6 mm. The worms are sausage-shaped, semitransparent, greyish white with ends darker and slightly reticulate. The hooks are brown, bluntly pointed and slightly curved. The largest specimen (from St. 638) has numerous eggs in its body cavity. Contractile vessel villi are few, short, and unbranched.

Distribution: Previously known from Japan, China, and South Africa. These finds from the Australian region suggests an Indo-West Pacific distribution. These deep records are noteworthy and very uncharacteristic for this species.

Aspidosiphon (Aspidosiphon) hartmeyeri

W. Fischer, 1919

Material:

- St. 556. Great Australian Bight (37°18'S, 138°43'E), 795 m, 6 Dec. 1951, grab, clay. - 1 specimen.
- St. 675. Raoul Island, Kermadec Is. (29°13'S, 177°57'W), 60 m, 3 Mar. 1952, dredge. - 3 specimens.

This 12 mm, whitish worm was living in a *Dentalium* shell. The brown, oval, anal shield has a few long ribs with shorter ribs between them near the posterior side. The anterior portion has numerous rectangular areas. The intestine is irregularly coiled as in *Phascolion*.

Distribution: Previously recorded from Australia, West Africa, and Cuba. The record from St. 675 is a modest extension into the western Pacific Ocean. The depth of St. 556 is of interest.

Aspidosiphon (Aspidosiphon) muelleri Diesing, 1851

Material:

- St. 196. Off S. E. Africa (29°55'S, 31°20'E), 425 m, 13 Feb. 1951, dredge, sand and clay. - 1 specimen.
St. 345. Off Singapore, 1 km E. of Tanjong Rhu, 10 m, 23 May 1951, dredge, mud. - 1 specimen.
St. 357. 800 m S. of Tg. Gul., Singapore Island, 15 m, 31 May 1951, grab, muddy sand. - 1 specimen.
St. 451. Makassar Strait (1°25'S, 117°05'E), 60 m, 23 Aug. 1951, grab, mud and shells. - 1 specimen.
St. 454. Java Sea (5°23'S, 116°02'E), 60 m, 25 Aug. 1951, coral clay. - 1 specimen.
St. 500. Arafura Sea (7°34'S, 132°44'E), 390 m, 25 Sep. 1951, dredge, coral sand. - 30 specimens.
St. 585. Campbell Island (52°34'S, 169°09'E), 36 m, 4 Jan. 1952, grab. - 1 specimen.
St. 596. Campbell Island (52°33'S, 169°09'E), 43 m, 5 Jan. 1952. - 2 specimens.

The dark brown specimen from St. 196 had the characteristic external appearance but as it had been allowed to dry out, it was impossible to confirm its internal structure. E. Wesenberg-Lund had identified it as *A. muelleri*.

Several of the shallow water specimens are referred to this species with reservations. They have only unidentate hooks, paler, less distinct shields, and thin, translucent body walls. This species is very poorly defined as detailed in Stephen & Edmonds (1972: 233) and is in need of some close attention.

Distribution: Common in cold water of the N. E. Atlantic, Mediterranean, West Africa, and Azores area. There are also reports from East Africa, Mauritius, and Japan. These records expand the range in a southerly direction but it is still absent from either coast of the Americas. The shallow,

tropical stations are surprising and uncharacteristic.

Aspidosiphon (Aspidosiphon) venabulum

Selenka, de Man & Bülow, 1883

Material:

- St. 94. Off Congo River (6°48'S, 11°19'E), 960 m, 10 Dec. 1950, grab, muddy clay. - 1 specimen.

The yellowish-white specimen had occupied a gastropod shell. The dark anal shield has large randomly scattered spinelike papillae over its entire surface and is distinctly set off from its surroundings.

Distribution: Seems to be restricted to the West African coast, usually in shallow water. The depth of this record is unique.

Aspidosiphon (Paraspidosiphon) steenstrupi

Diesing, 1859

Material:

- St. 196. Off S. E. Africa (29°55'S, 31°20'E), 425 m, 13 Feb. 1951, dredge, sand and clay. - 4 specimens.
St. 759. Puerto Rico Trench (18°30'N, 66°15'W), 1250 m, 31 May 1952, grab, stiff red clay. - 1 specimen.

The granular anal shield is pigmented but the caudal shield is almost colorless with white calcareous grains attached to it. The hooks are double pointed and in rows. The nephridia are long, almost reaching the posterior end and the spindle muscle is attached posteriorly. The origins of the two retractor muscles appear to be subdivided into two to four roots.

Distribution: Common in warm water around the globe except for the eastern Pacific. These depths are unusual for the species.

Lithacrosiphon cristatus

sensu Cutler & Jurczak, 1975

Material:

- St. 716. East Pacific (9°23'N, 89°32'W), 3570 m, 6 May 1952, trawl, dark muddish clay, c. 1.9°C. - 1 specimen.

The distal half of the anal shield is covered by a pinkish foraminiferan, possibly of the genus *Homotrema*. The base of this cone is surrounded by the hard, brown, longitudinally ridged epithelium reminiscent of an *Aspidosiphon* shield. There are about 37 grooves in the anal shield. The introvert is completely withdrawn but upon dissection, many small unidentate hooks were initially found. This probably led Wesenberg-Lund to identify it as *L. kukenthali*. Upon subsequent observation and removal of tissue from the distal 1 mm of the introvert, a few rows of bidentate hooks were found. The unidentate hooks measure 0.024-0.029 mm high and the bidentate 0.029-0.036 mm high.

The yellowish white trunk is 12 mm long, and about 18 anastomosing longitudinal muscle bands are present. The posterior end lacks a well developed shield but has circular ridges or wrinkles. The two retractor muscles originate about 90% of the distance to the posterior end and are fused for more than half their length. Both the oesophagus and rectum are long, and there are few whorls to the intestine. The rectum lacks a caecum. The long nephridia are not straight but would probably be about 3/4 as long as the trunk. The nephridiopores are slightly behind the anus.

This individual (which I first took to be something between *L. kukenthali* and *L. poritidis*) was the stimulus for a comparative review of this genus which resulted in a reduction of species from nine to three (Cutler & Jurczak 1975).

Distribution: Recorded from several areas in the Pacific and Caribbean. This is the first record from

the eastern Pacific Ocean and the great depth is very striking, all previous records coming from shallow depths, usually from coral. Unfortunately the information in the literature on vertical distribution is often incomplete or very vague.

Cloeosiphon aspergillum Quatrefages, 1865

Fig. 10

Material:

- St. 334. Keppel Harbor, Singapore, tidal zone, 16 May 1951, corals. - 9 specimens.
- St. 337. Pulau Sudong, Singapore, tidal zone, 19 May 1951, coral reef. - 1 specimen.
- St. 423. E. of Cebu, Philippines (10°27'N, 124°18'E), 750 m, 25 Jul. 1951, dredge, green mud. - 1 specimen.
- St. 426. Philippines, west coast of Bucas Grande Island, tidal zone, 30 Jul. 1951. - 1 specimen.
- St. 436. E. of Cebu, Philippines (10°12'N, 124°14'E), 710 m, 9 Aug. 1951, dredge, green mud. - 1 specimen.
- St. 478. S. of Bali (8°50'S, 114°55'E), 600 m, 12 Sep. 1951, grab, sandy clay. - 1 specimen.
- St. 480. S. of Bali (8°49'S, 115°00'E), 440 m, 12 Sep. 1951, grab, sand with a little clay. - 13 specimens.

The trunks are yellowish-brown, 4-25 mm long and many of them are ruptured, with the intestine protruding from the body wall. The characteristic white anal shield, made up of flattened, rhomboidal facets, is present. In the specimens from Sts. 436 and 478 some of these calcified papillae are elongate and

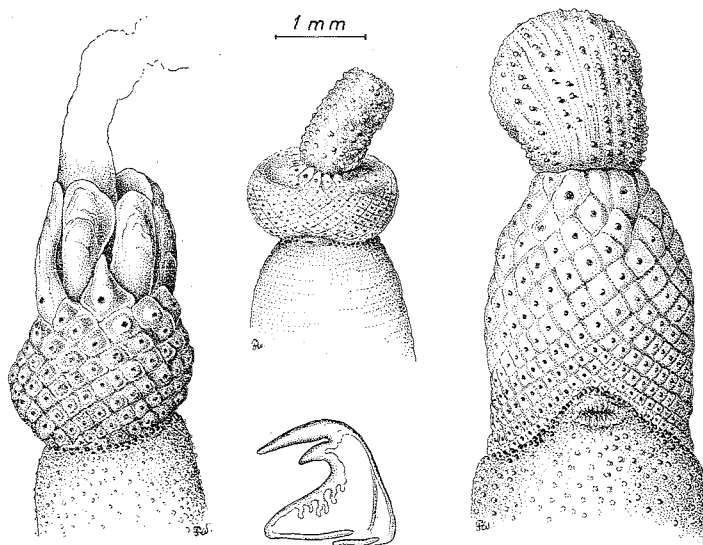


Fig. 10. *Cloeosiphon aspergillum*. A-C, calcified anal shield; A, with long incisorlike units; B and C, showing variable shapes possible. D, hook from introvert.

much like incisors. This whole "cap" assumes highly variable shapes according to the state of contraction (Fig. 10 A-C).

The prominent anus lies at the dorsal posterior border of this shield lying in a transverse fissure. The introvert has about 25 rings of bidentate hooks with an irregular concave side to the clear space (Fig. 10 D).

Distribution: Found in warm waters of the Indian and western Pacific Oceans. These records are of interest because of their depth. It is difficult to imagine this tropical, coral dwelling worm living at bathyal depths in green mud.

Phascolosoma (Antillesoma) antillarum

Grube & Ørsted, 1858

Material:

St. 734. Panama Gulf (7°20'N, 79°38'W), 520 m, 15 May 1952, grab, green clay, c. 7.7°C. - 4 specimens.

This species exhibits the contractile vessel villi and posteriorly attached spindle muscle characteristic of the subgenus. The specimens have light brown trunks measuring 15-20 mm long with darker bands at the extremities. The introvert is without hooks. The nephridia almost reach the posterior end of the worm, longer than usual, and are fastened nearly for the whole length.

Distribution: A common littoral species from the Caribbean, both sides of tropical South and Central America, with one record from West Africa and one from both Hawaii and Japan. Not yet recorded from the Indian Ocean. The depth of this record is unusual.

Phascolosoma (Antillesoma) pelmum

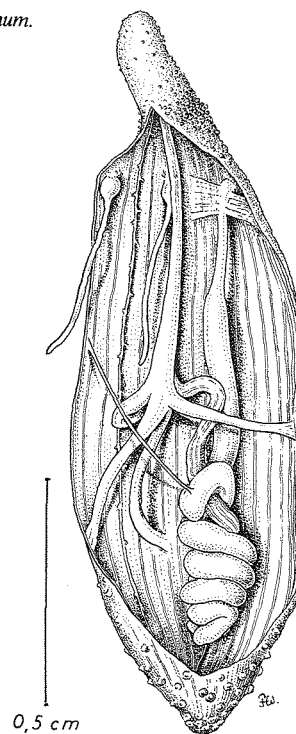
(Selenka, de Man & Bülow, 1883)

Fig. 11

Material:

St. 311. Off Ganges Delta (20°49'N, 88°40'E), 445 m, 2 May 1951, grab, clay and a little sand. - 1 specimen.
St. 452. Makassar Strait (3°37'S, 118°34'E), 2000 m, 24 Aug. 1951, grab, greenish clay. - 1 specimen.

Fig. 11. *Phascolosoma pelmum*.
Dissected specimen.



These small specimens agree fairly well with published descriptions but there are some differences. The presence of contractile vessel villi apparently has been mixed historically, and they are not apparent in this material. The papillae are not large and lack any enlarged platelets, the central clear area being surrounded by rather uniformly small polyagonal structures, slightly larger and darker than the more peripheral ones. Hooks are not found. There are about 17 longitudinal muscle bands in the mid-section of the trunk, and the four short retractor muscles originate just behind the middle of the trunk (Fig. 11).

Distribution: Known from the Indian and West Pacific Oceans. These depths are greater than any reported before.

Phascolosoma (Saitonus) pectinatum

Keferstein, 1867

Fig. 12

Material:

St. 574. Tasman Sea (39°45'S, 159°39'E), 4670 m, 18 Dec. 1951, dredge. - 5 specimens.
St. 734. Gulf of Panama (7°20'N, 79°38'W), 520 m, 15 May 1952, grab, green clay, c. 7.7°C. - 1 specimen.



Fig. 12. *Phascolosoma pectinatum*.
Fringed nephrostome.

- St. 741. Gulf of Panama (7°28'N, 79°36'W), 440-460 m, 16 May 1952, dredge, green clay. - 7 specimens.
- St. 745. Gulf of Panama (7°15'N, 79°25'W), 915 m, 16 May 1952, dredge, green clay, c. 5°C. - 2 specimens.
- St. 755. Caribbean (11°52'N, 77°41'W), 3960 m, 22 May 1952. - 2 specimens.

This distinctive species is unique in this genus in that it has bilobed nephridia and a comb of accessory spines at the base of its hooks. These small hooks are arranged in about 50 rows. The introvert is considerably more than twice the length of the trunk, the latter ranging from 13 to 50 mm in these specimens. The light brown skin is rough and somewhat reticulate with randomly arranged papillae. The 22-28 longitudinal muscle bands are visible through the skin. The internal morphology compares well with published descriptions. The slender retractor muscles originate about the same distance from the ventral nerve cord and soon fuse together. The rusty red, bilobed nephridia (the shorter lobe about one half the size of the longer) open to the exterior between longitudinal muscle bands four and five. Their internal openings (nephrostome) are surrounded by an elaborate fringe (Fig. 12). The specimens from St. 741 have mature ova.

Distribution: Prior records show this to be an uncommon but apparently circumtropical, shallow water species found in the tropical Atlantic Ocean, off Panama and California in the Pacific, and Mauritius in the Indian Ocean. Once again we have a shallow, warm water species now recorded from great depths.

Phascolosoma (Phascolosoma) perlucens

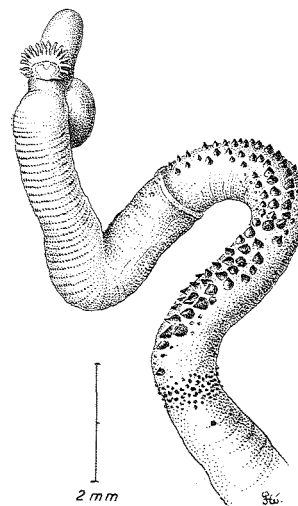
Baird, 1868

Fig. 13

Material:

- St. 741. Gulf of Panama (7°28'N, 79°36'W), 520 m, 16 May 1952, grab, green clay. - 3 specimens.

Fig. 13. *Phascolosoma perlucens*. Introvert showing characteristic papillae. The skin had burst and part of the oesophagus is protruding near the distal end.



This name has recently come back into use as a senior synonym for *P. dentigerum*, as a result of Rice & Stephen's (1970) work. It is easily recognized by the large, conical, reddish-brown papillae on the dorsal side of the introvert and posterior end of the trunk. There are about 25 rings of hooks, about 18 short tentacles, and 22 longitudinal muscle bands (Fig. 13).

Distribution: Common in the Indian Ocean but circumtropical, usually in shallow depths, with one record from the South Atlantic (56°S).

Phascolosoma (Phascolosoma) annulatum

Hutton, 1879

Material:

- St. 626. Tasman Sea (42°10'S, 170°10'E), 610 m, 20 Jan. 1952, trawl, globigerina ooze, c. 7.5°C. - 8 specimens.

The name is a subject of some disagreement. Edmonds (1960) is of the opinion that it is the senior synonym for *P. tasmaniense*, but Wesenberg-Lund (unpublished) disagreed. We have concurred with Edmonds' views as he has had considerable first hand experience with these animals.

The trunks of this material ranged from 31 to 50 mm long, the introvert being nearly equal in length. The numerous papillae are much darker than their surroundings. Scattered between the papillae are numerous brown platelets, especially on the dorsal surface and posterior end (see Augener 1903, fig. 2, pl. 18). There are about 40 rings of light brown,

strongly bent hooks. The basal triangular space is often indistinctly outlined. The nephridia reach the base of the ventral retractor muscles and only the last quarter is free. The wing muscle is very delicate and fastens far from the anus. In some, ripe eggs were present.

Distribution: Common in the Australia-Tasmania-New Zealand area in depths shallower than this record.

Phascolosoma (Phascolosoma) nigrescens
Keferstein, 1865

Material:

- St. 192. Off S.E. Africa (32°00'S, 32°41'E), 3430 m, 5 Feb. 1951, trawl, globigerina ooze, 1.2°C. - 7 specimens.
- St. 196. Off S. E. Africa (29°55'S, 31°20'E), 430 m, 14 Feb. 1951, dredge, sandy mud with stones. - 11 specimens.
- St. 255. Mombasa, tidal, 22 Mar. 1951, corals. - 4 specimens.
- St. 259. Off Mombasa (4°06'S, 39°43'E), 40 m, 22 Mar. 1951, grab, coralline sand and gravel. - 19 specimens.
- St. 321. Great Nicobar, tidal zone, 7 May 1951, sand. - 6 specimens.
- St. 340. Off Singapore, 8 m, 20 May 1951. - 1 specimen.
- St. 411. Manila Bay (14°22'N, 120°45'E), 21 m, 10 Jul. 1951, grab, green mud with smell of H₂S. - 15 specimens.
- St. 414. Dinagat Island, Philippines (10°20'N, 125°32'E), 40 m, 16 Jul. 1951, grab, corals. - 13 specimens.

These specimens had the papillae and hooks which characterize this common species. On several worms the hooks were small. In one from St. 321 with a trunk about 20 mm long, the hooks measured about 0.03-0.04 mm in height. This fits the pattern for hook size established in Cutler (1965), but extends the lower end of the scale. It is possible that smaller worms have smaller hooks than larger worms.

Distribution: Widely distributed around the world in shallow tropical and subtropical waters. The great depth of St. 192 is unique.

Phascolosoma (Phascolosoma) noduliferum
Stimpson, 1855

Material:

- St. 324. Malacca Strait (6°38'N, 96°00'E), 1140 m, 9 May 1951, dredge, brownish globigerina ooze. - 1 specimen.
- St. 428. Candos Bay, Mindanao (9°36'N, 125°46'E), 22 m, 30 Jul. 1951, grab, greenish mud. - 1 specimen.
- St. 530. Bay of Pt. Moresby, New Guinea, 8 m, 24 Oct. 1951, dredge, mud, gravel. - 3 specimens.
- St. 554. Great Australian Bight (37°28'S, 138°55'E), 1320-1340 m, 5 Dec. 1951, dredge, globigerina ooze, c. 3.5°C. - 3 specimens.
- St. 555. Great Australian Bight (37°21'S, 138°44'E), 875 m, 6 Dec. 1952, grab, clay. - 2 specimens.
- St. 562. Great Australian Bight (37°01'S, 138°38'E), 85 m, 6 Dec. 1951, grab, bryozoan sand. - 2 specimens.
- St. 584. Campbell Island (52°33'S, 169°08'E), 36 m, 4 Jan. 1952, grab, mud with sand and shells. - 1 specimen.

The largest of the bathyal worms is about 6 cm in total, trunk and introvert each about 3 cm long. The characteristic papillae are of equal size all over and most dense at the base of the introvert and posterior end. From 12-25 complete rings of hooks plus additional incomplete rings (up to 60) are found on the introvert. These hooks are sharply bent at the tip and have a simple clear streak in them with no accessory tooth. Internally the only variation is the unusual length of the nephridia, longer than half the length of the trunk. This species is very similar to *P. japonicum* and is discussed in Edmonds (1956: 286).

Distribution: Earlier records are from Australian waters; the one from the Strait of Malaca is a northern extension and noteworthy because of the great depth. Shallow records add support to a slightly wider distribution, still centered in the greater Australian region.

Phascolosoma (Phascolosoma) scolops
(Selenka, de Man & Bülow, 1883)

Material:

- St. 180. Off S. E. Africa (34°56'S, 36°31'E), 5220 m, 25 Jan. 1951, dredge. - 2 specimens.

St. 554. Great Australian Bight (37°28'S, 138°55'E), 1320-1340 m, 5 Dec. 1951, grab, c. 3.5°C. - 4 specimens.

The trunk length of these well preserved specimens ranged from 9-23 mm.

Distribution: This well-known, circumtropical and subtropical, shallow water species extends north to Japan and south to South Africa. These two records are of interest because of the great depth.

Phascolosoma (Phascolosoma) stephensoni

Stephen, 1942

Material:

St. 33. Bay of Guinea (4°00'N, 1°43'W), 1445 m, 20 Nov. 1950, grab, gray clay. - 3 specimens.

The specimens are small, the trunk 5 mm or less and possibly not sexually mature. About 25 complete rings of characteristic hooks and numerous incomplete ones are found.

Distribution: Recorded previously from southeast coast of Africa. This record extends the distribution around to West Africa and into much greater depths.

Phascolosoma (Phascolosoma) varians

Keferstein, 1865

Fig. 14

Material:

St. 743. Gulf of Panama (7°27'N, 79°37'W), 600 m, 16 May 1952, grab, green clay. - 2 specimens.

St. 744. Gulf of Panama (7°28'N, 79°39'W), 420 m, 16 May 1952, grab, green sandy clay. - 3 specimens.

St. 745. Gulf of Panama (7°15'N, 79°25'W), 915 m, 16 May 1952, dredge, green clay, c. 5°C. - 1 specimen.

The specimens of this well-known species are less than 2 cm in length, with retracted introverts. The hooks show the large accessory tooth, the broad



Fig. 14. *Phascolosoma varians*. Hook from introvert.

clear streak, and are arranged in about 40 rings (Fig. 14). Internally the only variation from published accounts is the nephridia which are fastened for their entire length.

Distribution: Primarily a Caribbean form but perhaps circumtropical with scattered reports from the Formosa and Indo-China area, and East Africa. These are the first records from the eastern Pacific and unusually deep.

SUMMARY OF DISTRIBUTION

Table 1 notes those species whose range was significantly expanded (more than 30° latitude or longitude) by these collections. For information on particular species refer to the preceding section.

DISCUSSION

Sipunculans have been found throughout the world's oceans at most depths. There are certain species which are generally found within restricted vertical ranges. Unfortunately, many authors in years past failed to record the depth or even the precise location, so it becomes very difficult to accurately analyze earlier records. Nevertheless, we can draw certain pictures about vertical as well as horizontal distribution (Table 1). Whether the numerous exceptions to the "rule" found in these collections are real we cannot tell, but for the time being must accept them for what they are.

It should be noted that there are several "typically" deep water species which were not found in these collections (Table 2), and this is also surprising. In reading through the other Galathea Reports (vols 1-10), it is hard to find a parallel situation in other taxa. In many groups new species predominate. In others there were only rare instances of shallow water forms occurring at great depths and often these were examples of equatorial submergence of species found on the shelf only at high latitudes (Wolff 1956; Zenkevitch 1966). The one possibly similar taxon is the Hydroidea (Vervoort 1966) where 11 out of 42 deep water species had previously been found in shallow water less than 50 m deep. A few other groups such as the holothurians, crinoids, and polychaetes (Gislén 1956; Hansen 1956; Kirkegaard 1956) show very wide vertical distribution and downward extensions of known ranges, but not to the extent shown here.

Table 1. Vertical distribution of sipunculans in this report

A, species whose previously known range was littoral but found at depths between 400-1000 m by the "Galathea". B, previously littoral species herein recorded from 1000-3000 m. C, previously littoral species herein recorded at depths greater than 3000 m. H, horizontal range significantly increased by "Galathea" records.

Species	Previously known vertical distribution	Number of previously literature references	"Galathea" depths	Comment
<i>Aspidosiphon hartmayeri</i>	littoral	5	60 & 795 m	A, H
<i>Aspidosiphon muelleri</i>	1-1200 m	20	10-425 m	H
<i>Aspidosiphon steenstrupi</i>	littoral	16	425 & 1250 m	B
<i>Aspidosiphon venabulum</i>	littoral (1-50 m)	5	960 m	A
<i>Cloeosiphon aspergillum</i>	littoral (0-20 m)	20	0-750 m	A
<i>Golfingia appendiculata</i>	288-4811 m	2	4510 m	H
<i>Golfingia capensis</i>	1-300 m	6	430 m	
<i>Golfingia flagrifera</i>	1500-5350 m	6	200-5160 m	H
<i>Golfingia margaritacea</i>	1-2900 m	24	0-5285 m	
<i>Golfingia minuta</i>	1-6700 m	20	3200 m	
<i>Golfingia muricaudata</i>	450-3000 m	5	3680 & 4410 m	
<i>Golfingia murinae</i>	1000-4750 m	3	700-4530 m	H
<i>Golfingia cf. pellucida</i>	1-130 m (750 m)	14	660 & 1555 m	
<i>Golfingia rutilofusca</i>	1362 m	1	380 m	
<i>Golfingia trichocephala</i>	1-360 m	4	15-610 m	H
<i>Lithacrosiphon cristatus</i>	littoral	6	3570 m	C, H
<i>Onchnesoma steenstrupi</i>	20-1100 m	15	610 & 1435 m	H
<i>Phascolion collare</i>	7-465 m	2	545-2000 m	
<i>Phascolion denticolum</i>	littoral	1	1360-4510 m	C, H
<i>Phascolion lutense</i>	> 3500 m	5	4410 m	H
<i>Phascolion pacificum</i>	2965-6860 m	6	1320-1340 m	
<i>Phascolion strombi</i>	5-3500 m	30	1260 m	
<i>Phascolosoma annulatum</i>	littoral	2	610 m	A
<i>Phascolosoma antillarum</i>	littoral (0-10 m)	12	520 m	A
<i>Phascolosoma nigrescens</i>	littoral (1-180 m)	30	0-3430 m	C
<i>Phascolosoma noduliferum</i>	littoral	4	8-1340 m	B, H
<i>Phascolosoma pectinatum</i>	littoral (1-98 m)	6	440-4670 m	C
<i>Phascolosoma pelmum</i>	littoral	6	445 & 2000 m	A
<i>Phascolosoma perlucens</i>	littoral (0-45 m)	11	520 m	A
<i>Phascolosoma scolops</i>	1-380 m	30	1320 & 5220 m	C
<i>Phascolosoma stephensoni</i>	littoral	3	1445 m	B, H
<i>Phascolosoma varians</i>	littoral (0-20 m)	9	420-915 m	A, H
<i>Siphonosoma australe</i>	littoral	11	610 m	A
<i>Siphonosoma cumanense</i>	littoral	20	810 m	A
<i>Siphonosoma novaepommeraniae</i>	littoral	2	1560 m	B
<i>Sipunculus natans</i>	0 m	1	610 m	A, H
<i>Sipunculus norvegicus</i>	30-1800 m	15	610 & 1560 m	B
<i>Sipunculus robustus</i>	littoral	13	1140 & 2720 m	B
<i>Sipunculus titubans</i>	littoral	7	1500 m	B
<i>Themiste huttoni</i>	littoral	2	610 & 660 m	A
<i>Themiste lageniformis</i>	littoral	13	0-730 m	A
<i>Themiste minor</i>	littoral	3	126-4510 m	C, H
<i>Xenosiphon mundanus</i>	littoral	3	1340 m	B

Table 2. Some deep-sea Sipuncula not collected by the "Galathea".

Species	Depth Range
<i>Aspidosiphon zinni</i>	1102-3000 m
<i>Golfingia abyssora</i>	5-4990 m
<i>Golfingia anderssoni</i>	75-6135 m
<i>Golfingia constricticervix</i>	1700-4800 m
<i>Golfingia eremita</i>	0-3867 m
<i>Golfingia mawsoni</i>	45-3990 m
<i>Golfingia vitjazi</i>	4150 m
<i>Onchnesoma magnibatha</i>	2520-4977 m
<i>Phascolion tuberculosum</i>	1517-2136 m
<i>Phascolosoma loveni</i>	1504-2050 m
<i>Phascolosoma sewelli</i>	1945-2050 m
<i>Sipunculus lomonosovi</i>	3355 m

As many sipunculans burrow into the substrate their recovery depends to a great extent on the nature of the collection gear used. A grab will often collect a worm which would have been passed over by a trawl skimming only the top two or three centimeters. This has recently been shown by N. Christie where he collected two species of the genus *Siphonosoma* from 30-60 cm below the surface in

False Bay off Cape Town, using a new collecting apparatus (Cutler & Christie 1974). No less than 43% of a total of 83 samples providing sipunculans were grab samples covering 0.2 m² (one sample even a core sample) so perhaps these new deep records from the "Galathea" are only a reflection of more extensive collections using a variety of collecting techniques. One does wonder, however, why these species have not shown up in other deep-sea collections such as those made by Sanders, Hessler & Hampson (1965). Another possible explanation is that the presence of a few individuals may indicate a fringe population resulting from a chance immigration from their "normal" range. These may not represent permanent, breeding populations but rather explorers or wayward individuals. This phenomenon is discussed in Mayr (1947: 275), Wells & Gray (1960), and Cutler (1973: 186).

I must repeat that I have serious reservations about the reality of some of these records, but cannot do other than report what I have. The expansion of the horizontal distribution in fourteen of the species is not quite so difficult to believe. In most cases these involve habitats not much different from those previously known.

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