

## Sipuncula from Antarctic waters

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*Abstract.*—A collection of 3156 Sipuncula from water south of 53° S latitude collected by several American expeditions during 1948–1986, at depths from 1–5790 m yielded 11 species. Only *Apionsoma murinae* (both subspecies) are new to this region but the known longitudinal ranges of the others are expanded. There is one numerically dominant species in each of the other three genera: *Golfingia margaritacea*, *Phascolion lutense* and *Nephasoma diaphanes*. Comments on the morphology of each taxon are presented plus a general observation about the deciduous nature of introvert hooks across these four genera. An illustrated key and distribution maps are provided.

*Resumen.*—Se estudia una colección de 3156 ejemplares de sipuncúlidos procedentes de los mares antárticos situados por debajo de los 53° latitud sur, siendo encontrándose un total de 11 especies. *Apionsoma murinae* (ambas subspecies) representan citas nuevas para la zona investigada, mientras que se amplían los rangos de distribución longitudinal de las otras especies identificadas. Una de las especies de cada uno de los géneros restantes: *Golfingia margaritacea*, *Phascolion lutense* y *Nephasoma diaphanes*, siempre es particularmente abundante en la colección. Asimismo se presentan comentarios sobre la morfología de cada taxon identificado, destacándose la naturaleza caediza de los ganchos de la trompa en los 4 géneros investigados. Finalmente se incluyen claves de identificación y mapas de distribución de todas las especies tratadas.

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This report is based on 3156 specimens collected at 456 stations over 38 years (1948–1986) by several American research vessels, Operation Deepfreeze contributed a few in 1948, then no more until 1956. Most of the collecting was done over the next two decades, with less intensity from the mid 1970's through the mid 1980's. Among the ships making the largest contribution are the R/V *Eltanin*, *Hero*, *Glacier*, and *Islas Orcadas*, but there were several others as well as a few land based operations.

Initial processing was by the Smithsonian Oceanographic Sorting Center (SOSC). The samples came from depths of 1–5790 m and latitudes of 53–78.5° S. This is an arbitrary

northern boundary since there are specimens scattered throughout the oceans of the world, including some from the Arctic Ocean. These will be treated in other reports. Several dozen Antarctic specimens were omitted from this report due to their damaged or incomplete nature. The nomenclature used here follows that of Cutler (1994).

### Materials and Methods

Specimens were collected using a wide range of trawls, dredges and grabs. The location and number of specimens are listed in the text if there were five or fewer stations. For more commonly collected species

this is summarized in the text and the detailed data can be found in Appendix I. For identification, standard dissecting techniques and both binocular dissecting and compound microscopes were used as required. The specimens are housed in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Results

Key to the species in this report (see Fig. 1).

- 1. Single nephridium ... (genus *Phascolion*) ..... 2
  - Two nephridia ..... 4
- 2. Introvert retractor muscles appear as two separate units and of nearly equal size ..... *Phascolion (Isomya) hedraeum*
  - Introvert retractor muscles fused into single column with very short distinct origins ..... (subgenus *Montuga*)
- 3. Trunk smooth, without apparent holdfast papillae, lives in clay tubes ....
  - ..... *Phascolion lutense*
  - Trunk with thin but distinct holdfast papillae ..... *P. pacificum*
- 4. One pair introvert retractor muscles ..
  - ..... (genus *Nephasoma*) ..... 5
  - Two pair introvert retractor muscles .. 7
- 5. Elongate very slender trunk, sometimes threadlike (width usually <0.1 the length); gut with separated coils .....
  - ..... *Nephasoma capilleforme*
  - Cylindrical trunk (width rarely <0.1 the length); gut coils close together ..... 6
- 6. Introvert hooks spine-like (one edge shorter than others) <50 μm tall ....
  - ..... *Nephasoma diaphanes*
  - Hooks pyramidal, >50 μm tall .....
    - ..... *Nephasoma abyssorum benhami*
- 7. Introvert more than twice length of trunk .... (*Apionsoma murinae*) ..... 8
  - Introvert less than twice trunk length (*Golfingia*) ..... 9
- 8. Nephridia single-lobed .....
  - ..... *Apionsoma murinae murinae*
  - Nephridia with secondary lobe .....
    - ..... *Apionsoma murinae bilobatae*
- 9. Posterior trunk without caudal appendage ..... *Golfingia margaritacea*

- Posterior trunk with caudal appendage ..... 10
- 10. Large bladder-like papillae at base of tail ..... *Golfingia anderssoni*
  - Base of tail without large bladder-like papillae ..... *G. muricaudata*

Note: If one has worms less than 2 or 3 mm long, one must use more comprehensive sources to go beyond the generic level.

Genus *Golfingia* Lankester, 1885  
*Golfingia anderssoni* (Théel, 1911)

*Material examined.*—48 specimens from 60 stations at latitudes 53–78° S, longitudes from 26–64° W, then skip to 160° W–165° E. The total depth range was 22–3413 m, but 70% of the samples from 100–1200 m (Fig. 5a).

*Description.*—The trunks range from 2–133 mm in length; most from depths >1000 m are >35 mm long, while those from shallower water are mostly <10 mm long. Unlike data published prior to Saiz (1995) (he had specimens up to 110 mm from the Antarctic) that records no specimen longer than 35 mm, this collection has 44 worms (30%) that exceed this length. A surprising number of specimens were unusually elongated and thin reflecting the highly plastic nature of this body and perhaps a distortion of their living state.

The posterior end of most specimens exhibits the characteristic large, bladder-like papillae on the posterior quarter of the trunk and thin, rat-like caudal appendage (tail, Fig. 2a). In worms less than 8 mm long these attributes may be under-developed (Fig. 2b) and inspection under a compound microscope may be necessary to differentiate this from small *G. muricaudata*. Occasionally, these papillae resembled bladders that had been drained, thus looking more like flattened scales. Tails can be broken during collection, but in a sample of 24 worms 11–133 mm long, the tails are 4–16% of the trunk plus one each at 22 and 33%.

While earlier observers did not see intro-

vert hooks on this species, we observed small (30–35  $\mu\text{m}$ ), triangular, pale, scattered hooks on a number of specimens (Fig. 2c). These could not be seen with the dissecting microscope but required examination under the compound scope. However, as predicted in Cutler (1994), these hooks are numerous on 2–6 mm worms. They are still present but few on 9–12 mm worms and absent in 17 and 30 mm worms from the same station.

A single worm from the most southerly station (USNM 170138) displayed what we interpret to be an anomalous condition in that the dorsal pair of introvert retractor muscles is absent. If this worm were collected from another part of the world it would very likely be identified as *Nephasoma flagriferum*. The occasional absence of one or two retractor muscles in *Golfingia* species has been commented previously (Gibbs 1973).

**Distribution.**—Of the 14 previous reports between 1911–1996, all but three are from the far southern latitudes at depths of 75–1880 m. One is from the equatorial Atlantic Ocean (4 worms near 18° S, 9° E) at 4300–4600 m. This might be a case of equatorial submergence or a mistake (Cutler & Cutler 1987). Two northern Pacific Ocean reports of single worms (28 and 44° N) from deep water (3150 and 6135 m), are difficult to reconcile with what seems to be a southern ocean taxon (Murina 1964, 1971). The present data strengthens the concept of this as a circum-Antarctic bathyal species.

*Golfingia margaritacea* (Sars, 1851)

**Material examined.**—These 1442 specimens came from 305 stations at depths from 1–4886 m. However, 90% came from 50–1200 m (9% <50, none between 1200–2273 and only 1% >2200 m). The full range of latitudes from 53–78.5° S is represented but the longitudinal coverage is discontinuous. Going westward from 0°, there are scattered records from 16 and 22°, then the bulk from 26–70°, then scattered

again at 110–115°, 158° and 166° W, then another heavy concentration between 173° W and 159° E. A final few came from 150°, 116–110°, 101°, and 93° E (Fig. 5b).

**Description.**—This most common Antarctic species (45% of the material) ranges in trunk length from 1–79 mm. Those worms exceeding 25 mm lived at depths >150 m, mostly >300 m. One exception is the two intertidal worms from the tip of South America (USNM 170049) measuring 23 and 34 mm. Small worms dominated this collection with 94% being <10 mm long, while 4% are 10–25 mm, and only 2% are >25 mm in trunk length.

While most specimens are cylindrical (length 4–8 times width) with rounded or bluntly pointed conical posterior ends (occasionally with a dimple or small depression), others are elongate and thin while some are short and fat. The color varies from pale through orange to dark brown and the skin which is usually thin and smooth can be quite thick and rugose. The more slender introvert in the smaller worms is about equal to the trunk in length, but due to allometric growth is only about half the trunk length in larger specimens. Also, in small worms (1.5–8 mm) small (20–35  $\mu\text{m}$ ) scattered hooks exist that are lost as the worm matures. Papillae are more dense near the extremities of the trunk, and are generally small digitiform structures, but their size is remarkably variable.

Internally, one can often observe vesicles or bubbles on the swollen contractile vessel. Two individuals had only 3 retractor muscles, one of the dorsals being absent, a phenomenon known in other populations (e.g., Gibbs 1973). Within the coelomic cavity of several worms maturing ova were seen. These worms were 6–17 mm long and had been collected between December and May, most during February and March.

**Note.**—When Cutler (1994:73) retained the sub-species *G. margaritacae ohlini* (Théel, 1911), it was with some hesitation since there were only two indistinct differences, i.e. hooks sometimes present and a



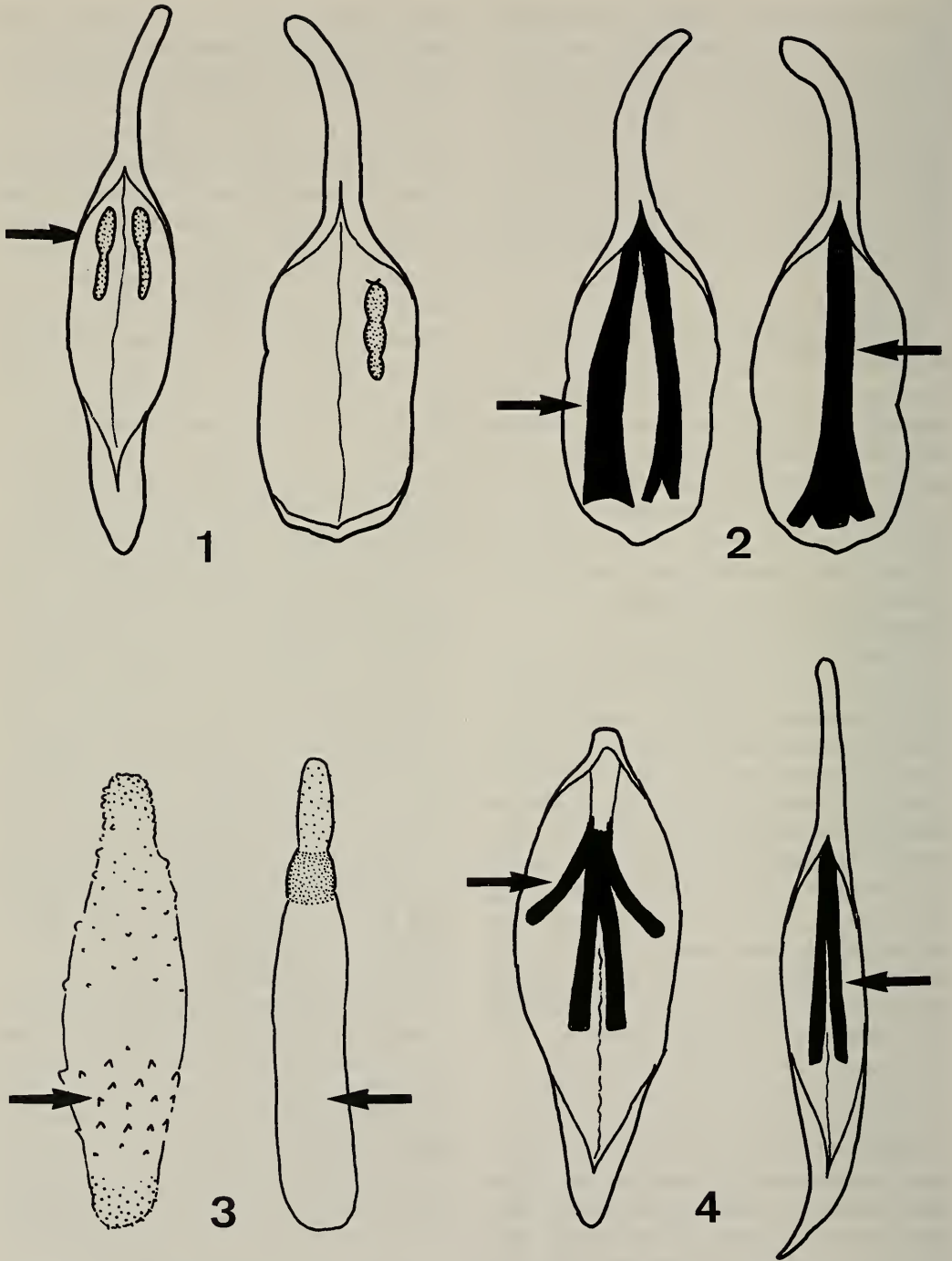


Fig. 1. Schematic drawings of the sipunculans to illustrate the identification key. Numbers are in accordance with the couplet numbers of the key.

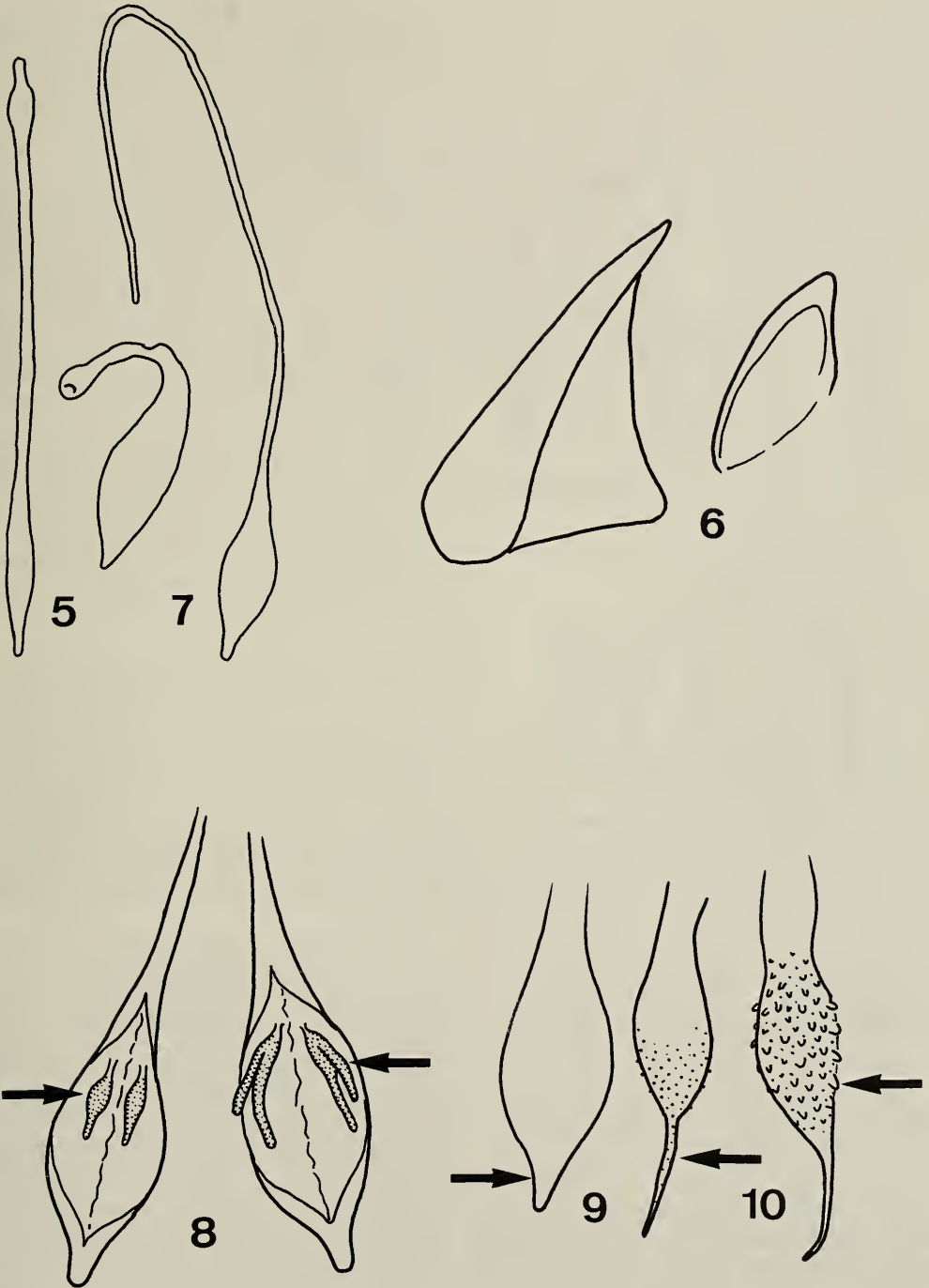


Fig. 1. Continued.

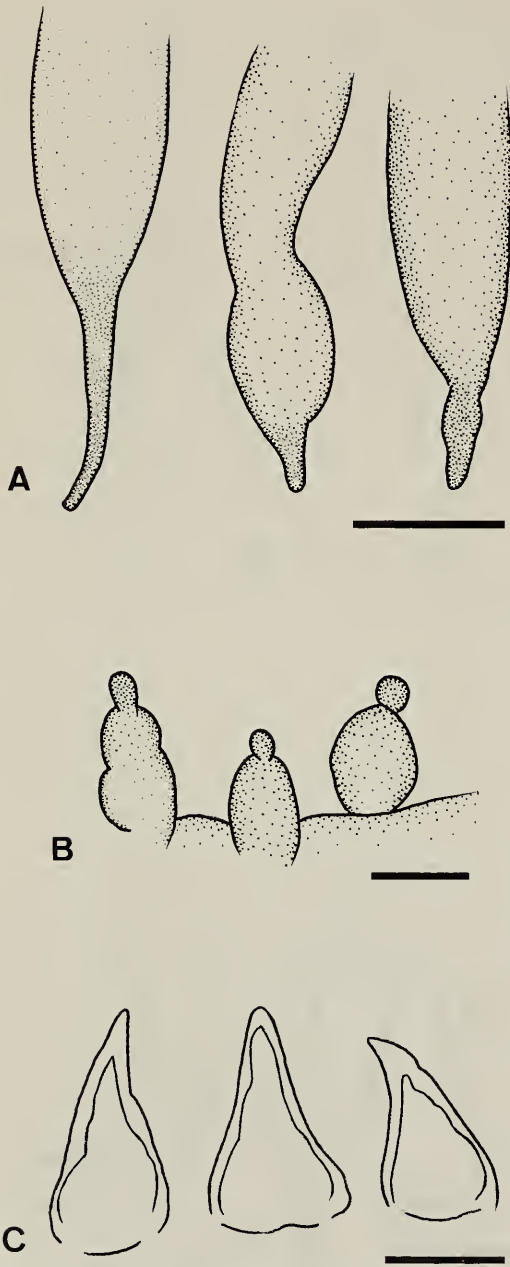


Fig. 2. Small specimens (less than 8 mm trunk length) of *Golfingia anderssoni*. A: Variation in caudal appendage development. B: Bladder-like papillae. C: Hooks. Scale bars: A = 2 mm; B = 50  $\mu$ m; C = 20  $\mu$ m.

variably pointed posterior end. When Saiz (1995) examined a large collection of Weddel Sea specimens, he concluded that any attempt to retain a distinction between these putative sub-species was an exercise in futility. We affirm that conclusion.

*Distribution.*—Very wide-spread in the Atlantic, Arctic, and Antarctic oceans ( $80^{\circ}$  N to  $78^{\circ}$  S). In the Pacific Ocean at higher latitudes ( $>30^{\circ}$  N & S) and on those occasions when reported from lower latitudes it is from depths  $>2000$  m. Recent Indian Ocean records are limited to sub-Antarctic latitudes ( $46$ – $50^{\circ}$  S) most from near the Kerguelen Islands. The reported depth range is 1–5300 m, but most specimens have been collected from depths less than 400 m. Eighty six percent of the specimens reported here were from that depth range, and while filling in some gaps in longitudinal distribution there are no surprises.

*Golfingia muricaudata* (Southern, 1913)

*Material examined.*—69 specimens from 30 stations at latitudes  $54$ – $77.8^{\circ}$  S, and the bulk between longitudes  $27.5$ – $65^{\circ}$  W, plus a few at  $166$ – $170^{\circ}$  E, and a single station at  $90.6^{\circ}$  E. Depths range from 20–892 m, but 80% of these stations were at 100–600 m (Fig. 5a).

*Description.*—The trunks in this collection range from 2–19 mm long, but only 5 (7%) are over 10 mm long, thus somewhat smaller than elsewhere. The characteristic caudal appendage easily seen in larger worms, may be only a small pointed bump in worms less than 5 mm long. These small worms are not easy to differentiate from *G. anderssoni* except for the papillae on the posterior trunk which are very small, thin, and hair-like, not large bladders (Fig. 3a). Scattered hooks, known to be deciduous, were observed on a few small (4–7 mm) worms (Fig. 3b).

Not included above are two worms from USNM 170708 that are much larger (32 & 60 mm) and collected from much greater depths (2975 m). While such depth and size

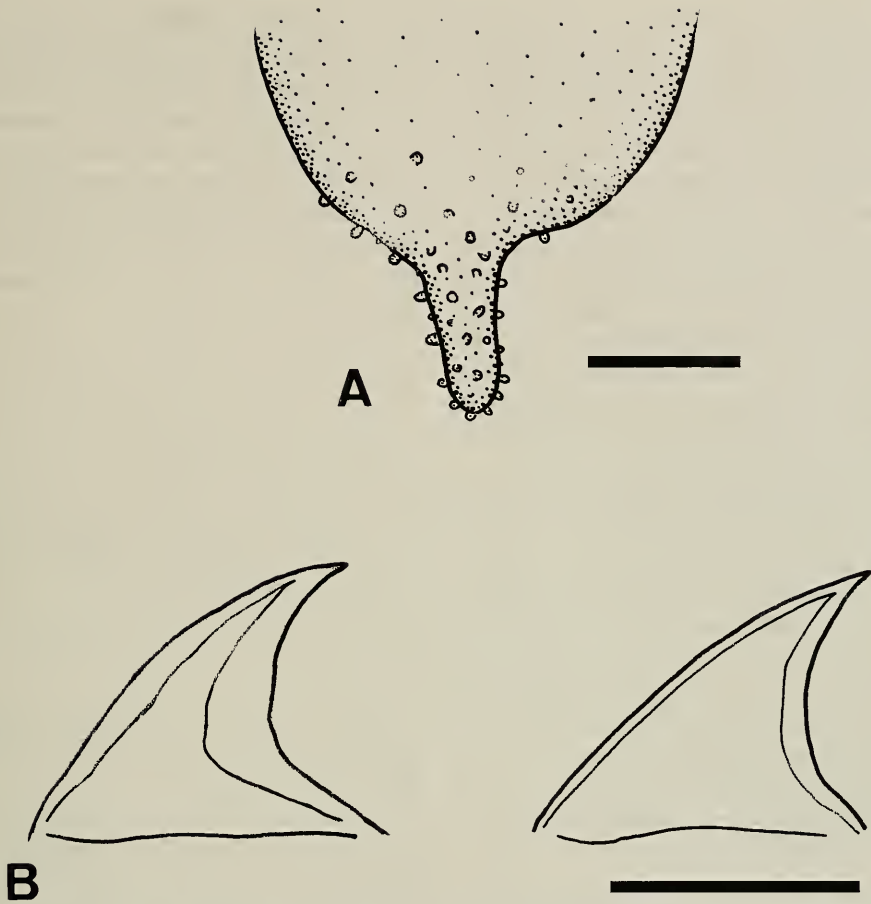


Fig. 3. Small specimens (less than 7 mm trunk length) of *Golfingia muricaudata*. A: Caudal appendage showing thin papillae. B: Hooks. Scale bars: A = 200  $\mu\text{m}$ ; B = 15  $\mu\text{m}$ .

are not unusual for the species they are very striking in this collection. Their caudal appendages are 28 & 17%, respectively. Of particular interest is the fact that at this same station we found two examples of the very similar *G. anderssoni* of similar large size.

*Distribution*.—A widely distributed but low density cold water species in the higher latitudes of the Atlantic, Pacific, and Indian Oceans (e.g., Bering and Weddell Seas). The few records at lower latitudes (<35) are at bathyal or abyssal depths. The present data supplement those of Saiz (1995) showing this to be a well established inhabitant of the Antarctic Ocean.

Genus *Nephasoma* Pergament, 1940  
*Nephasoma abyssorum benhami* (Stephen, 1948)

*Material examined*.—56°51'S. 34°25'W, 3170 m, 13 ind., 6 Sep 1963, USNM 170243; 67°14'S, 70°12'W, 640 m, 3 ind., 26 Feb 1972, USNM 170420; 73°28'S, 30°27'W, 3111 m, 4 ind., 13 Mar 1969, USNM 170860; 77°32'S. 163°02'W, 624 m, 1 ind., 5 Feb 1968, USNM 170963; 78°24'S, 168°58'W, 565 m, 1 ind., 27 Jan 1968, USNM 170187 (Fig. 5c).

*Description*.—There are 21 specimens 2–13 mm long and only 3–6 times longer than wide with the smooth white trunks typical



of this species. The ends of the trunks have low skin bodies and may appear rough in a few individual, significant papillae are not present. The introvert seems to be from 50–150% of the trunk length and bears dark pyramidal hooks 40–100  $\mu\text{m}$  tall that are arranged in an irregular spiral manner, not random. The pair of retractor muscles originate at 50–65% of the distance towards the posterior end of the trunk, and the longitudinal muscle layer is fractured into partially separate bundles in the area around the anus in one 10 mm worm. Maturing ova are present in one 6 mm specimen that had been collected in September.

The most southerly specimen (USNM 170187) is quite different looking since it seems to have lost the outer layer of cuticle/epidermis such that the underlying papillae are now exposed looking like tall, thin, hair-like papillae. It is also much larger, the trunk being 48 by 7 mm so it is longer and thinner than the others. This has clearly experienced some post-collection stress.

*Distribution.*—The single previous report consisted of two worms taken at 66–67° S, 71 and 138° E, from 540 and 640 m. These new records are quite disjunct at 57–77.5° S and greatly increase the known range into the western longitudes and greater depths. One pair of stations is from 3100–3200 m at 30.5 and 34.5° W, while the other pair is from 600–650 m at 70 and 163° W (Fig. 5c).

*Nephasoma capilleforme* (Murina, 1973)

*Material examined.*—74°07'S, 39°38'W, 650 m, 4 ind., 6 Feb 1968, USNM 170838; 77°18'S, 37°43'W, 1025 m, 1 ind., 6 Mar 1969, USNM 170844 (Fig. 5c).

*Description.*—The five worms are 5–11 mm long and about 0.5 mm wide so that their trunks are 10–20 times longer than wide and the introverts are less than half the trunk length. The pair of retractor muscles originates in the middle of the trunk. All had been living in tubes of agglutinated sand grains and have scattered skin bodies

but no papillae on the posterior end. Scattered small hooks (25–50  $\mu\text{m}$ ) are present.

*Distribution.*—Widespread in the northern Atlantic and scattered reports in the southern hemisphere, including the Weddell Sea at 75° S, and the northern Pacific Ocean (to 56° N) at bathyal and abyssal depths (900–5000 m). These new records expand the southern boundary a small distance to 77.3° S.

*Nephasoma diaphanes* (Gerould, 1913)

*Material examined.*—There were 589 specimens from 46 stations (1 station yielded 472 worms, i.e. 80% of the total) from 53.2–78.5°S, but with a gap between 66–73.5° S. Longitudinally there are scattered stations from 27–56° W then a concentration at 66–71° W, and widely scattered stations to 180° and a small cluster at 170–175° E (Fig. 5c). Vertically the total range is from 1–5033 m, but 57% of the stations are between 100–1000 m, with 20% <100 and 23% >1000 m.

*Description.*—The vast majority of these worms are 1–6 mm long, a few measure 7–11 mm. Particular trunk length to width ratios are characteristic for many species, but given the plastic nature of sipunculans this value does vary. In 42 measured worms 71% have lengths 2–5 times the width, 21% are 6–8 times longer than wide, but 3 worms (7%) have lengths 10–13 times the width. These last 3 elongate worms approach the dimensions of *N. capilleforme*. The skin is generally smooth with low skin bodies more concentrated near the ends of the trunk. Some worms do have small digitiform papillae towards the posterior end, especially those taken from arenaceous foraminiferan tests. Introverts are rarely extended but most appear to be 50–100% (a few up to 150%) of the trunk length. While not always present, scattered pyramidal or triangular hooks generally 25–40  $\mu\text{m}$  tall, can be found. It is very possible that hookless members of this species have been identified as small *N. eremita*.



The single pair of introvert retractor muscles are fused for about one-half their length and they have their origins from the body wall 50–75% of the distance towards the posterior of the trunk. Developing ova were observed in 4 worms 5–6 mm long collected in October, February, and April, and sperm in a single 5 mm worm collected in February.

*Distribution.*—Cosmopolitan (from 82° N to 50° S) in cold water, most from bathyal and abyssal depths (down to 5300 m). This material significantly extends its known range into and around the Antarctic Ocean.

Genus *Phascolion* Théel, 1875

Subgenus *Phascolion* (*Isomya*) Cutler & Cutler, 1985

*Phascolion* (*Isomya*) *hedraeum* Selenka, de Man & Bülow, 1883

*Material examined.*—The 159 specimens are from 23 stations at 54–61.5° S, plus 1 at 74.5° S and longitudes 30.5–46° S plus 1 at 71° W at depths of 70–604 m (Fig. 5d).

*Description.*—The trunks are often coiled indicating a life within gastropod shells and are 2–25 mm long. The distinct holdfast papillae have granular borders that may not completely surround the papillae. In some worms this hardened protein is easily seen but on others may only be seen with the compound microscope. The slightly bent, scattered, spine-like hooks are 55–95 µm tall when present. These appear to be weakly attached, sometimes just a few present, and many worms, often the larger ones, have no hooks at all. Around the base of the introvert, which is shorter than the trunk, are large, densely packed, grey papillae, only a very few of these having more than a single tip. The two retractor muscles originate at the posterior end of the trunk. These muscles are usually slightly subequal in size, the ventral being 75–90% the diameter of the dorsal muscle. Developing ova were observed in 7 individuals ranging in length from 12–23 mm, having been col-

lected during the months of February, April and June.

Saiz (1995) identified 5 specimens as *P. convestitum* from the Weddell Sea, now considered as *P. hedraeum*, a closely related species and common representative in Antarctic waters. The main difference is the shape of the hooks; broad based and recurved in *P. convestitum*, but blunt and spine-like in *P. hedraeum*. Fig. 4a shows variation in this character, which includes both shapes.

*Distribution.*—Several southern Atlantic reports down to 65° S and a few from the southern Pacific, near Australia, and also off Japan. They live at shelf and slope depths, rarely over 800 m in gastropod or scaphopod shells. A single specimen from 4510 m was assigned to this taxon “with reservations”, and, as stated in that report (Cutler 1977), there are several questions about the reliability of the station data in these Galathea collections. These additions add to the one prior Antarctic record (Cutler & Cutler 1980) and show a broader, but still compact population in this Weddell Sea region.

Subgenus *Phascolion* (*Montuga*), Gibbs, 1985

*Phascolion* (*Montuga*) *lutense* Selenka, 1885

*Material examined.*—The 709 specimens came from 40 stations at latitudes from 53–68° S plus one station at 73.5° S. Longitudinally, there is a block of stations between 22–40° W, then scattered records across to 156° W, plus 3 in the east (108, 158, 164° E). This is clearly a deep-water taxon since they came from depths of 2160–5790 m, 50% of the stations and 40% of the specimens came from depths >4000 m (Fig. 5d).

*Description.*—Most of this material was 10–25 mm long but the total size ranged from 4–35 mm. The uniformly smooth skin free of visible holdfast papillae, and array of small papillae around the base of the introvert forming a grey cap, characterize this

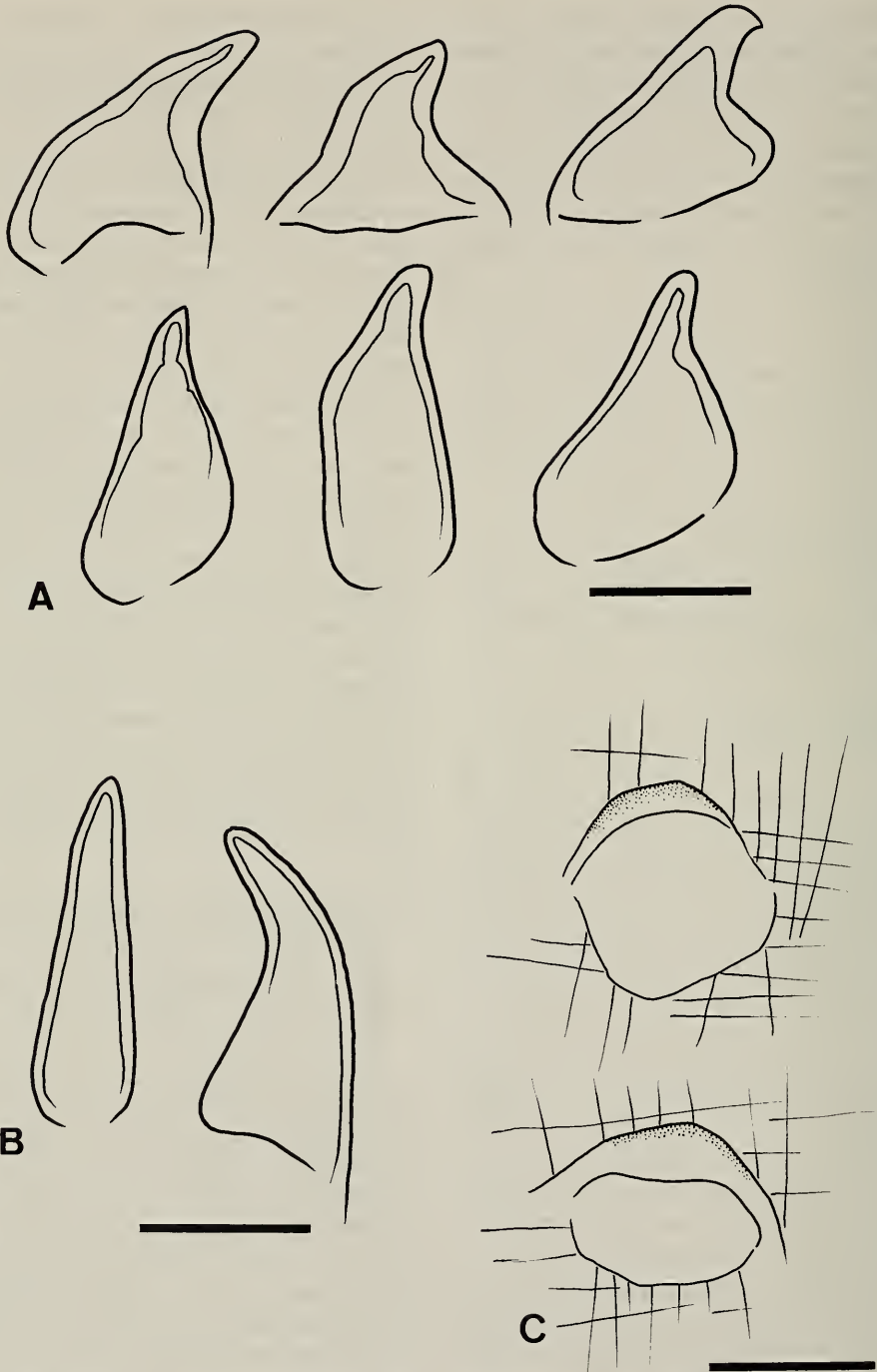


Fig. 4. A: *Phascolion (Isomya) hedraeum*, variation in hook shape. B: Hooks of *Phascolion (Montuga) lutense*. C: Weakly developed holdfast papillae of *P. (M.) lutense*. Scale bars: A = 50  $\mu\text{m}$ ; B = 35  $\mu\text{m}$ ; C = 200  $\mu\text{m}$ .

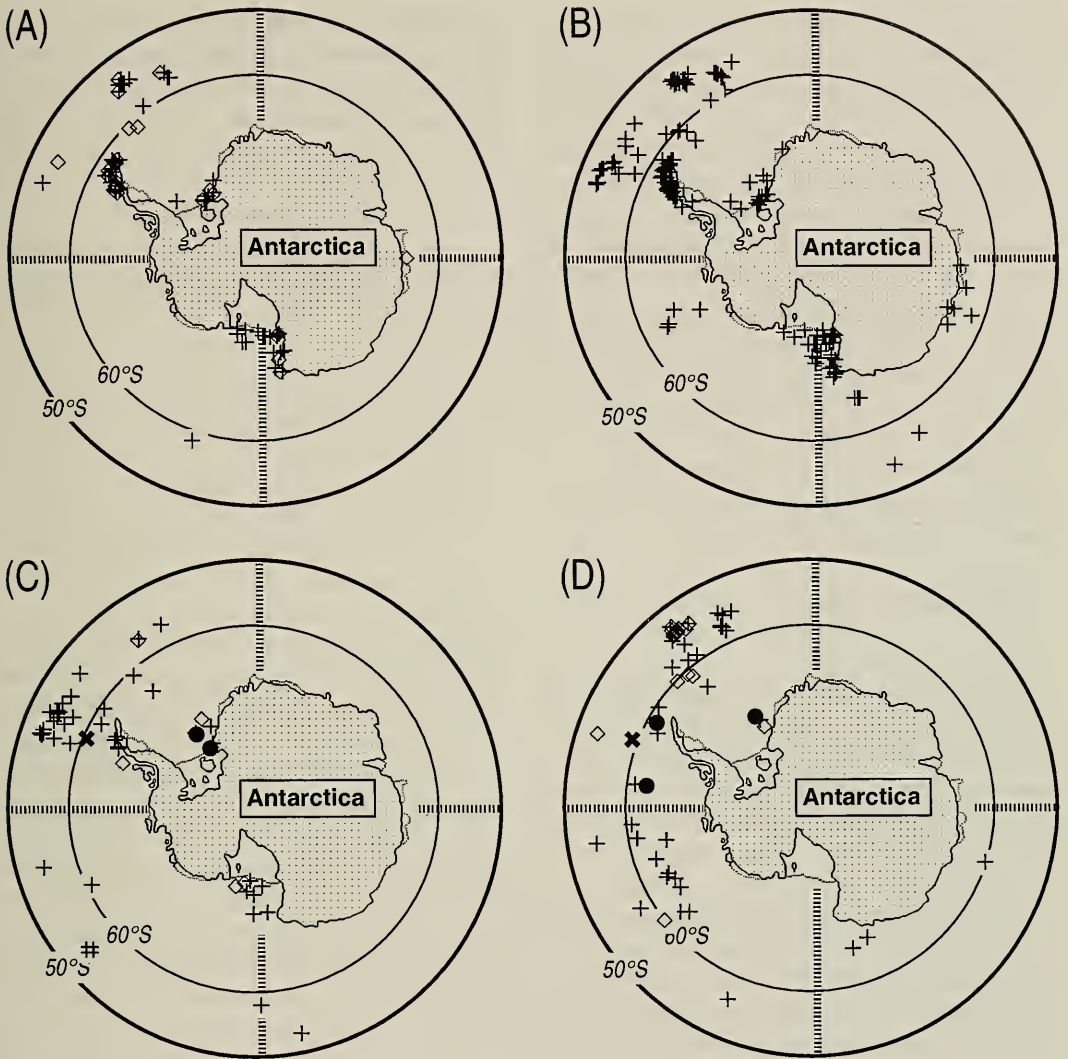


Fig. 5. A–D Distribution maps of the US-collected Antarctic sipunculans. A: (+) *Golfgingia anderssoni*, (◇) *G. muricaudata*. B: (+) *Golfgingia margaritacea*. C: (+) *N. diaphanes*; (◇) *Nephasoma abyssorum benhami*; (●) *N. capilleforme*; (X) *Apionsoma murinae murinae*; (#) *Apionsoma murinae bilobatae*. D: (+) *Phascolion (Montuga) lutense*; (◇) *Phascolion (Isomya) hedraeum*; (●) *Phascolion (Montuga) pacificum*; (X) *Phascolion* sp.

species. Papillae are present on the trunk that might have secreted some peripheral protein, but only a trace can be seen in a few larger worms (Fig. 4c). It is also the only known member of this genus to form a stable clay/mud tube as a dwelling place, an interesting adaptation to very deep life where empty calcareous mollusc shells or coral do not exist. The tentacular crown is reduced to a membranous ridge that may

have a few short lobes around the margin, another adaptation seen in other deep-sea species. Thin spine-like introvert hooks are seen only rarely and then in very small numbers measuring about 50 μm tall (Fig. 4b). It seems clear that these are not permanent structures. Living on the anterior end of a few worms were small clusters of epizoans, probably Entoprocta.

Internally the retractor muscles are fused



into a single column for almost their entire length, and the single nephridium is often quite large. Eggs were observed in only two worms 8 and 31 mm long, collected during August and October. Sperm were present in one 20 mm worm also collected in October.

*Distribution.*—A cold-water species (1000–6860 m) unknown from lower latitudes, even in deep water. Widely collected in the Southern Hemisphere in all three oceans, 36–66° S in the Pacific, 20–32° S in the Atlantic, and 32–38° S in the Indian Ocean. From northern waters it is recorded from the northwestern Pacific and the northeastern Atlantic, 47–56° N. This collection significantly broadens the longitudinal range at these high southern latitudes.

*Phascolion (Montuga) pacificum* Murina,  
1957

*Material examined.*—61°45'S, 61°14'W, 4758 m, 1 ind., 1 Aug 1962, USNM 170134; 63°00'S, 82°31'W, 4602 m, 2 ind., 24 Oct 1963, USNM 170681; 73°28'S, 30°26'W, 3111 m, 2 ind., 13 Mar 1969, USNM 170845 (Fig. 5d).

*Description.*—These 5 specimens are 5–17 mm long and differ from the other more common member of this deep-water subgenus by having holdfast papillae with thin but distinct U- or V-shaped hardened borders, and they do not construct the clay/mud houses of *P. lutense*. Both have retractor muscles almost totally fused into a single column, and tentacles reduced to lobes. This 17 mm worm was unusually thin (2 mm wide) thus not in its natural sausage shape. Small scattered hooks may be present near the tip of the introvert which is longer than the trunk in one, but shorter in another.

*Distribution.*—A bathyal and abyssal species (300–6860 m) widespread at high latitudes in the northwestern and southwestern Pacific, the northeastern and southern Atlantic, and the sub-Antarctic Indian Oceans. Two records from lower latitudes are the Peru-Chile Trench (5760–6860 m)

and 28° N (1760 m) in the eastern Atlantic. The only previous Antarctic record was at 77° E so these new records greatly expand the known range to the other side of the world in Antarctic waters.

*Phascolion* species?

*Material examined.*—59°14'S, 69°13'W, 3738 m, 1 ind., 6 Oct 1962 USNM 170211 (Fig. 5d).

*Description.*—This single 6 mm worm is interesting, but not sufficient for a positive identification. It most closely resembles the published description of *Phascolion ushakovi* (Murina, 1974). The similarities are of two types; long, thin, dark hooks 200–250 μm tall and mammiform papillae at both ends of the trunk. However, this set of retractor muscles are not of distinctly different sizes as is the case in *P. ushakovi* (i.e., ventral about 75% the diameter of the dorsal, not the expected 10–20%). This ventral muscle has two origins that quickly fuse. The mid-trunk region is smooth with no holdfast papillae.

Given that we have only a single small specimen, and the lack of congruity in retractor muscles, we hesitate to assign this a species name. Also, the location of our material is far from the only reported location of *P. ushakovi*, i.e., western Australia, at 330 m.

Genus *Apionsoma* Sluiter, 1902  
*Apionsoma murinae murinae* (Cutler,  
1969)

*Material examined.*—59°56'S, 65°18'W, 3687 m, 1 ind., 10 Aug 1962, USNM 170204 (Fig. 5c).

*Description.*—This single 17 mm specimen is large for this species and has a thin introvert about 110 mm long. The posterior trunk bears the larger mammiform papillae and the tip of the introvert carries rings of very small hooks. The nephridia are clearly single lobed and while the thin dorsal retractor muscles are partially hidden under the ventral pair they are present.



*Distribution.*—Widespread in cold water (100–5200 m) across the northern Atlantic and down to 15° S on the eastern side. In the Pacific it has been recorded from the Bering Sea and several deep water southern locations including the Peru-Chile Trench. Recent Indian Ocean records show it to be present there at depths from 250–3600 m as far south as 38° S. Therefore, this Weddell Sea specimen is the first for this taxon in Antarctic waters.

*Apionsoma murinae bilobatae* (Cutler, 1969)

*Material examined.*—54°50'S, 129°48'W, 1035 m, 2 ind., 7 Nov 1964, USNM 170774 (Fig. 5c).

*Description.*—These flask-shaped trunks are 8 and 11 mm long with prominent mammiform papillae posteriorly. Rings of small pale hooks show only very short spinelets almost as if they had been broken off. Since these are larger than most known specimens (1–7 mm) it is possible that the fragile spinelets wear down with age. This is similar to what Popkov (1993) observed in his 11 mm specimen from New Zealand that he called *Apionsoma claviformes*. The nephridia have the distinctive secondary lobe and two pair of introvert retractor muscles are long and very thin with their origins about 75–80% of the distance towards the posterior end.

*Distribution.*—Known from moderate depths in the northern Atlantic Ocean and Mediterranean Sea plus scattered reports from the eastern and western Indian Ocean, and one near New Zealand. Thus, this record is the first in the Antarctic region (far southern Pacific) for this taxon.

### Discussion

The taxa discussed above include all that have been reported by earlier authors, except these four:

*Golfingia elongata* (Hérubel 1906, 1907a, 1907b) What appears to be three records is actually one record repeated three

times. It is our supposition that this material is most likely a few *G. margaritacea* in which Hérubel saw some ordered array of hooks.

*Nephasoma confusum* (Murina 1957, 1972) This species is very similar to *N. abyssorum* with moderate sized, dark hooks. If the ill-defined spiral order of these hooks was not evident these two taxa could be easily confused. Hook shape has also been used as a diagnostic character. The original description of *N. confusum* by Sluiter (1902) said there is a reinforced rim in the hook. However Sluiter illustrated a hook with a rim not especially thick. Murina (1972) identified material from Antarctic waters with large hooks and stated that their hooks were similar to those drawn by Sluiter in 1902. Specimens identified as *N. confusum* sent to one of us (EC) by Murina, have large hooks with the suggestion of a thin reinforced rim. These hooks are not pyramidal as are the 'typical' hook of *N. abyssorum*. Ditadi & Migotto (1981) stated: "As pointed out by Sluiter (1902) a very characteristic feature of this species is the chitinous reinforcement of the hooks, a trait we have also found and shown in Fig. 4h4." They illustrate several hooks showing variation, some are only partially reinforced. Cutler & Cutler (1986) and Cutler (1994) draw a hook with a thick reinforced rim and a little bend in the apex. Saiz & Villafranca (1990) found specimens in South Spain with the same shape as shown in the Cutlers' work. The typical *N. abyssorum* hook in Théel (1905) is pyramidal. However he drew a specimen with the introvert out in which the 'spiral arrangement' of the hooks is not obvious.

In this study we have identified as *N. abyssorum benhami* worms with diverse hooks, some having pyramidal edges, others triangular in shape, and others in between. It seems that hook shape is more variable than previously reported. Therefore, we consider it very likely that what Murina named *N. confusum* we would have called *N. abyssorum benhami*.

*Nephasoma eremita* (Fischer 1928, Murina 1972, Saiz 1995) Given the experience of one of us (JISS) it now seems probable that these specimens represent a few *N. diaphanes* that lack hooks.

*Phascolion strombus* (Fischer 1920, Stephen 1948, Murina 1972) It is most likely that these records are what we are here calling *P. hedraeum*.

Thus, we suggest that this report includes all the known members of this phylum living in Antarctic waters.

**Morphology.**—The impermanent or deciduous nature of introvert hooks has been observed in a few isolated cases previously, but this study affirms the more widespread reality of this condition in most of these Antarctic species (all three *Golfingia* species, *Nephasoma diaphanes*, and all three *Phascolion* species). As a rule hooks are less numerous in larger individuals. One strong message here is that the absence of hooks in a few individuals does not warrant the naming of a new species. None of the species we encountered are new to science and all have been well described from large sample sizes, the unnamed *Phascolion* being the single exception.

**Ecology.**—*Golfingia margaritacea*, with 46% of the specimens, dominates this fauna, but by adding *Phascolion lutense* with 22% and *Nephasoma diaphanes* with 19%, we have 87% of the collection in three species. A second tier of species each making up 2–5% consists of *P. hedraeum*, *G. anderssoni*, and *G. muricaudata*. The remaining 5 species if added together comprise just 1.1% of the total.

Of the 456 stations, 395 contained a single sipunculan species, but 58 yielded 2 species and 3 contained 3 species. Eight of the 11 species were found together with a second. The remaining 3 were the least common with only 1–5 representatives each.

**Zoogeography.**—The numbers of specimens examined (3156) and species identified (10) in this study are comparable to others previously reported from Antarctica (cf. Murina 1972, Saiz 1995). All species have been

previously collected by other expeditions, except for *Apionsoma murinae*, here recorded for the first time south of the Antarctic Convergence. Concerning spatial horizontal distribution within Antarctic waters, the most ubiquitous species is *Golfingia margaritacea*, present along almost the entire coastline of Antarctica with a few gaps such as off 'Dronning Maud Land' (between longitude 0–45° E) and 'Marie Byrd Land' (120–150° W). Several other common species (*G. anderssoni*, *G. muricaudata*, *N. diaphanes*, *P. lutense*, *P. hedraeum*) appear a more restricted in those areas heavily sampled by oceanographic vessels such as the Antarctic Peninsula, the Ross and Weddell Seas. The remaining species: *N. abyssorum benhami*, *N. capilleforme*, *P. pacificum*, and *A. murinae* are represented by only a very few specimens from widely scattered locations. With regard to the vertical distribution, most sipunculan species in the US Antarctic collections were found at sub-littoral (1–200 m) and bathyal (200–3000 m) depths, whereas only two, *Phascolion lutense* and *P. pacificum*, showed a preference for deeper water (>2000 m).

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Appendix.—Station data for sipunculan species found at more than 5 locations. See text for less common taxa.

Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
<i>Golfingia anderssoni</i>					
5340	W07015	0307	2	79.04.28	170193
5357	W03721	0033	1	75.05.16	170147
5403	W03724	0070	2	75.05.16	170074
5414	W03754	0173	1	75.06.10	170156
5417	W03828	0243	1	86.12.03	170986
5422	W03828	0220	1	86.12.03	170987
5431	W03535	0265	4	75.05.19	170149
5506	W03955	2975	2	66.02.08	170708
5629	W02646	2270	1	75.05.30	170084
5723	W02634	2325	1	75.05.26	170151
5739	W02600	2500	4	75.05.27	170152
5855	W15945	0750	3	64.08.12	170761
5908	W03649	2817	7	64.04.10	170172
6157	W05553	2340	10	64.03.14	170170
6203	W06109	1437	1	62.08.08	170203
6205	W05823	0048	1	72.01.15	170399
6207	W05558	1133	2	63.01.01	170158
6221	W05848	0082	3	72.01.16	170976
6233	W05801	1680	2	63.01.04	170159
6241	W05443	0215	1	64.03.15	170957
6241	W05443	0215	2	64.03.15	170253
6242	W05610	0430	1	63.01.02	170220
6252	W05927	0910	1	63.01.07	170862
6256	W06048	0100	1	72.01.08	170395
6326	W06215	0122	1	69.02.10	170348
6419	W06259	0045	1	63.02.06	170820
6437	W06251	0655	18	82.03.25	171032
6446	W06404	0028	3	72.03.10	170438
6447	W06419	0047	1	71.12.04	170403
6447	W06407	0055	1	72.01.03	170392
6447	W06410	0208	1	83.03.20	170125
6503	W06354	0365	1	72.03.01	170421
7120	E16955	0439	2	59.01.25	170803
7208	E17210	0434	1	58.01.13	170785
7400	W05456	0438	1	68.02.12	170852
7432	E16817	0876	5	68.01.18	170143
7457	E17206	0525	2	68.01.18	170180
7458	E16534	1124	2	78.02.08	175516
7531	W03008	0412	3	69.02.25	170853
7607	W16837	0514	1	68.02.03	170309
7625	W17034	0558	1	68.01.30	170188
7650	W04055	0513	1	69.03.01	170855
7704	E16819	0916	10	68.01.22	170182
7705	W03504	0793	3	69.02.26	170854
7709	W03858	0851	3	69.04.05	170843
7716	W04238	0512	10	69.03.01	170133
7716	W04238	0512	1	69.03.01	170841
7720	E17239	0633	1	67.01.24	170141
7730	E16800	0107	1	48.01.29	021097
7731	W16305	0606	5	68.02.05	170190
7736	E16609	0249	1	56.12.26	170780
<i>Golfingia margaritacea</i>					
7736	W04230	0585	3	69.03.02	170842
7742	E17712	0746	1	78.01.23	175509
7750	W04205	0659	4	69.03.04	170858
7759	E17811	0647	1	68.01.25	170185
7809	W17832	0695	1	78.01.24	175514
7810	W16230	0500	1	56.01.27	170775
7824	W16858	0565	1	68.01.27	170138
5306	W06704	0086	3	70.03.05	175492
5306	W06704	0086	2	70.03.05	175493
5320	W06651	0080	2	62.09.27	170210
5331	W07050	0001	2	69.04.24	170049
5336	W03735	0310	1	75.05.11	170064
5338	W03754	0133	1	75.05.13	170068
5338	W03802	0137	1	75.05.12	170067
5340	W06620	0081	1	64.02.10	170248
5340	W07024	0100	56	69.05.13	171090
5342	W03757	0147	2	75.05.14	170070
5349	W07025	0021	1	70.04.29	170837
5351	W03738	0100	38	66.02.07	171004
5357	W03721	0033	7	75.05.16	170147
5400	W03741	0074	4	75.05.15	170073
5401	W03651	0112	1	75.05.17	170075
5402	W03740	0058	4	75.05.15	170072
5402	W03740	0065	3	75.05.15	171037
5408	W05208	0450	1	66.01.30	170274
5411	W03802	0160	1	86.12.05	170988
5412	W03736	0069	1	75.06.10	170105
5412	W03740	0080	12	75.06.10	170104
5412	W03741	0074	1	75.06.09	170102
5412	W03741	0074	19	75.06.09	170103
5412	W03743	0085	2	75.06.09	170101
5414	W03754	0200	1	75.05.12	170066
5422	W03359	0155	9	75.05.19	170148
5424	E15901	0086	5	65.02.10	170764
5431	W03535	0265	6	75.05.19	170149
5432	E15902	0093	6	65.02.10	170765
5434	W06430	0074	1	71.11.07	170382
5439	W06350	0136	17	71.10.26	170377
5439	W06420	0048	1	71.10.20	170829
5440	W05705	0126	1	66.03.14	170276
5443	W03649	0188	2	75.05.17	170076
5445	W06410	0022	1	71.05.20	170363
5447	W06404	0040	1	71.10.29	170379
5451	W03503	0170	1	86.12.10	170971
5456	W03550	0151	47	75.06.06	170098
5500	W06450	0543	2	71.11.03	170381
5503	W05857	N.R.	13	62.12.04	170216
5507	W03547	0131	4	75.06.06	170097
5509	W03545	0130	11	75.06.06	170096
5542	W03539	0240	1	86.12.11	170972
5549	W02211	4256	1	66.03.04	170710
5606	W06619	0440	2	63.09.18	170769



## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
5616	W02730	0290	15	75.06.02	170092
5616	W02735	0132	22	75.06.03	170093
5619	W02729	0175	27	66.03.06	170711
5620	W02729	0175	9	66.03.06	171003
5620	W02730	0130	5	75.06.04	170094
5623	W02723	0185	1	75.06.02	170091
5624	W02725	0186	2	75.06.02	170090
5642	W02700	0107	29	75.05.30	170083
5643	W02700	0125	6	75.05.31	170087
5644	W02659	0337	1	75.05.31	170086
5644	W02702	0146	2	75.05.31	170088
5645	W02654	0740	5	75.05.31	170085
5700	W02610	2742	1	75.05.22	170150
5722	E14937	3299	1	69.04.19	170320
5730	W05858	3533	2	62.12.07	170217
5739	W02600	2500	1	75.05.27	170152
5741	W02622	0412	3	75.05.26	170082
5839	W06407	0024	1	71.05.17	170362
5900	W04900	3867	1	63.03.08	170677
5928	W02703	0093	1	76.02.27	170061
5953	W03219	0600	2	76.02.25	170869
6026	W04622	0105	2	76.02.16	170108
6026	W04623	0155	6	76.02.16	170109
6026	W04628	0110	6	76.02.16	170110
6027	W04550	0103	1	76.02.15	170106
6030	W04643	0126	4	76.02.16	170058
6030	W04643	0129	10	76.02.17	170059
6116	W05611	0224	4	62.12.31	170218
6117	W04429	0295	1	76.02.22	170060
6119	W05609	0230	31	62.12.31	170135
6119	W05609	0230	1	62.12.31	170953
6125	W05630	0300	1	64.03.13	170251
6202	W05905	0101	2	63.01.12	170230
6205	W05823	0048	1	72.01.15	170399
6206	W05600	1200	2	63.01.01	170219
6218	W05835	0066	1	71.12.21	170384
6219	W05911	0044	2	71.12.19	170414
6219	W05911	0044	4	71.12.19	170415
6219	W05911	0044	2	71.12.19	170866
6219	W05911	0044	1	71.12.19	170867
6219	W05912	0073	9	71.12.26	170386
6221	W05845	0050	1	72.01.16	170400
6221	W05848	0082	6	72.01.16	175495
6222	W05912	0670	1	81.02.21	170128
6230	W05758	1058	4	63.01.05	170161
6240	W05445	0265	18	64.03.15	170252
6240	W05445	0265	1	64.03.15	175498
6240	W05610	0365	18	63.01.02	170222
6241	W05443	0215	1	64.03.15	170253
6241	W05443	0215	4	64.03.15	170690
6241	W05443	0215	1	64.03.15	170999
6241	W05443	0215	5	64.03.15	170254
6241	W05602	0225	1	83.04.01	170127
6243	W06101	0059	3	72.01.14	170397

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6243	W06102	0073	7	72.01.14	170398
6249	W05610	0378	1	63.01.02	175502
6255	W05927	0915	1	63.09.07	170162
6257	W06051	0154	2	70.03.28	171042
6257	W06051	0154	1	70.03.28	175490
6258	W06041	0087	1	70.03.25	170357
6258	W06047	0140	1	70.03.25	170356
6258	W06048	0057	1	70.03.25	170355
6259	W06034	0056	3	82.03.13	171014
6259	W06035	0060	1	82.04.03	170992
6301	W06044	0040	1	74.01.12	175517
6313	W11038	0036	31	61.12.28	170129
6314	W05845	0073	5	63.01.08	170225
6314	W05845	0073	1	63.01.08	170226
6324	W04451	3622	1	63.02.24	170234
6324	W06210	0074	1	85.03.31	170969
6324	W06214	0093	1	69.02.10	170449
6326	W06215	0122	14	69.02.10	170348
6351	W06238	0147	1	63.01.09	170228
6351	W06238	0147	5	63.01.09	170229
6351	W06238	0147	1	63.01.09	175500
6400	W06100	0570	1	83.03.23	118765
6402	W06407	0075	7	72.03.01	170432
6402	W06407	0075	1	72.03.01	170978
6406	W11517	4873	1	66.04.30	170984
6409	W06240	0097	3	69.02.10	170448
6413	W06105	0115	1	71.12.16	170410
6413	W06105	0131	4	71.12.16	170411
6413	W06105	0129	3	71.12.16	170412
6414	W06158	0260	2	82.03.24	171029
6414	W06235	0085	1	82.03.24	175494
6414	W06235	0085	1	82.03.24	171031
6418	W06258	0170	2	82.03.22	171024
6419	W06259	0045	1	63.02.06	170810
6419	W06259	0045	2	63.02.06	170819
6419	W06259	0107	34	82.03.22	171023
6419	W06300	0067	5	82.03.22	171022
6420	W06358	0005	4	69.02.03	171038
6421	W06128	0132	1	82.03.23	171025
6421	W06135	0093	17	82.03.24	171028
6422	W06128	0105	6	82.03.23	171026
6422	W06128	0106	4	82.03.23	171027
6429	W06229	0120	1	82.03.24	171030
6434	W06200	0045	5	63.02.09	170821
6442	W06238	0097	2	71.12.15	170408
6442	W06238	0098	4	71.12.15	170409
6444	W06405	0067	1	72.03.07	170434
6445	W06439	0014	1	63.03.01	170825
6445	W06408	0193	1	82.03.29	171034
6445	W06439	0038	2	63.03.01	170823
6445	W06439	0014	1	63.03.01	170824
6446	W06404	0021	1	73.02.18	170111
6446	W06404	0028	2	72.03.10	170437
6446	W06404	0020	4	73.02.18	170443

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6446	W06404	0027	1	63.01.25	170814
6446	W06405	0020	3	71.12.31	170388
6446	W06406	0224	1	73.11.08	175513
6446	W06407	0111	2	72.01.02	170391
6447	W06407	0027	1	73.02.20	175508
6447	W06326	0125	1	73.03.11	170122
6447	W06403	0031	1	69.01.27	170057
6447	W06404	0037	7	73.03.06	170118
6447	W06404	0048	1	73.03.06	170119
6447	W06404	0048	1	73.03.06	171045
6447	W06405	0017	1	73.01.27	175510
6447	W06406	0213	1	74.10.23	175512
6447	W06407	0069	4	73.02.19	170112
6447	W06407	0100	2	73.02.20	170114
6447	W06407	0055	2	72.01.03	170392
6447	W06407	0107	1	72.01.26	170402
6447	W06407	0108	2	72.02.23	170417
6447	W06407	0100	9	72.02.23	170418
6447	W06407	0100	1	72.02.23	171043
6447	W06407	0077	3	72.03.17	170440
6447	W06410	0208	3	83.03.20	170125
6447	W06411	0245	1	82.03.29	171035
6448	W06330	0056	1	63.01.26	170815
6448	W06404	0055	3	72.03.10	170436
6448	W06407	0100	45	72.01.28	170416
6448	W06407	0100	5	72.02.23	171044
6448	W11430	4886	3	64.01.11	170683
6449	W06205	0075	1	63.03.01	170812
6449	W06330	0024	1	70.03.16	170352
6449	W06330	0023	1	70.03.16	171041
6449	W06333	0053	1	73.03.09	170120
6449	W06333	0053	1	73.03.09	171046
6449	W06407	0093	4	82.03.29	171036
6452	W06340	0290	1	73.02.19	170113
6453	W06253	0268	3	73.03.11	170123
6453	W06333	0115	1	73.03.09	175489
6454	W06447	0480	1	72.03.04	170433
6504	W06401	0024	3	72.03.13	170439
6504	W06456	0355	2	73.03.03	170117
6505	W06455	0270	5	73.03.03	170116
6512	W06413	0060	1	63.???	170817
6514	W06412	0335	1	82.03.19	171020
6514	W06412	0335	62	82.03.19	171021
6514	W06412	0335	10	82.03.19	175505
6514	W06415	0054	4	82.03.16	171017
6514	W06415	0060	1	82.03.15	170980
6515	W06412	0295	1	82.03.19	171019
6525	E10113	0183	1	48.01.14	170794
6554	W06517	0258	5	82.03.16	170981
6605	W06521	0086	2	82.03.16	170990
6608	W06635	0175	1	82.03.18	171018
6610	E11041	0128	2	61.12.29	170872
6610	E11641	0036	2	61.12.29	170871
6613	E11038	0036	2	61.12.28	170874

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6613	W11038	0038	2	61.12.29	170055
6615	E11029	0045	3	58.01.23	170784
6617	E11031	0137	7	62.02.12	170052
6618	E11032	0101	14	61.12.11	170050
6621	E11027	0210	33	61.12.06	170053
6621	E11028	0238	5	61.12.03	170056
6622	E11029	0315	9	61.12.13	170051
6622	E11029	0254	3	61.12.13	170054
6622	E11029	0247	3	61.12.13	170870
6633	E09254	0080	1	58.01.29	170786
6637	E16256	0217	1	67.02.05	170453
6650	E16432	3515	1	67.02.05	170451
6653	E16319	0100	8	74.02.10	170047
6718	E11019	0135	12	58.01.27	170793
6730	W06800	0073	1	48.02.22	021091
6730	W06800	0073	1	48.02.22	021092
6730	W06800	0074	1	48.02.22	021089
6730	W06800	0074	1	48.02.22	021093
6848	W06407	0100	5	56.02.07	170796
7003	W11451	0366	3	56.02.06	170795
7055	E17155	2273	1	59.01.18	170801
7122	E17043	0162	1	68.02.13	170303
7130	E16930	0250	5	56.02.07	170796
7132	E17018	0027	3	56.02.06	170795
7150	W01550	1102	1	59.01.18	170801
7206	E17215	0392	2	58.01.12	170792
7208	E17210	0434	2	58.01.13	170785
7216	E17018	0134	1	59.01.12	170799
7217	E17018	0134	2	59.01.12	170800
7304	E17903	0570	1	68.02.11	170311
7319	E16915	0100	31	56.02.12	170797
7359	E17051	0597	1	68.01.13	170296
7400	W05456	0438	1	68.02.12	170852
7401	E17853	0257	2	68.01.14	170298
7406	W03938	0731	1	68.02.06	170850
7406	W17911	0256	4	68.01.05	170300
7407	W03938	0650	1	68.02.06	170838
7428	W03032	0513	19	69.02.24	170131
7431	E17010	0320	4	67.01.16	171008
7500	E17642	0336	2	68.01.17	170179
7531	W03008	0412	9	69.02.25	170853
7600	E17210	0575	2	68.01.19	170181
7600	W05500	0457	2	68.02.09	170851
7600	W17648	0567	1	68.01.20	170305
7600	W17648	0567	2	68.01.20	170961
7602	E17822	0487	1	67.01.20	170286
7602	E17822	0487	1	67.01.20	171009
7602	E17950	0394	1	72.02.08	170340
7602	W17957	0352	1	72.02.09	171011
7602	W17957	0352	2	72.02.09	170341
7610	E16817	0075	2	67.01.18	170285
7630	E17040	0643	5	67.01.21	170140
7650	W04055	0513	2	69.03.01	170855
7701	E16838	0917	2	68.01.22	170307

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
7702	W16644	0411	2	68.02.04	170189
7704	E16819	0916	1	68.01.22	170182
7706	W15817	0200	6	60.12.24	170811
7709	W03858	0851	4	69.03.05	170859
7716	W04238	0512	35	69.03.01	170133
7719	E16548	0832	2	68.01.23	170183
7720	E17239	0663	1	67.01.24	170141
7720	W03641	1079	2	69.02.27	170132
7727	E16630	0321	2	56.02.18	170798
7730	E16800	0102	9	48.01.29	021094
7730	E16604	0364	2	56.12.?	170777
7730	E16800	0107	6	48.01.29	021097
7734	E17443	0728	2	67.01.25	170142
7735	E17458	0731	2	68.01.25	170144
7736	W04230	0585	2	69.03.02	170856
7739	E16616	0315	1	60.02.19	170877
7739	W04450	0256	1	58.01.16	170787
7740	E16614	0382	1	56.11.04	170778
7740	W03530	0391	1	59.01.28	170804
7740	W03530	0410	1	59.01.30	170806
7743	E16621	0419	5	56.12.29	170782
7750	E16636	0020	9	60.01.03	170887
7750	E16636	0087	1	58.12.30	170876
7750	E16637	0020	6	59.12.16	170885
7750	E16637	0020	2	59.12.31	170886
7750	W04205	0659	24	69.03.04	170858
7751	E16634	0124	4	58.02.05	170788
7751	E16637	0051	1	58.12.30	170875
7751	E16638	0016	1	61.04.01	170888
7751	E16638	0021	2	61.05.14	170895
7752	E16641	0190	2	61.04.14	170891
7752	E16641	0136	1	61.05.22	170892
7752	E16641	0129	3	61.10.11	170893
7752	E16641	0128	1	61.10.31	170894
7752	E16643	0284	1	61.06.03	170889
7752	E16643	0282	9	61.11.02	170890
7752	E17733	0770	1	67.01.25	170177
7753	E16644	0585	1	60.11.30	170882
7753	E16649	0585	1	61.03.08	170884
7754	W04513	0252	4	69.03.03	170857
7758	E17802	0655	3	68.01.25	170184
7759	E17811	0647	1	68.01.25	170185
7820	W17300	0456	1	72.02.18	170343
7823	E17306	0474	1	68.01.26	170186
<i>Golfingia muricaudata</i>					
5351	W03738	0100	1	66.02.07	175501
5444	W06353	0044	1	71.05.11	170827
5506	W03955	2975	2	66.02.08	170708
5619	W02729	0175	2	66.03.06	170711
6055	W04441	0237	1	76.02.22	175507
6125	W04155	0595	1	64.04.13	171000
6219	W05912	0073	7	71.12.26	170386
6240	W05610	0365	9	63.01.02	170222

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6241	W05751	0892	1	63.01.05	170224
6241	W05443	0215	1	64.03.15	170999
6258	W06050	0123	1	70.03.28	170358
6413	W06105	0118	4	71.12.16	170413
6442	W06238	0098	2	71.12.15	170409
6446	W06405	0054	1	72.03.07	170435
6447	W06407	0143	1	72.01.26	170977
6447	W06407	0108	1	72.02.23	170417
6448	W06407	0100	2	72.01.28	170416
6449	W06251	0075	2	63.02.04	170818
6452	W06333	0114	1	73.03.09	170121
6453	W06253	0268	4	73.03.11	170123
6504	W06456	0355	1	73.03.03	170117
6635	E09040	0278	2	47.12.30	021096
7120	E16955	0439	2	59.01.25	170803
7319	E16915	0100	7	56.02.12	170797
7730	E16800	0107	3	48.01.29	021090
7736	W04230	0585	4	69.03.02	170856
7740	W03530	0393	1	59.01.28	170802
7740	W03530	0410	2	59.01.30	170805
7740	W03530	0391	1	59.01.28	170804
7743	E16619	0391	1	60.02.19	170878
7750	E16636	0020	2	60.01.03	170887
<i>Nephasoma diaphanes</i>					
5311	W07050	0001	1	66.03.27	170277
5329	E16948	0591	2	68.01.01	170289
5333	W06457	0121	3	64.02.12	170249
5335	W06945	0041	1	69.05.17	170124
5346	W07053	0288	472	64.02.06	170982
5349	W07025	0021	3	70.04.29	170360
5408	W05208	0450	4	66.01.30	170274
5427	W06612	N.R*	1	63.01.21	170231
5429	W06350	0840	2	71.10.27	170378
5434	W06410	0073	1	71.10.20	175488
5434	W06420	0091	1	71.10.20	170375
5445	W06100	0001	2	71.05.20	170371
5445	W06353	0044	11	71.05.11	170361
5446	W06423	0051	2	71.05.24	170974
5458	W06503	0247	28	64.02.10	170687
5459	W10510	4180	1	65.11.20	170704
5502	W05857	0120	1	62.12.04	170952
5542	W07035	0174	2	62.08.20	170208
5606	W06619	0440	1	63.09.18	170680
5606	W06619	0440	6	63.09.18	170769
5606	W06619	0436	1	63.09.18	170995
5624	W02719	0950	2	75.06.02	170089
5651	W03425	3170	1	63.09.06	170242
5706	W06321	3975	1	62.07.28	170199
5800	W07056	4010	1	62.11.03	?EL311
5829	E17948	0592	1	68.01.01	170288
6051	W04255	0300	5	64.04.14	170259
6056	W05652	2850	1	64.03.13	170689
6057	W11453	5033	2	64.01.06	170682



## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6145	W06114	4728	1	62.08.01	170201
6442	W06238	0097	2	71.12.15	170830
6446	W04130	4575	1	69.03.19	170861
6447	W06410	0198	1	83.03.20	175491
6535	W06540	0200	1	73.03.01	175511
6558	W06651	0200	1	59.04.04	170809
7316	W17705	1210	1	68.02.10	170310
7340	E17517	0519	1	57.11.09	170781
7406	W03938	0731	2	68.02.06	170130
7406	W03938	0731	2	68.02.06	170850
7428	W03032	0513	1	69.02.24	170839
7604	W17640	0564	1	68.01.21	170306
7658	W17107	0431	1	68.02.02	170308
7705	W03504	0743	2	69.02.26	170840
7705	W03504	0793	9	69.02.26	170854
7752	E17733	0770	1	67.01.25	171002
7823	W17306	0474	1	68.01.26	1710962
<i>Phascolion (Montagu) lutense</i>					
5302	W03740	3080	1	63.09.17	170245
5403	W03340	2690	21	63.09.09	170160
5501	W09915	3931	1	65.06.05	118738
5501	W09915	2160	4	65.06.05	118728
5506	W03955	2975	2	66.02.08	170708
5508	W02559	5440	128	63.03.29	170679
5508	W02559	5440	3	63.04.29	170758
5549	W02211	4256	9	66.03.04	170710
5552	W02449	5790	54	63.04.30	170759
5618	W15613	3694	4	66.11.11	170445
5653	W03733	3141	1	83.08.28	170240
5700	W02610	2742	39	75.05.22	170150
5723	W02634	2325	109	75.05.26	170151
5739	W02600	2500	113	75.05.27	170152
5806	W12008	4173	1	64.10.31	170772
5808	W04456	2800	4	63.02.15	170676
5811	W02548	2400	14	63.05.03	170164
5814	W02544	2492	55	63.05.03	170776
5900	W03945	2825	4	66.02.10	170767
5903	W03649	2817	41	64.04.10	170172
6056	W05652	2850	1	64.03.13	170689
6100	W09502	4941	2	64.10.11	170763
6120	W08237	4455	1	63.10.22	170863
6127	E10800	5043	8	66.04.25	170713

## Appendix.—Continued.

Latit. South	Longit.	Depth in m.	Num. ind.	Date y.m.d.	USNM #
6144	W09952	5046	1	65.07.16	170700
6145	W06114	4758	1	62.08.01	170200
6239	W06406	3737	1	62.08.06	170202
6307	W12812	4682	5	66.11.03	170444
6353	W10839	4948	46	66.03.27	170983
6406	W11517	4873	2	66.04.30	170984
6408	W04048	4510	2	64.03.21	170255
6417	W13013	4645	8	64.06.22	170173
6417	W13013	4695	2	64.06.22	170757
6448	W11430	4886	2	64.01.11	170683
6520	W11730	4845	1	64.06.15	170756
6537	W12106	4781	1	64.06.17	170262
6612	W10228	4713	6	64.06.10	170755
6650	E16432	2515	2	67.02.05	170451
6748	E15812	2315	3	67.02.05	170178
7328	W03027	3111	6	69.03.13	170860
<i>Phascolion (Isomya) hedraeum</i>					
5302	W03740	3080	1	63.09.17	170245
5338	W03802	0137	2	75.05.12	170067
5342	W03757	0147	3	75.05.14	170070
5344	W03759	0133	3	75.05.13	170069
5346	W07053	0288	2	64.02.06	170982
5351	W03738	0100	78	66.02.07	170707
5403	W03724	0070	1	75.05.16	170074
5406	W03631	0135	1	75.05.19	170078
5411	W03802	0160	1	86.12.05	170988
5412	W03740	0070	4	75.06.10	170100
5414	W03754	0200	1	75.05.12	170065
5422	W03359	0155	40	75.05.19	170148
5439	W03851	0267	1	75.06.09	170155
5451	W03503	0170	1	86.12.10	170971
6009	W12709	4375	1	65.10.09	170835
6022	W04650	0350	3	64.04.15	170697
6051	W04255	0300	4	64.04.14	170696
6125	W04155	0396	3	64.04.13	170258
6125	W04155	0595	1	64.04.13	170694
6125	W04155	0595	1	64.04.13	170137
6125	W04155	0595	3	64.04.13	170695
6127	W04155	0604	1	64.04.12	170257
6127	W04155	0604	1	64.04.12	170692
6127	W04155	0604	1	64.04.12	170693
7428	W03032	0513	3	69.02.24	170839