JOURNAL OF NATURAL HISTORY, 1999, **33**, 1835–1876

Some benthic Tunicata from the southern Indo-Pacific Ocean

K. E. SANAMYAN and N. P. SANAMYAN

Kamchatka Institute of Ecology and Environment, Partyzanskaya 6, Petropavlovsk-Kamchatsky, 683000, Russia

(*Accepted: 14 December 1998*)

Forty one species of benthic Tunicata are recorded in the material collected from 87–5760 m from the Coral Sea, Tasman Sea and the waters south of Australia and New Zealand, up to 65°S. Several species, recorded for the first time from the region, were previously known from the central and western Indian Ocean. Seven new species are described.

KEYWORDS: Tunicata, Ascidiacea, Indo-Pacific.

Introduction

The present paper describes ascidians collected in 1975–1976 during the 16th cruise of RV *Dmitry Mendeleev* and deposited in the Institute of Oceanology, Moscow. The samples were collected from the waters south of New Zealand and Australia, from the Tasman Sea, and from one station in the Coral Sea. The material is from deep water—from 87 to more than 5000 m. The bathyal and abyssal ascidian fauna of this region is still poorly known; the only recent substantial publication is that of Monniot and Monniot (1991) on the deep-sea ascidians of New Caledonia. The present collection gives an opportunity to redescribe several rarely recorded species; some of them were found only for the second time and others were recorded for the first time from the region. Seven new species are described.

List of stations

The Coral Sea

1235, 16 December 1975, 3070–3080 m, 11°30.5′S, 152°10.2′E–11°30.5′S, 152°11.7′E.

North of the Tasman Sea

1237, 26 December 1975, 4850 m, 32°41.5′S, 155°11.7′E–32°40.8′S, 155°11.0′E.

1245, 29 December 1975, 1210 m, 30°25.5′S, 161°48.0′E–30°24.0′S, 161°57.0′E.

Journal of Natural History
ISSN 0022-2933 print/ISSN 1464-5262 online © 1999 Taylor & Francis Ltd
http://www.tandf.co.uk/JNLS/nah.htm
http://www.taylorandfrancis.com/JNLS/nah.htm

North-west of North Island, New Zealand

1264, 5 January 1976, 2010 m, 33°55.8′S, 170°47.0′E–33°56.4′S, 170°47.3′E.
1265, 5 January 1976, 680 m, 34°18.0′S, 171°31.1′E–34°18.2′S, 171°31.1′E.
1266, 6 January 1976, 390 m, 38°35.9′S, 172°41.1′E–38°35.9′S, 172°41.9′E.

East of South Island, New Zealand

1269, 12 January 1976, 710–720 m, 44°26.9′S, 174°29.0′E–44°27.1′S, 174°27.6′E.

South of New Zealand

1276, 14 January 1976, 1100–1200 m, 48°25.7′S, 171°42.2′E–48°24.6′S, 171°42.0′E.

East of Auckland Islands

1277, 15 January 1976, 570 m, 51°00.8′S, 169°59.5′E–51°00.8′S, 169°59.0′E.

South-west of Campbell Island

1281, 17 January 1976, 1026 m, 53°22.7′S, 167°07.8′E–53°23.0′S, 167°07.8′E.

Macquarie Island

1290, 23 January 1976, 5450–5410 m, 54°34.6′S, 159°22.7′E.
1292, 25 January 1976, 5400 m, 54°48.8′S, 159°10.4′E–54°48.6′S, 159°10.4′E.
1293, 25 January 1976, 87 m, 54°53.2′S, 158°48.7′E–54°52.5′S, 158°46.7′E.
1294, 25 January 1976, 320–200 m, 54°56.5′S, 158°49.7′E.
1295, 25–26 January 1976, 4370–4330 m, 55°00.0′S, 160°10.9′E–54°59.5′S, 160°10.5′E.

South of Macquarie Island

1299, 28 January 1976, 5760–5460 m, 57°17.0′S, 157°14.0′E–57°16.6′S, 157°12.4′E.
1303, 30 January 1976, 4400–4420 m, 59°01.9′S, 157°56.3′E.
1315, 3 February 1976, 2030–2120 m, 59°56.4′S, 158°46.2′E.

Antarctic

1320, 5 February 1976, 2800 m, 65°31.0′S, 152°26.7′E.

South of Tasmania

1335, 13 February 1976, 4395 m, 49°49.5′S, 148°24.2′E–49°50.4′S, 148°23.6′E.

Tasmania

1343, 16 February 1976, 160–170 m, 43°41.5′S, 147°43.0′E.
1349, 21 February 1976, 4464 m, 43°36.8′S, 144°03.7′E–43°36.5′S, 144°03.9′E.

Great Australian Bight

1357, 24 February 1976, 5540 m, 38°25.7′S, 132°28.5′E–38°24.9′S, 132°27.8′E.
1358, 25 February 1976, 5020 m, 35°21.0′S, 128°42.0′E.

West of south-western Australia

1389, 9 March 1976, 5140–5150 m, 31°15.0′S, 110°44.9′E–31°13.8′S, 110°44.0′E.

Description of species

Aplidium pseudoradiatum Millar, 1982

(Figure 1)

Aplidium pseudoradiatum Millar, 1982: 26.

Material examined. St. 1299, 87 m, about 10 colonies and numerous fragments.

Description. The small colonies resemble those described by Millar (1982), they are short cylinders with slightly expanded flattened upper surface on which zooids open. The larger colonies are more irregular in shape. They are hard, wide, flattened vertically sandy masses attached to substratum by nearly whole basal portion, up to 6 cm in diameter and up to 1 cm thick. Zooids open on the upper flattened surface of the colony, which contains less sand and is yellowish, contrasting with the otherwise grey colour caused by the large amount of sand embedded in the remainder of the test. The upper flattened surface surrounded by a low marginal elevation of the test. The zooids arranged in indistinct double rows distributed rather irregularly. Several common cloacal openings on the upper surface of each colony.

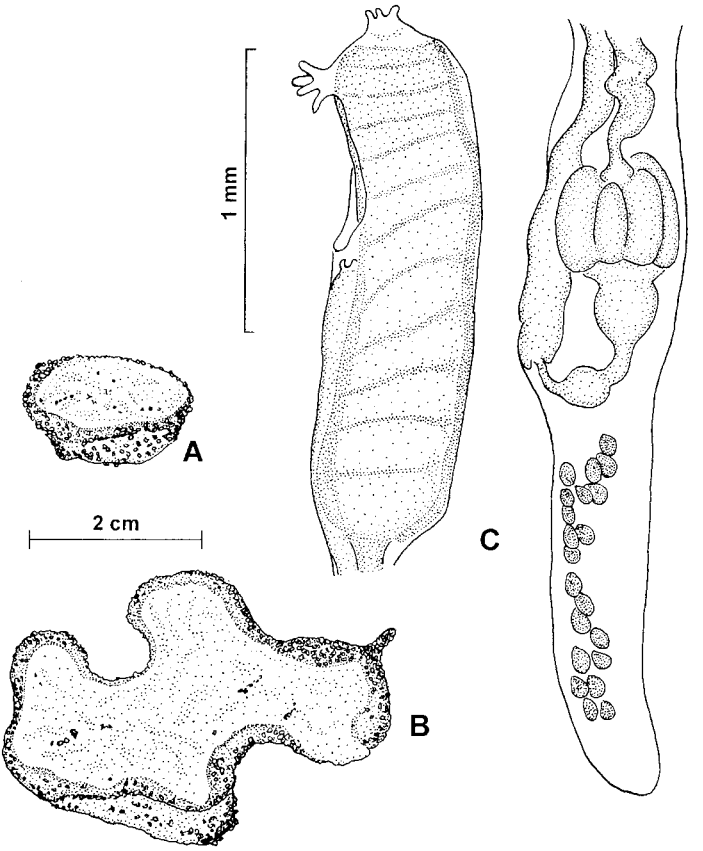

FIG. 1. *Aplidium pseudoradiatum* Millar, 1982: (A, B) colonies; (C) zooid.

The thorax usually is 1.0–1.5 mm long, although in the few fully expanded zooids it attains 3.5 mm. The abdomen is 1.2–1.4 mm long, and the postabdomen is up to 3 mm long. The branchial siphon has six lobes. The atrial opening is very large in most zooids. The atrial languet usually has four long lobes. The branchial sac has 12 rows of stigmata, with 10–12 stigmata per half row. There are very thin longitudinal muscles continuing from the thorax to the postabdomen.

The stomach is in the middle of the abdomen and has six high folds. The short duodenum, mid-intestine, rounded posterior stomach and rectal valve are distinct. The testis follicles, when present, are small and sparsely distributed.

Remarks. *Aplidium pseudoradiatum* was known only from the original description, based on several colonies from Macquarie Island. The present specimens from the same place conform to the original description, despite some differences in the colony form.

Monniot and Monniot (1983) regarded this species as a possible synonym of *Aplidium undulatum* Monniot and Gaill, 1978 (*nom. nov.* for *A. fuscum* Herdman, 1886, a commonly encountered species in the Subantarctic). Indeed, *A. pseudoradiatum* closely resembles *A. undulatum*, especially in the structure of zooid, nevertheless, it is desirable to compare the larvae, to confirm their synonymy, and the larva of *A. pseudoradiatum* is at present unknown.

Aplidium tabachniki sp.n.
(Figure 2)

Material examined. St. 1335, 4395 m, three specimens. HOLOTYPE KIE 1/925.

Description. The holotype is 7.5 mm in diameter and 6 mm in height. It is a short column with a somewhat expanded flat top and the base divided into two short thick branches. Sediments and foraminifer shells coat the whole surface and

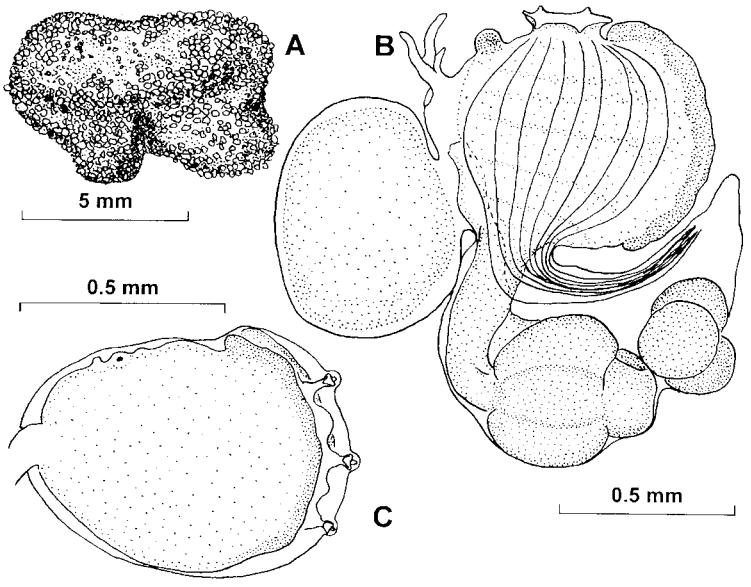

FIG. 2. *Aplidium tabachniki* sp.n.: (A) colony; (B) zooid; (C) larva.

are embedded in the test. The test is hard. The other colonies are irregular sandy masses and contain only degenerate zooids.

The colony contains eight zooids forming a single circular system with a central common cloacal opening. The zooids are about 1.3 mm long in strongly contracted state and externally somewhat resemble zooids of *Distaplia*. The thorax is about as long as wide. The branchial siphon is short and wide and with six small lobes around the opening. The atrial aperture is small with a large atrial languet divided into three long lobes. Eight or nine thin and widely separated branchial tentacles project from the branchial opening. Seven to nine widely separated longitudinal muscles are on each side of the thorax and form strong ribbons on the ventral side of the abdomen. The stigmata are in six rows of about ten stigmata per row. The abdomen bends at a right angle to the thorax. The stomach is wide and has five indistinct longitudinal folds. The intestine curves immediately behind the stomach and its subdivision into regions is indistinct in these contracted zooids. The postabdomen is very short, containing only three or four large spherical follicles (possibly testis) situated just behind the gut loop.

A single immature larva is in a thin-walled thoracic brood-pouch. The trunk is 0.8 mm long and the tail makes a complete circle around it. The larva has three adhesive organs on short wide stalks and two wide median ampullae in each interspace between them. There is a vertical ridge of larval epidermis on each side of the median adhesive organ. No vesicles or lateral ampullae are present. Only one pigmented body is in the cerebral vesicle.

Remarks. *Aplidium tabachniki* sp.n. appears to be closely related to the abyssal Atlantic *A. enigmaticum* Monniot and Monniot, 1973. This species, however, has a different larva with long median ampullae, and many specimens have only a single zooid and enlarged branchial lobes (see Monniot and Monniot, 1973).

Etymology. The species is named after Dr Konstantin Tabachnik from the Institute of Oceanology.

Aplidium tasmaniensis sp.n.
(Figure 3)

Material examined. St. 1343, 160 170 m, one specimen. HOLOTYPE KIE 1/926.

Description. Massive, club-shaped and somewhat laterally flattened colony is 6.5 cm high and 5 cm wide. The area of attachment is relatively small. There is no adherent or embedded sand. The surface, free from foreign matter, is covered by shallow folds and wrinkles. The test is soft and opaque, its peripheral layer is firmer and darker than the inner test. The zooids are not seen through the test and the form of the systems is not clear. There are several small common cloacal openings randomly distributed over upper half of the colony.

The zooids are thin and long. They are more or less parallel to the vertical axis of the colony and open on the top and around the sides of the upper half of colony. The thorax is up to 3 mm long; the abdomen is usually half the length of the thorax. The postabdomen is thin and very long, up to 20 mm. The branchial siphon is six-lobed and terminal. The atrial aperture is relatively large and situated on the level of sixth or seventh stigmata rows. The simple atrial languet is close to the atrial opening and in most zooids is directed vertically. It does not reach the anterior end of the zooid. There are about 15 thin longitudinal thoracic muscles. The stigmata are in 20–23 rows of seven or eight stigmata per row. The small, symmetrical

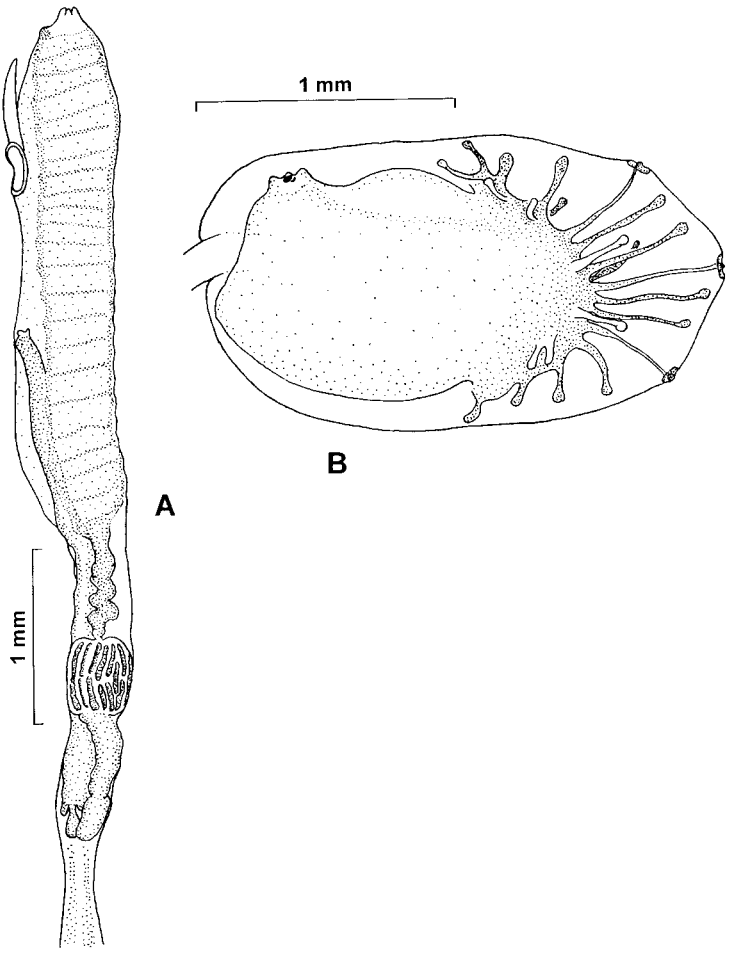

FIG. 3. *Aplidium tasmaniensis* sp.n.: (A) zooid; (B) larva.

stomach with about 15 high, broken and somewhat irregular folds is in the middle of the abdomen. There is a long duodenum, a mid-intestine and a small posterior stomach. The rectal caeca are large. Gonads are not developed and the postabdomen is filled with pink tissue.

A single large larva is present in the atrial cavity of some zooids. The larval trunk is 2.0–2.1 mm long, and the tail is wound halfway around it. There are three antero-median adhesive organs on long thin stalks. Two long and narrow median ampullae in each interspace between the adhesive organs and a further two to four dorsal and ventral to the adhesive organs. About seven to ten pairs of narrow lateral ampullae are regularly spaced. Vesicles absent.

Some other colonies from the same station apparently belong to this species, but they have only degenerate zooids.

Remarks. This species is characterized by the large number of stomach folds and rows of stigmata, narrow thoraces and its large larva. *Aplidium magnilarvum* Kott, 1992 from Western Australia has 21 rows of stigmata and large larvae, but only five stomach folds and about 20 stigmata per row. The larva most resembles

those of *A. rubricollum* Kott, 1963, but it is larger and the stomach folds are more numerous. *Aplidium gelasinum* Kott, 1992, has similar zooids to the present species but its colony and its tropical location suggest that it is different and its larva is not known. Several other species of the genus *Aplidium* are recorded from the southern hemisphere with 20 or more rows of stigmata, but all of them have no more than five to seven stomach folds, smaller larvae and ectodermal vesicles in the larval test.

Sidnyum sp.

Material examined. St. 1237, 4850 m, two specimens.

Description. The colony is an upright cylinder with a single circular system of zooids. The zooids are strongly contracted and damaged. The branchial siphon has eight pointed lobes and there are five (or six?) rows of stigmata. The stomach appears to have a smooth wall, but it is possible that several flattened longitudinal folds are present.

Remarks. The zooids are in a so poor condition, that it is not possible to provide a complete description or to determine the species. This is the deepest record for the genus *Sidnyum*, the greatest depth previously recorded for this genus was 4100 m (*Sidnyum* sp.: Monniot and Monniot, 1974a).

Pharyngodictyon sp.

Material examined. St. 1264, 2010 m, one specimen.

Remarks. The thorax is degenerated or completely absent in all zooids and therefore it is not possible to identify this specimen. The colony contains only postabdomens filled with large and numerous testicular follicles. The shape of the colony resembles those of *Pharyngodictyon bisinus* Monniot and Monniot, 1991 and the branchial sac (seen very indistinctly in one zooid only) has apparently only two transverse vessels.

Polycitor emergens Kott, 1990
(Figure 4)

Polycitor emergens Kott, 1990: 170.

Material examined. St. 1343, 160–170 m, one specimen.

Description. The single damaged colony has its posterior half deeply embedded in a mass of bryozoa and broken shells, and is divided into branches containing posterior ends of zooids, as described by Kott (1990). These branches are, however much shorter than those figured by Kott. The upper half of the colony is cylindrical and rather soft. Reddish zooids can be seen through the translucent test. They are contracted and do not reach the anterior end of the colony.

The thorax is up to 2 mm; the abdomen up to 8 mm. The branchial sac has nine rows of about 20 stigmata per row. About 15 longitudinal muscles arising on the thorax continue to the end of the abdomen as two lateral muscle bands. The stomach has four wide and rather unclear longitudinal folds.

Remarks. This species was previously known only from the original description, based on three colonies from New South Wales, 60 m. The present specimen from Tasmania has more longitudinal muscles and nine, rather than eight rows of stigmata.

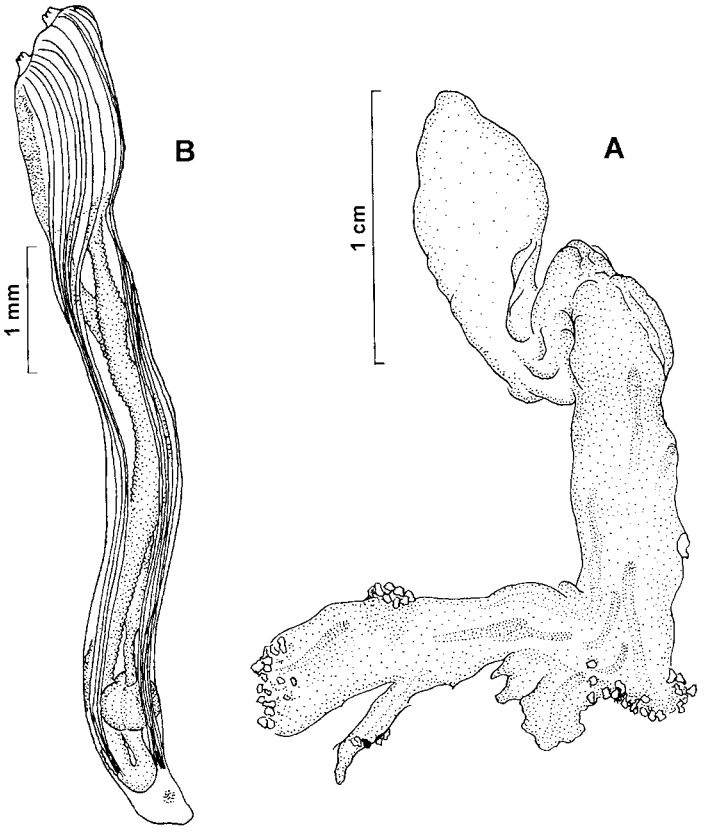

FIG. 4. *Polycitor emergens* Kott, 1990: (A) colony; (B) zooid.

Ascidia thompsoni Kott, 1952

Ascidia thompsoni Kott, 1952: 312; 1985: 56 (synonymy).

Material examined. St. 1343, 160–170 m, 15 specimens.

Remarks. The specimens agree with previous descriptions. This species was recorded only from south-eastern Australia and Tasmania.

Corella eumyota Traustedt, 1882

Corella eumyota Traustedt, 1882: 271. Kott, 1985: 83 (synonymy).

Material examined. St. 1277, 570 m, about 30 specimens; st. 1293, 87 m, two specimens; st. 1294, 320–200 m, 18 specimens; st. 1299, 87 m, one specimen.

Remarks. This species is well known and widely distributed in the southern hemisphere.

Adagnesia antarctica Kott, 1969

(Figure 5)

Adagnesia antarctica Kott, 1969a: 99; 1969b: 453.
Not *Adagnesia antarctica*: Millar, 1982: 59.

Material examined. St. 1299, 87 m, one specimen.

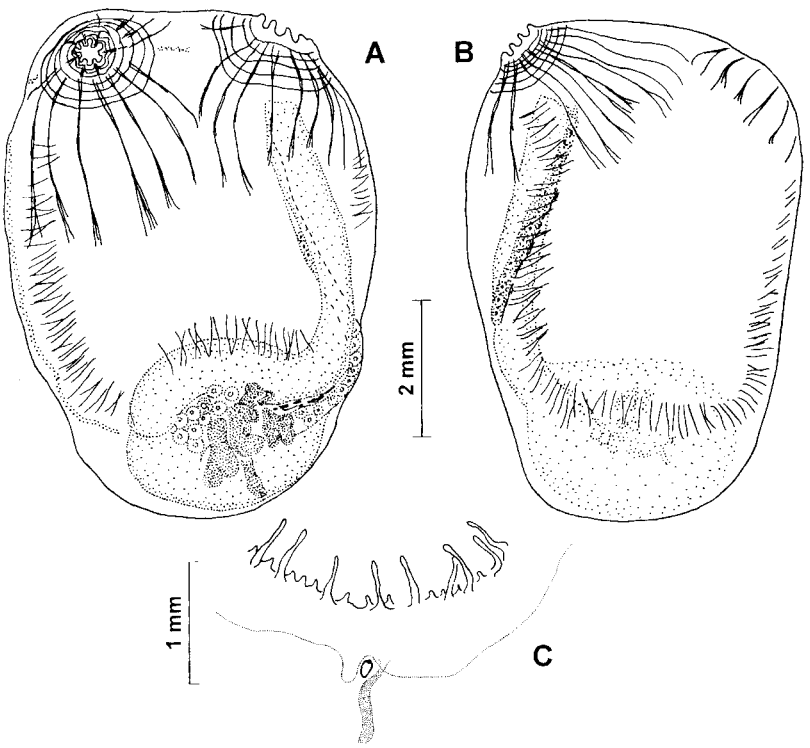

FIG. 5. *Adagnesia antarctica* Kott, 1969: (A, B) left and right sides of a specimen; (C) dorsal area.

Description. The unique specimen was found embedded in the colony of *Aplidium pseudoradiatum*. The elongated body is 10 mm in height. The test is thin and translucent, with only a few sand grains adherent to the surface. There are no test fibrils. The apertures are terminal and sessile and have eight lobes. The circular siphonal muscles are present only just close to the siphons. The radial muscles do not extend beyond the anterior half or one-third of the body. Short parallel muscles form a band on each side of the ventral mid-line and across the dorsal mid-line.

There are 21 tentacles arranged in two cycles. The peripharyngeal band extends for a large distance from the tentacles and has no dorsal V. The dorsal tubercle is small and situated just anteriorly to the long neural ganglion. The dorsal languets are long and situated on the transverse branchial vessels. Each side of the branchial sac has six double rows of nine or ten square spirals with four or five coils. Double rows are separated by high transverse vessels, each with eight large T-shaped papillae.

The gut loop is not voluminous, and occupies the posterior one-third of the body. The rectum is long and straight. The sperm duct and the oviduct follow the rectum.

Remarks. The present specimen was collected close to the type locality (Macquarie Island), and from the same depth, and conforms exactly with the original description.

Adagnesia antarctica: Millar, 1982, described from the east of New Zealand (close to the Chatham Islands), has a different structure of the branchial sac and

lacks the rows of transverse muscles along the ventral and dorsal mid-lines. It is not conspecific with *A. antarctica*.

Adagnesia charcoti Monniot and Monniot, 1973
(Figure 6)

Adagnesia charcoti Monniot and Monniot, 1973: 424; 1974a: 744; 1976b: 666; 1976c: 635; 1985b: 23; 1985c: 284; Monniot, 1994: 235; Millar, 1978: 104; 1982: 168.
Not *Adagnesia charcoti* Kott, 1985: 78.

Material examined. St. 1290, 5450–5410 m, one specimen.

Description. The specimen is rather damaged and shapeless, and measures about 10 × 12 mm. The test is naked, without foreign particles or hair-like outgrowths. The body musculature consists of circular siphonal muscles and thick radial bands originating on the siphons, extending over one-third or -half of the body width and terminating abruptly more or less in a line. In the middle of each side of the body there is a series of thick but short longitudinal muscles crossing the body in a horizontal direction. Fine muscles cross mid-dorsal and mid-ventral lines of the body, but are absent between the siphons. Branchial tentacles are long and numerous. The prepharyngeal band has a deep dorsal V. We did not find any papillae in the peribranchial area. The small dorsal tubercle is halfway between the siphons. Spiral stigmata of about 12 spirals are arranged in 11 transverse rows; each row separated by a transverse vessel. It is not possible to count exactly the number of bifid papillae arising from the transverse vessels, but they are more numerous than the spirals in the same row.

Remarks. The specimen shows some differences from those previously described from the Atlantic and the central Indian Ocean. The arrangement of the body muscles resembles more closely those of the specimen described by Monniot (1994) from Amsterdam Island than the type material, or other described specimens. Other

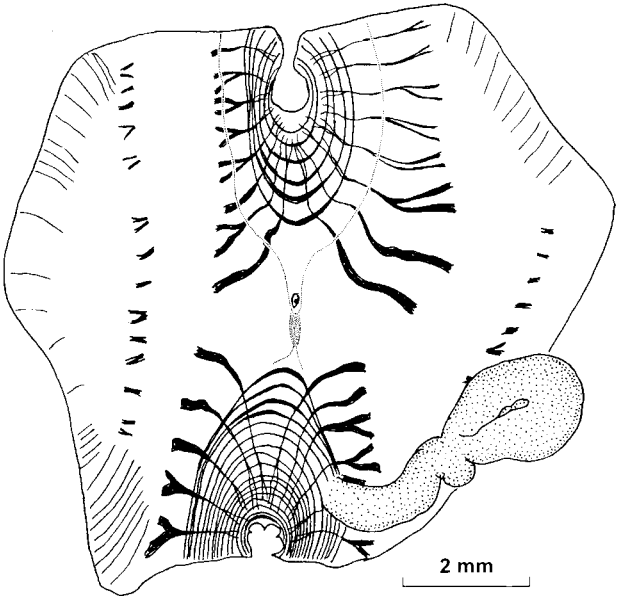

FIG. 6. *Adagnesia charcoti* Monniot and Monniot, 1973.

described specimens of *A. charcoti* lack the band of short longitudinal muscles in the middle of the body described above. Absence of papillae between the dorsal tubercle and the branchial tentacles may constitute a valid character for specific separation of the present specimen from *A. charcoti*. It is necessary, however, to confirm this character in additional specimens.

Identification of *A. charcoti*: Kott, 1985, recorded from only 22 m from the Bass Strait is dubious. The body muscles illustrated by Kott (1985, figure 30) differ from those of other described specimens, the radial siphonal muscles being much more numerous and thinner.

A. antarctica Kott, 1969 was described from the west of Macquarie Island, close to the locality from where the present specimen was collected. It has a branchial sac with double transverse rows of stigmata and differs distinctly from *A. charcoti*.

Dicopia fimbriata Sluiter, 1905
(Figure 7)

Dicopia fimbriata Sluiter, 1905: 325; Monniot and Monniot, 1991: 386.

Material examined. St. 1245, 1210 m, one specimen.

Description. The single specimen is too damaged to provide a detailed description. The body removed from the larger, shapeless test measures 2 cm. Groups of short and strong muscles close to the corners of the branchial aperture are on each side of the body (figure 7B). Branchial tentacles are long and crowded and were seen only on a small part of the prebranchial area close to the dorsal tubercle, where they arise from a short velum. The neural ganglion is outside the ring of branchial tentacles and distant from the dorsal tubercle. The prepharyngeal band lacks a dorsal V. Short papillae are between the tentacles and prepharyngeal band. The dorsal lamina has two high lamellae diverging anteriorly. The branchial sac is cone-shaped and symmetrical; the perforated area makes a complete ring. Stigmata of various sizes, mostly large and oval, are arranged in irregular rings or spirals (figure 7A).

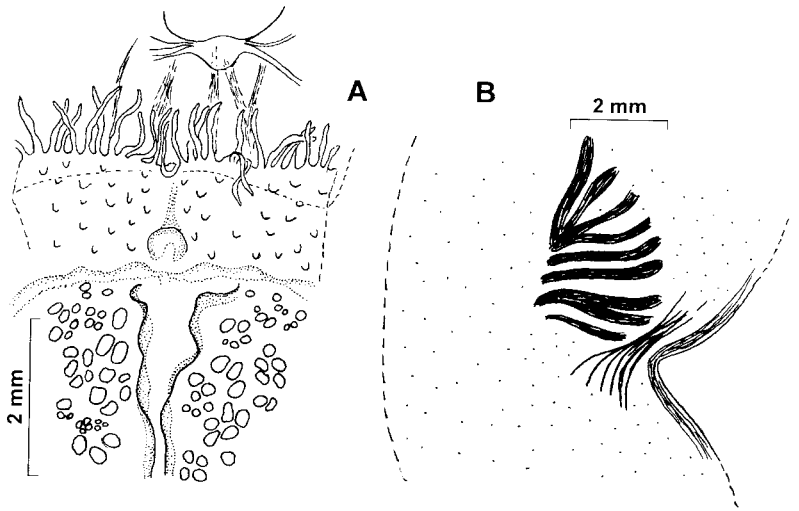

FIG. 7. *Dicopia fimbriata* Sluiter, 1905: (A) dorsal area; B: body muscles near the lips corners.

Remarks. *Dicopia fimbriata* originally was described from Indonesia. Monniot and Monniot (1991) recently redescribed it from New Caledonia. The present specimen from the Tasman Sea corresponds exactly to the description and figures given by Monniot and Monniot (1991) in the shape and relative arrangement of the tentacles, neural ganglion and dorsal tubercle, and the shape of the lateral muscles, but differs in having a symmetrical branchial sac. In the specimen from New Caledonia the left side of the branchial sac was described as fully perforated, while on the right side perforations are present only dorsally.

Octacnemus vinogradovae sp.n.
(Figures 8, 9)

Material examined. St. 1292, 5400 m, one specimen. HOLOTYPE KIE 1/924.

Description. The unique specimen is about 7 cm high and 3 cm in greatest diameter. The test is relatively thick, soft, glossy and transparent. It probably had been anchored in the sediments by the posterior end, where an oval area about 2 cm in diameter has thin test hairs. The body closely adheres to the test only around the oral lobes. Several large Isopoda were found in the cavity between the body and the test.

The body removed from the test is laterally flattened, 3 cm high and 2 cm wide.

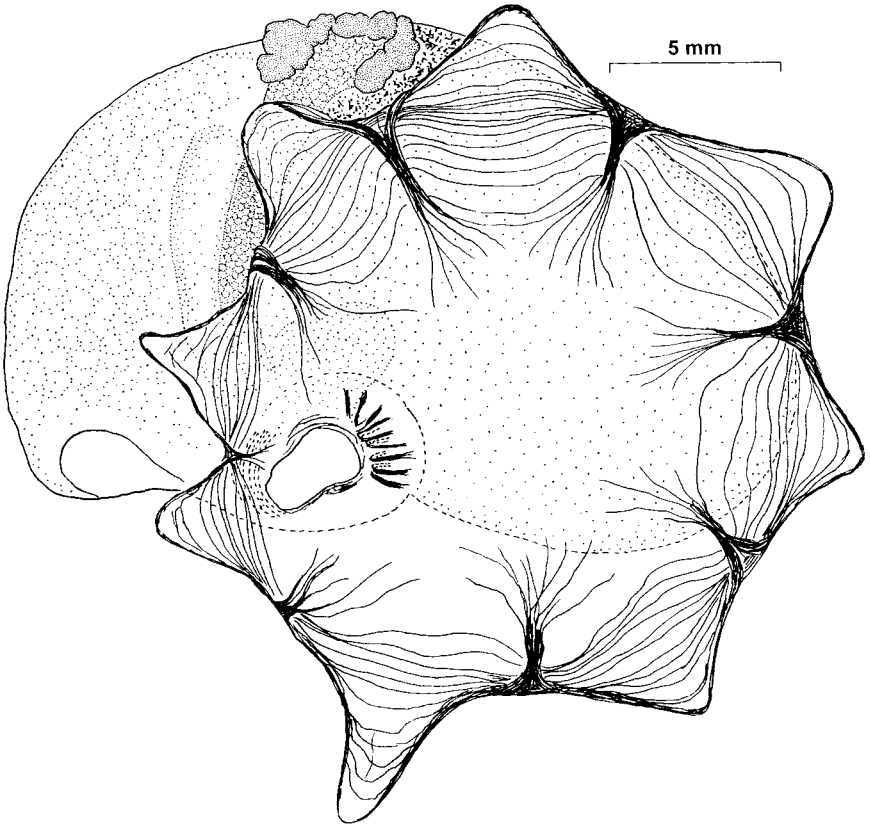

FIG. 8. *Octacnemus vinogradovae* sp.n. Holotype, test removed.

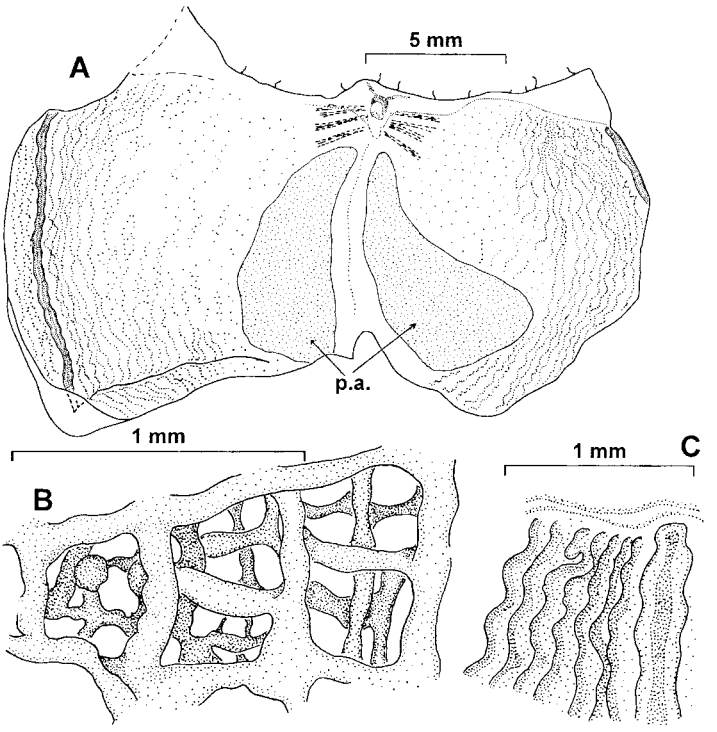

FIG. 9. *Octacnemus vinogradovae* sp.n.: (A) branchial sac opened along ventral line (p.a.—perforated area); (B) perforations of the branchial sac; (C) detail of the branchial sac with endostyle, peripharyngeal band and longitudinal vessels.

Eight oral lobes form an oral disk of slightly greater diameter than the body width. The lobes are low and wide and have rounded tips. The two most dorsal lobes are a little smaller than the others. The oral aperture is close to the dorsal margin of the oral disk. The body wall below the oral aperture is damaged and the atrial siphon was not seen, although there is a short papilla on the test in the same position as the atrial siphon.

The arrangement of muscles on the oral disk resembles that in other species of the genus. Circular muscle fibres are confined to the periphery of the oral disk, they are more or less regularly spaced on the oral lobes and gathered together between the lobes. The muscle fibres from around the margin of adjacent lobes meet together between the lobes and form thick radial (or longitudinal) muscle bands across the outer half of the oral disk. They are divided into several thin terminal branches. Muscles are not present in the centre of the oral disk. Thin circular muscles run around the margin of the oral aperture. Very thick, short, transverse muscles are on the body wall close to the dorsal side of the oral aperture and several short, thick, radial muscles are on its ventral side (figure 8).

The oral tentacles are short, thin and sparse. The prepharyngeal band was seen rather indistinctly. It is composed of two laminae and runs close to the tentacles dorsally and far from them ventrally. The oval dorsal tubercle with a simple opening and the neural ganglion are close to each other, the prepharyngeal band apparently making a V around the dorsal tubercle. The endostyle is straight and composed of two thick laminae. The retropharyngeal band is long and makes a sharp angle with

the endostyle. The thick wall of the branchial sac has numerous internal longitudinal plications, which probably are homologous with longitudinal branchial vessels. These plications are confined mainly to the ventral side of the branchial sac. They are seen clearly on both sides of the endostyle, while the antero-dorsal side of the branchial wall is nearly smooth. The unciliated branchial perforations are irregular and characteristic (figure 9B). They are formed by crossing vessels in the thick wall of the branchial sac and occupy about one third of the surface of the branchial wall. The perforated areas are situated along each side of the dorsal line, they are narrowed anteriorly and enlarged posteriorly (figure 9A).

Internal organs form a compact visceral mass and are seen indistinctly. The long tubular ovary crosses the body longitudinally. The male follicles form an irregular mass around the proximal end of the ovary. The ventral half of the body is filled by sediments and sponge spicules.

Remarks. The genus *Octacnemus* comprises four species, two of which, *O. bythius* Moseley, 1876 and *O. ingolfi* Madsen, 1947, are widely distributed and were recently recorded together from New Caledonia. *Octacnemus ingolfi* has pinnules on the oral lobes, a long posterior extension of the body and a different stigmata. *Octacnemus bythius* resembles the present species externally, although the specimen described by Millar (1959) has much longer lobes on the oral disk. This species has a simple branchial sac with flat wall, the stigmata being reduced to 'two or three adjacent oval slits' on each side of the dorsal line (Millar 1959). *Octacnemus zarcoi* Monniot and Monniot, 1984, from the north Atlantic, resembles the present species in the shape of the stigmata. However, it differs in having long posterior extensions of the body wall, numerous crowded branchial tentacles, a completely perforated branchial sac wall, and a difference in the relative position of the neural ganglion to the dorsal tubercle. *Octacnemus alatus* Monniot and Monniot, 1985, from the Indian Ocean, has long lateral extensions of the body and is obviously distinct from the present species.

The present species is unique in having internal longitudinal branchial vessels, at least on the ventral half of the branchial sac. The papillae, distributed over the whole inner branchial wall of *O. alatus* and on the dorsal line of the *O. zarcoi*, were not detected in *O. vinogradovae* sp.n.

Etymology. The species is named in honour of the late Nina Vinogradova, who made many contributions to the knowledge of deep-sea fauna.

Styela crinita Monniot and Monniot, 1973
(Figure 10A)

Styela crinita Monniot and Monniot, 1973: 438; 1985a: 45; 1985b: 29; 1985c: 297; Monniot, 1994: 238.

Material examined. St. 1290, 5450–5410 m, five specimens; st. 1315, 2030–2120 m, four specimens.

Description. Spherical body 5–7 mm in diameter. The largest specimen has about 30 branchial tentacles. The prepharyngeal band is a regular circle, the dorsal V being absent. The small dorsal tubercle has a simple opening. The relatively large neural ganglion is close to the dorsal tubercle. The branchial sac lacks folds. In the largest specimen it has 64 vessels on the right and 51 on the left, with 0.5–1.5 stigmata in each mesh. Long, straight, longitudinal stigmata are in eight or nine transverse rows, each crossed by three or four parastigmatic vessels. A few transverse

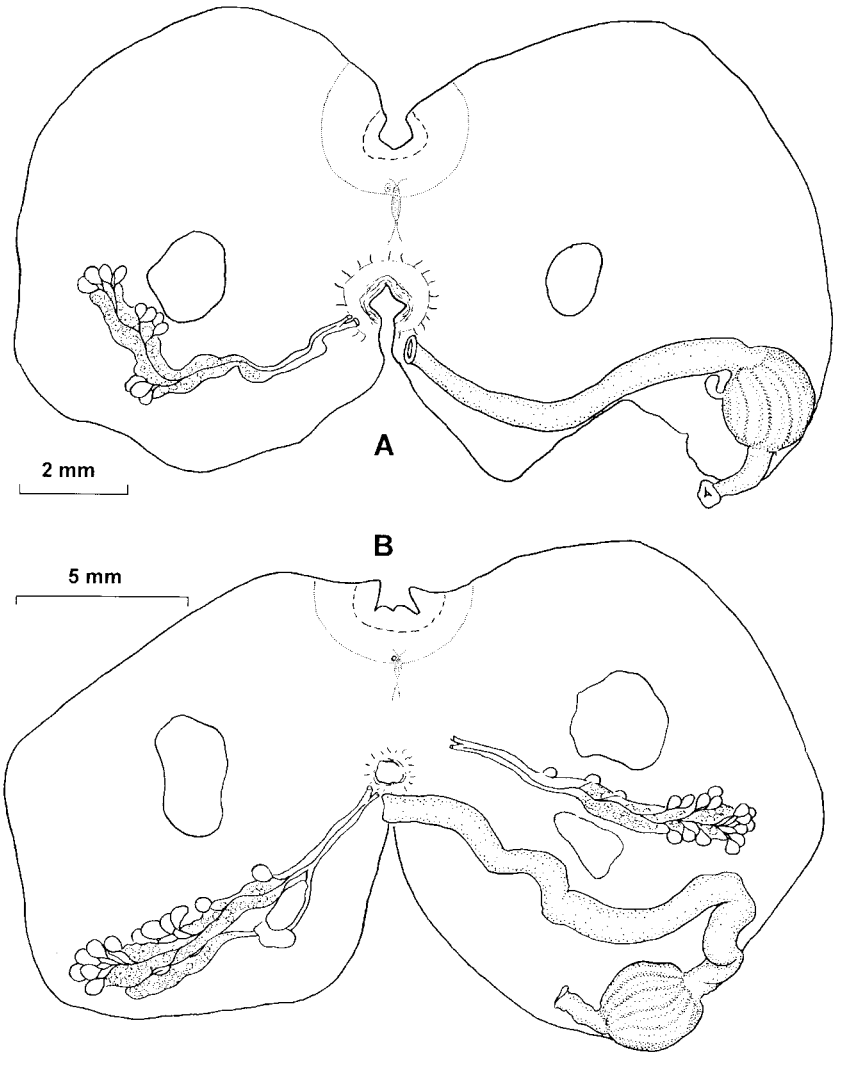

FIG. 10. (A) *Styela crinita* Monniot and Monniot, 1973; (B) *Styela tenuibranchia* Monniot, Monniot and Millar, 1976.

stigmata are on the posterior part of the sides of the branchial sac. A single gonad is on the right. The ovary is long and curved, its anterior half, extending to the atrial orifice, is almost at a right angle to the posterior half. Testis follicles are large and arranged in a few compact groups along the proximal half of the ovary.

The nearly globular stomach has eight or nine distinct folds and a curved pyloric caecum. The rectum is long and the anus has a plain margin. One large endocarp is on each side of the body. Thin atrial tentacles are in a circle around the aperture.

Remarks. The morphological characters of the species are stable, and the present specimens conform to previous descriptions. This deep water species has a wide distribution, being recorded from the north and central Atlantic and the west and central Indian Ocean.

Styela tenuibranchia Monniot, Monniot and Millar, 1976
(Figure 10B)

Styela tenuibranchia Monniot *et al.*, 1976: 1193; Monniot and Monniot, 1985c: 297.

Material examined. St. 1235, 3070–3080 m, one specimen; 1349, 4464 m, one specimen.

Description. Specimens are about 12–15 mm in diameter. The test is covered by a dense mat of long hair-like processes. About 14 branchial tentacles are present. The prepharyngeal band makes a regular circle, dorsal V being absent. The small neural ganglion is close to a minute dorsal tubercle. The branchial sac is flat, without true folds. About 95–100 internal longitudinal branchial vessels on each side. No more than 1.5 stigmata are between adjacent vessels, but up to 18 stigmata are present on the right side of the branchial sac between the most dorsal longitudinal vessel and the dorsal lamina. Transverse branchial vessels on the right side of the dorsal lamina are raised into laminar expansions and the branchial wall here forms an inverted fold (directed to the outside from the branchial cavity); a structure is known also for some other deep water Styelidae. One gonad is on each side of the body. The ovary is long and nearly straight; the testis follicles are pear-shaped and relatively large. In the specimen from st. 1349 the right ovary is divided into two unequal branches (figure 10B).

The stomach is almost globular and has longitudinal folds. The rectum is long and the anus has a plain margin. Two endocarps are present on the left, one posterior to and one anterior to the gonad. In the specimen with bifurcated ovary three endocarps are on the right, the larger anterior to the gonad, and two smaller ones between the branches of the ovary. On the right side of another specimen one large endocarp is anterior to the gonad and one very small is on the ovary. Fine atrial tentacles are in a circle close to the atrial orifice.

Remarks. The bifurcated ovary on the right seems to be an abnormality. In other features this specimen agrees with the original description. The species was previously recorded from the Tasman sea and from the Indian Ocean near Sri Lanka.

Cnemidocarpa drygalskii (Hartmeyer, 1911)

Tetyum drygalskii Hartmeyer, 1911: 452.
Cnemidocarpa drygalskii: Monniot and Monniot, 1983: 69 (synonymy).

Material examined. St. 1294, 320–200 m, four specimens.

Remarks. The specimens are hemispherical and attached by wide ventral surfaces to small stones. They correspond closely to previous descriptions, particularly to that of Monniot (1978). This species is distributed widely in the Antarctic.

Cnemidocarpa platybranchia Millar, 1955
(Figure 11)

Cnemidocarpa platybranchia Millar, 1955: 226; Monniot and Monniot, 1984: 141; 1985b: 28; 1985c: 294; Monniot *et al.*, 1976: 1192.

Material examined. St. 1237, 4850 m, three specimens; st. 1335, 4395 m, one specimen.

Description. Globular specimens are 3.5–8.0 mm in diameter. The tentacles are numerous and short. The branchial sac is flat, with about 30 internal longitudinal vessels on each side. Stigmata are in nine transverse rows, each crossed by a

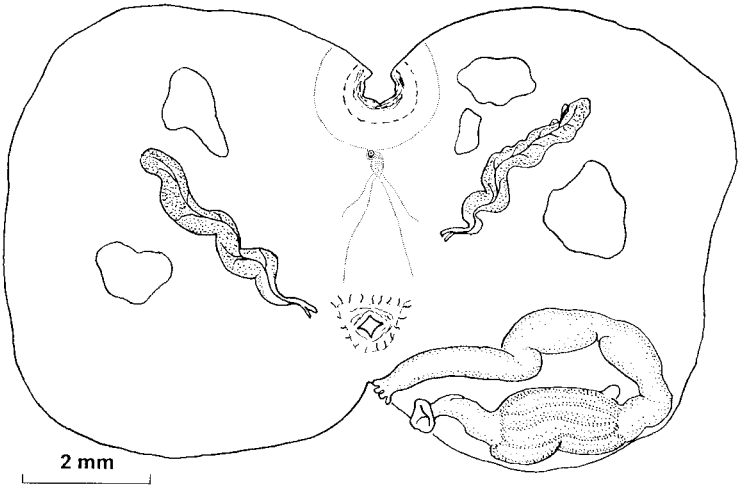

FIG. 11. *Cnemidocarpa platybranchia* Millar, 1955.

parastigmatic vessel. About three stigmata are between adjacent longitudinal vessels. In other features the specimens conform to original and subsequent descriptions.

Remarks. The main distinguishing characters of the species are the flat branchial sac, lobed anus and the arrangement of the atrial tentacles on an angular line (figure 11). The species was previously recorded from the north and central Atlantic, and the central Indian Ocean.

Polycarpa zeteta Millar, 1982

Polycarpa zeteta Millar, 1982: 76.

Material examined. St. 1269, 710–720 m, 16 specimens; 1276, 1100–120 m, 22 specimens; st. 1277, 570 m, ten specimens; st. 1281, 1026 m, eight specimens.

Remarks. This species was based on several specimens described by Millar (1982) from New Zealand, from 99–710 m. The present material was collected close to the type locality (st. 1269) and from waters south of New Zealand, and conforms closely to the original description. The main distinguishing characters of the species are the gut, forming a simple open arc, the arrangement of gonads along both sides of the endostyle, and the small endocarps confined to the posterior end of the left side of the body, within the gut loop.

Dicarpa antarctica Monniot and Monniot, 1977

(Figure 12)

Dicarpa antarctica Monniot and Monniot, 1977: 311.

Material examined. St. 1335, 4395 m, three specimens.

Description. One specimen is 7 mm in diameter, and two others are about 4 mm in diameter. Body oval or almost globular. Hair-like test processes with adherent sediments cover the body except around the apertures. Apertures are relatively close to each other on low, inconspicuous siphons. About 28 long flattened branchial tentacles of three size orders are on the edge of a thin, high velum. The small dorsal tubercle has a simple opening. The prepharyngeal band is a single wide lamella close to the branchial velum. The dorsal V very shallow. The neural ganglion is present

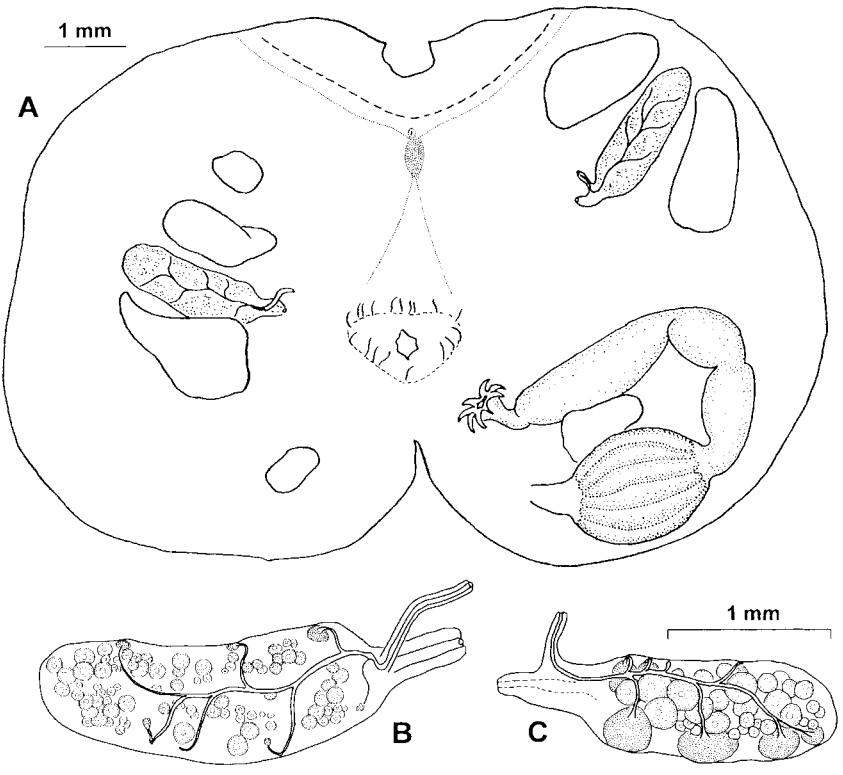

FIG. 12. *Dicarpa antarctica* Monniot and Monniot, 1977: (A) specimen opened ventrally; (B, C) gonads.

just posterior to the tubercle. The dorsal lamina is high and has a plain undulating margin.

The flat branchial sac has four internal longitudinal vessels on each side. Stigmata are distributed between longitudinal vessels as follows: E 17 10 9 7 5 DL 5 6 7 8 14 E. Seven or eight transverse rows of long, longitudinal stigmata are present and several transverse stigmata are on the most posterior part of the right and left sides of the branchial sac. Parastigmatic vessels are present only occasionally.

The gut forms a simple open loop. The spherical or slightly elliptical stomach has 12 14 longitudinal folds and lacks a pyloric caecum. The anal border has several long, sharply pointed lobes.

One rather long gonad is on each side of the body, the left one is anterior, well removed from the gut loop. Up to six pear-shaped male follicles are along each side of the ovary, between the ovary and the body wall. The follicles are small in the large specimen but large in others. The oviduct is of moderate length and not attached to the body wall. The distal free end of the sperm duct is almost at right angle to the oviduct.

Two large endocarps are on each side of the left gonad; one or two endocarps are anterior to and two posterior to the right gonad. An endocarp is present in the gut loop in all examined specimens.

The atrial tentacles are fine and arranged in an oval.

Remarks. This species is based on three specimens from the southern Indian Ocean. The present ones show certain differences from the original description. They have fewer transverse rows of stigmata and only one male opening on each gonad. Among four gonads of this species figured by Monniot and Monniot (1977), one has a single male opening and three have two male openings.

In most features, including the structure of the gonads, the present specimens resemble closely *Dicarpa pacifica* Millar, 1964 but this species lacks an endocarp in the gut loop.

Dicarpa lata Monniot and Monniot, 1976 has an endocarp in the gut loop, but the gonads are different and in this species the peripharyngeal band makes a distinct dorsal V.

Dicarpa lata Monniot and Monniot, 1976
(Figure 13)

Dicarpa lata Monniot and Monniot, 1976a: 674.

Material examined. St. 1237, 4850 m, one specimen.

Description. The single specimen 4 mm in diameter conforms to the original description, although it is damaged and not all features can be observed. The neural ganglion is unusually large and wide, the prepharyngeal band makes a U-shaped

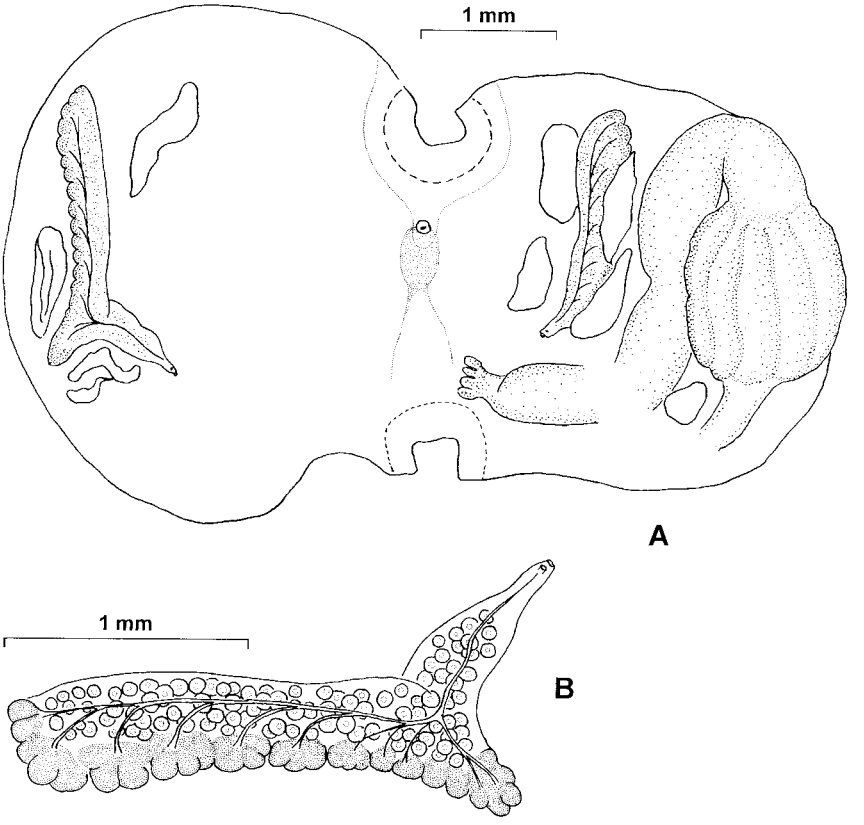

FIG. 13. *Dicarpa lata* Monniot and Monniot, 1976: (A) specimen opened ventrally; (B) right gonad.

indentation around the oval dorsal tubercle, which has a transverse slit-like opening. The branchial sac has the usual structure for *Dicarpa*, but the distribution of stigmata could not be determined. The gut forms a closed loop; the stomach is large with longitudinal folds and a small caecum. Several lobes are on the anal margin. One long gonad is present on each side of the body, the left one lying close and parallel to the intestine, the right extending along the ventral line of the body. Large branched male follicles are along the ventral side of the ovary. The oviduct is short and the sperm duct opens close to the opening of the oviduct. Several endocarps are around the gonads and one is present in the gut loop, between the oesophagus and intestine.

Remarks. The species was previously recorded only from the south-eastern Atlantic.

Bathystyeloides anfractus Monniot and Monniot, 1985
(Figure 14)

Bathystyeloides anfractus Monniot and Monniot, 1985a: 39.

Material examined. St. 1269, 710–720 m, two specimens; st. 1276, 1100–1200 m, one specimen; st. 1281, 1026 m, seven specimens.

Description. All specimens have a spherical or oval body, 3–5 mm in diameter, and covered by thin and apparently unbranched hair-like test processes heavily incrusted by sediments and foraminiferan shells. The test processes are longer and more crowded on the ventral side of the body than around the inconspicuous siphons, which are no more than 2 mm from each other.

The body wall is thin and nearly transparent. About 20 distinct muscle-bands radiate from each siphon on each side of the body, and a number of circular muscle fibres are around the siphons. About 20 branchial tentacles of two size ranges arise from the edge of the branchial velum. The prepharyngeal band makes no dorsal V. The neural ganglion is just behind and close to the dorsal tubercle. The branchial sac has about 40 internal longitudinal vessels on each side. Longitudinal stigmata are on the right side of the branchial sac between the dorsal lamina and the dorsal longitudinal vessel. They are in several short transverse rows (see Monniot and Monniot, 1985a: 41, figure 2). The gut forms a simple loop. The long stomach has 11 longitudinal folds and a small caecum. The anal border is lobed.

A single gonad is on each side of the body. Large male follicles are in a single

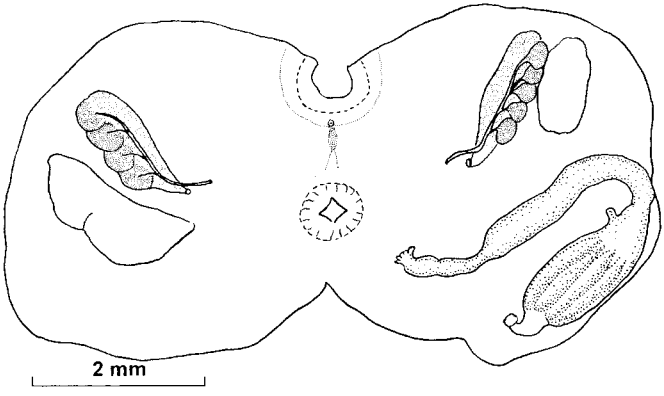

FIG. 14. *Bathystyeloides anfractus* Monniot and Monniot, 1985.

row along the ventral side of each ovarian tube. The male opening is on the long duct projecting from the distal end of gonad. In most specimens one large endocarp is present on each side of the body. One specimen (st. 1269) has two endocarps on the right posterior to the gonad.

Remarks. Previously the species was recorded only from the western Indian Ocean, from 400–675 m.

Bathystyeloides magnus sp.n.
(Figure 15)

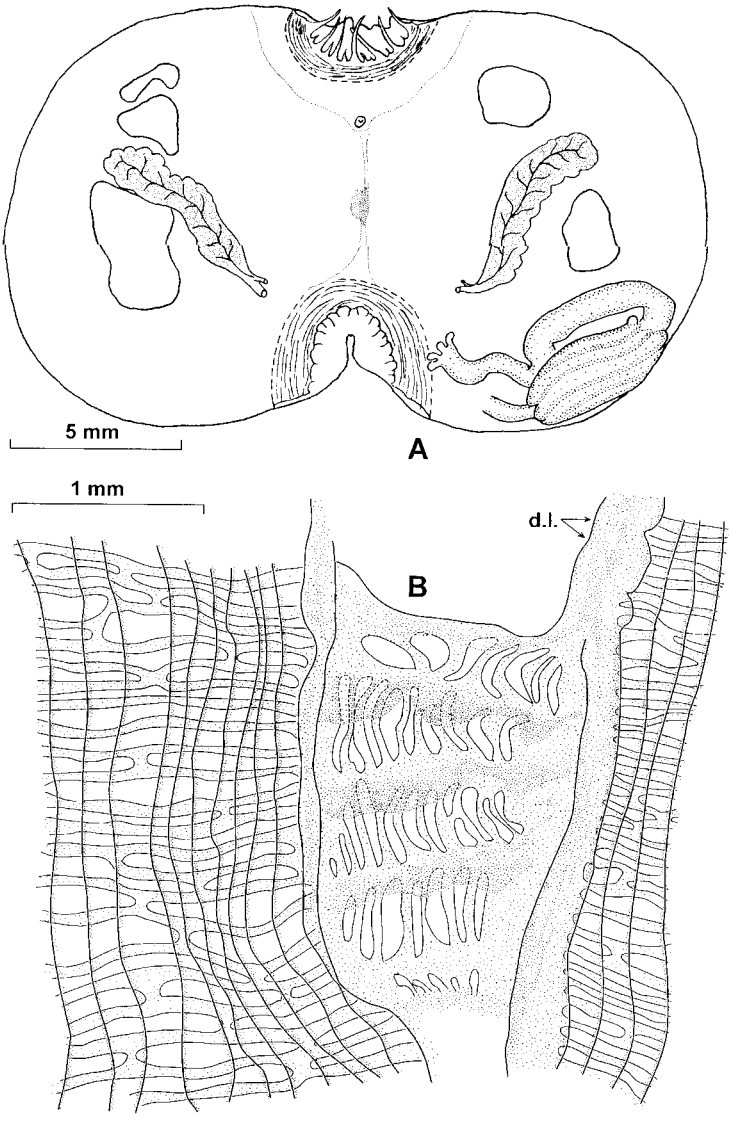

FIG. 15. *Bathystyeloides magnus* sp.n.: (A) holotype opened ventrally; (B) dorsal part of the branchial sac, lamellae connecting dorsal lamina (d.l.) and the closest longitudinal vessel are dissected to show longitudinal stigmata.

Material examined. St. 1237, 4850 m, 12 specimens; st. 1315, 2030–2120 m, one specimen; st. 1335, 4395 m, four specimens; st. 1357, 5540 m, nine specimens; st. 1358, 5020 m, 13 specimens; st. 1389, 5140 m, eight specimens. Holotype KIE 1/923 (st. 1357).

Description. The individuals are up to 17 mm in greatest diameter (the holotype measures 16 mm). The body is oval and somewhat depressed. The test is covered by branched processes, which are sparse in some specimens, but crowded in others, especially on the ventral and lateral surfaces of the body. Test processes have sparse sediment attached or are completely devoid of foreign matter. Apertures are on the tops of wide conical elevations on the upper surface of the body.

The body wall has distinct radial and circular siphonal muscles. The holotype has 14 flattened branchial tentacles arising from a high velum. The small dorsal tubercle has a U-shaped or simple, transverse, slit-like opening. The prepharyngeal band has no distinct dorsal V. The neural ganglion is halfway between the two siphons, and well removed from the dorsal tubercle.

In the holotype the branchial sac has about 70 internal longitudinal vessels on each side. A deep inverted fold is to the right of the dorsal lamina, protruding out from the branchial cavity. The branchial stigmata are transverse, with the exception of those on the inverted fold which are longitudinal and arranged in several transverse rows (figure 15B).

The gut forms a simple, narrow and usually closed loop. The long stomach has about 11 longitudinal folds and a small straight caecum. The intestine is short but sometimes, especially in large specimens, it has irregular curves, that appear to be the result of contraction. The anal border has several distinct lobes.

One gonad is on each side of the body. Male follicles are along both sides of the long ovary, and between it and the body wall. Male and female openings are close to each other on the distal end of the ovary. Usually one or two large endocarps are on each side of each gonad, but occasionally only one is posterior to the gonad on each side of the body.

A high atrial velum has thin atrial tentacles arising from its edge.

Remarks. The present species resembles *B. anfractus* in its numerous longitudinal branchial vessels and longitudinal stigmata on the right side of the dorsal lamina. It is distinguished from the latter species by the widely separated neural ganglion and dorsal tubercle.

It also resembles the widely distributed *B. enderbyanus* (Michaelsen, 1904), from which it is distinguished by its longitudinal stigmata in the inverted fold. However, owing to the position of this fold, projecting out into the atrial cavity, it is possible that sometimes it has been overlooked, and some specimens recorded as *B. enderbyanus*, particularly those from the Tasman Sea (Millar 1959), may belong to *B. magnus* sp.n.

Bathyoncus mirabilis Herdman, 1882
(Figure 16)

Bathyoncus mirabilis Herdman, 1882: 165; Kott, 1969a: 126; Monniot and Monniot, 1985b: 30.
Bathyoncus herdmani Michaelsen, 1904: 228; Monniot and Monniot, 1973: 443.

Material examined. St. 1320, 2800 m, one specimen.

Description. The specimen has a pear-shaped body 8 mm high and 5 mm diameter on a short, broken stalk. The thin test is covered by fine sand. The apertures

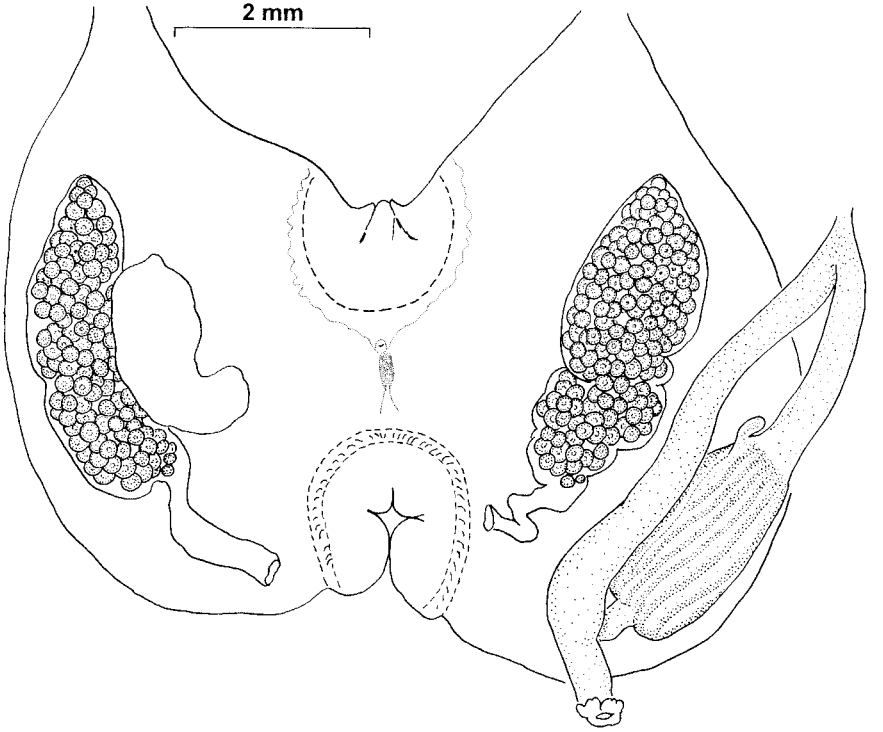

FIG. 16. *Bathyoncus mirabilis* Herdman, 1882.

are on the side of the head, the branchial one closer to the stalk and the atrial above it. There 19 short and thick branchial tentacles are of two size orders. The prepharyngeal band has one wide lamella and forms a shallow V around the small dorsal tubercle. The neural ganglion is just posterior, and close, to the dorsal tubercle. The branchial sac is damaged, but at least 11 (or a few more) longitudinal vessels are on the right and about nine on the left. The gut forms a narrow straight loop. The large cylindrical stomach has well-marked internal longitudinal folds and a small caecum. The anus has four primary lobes, each with three or four secondary lobules. The one gonad on each side of the body is large and voluminous. Large and numerous male follicles are beneath the ovary. The oviduct is long and opens close to the atrial orifice. Sperm ducts are seen very indistinctly; the male opening is apparently close to the oviduct opening. One large endocarp situated on the right side of the body, no endocarps on the left. There is a ring of minute atrial tentacles.

Remarks. The species is distributed around the Antarctic continent and in the Atlantic Ocean.

Monandrocarpa abyssa sp.n.
(Figures 17, 18)

Material examined. St. 1295, 4370–4330 m, three specimens; st. 1320, 2800 m, 60 specimens. HOLOTYPE KIE 1/922 (st. 1320).

Description. The specimens, described by the collector as 'bubbles on the stones', are up to 3 cm long, with a large egg-shaped, oval or nearly spherical head tapering abruptly to a stalk, firmly attached to the stones by a flat expansion of the

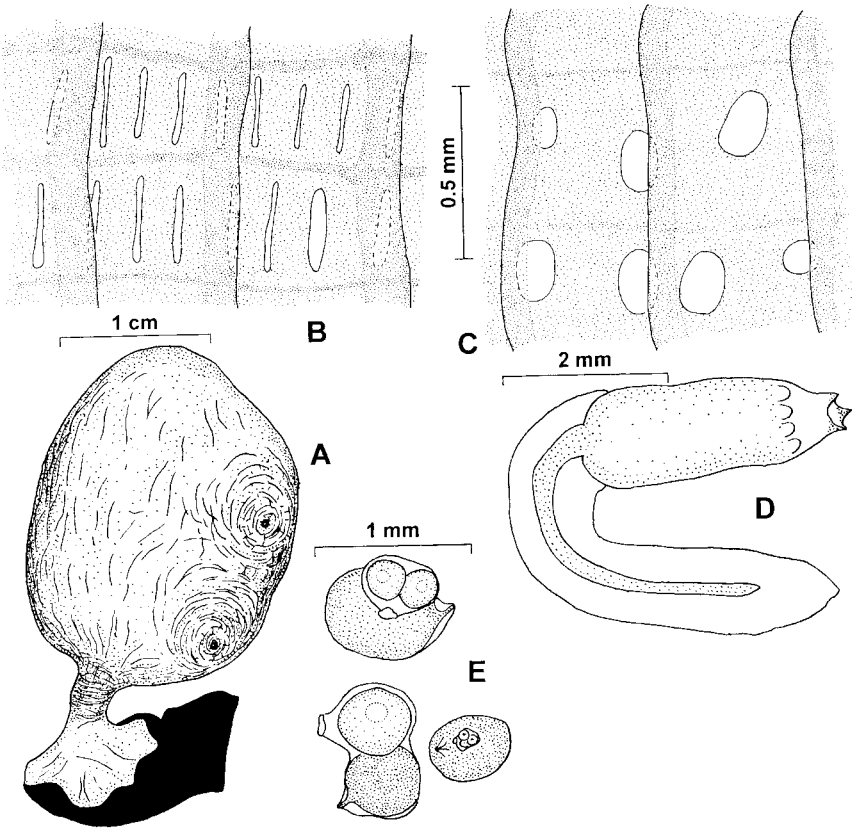

FIG. 17. *Monandrocarpa abyssa* sp.n.: (A) external appearance; (B) branchial sac of the holotype; (C) branchial sac of other specimen; (D) larva; (E) gonads.

test. One specimen was found living inside a damaged and empty test of *Culeolus*. Neither root-like processes of the test, nor connecting stolons were detected. The stalk is shorter than half of the head length, it is either cylindrical or with the lower end wider than the upper. Small, sessile and inconspicuous apertures are on the side of the head, the atrial one up to halfway down its length and the branchial aperture behind it and closer to the stalk. The test is naked, thin but hard and rigid, smooth and transparent in well-expanded specimens, and opaque and wrinkled in contracted ones.

The body wall is extremely thin and delicate, and extends into the stalk. Body muscles are thin and inconspicuous. About 50 long branchial tentacles arise from a low velum. The prepharyngeal band forms a wide, shallow V around the oval dorsal tubercle with its longitudinal slit-like opening. The neural ganglion is posterior and close to the dorsal tubercle. The dorsal lamina is plain-edged and high. The branchial sac has two high folds on each side. The branchial formula is E5(8)5(11)DL(10)6(9)6E. Internal longitudinal vessels are high, they are crowded on the folds and regularly spaced between them. The stigmata are small and narrow to oval (figures 17B,C), some specimens having all stigmata oval and sparse, or with oval stigmata only on a small part of the branchial sac, or with all stigmata

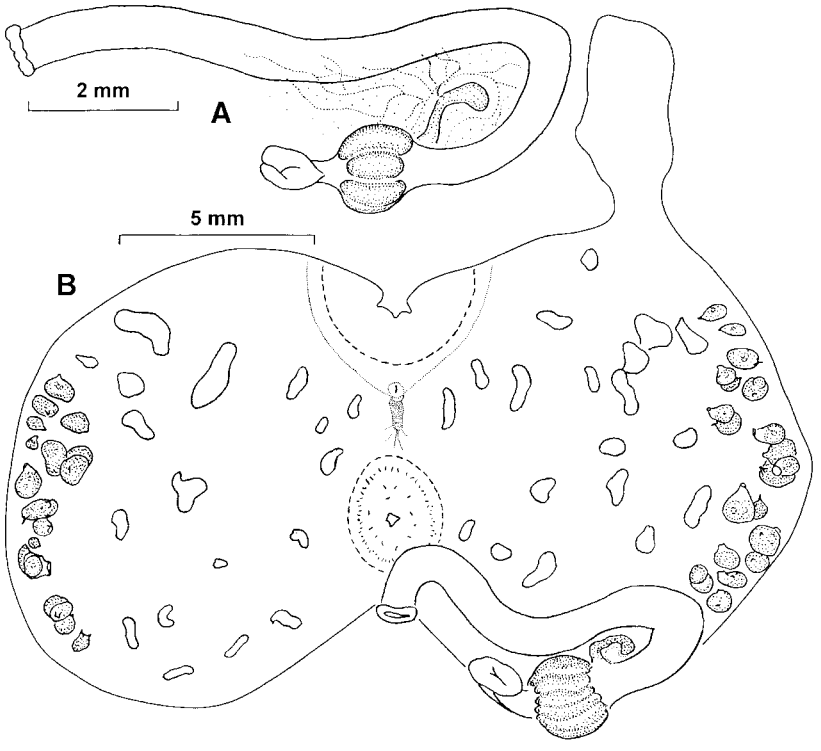

FIG. 18. *Monandrocarpa abyssa* sp.n.: (A) holotype opened ventrally; (B) gut loop of other specimen.

longitudinal. Up to four stigmata per mesh are between the folds and up to 12 between the dorsal lamina and first longitudinal vessel.

The gut forms a narrow straight loop, a secondary loop being shallow or absent. The oesophagus is short and the short, rounded stomach has six to 14 high folds and a long curved caecum. The intestine is long and the anus has a smooth or indistinctly lobed margin.

Ten to 30 gonads on each side of the body arranged in one to three irregular rows along the endostyle. Each gonad has a single large male follicle beneath the ovary and the male duct is short, opening apart from the opening of the oviduct. The ovary contains one to four oocytes.

Endocarps are small, numerous and fairly evenly distributed. Numerous minute atrial tentacles are on the atrial velum and sparsely distributed around the atrial orifice.

Up to three large, tailed larvae were found in several specimens. The trunk is 1.1–1.3 mm in diameter and 2.6–3.2 mm long, the tail is longer. Otolith and ocellus absent. Eight short lateral ampullae are indistinctly seen in the largest larvae.

Remarks. Kott (1985: 210) defined *Monandrocarpa* as the genus containing 'solitary styelids with hermaphrodite gonads that have either a single male follicle or a single pair' and placed the genus in the Styelinae. The vegetatively-reproducing species with similar gonads she placed in the genus *Eusynstyela* (subfamily Polyzoinae). Monniot and Monniot (1972) refer to *Monandrocarpa* and *Eusynstyela* as subgenera of the genus *Polyandrocarpa* (subfamily Polyzoinae); according to them

Polyandrocarpa (*Monandrocarpa*) has one testis in each gonad and *Polyandrocarpa* (*Eusynstyela*) has two. Kott (1985) refers to the absence of any trace of vegetative reproduction in the species, which she placed in *Monandrocarpa*, while Monniot and Monniot (1987) pay attention to the similarity in internal features between the species with and without ability for vegetative reproduction. They refer to Millar's (1975) opinion that *Polycarpa simpligona* Millar (= *Monandrocarpa plana* (Kott)) shows how compound species could have lost the power of budding.

The present species shows no signs of a capability for vegetative reproduction. Even when several specimens grow on one stone, they are widely separated and are not connected by stolons (it is clearly visible on clear surfaces of the stones, uncovered by sediments). In our opinion it belongs to Styelinae, rather than to Polyzoinae.

Kott (1985) recognized three species of *Monandrocarpa*, *M. tarona* (Monniot and Monniot, 1987) and the present species increasing this number to five.

The present deep-water species differ from other species of the genus in many significant characters, including shape of the body, clear and generally smooth test, presence of only two branchial folds.

Polyzoa opuntia Lesson, 1830

Polyzoa opuntia Lesson, 1830: 437; Kott, 1954: 147 (synonymy); Monniot and Monniot, 1983: 66.

Material examined. St. 1294, 320–200 m, one colony.

Remarks. This well-known species is widely distributed in Subantarctic waters.

Botrylloides perspicuum Herdman, 1886

Botrylloides perspicuum Herdman, 1886: 45; Kott, 1985: 278 (synonymy).

Material examined. St. 1343, 160–170 m, one specimen.

Remarks. This species was previously recorded from the Red Sea, Indonesia, the Philippines and from waters around Australia, including Tasmania.

Pyura elongata Tokioka, 1952

Pyura elongata Tokioka, 1952: 136; Millar, 1975: 311; Kott, 1985: 299 (synonymy).

Material examined. St. 1343, 160–170 m, three specimens.

Remarks. The specimens are small. They have circular scale-like thickening on the test, small siphonal spines corresponding to those figured by Millar (1975), simplified branchial tentacles, six branchial folds, an open gut loop without endocarps, and correspond closely to the previous description of the species. The species has a wide distribution from Hong Kong and Indonesia to southern Australia and Tasmania. All the previous records were from depths less than 15 m.

Pyura multiruga Monniot and Monniot, 1982

Pyura multiruga Monniot and Monniot, 1982: 116.

Material examined. St. 1320, 2800 m, eight specimens.

Description. The specimens are nearly globular and only slightly depressed, up to 45 mm in diameter. The test is naked except for bunches of short hair-like processes at the base. About 30 large branchial tentacles are much branched. The dorsal lamina has more than 70 crowded and sharply pointed languets. The branchial sac has eight or nine folds on each side with up to 20 internal longitudinal vessels

on each fold and one, or rarely two, vessels between the folds. The gut forms an open loop. The right gonad is better developed than the left one, the latter having only two small lobes. Several large, upright endocarps are on the pole of the gut loop and on each lobe of the gonad. Endocarps are not present on other parts of the body wall.

Remarks. The species was known only from the original description, based on a large number of specimens from about 70°S, 171–172°E, from 2273 and 2429 m. The present specimens from 65°S correspond exactly to the original description. This abyssal species is characterized by the large number of branchial folds and by the unequal development of gonads.

Pyura spinosa (Quoy and Gaimard, 1834)

Ascidia spinosa Quoy and Gaimard, 1834: 615.
Pyura spinosa: Kott, 1985: 327 (synonymy).

Material examined. St. 1343, 160–170 m, two specimens.

Remarks. The specimens correspond closely to Kott's (1985) description. The species is characterized by the presence of large crowded calcareous spicules in the test. Its range is around the southern half of Australia.

Pyura pilosa Monniot and Monniot, 1974
(Figure 19)

Pyura pilosa Monniot and Monniot, 1974b: 97; 1983: 97 (synonymy); Millar, 1982: 86.
Pyura jacatrensis (not Sluiter, 1890). Kott, 1954: 127; Millar, 1960: 125.

Material examined. St. 1293, 87 m, two specimens.

Description. Specimens are about 3 cm in diameter. The test is covered by a thick coat of sand and relatively large stones. The siphonal spines are 90–150 μ long. External circular muscles are present around the siphons and around the whole dorsal half of the body. Internal longitudinal muscles radiating from the siphons reach the mid-ventral line of the body and divide into several branches close to the endostyle. The 20 branchial tentacles have only small branches of the first order. The prepharyngeal band forms a deep dorsal V around the large dorsal tubercle, which in one specimen has a C-shaped opening, and in others a wide, irregular, longitudinal opening (figure 19C). The dorsal lamina is long, with about 35 short, pointed languets. The branchial sac has six folds on each side, with 10–20 longitudinal vessels on each and four vessels between the folds. The gut forms an open loop. A row of several arborescent liver diverticula with terminal lobules is in the pyloric region. Gonads are characteristic, having a central tubular ovary and more or less well separated rounded lateral sacs containing mainly male follicles. Endocarps are not present.

Remarks. The original description of the species was based on a single specimen from Kerguelen Island. Monniot and Monniot (1974b) treated *Pyura jacatrensis*: Kott, 1954 from Macquarie Island and Kerguelen as being conspecific with *P. pilosa*. Millar (1982) described numerous specimens from Macquarie Island as *P. pilosa* and indicated certain differences in the arrangement of the test spines, shape of dorsal tubercle and curvature of gonads between the material from Kerguelen and from Macquarie Island, which he considered to be intraspecific.

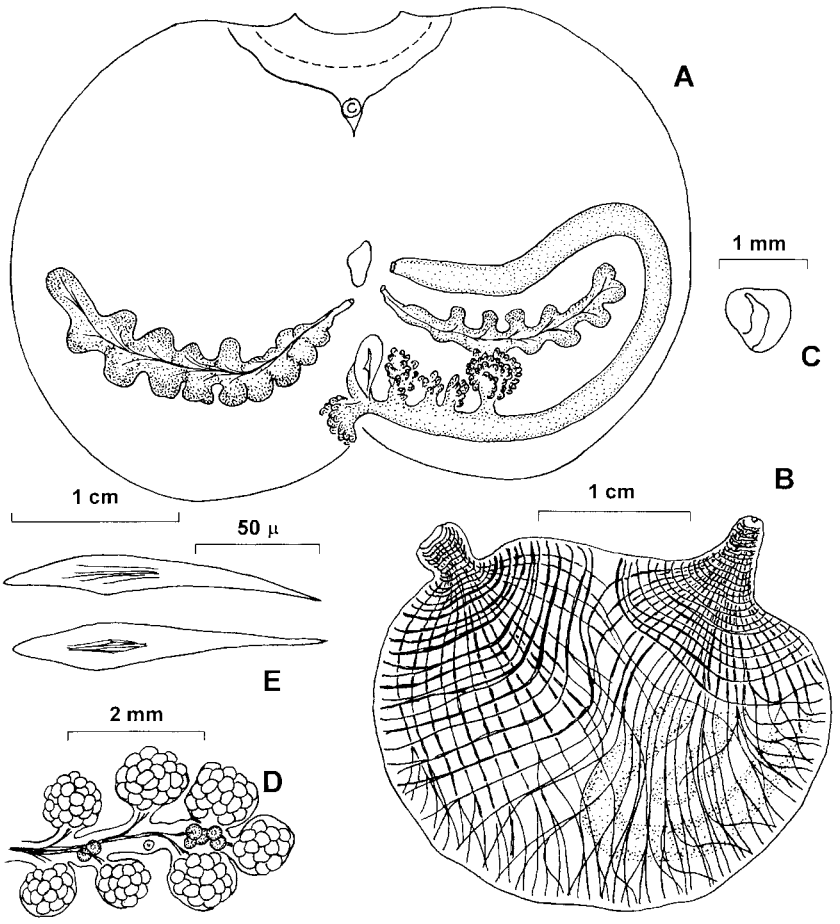

FIG. 19. *Pyura pilosa* Monniot and Monniot, 1974: (A) specimen opened ventrally; (B) body muscles; (C) dorsal tubercle; (D) detail of gonad; (E) siphonal spines.

Culeolus anonymus Monniot and Monniot, 1976
(Figure 20B)

Culeolus anonymus Monniot and Monniot, 1976c: 645; 1982: 121.

Material examined. St. 1299, 5760–5460 m, three specimens.

Description. Two of the three newly recorded specimens are damaged. The third is in more or less good condition, and the following description is based on this specimen. The body is about 5 cm long; the stalk is about 70 cm long and 1–1.5 mm in diameter. The stalk has a firm central axis consisting of a horny trabeculum, which externally looks like an irregular network of dark and light lines. The test is covered with low hemispherical papillae, clearly seen as light spots on the dark-brown surface of the body. A row of large crowded papillae encircles the posterior end of body at the level of the atrial aperture.

Body muscles form a rather regular network, without a particular concentration of circular fibrils around the siphons. About 16 branchial tentacles have primary and secondary branches. The prepharyngeal band runs close to the tentacles and forms a distinct V around the large dorsal tubercle. The branchial sac has five folds

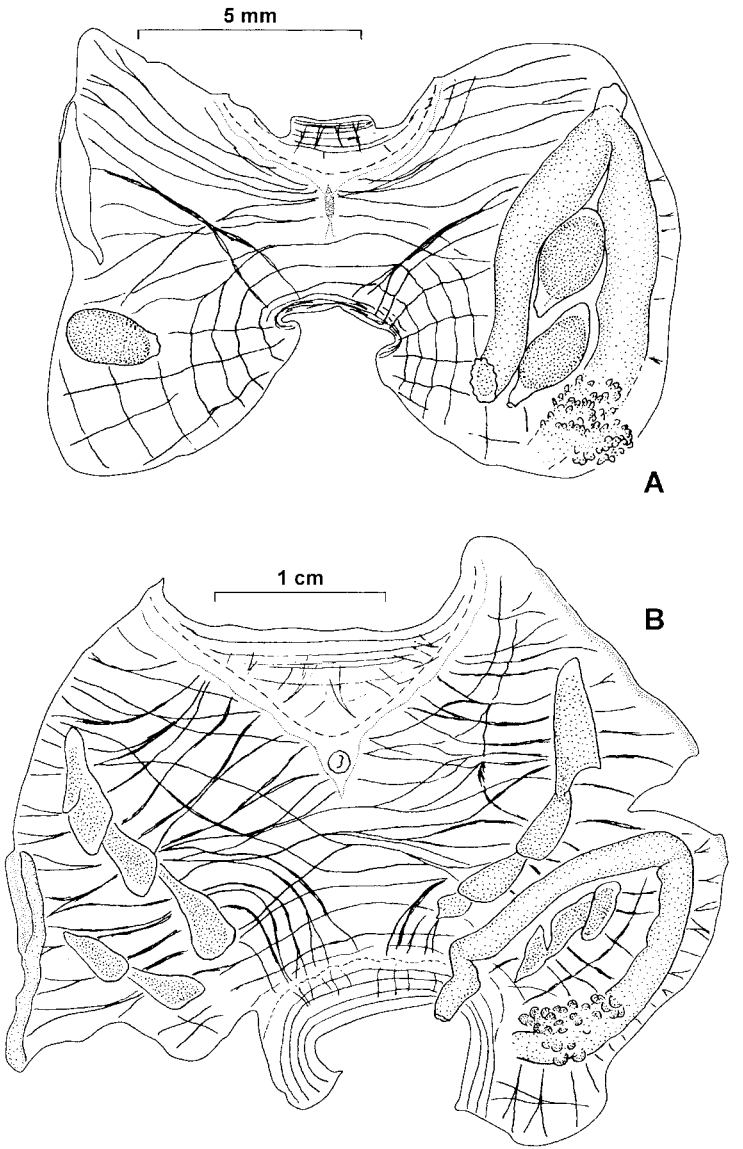

FIG. 20. (A) *Culeolus recumbens* Herdman, 1881; (B) *Culeolus anonymus* Monniot and Monniot, 1976.

on each side with eight to eleven internal longitudinal vessels on each fold and three to five vessels in each interspace. The gut forms an open loop and is not voluminous. Two gonads on each side of the body; on the left, one being inside and the other outside the gut loop. Each gonad consists of three or four long triangular lobes. A tubular heart lies on the right side of the body along the endostyle. Endocarps were not detected. Spicules are present in all tissues, but are especially crowded in the endostyle, wall of the heart, stomach and hepatic diverticula and in the dorsal tubercle and prepharyngeal groove.

Remarks. The specimens differ somewhat from others previously recorded in having a long stalk and crowded spicules in the internal tissues, although the shape of the gonads is identical to those figured by Monniot and Monniot (1982).

This species is known from the Argentine basin, western Antarctica and the Kermadec Trench.

Culeolus recumbens Herdman, 1881
(Figure 20A)

Culeolus recumbens Herdman, 1881: 85; 1882: 107; Monniot and Monniot, 1982: 122; 1991: 423.

Material examined. St. 1264, 2010 m, two specimens; st. 1265, 680 m, one specimen.

Description. The stalk is 60–80 mm long, the body 10–13 mm. Both are densely covered by sediments. An arc of small papillae is on the ventral half of the posterior end of one specimen only. Widely spaced muscle bands form an open network over the whole body. The anterior, obliquely directed, radial muscle arising from the atrial orifice on each side of the body is thicker than the others. There are about 12 branchial tentacles. The small dorsal tubercle has a simple slit-like opening. The prepharyngeal band crosses the neural ganglion and forms a shallow dorsal V. The branchial sac is ejected from the atrial orifice and it is not possible to count the number of folds. The gut forms a voluminous simple loop occupying the ventral half of left side of body. One or two compact gonads in the gut loop, and one or two are on the right side of the body. Testicular follicles form a dense oval mass and completely cover the ovary. A rather large, elongated and flattened endocarp lies along the endostyle in the anterior half of the right side of the body, and a smaller endocarp is on the pole of the gut loop.

Remarks. The sandy test and compact gonads are characteristic for the species. The present specimens agree with previous descriptions, but have fewer gonads. The presence of endocarps, mentioned by Monniot and Monniot (1991), is confirmed here.

Culeolus recumbens was previously recorded from the south-western and south-eastern Indian Ocean and New Caledonia. The present record from the north of New Zealand extends the known bathymetric range of the species, previously known from depths greater than 1590 m.

Molgula delicata Monniot and Monniot, 1991
(Figure 21)

Molgula delicata Monniot and Monniot, 1991: 426.

Material examined. St. 1276, 1100–1200 m, five specimens; st. 1277, 570 m, one specimen; st. 1281, 1026 m, six specimens.

Description. Body almost spherical, to 9 mm in diameter, covered by hair-like processes with adhering sand and foraminiferans. Apertures on short siphons are quite close to one another in the middle of the upper surface. Fine circular muscles surround the siphons and short longitudinal muscles radiate from them. A long straight muscle band passes across the mid-dorsal line in the intersiphonal region. About 15 large branchial tentacles alternate with about 10 smaller ones. Dorsal tubercle small, with longitudinal slit-like opening. Dorsal lamina with smooth margin. Six branchial folds are present on each side,

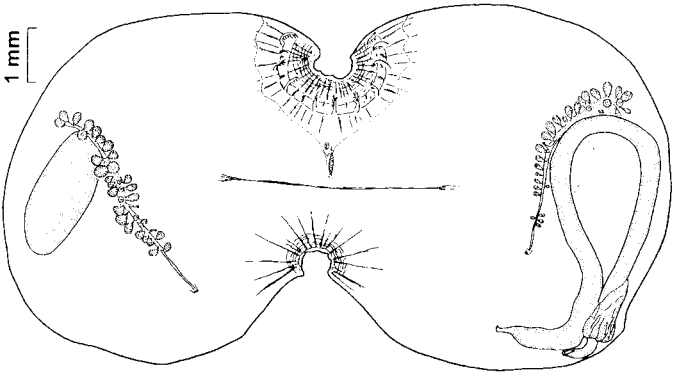

FIG. 21. *Molgula delicata* Monniot and Monniot, 1991.

internal longitudinal vessels in one specimen distributed as follows: E(9)1(6)1(8)2(7)1(8)1(6)1DL1(7)1(9)1(10)1(7)1(8)1(6)E.

Stigmata in square spirals are arranged in seven transverse rows.

Gonads are long and narrow, the right one lying at an angle to the oval renal sac, its proximal end bending around the anterior part of the renal sac; with the proximal half of left gonad in contact with the anterior half of the gut loop. Both ovaries poorly developed, each containing only a few oocytes. Oviducts are relatively long, but open far from the atrial orifice. Pear-shaped unbranched male follicles are distributed along sides of the ovary. There are two vasa efferentia opening on the mesial surface of the ovary on the right gonad, but only a single duct opening on the left.

Remarks. Specimens originally described by Monniot and Monniot (1991) are larger and have better developed body muscles, more numerous longitudinal branchial vessels and several vasa efferentia opening on each gonad. In other features, including the shape and position of gonads and the presence of the straight muscle band running across the intersiphonal area, the present species corresponds well with the original description.

The species was recorded previously only from New Caledonia.

Molgula pulchra Michaelsen, 1900
(Figure 22)

Molgula pulchra Michaelsen, 1900: 128; Millar, 1982: 97 (synonymy).

Material examined. St. 1293, 87 m, one specimen.

Description. Body about 1 cm high, nearly rectangular in outline and laterally flattened. The test is covered with sand and broken shell. The branchial sac has seven folds, the branchial formula is: E(3) (3) (4) (4) (4) (4) (2)DL(2) (3) (3) (4) (4) (4) (2)E.

The dorsal lamina has a dentate margin. The free end of the vas deferens on the right gonad is divided into two branches. The shape and position of the gut loop and the compact gonads with convoluted sperm ducts (figure 22B) are characteristic of the species.

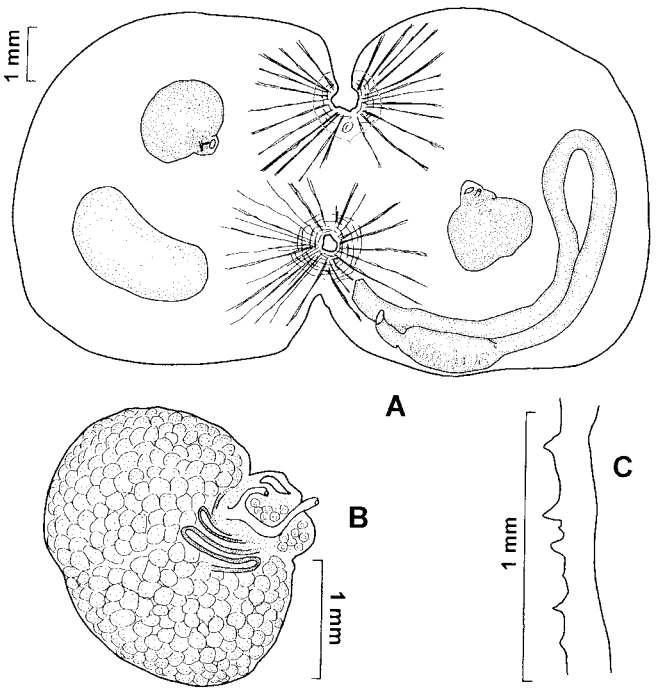

FIG. 22. *Molgula pulchra* Michaelsen, 1900: (A) specimen opened ventrally; (B) gonad; (C) dorsal lamina.

Remarks. The specimen agrees with the previous descriptions, but it has a dentate rather than plain margin on the dorsal lamina. The presence of two male openings on the right gonad is also an unusual feature for this species.

The species is widely distributed in Antarctic and Subantarctic waters.

Molguloides glans Monniot, 1978

Molguloides glans Monniot, 1978: 214.

Material examined. St. 1266, 390 m, one specimen, st. 1277, 570 m, ten specimens.

Description. Specimens are up to 15 mm in diameter and covered by hair-like processes with adherent sediments. Muscles are confined mainly to the dorsal area, their arrangement closely resembling those of *M. sulcatus* sp.n. The branchial sac is flat and has eight folds on each side. Stigmata are in rather irregular spirals, more like type B rather than D (see Monniot and Monniot, 1991: 429, figure 35). Some spirals show a tendency to be duplicated, but generally there are six transverse rows of spirals rather than eight. The ovary is small and globular, surrounded by branched testis follicles. A single male opening is on a short duct projecting from the middle of the mesial surface of the ovary.

Remarks. This identification is somewhat dubious, owing to the differences seen in the structure of the branchial sac. Also, the ovary in the original figure is elongated, rather than globular. The species was recorded previously only from Kerguelen Island.

Molguloides monocarpa (Millar, 1959)
(Figure 23)

Molgula immunda f. monocarpa Millar, 1959: 201.
Molguloides monocarpa: Monniot and Monniot, 1977: 321; 1991: 432.

Material examined. St. 1303, 4400–4420 m, three specimens.

Remarks. Specimens conform to previous descriptions. The main distinguishing character of the species is the presence of only one gonad, situated on the right side of the body. The gonad is compact and has a single male opening. The species was previously recorded from the southern Indian Ocean, the Kermadec Trench and New Caledonia.

Molguloides sulcatus sp.n.
(Figure 24)

Material examined. St. 1269, 720–710 m, eight specimens. HOLOTYPE KIE 1/918.

Description. The body is nearly globular or oval. The holotype is 22 mm in greatest dimension, but other specimens are smaller. The test is completely covered by short hair-like processes with adherent sand and foraminiferans. The siphons are not visible externally, being enclosed in a deep, median fold of the test that runs along the upper margin of the body. This fold often is obscured by test hairs and adherent sediments, but it was detected in all examined specimens. The branchial siphon has six lobes, and the atrial siphon has four lobes. The body wall is thin and transparent. Muscles are confined mainly to the dorsal area. The circular siphonal muscles are relatively thin and crowded. A band of short, thick transverse muscles crosses the mid-line between the siphons, and similar but thicker, parallel muscles

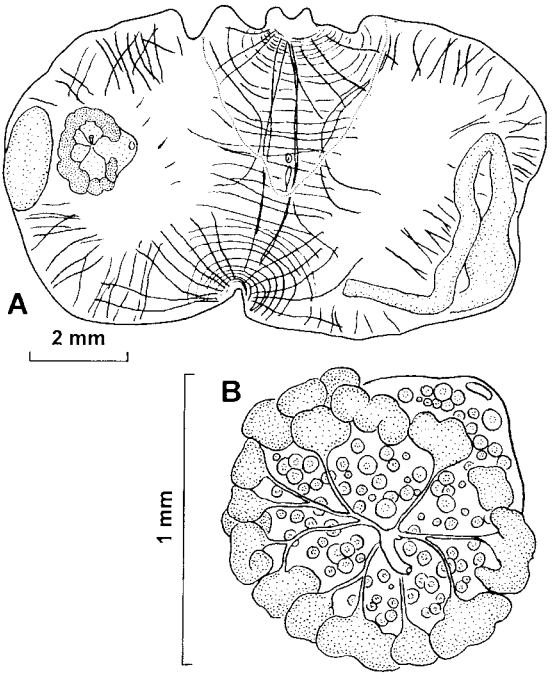

FIG. 23. *Molguloides monocarpa* (Millar, 1959): (A) specimen opened ventrally; (B) gonad.

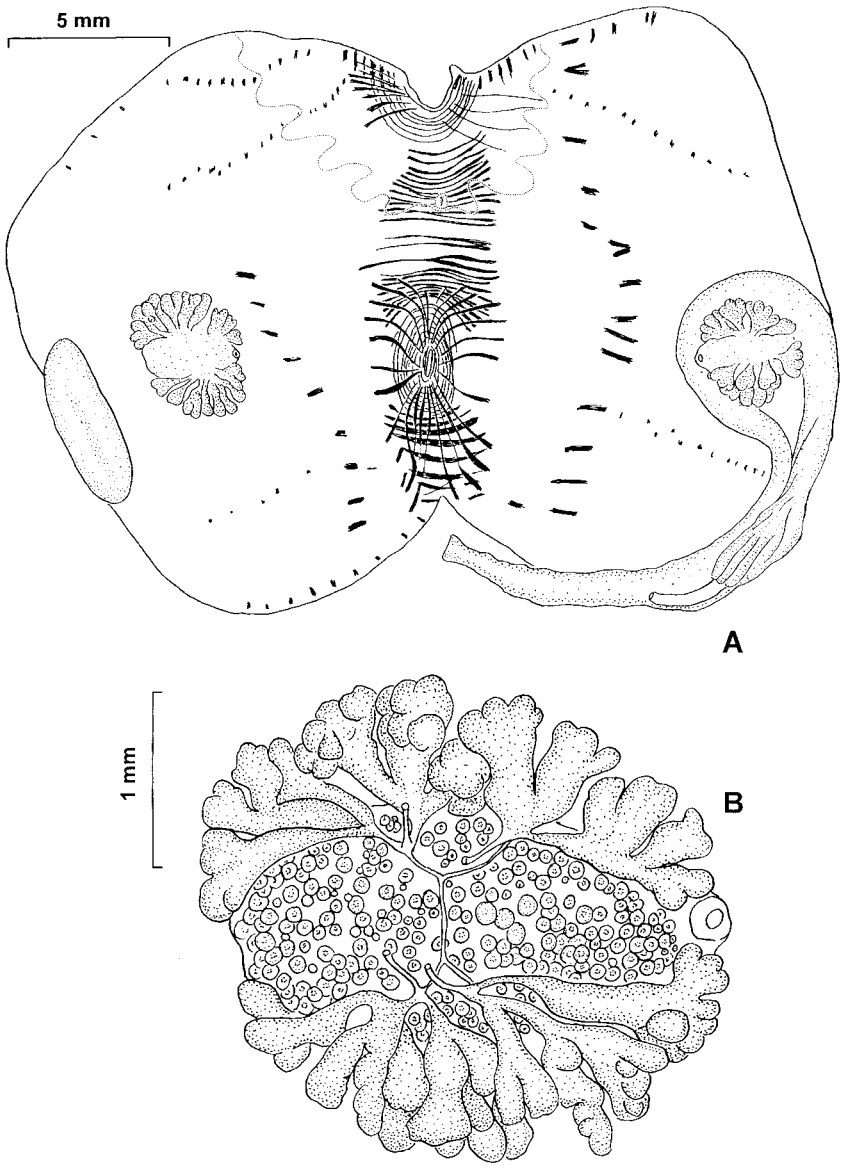

FIG. 24. *Molguloides sulcatus* sp.n.: (A) holotype opened ventrally; (B) gonad.

cross the mid-line just posterior to the atrial siphon. Radial muscles from the atrial siphon are better developed than those from the branchial siphon and they are short, thick and widely spaced. All these muscles are associated with the median fold of the test. A further series of thick but short and widely spaced longitudinal muscles forms a horizontal band across the middle of each side of the body. A series of thinner short muscles also radiates from each siphon.

About 25 tentacles of at least four size orders have up to four orders of branching.

The prepharyngeal band makes deep undulations associated with the branchial folds as in other species of the genus. The small dorsal tubercle has a simple

longitudinal slit-like opening. The dorsal lamina is a plain-edged membrane. The branchial sac has eight folds on each side. The branchial formula of the holotype is: E(11)(12)(11)(13)(13)(14)(14)(1)DL(5)(12)(14)(14)(14)(15)(13)(10)E.

Stigmata are in double, and seldom interrupted, spirals, each of up to eight coils, and the spirals are in six transverse rows, U-shaped stigmata occur ventrally to each spiral. The general arrangement of stigmata more or less corresponds to type B or B' (see Monniot and Monniot, 1991: 429, figure 35). Slightly projecting infundibula are developed only in the central part of spirals, otherwise the branchial sac is more or less flat. Small papillae are along the radial parastigmatic vessels at their junction with the stigmata. Papillae were not detected on the inner longitudinal or the transverse branchial vessels.

The gut forms a wide loop characteristic of the genus. The stomach has longitudinal folds and gradually tapers to the intestine. The rectum is long, ending in a plain-edged two-lobed anus. The left gonad is situated in the gut loop and the right is some distance from the renal sac. The oval ovary has a sessile opening directed to the atrial orifice. The axis of the left ovary is at a right angle to the axis of the primary gut loop. Testis follicles are arborescent, deeply subdivided into long lobes which have further subdivisions along their length and shallow indentations along their proximal ends. They are along both side of the ovary where they converge to one or more short ducts. The male ducts on one side of the ovary are joined to one another and to those on the opposite side by a narrow connecting duct across the surface of the ovary. Two to four male openings are on each gonad (the holotype has two on the left gonad and four on the right gonad).

Remarks. The main characteristics of the present species are shape of the gonads, arrangement of the body muscles and presence of the papillae on radial parastigmatic vessels. *Molguloides glans* Monniot, 1978 resembles the present species in the shape of the gonads and the arrangement of body muscles, but has a single male opening on each gonad and lacks papillae on radial parastigmatic vessels. These papillae were not mentioned in the original description and are absent in the specimens identified as *M. glans* in the present work. Similar papillae occur in *Molgula galatheae* Millar, 1959. All other species of the genus *Molguloides* with compact (globular or slightly elongated) ovary have a single male opening on each gonad.

Molguloides tonsus Monniot and Monniot, 1991
(Figure 25)

Molguloides tonsus Monniot and Monniot, 1991: 432.

Material examined. St. 1269, 720–710 m, eight specimens.

Description. The specimens are from 9 to 15 mm diameter. The test is covered by hair-like processes with adhering particles. The siphons are short and usually distinct, the branchial has six and the atrial four lobes. Body musculature is conspicuous and complex, consisting of circular and radial siphonal bands and long transverse muscles crossing the mid-ventral and -dorsal lines. Eight to ten especially thick longitudinal muscles radiate from the atrial siphon and end abruptly about halfway down each side of the body. There are about 16 branchial tentacles. The small dorsal tubercle halfway between the siphons has a simple longitudinal opening. The branchial sac has eight folds on each side and the branchial formula in 10 mm specimen is: E(10)(8)(12)(14)(14)(15)(16)(1)DL(7)(12)(14)(16)(11)(12)(11)(8)E.

Stigmata are in six transverse rows and similar to type B (see Monniot and

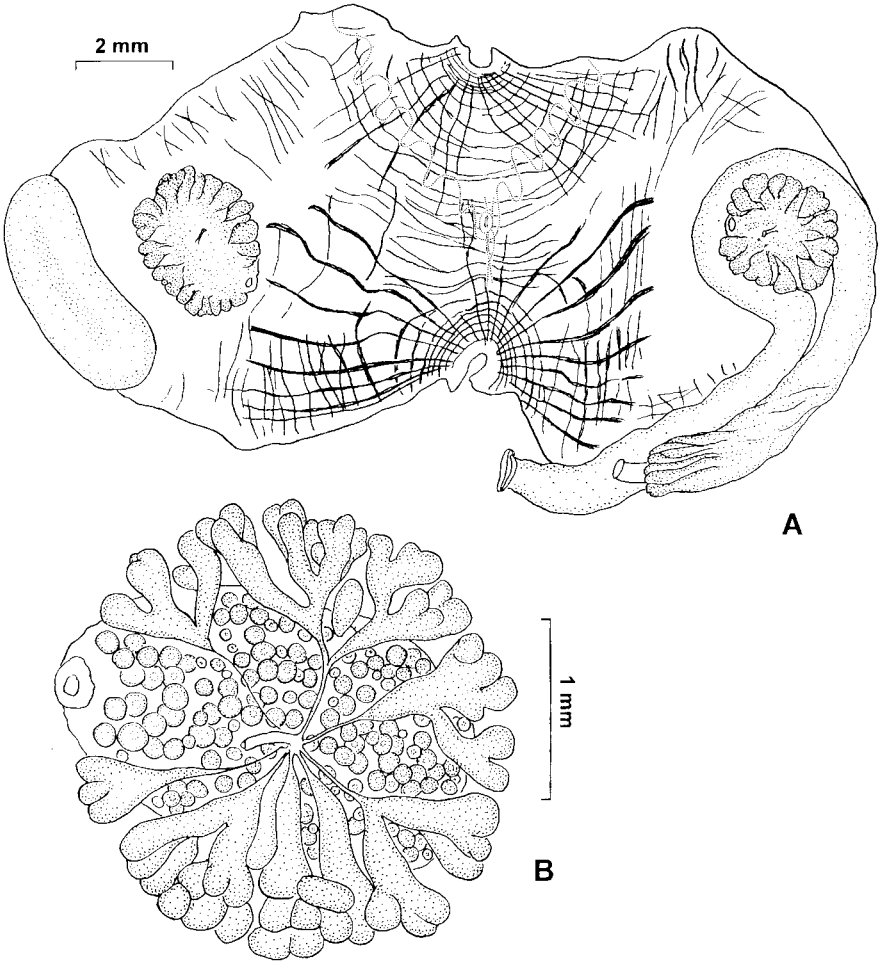

FIG. 25. *Molguloides tonsus* Monniot and Monniot, 1991: (A) specimen opened ventrally; (B) gonad.

Monniot, 1991: 429, figure 35). An oval ovary, surrounded by much branched testicular follicles is in the gut loop on the left and some distance from the renal sac on the right. A single short common sperm duct projects from the centre of the mesial surface of each ovary.

Remarks. The original description of this species was based on a single specimen from New Caledonia. The present specimens have better developed muscles, but their general distribution on the body wall agrees well enough with the original illustration (Monniot and Monniot, 1991: 433, figure 37A). The longer and more branched testis follicles in the present specimens may be related to the size of specimens.

Fungulus perlucidus (Herdman, 1881)
(Figure 26)

Culeolus perlucidus Herdman, 1881: 86; 1882: 111.
Fungulus perlucidus: Monniot and Monniot, 1976c: 655; 1977: 325; 1985c: 303.

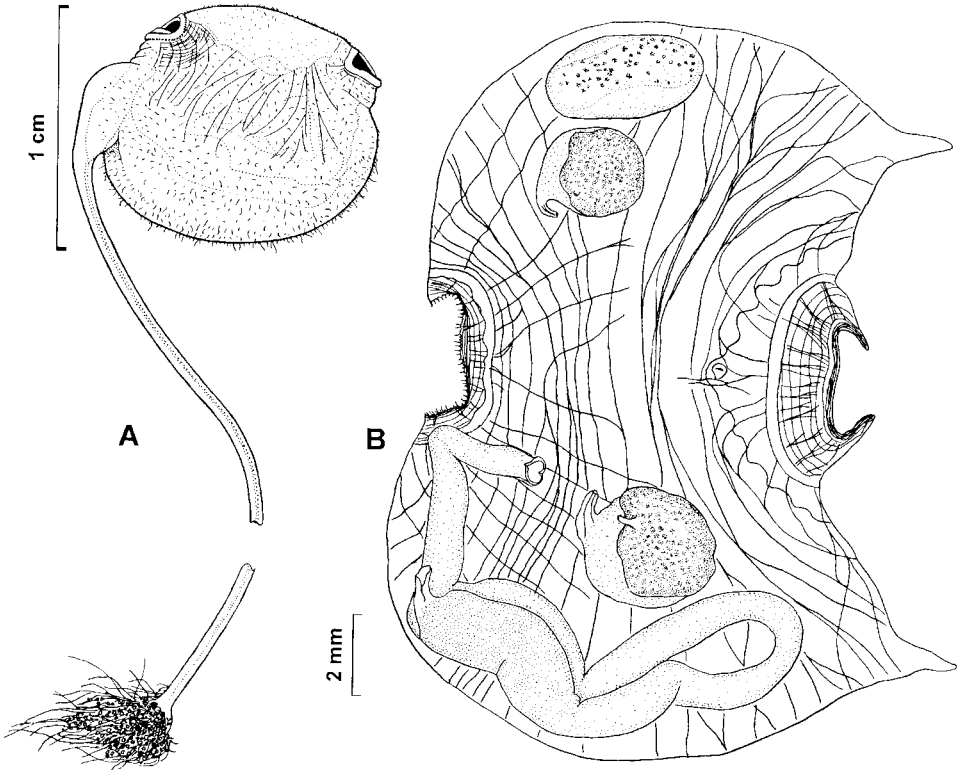

FIG. 26. *Fungulus perlucidus* (Herdman, 1881): (A) external appearance; (B) specimen opened ventrally.

Material examined. St. 1292, 5400 m, six specimens; ? st. 1320, 2800 m, two badly damaged specimens.

Description. The oval body is 11–13 mm in greatest diameter and the thin stalk up to 50 mm long. The transparent test is covered by minute processes, and the border of the atrial aperture is produced into numerous small pointed projections. Long and widely spaced muscle bands form an open network over whole body. About 25 large flattened tentacles have up to four orders of branching. The dorsal lamina is divided into long languets. The branchial sac lacks stigmata and has the structure usual for the genus. It has five transverse vessels and six branchial folds on each side, each with two longitudinal vessels. The gut forms a long, narrow, slightly curved loop. The stomach is large and smooth. One compact gonad on each side of the body is in the secondary gut loop on the left and anterior to the renal sac on the right. The spherical ovary is loosely attached to the body wall by a narrow area and the short oviduct is curved dorsally. Crowded testis follicles are on the upper surface of the ovary and the single male opening is on a short duct directed to atrial opening from the distal end of the testis.

Remarks. This rarely recorded species was previously known from the Argentine basin and the west and south Indian ocean.

Culeolus parvus Millar, 1970 was considered by Monniot and Monniot (1976c) to be conspecific with *Fungulus perlucidus*. Indeed, in most features *C. parvus* is similar to *F. perlucidus*, but it has only five branchial folds and the body muscles

are mainly around and between the siphons, the longitudinal muscles extending only 'for a short distance down the sides of the body' (Millar, 1970: 137). This species clearly belongs to *Fungulus*, rather than to *Culeolus*, but seems to be specifically distinct from *F. perlucidus*.

Minipera macquariensis sp.n.
(Figure 27)

Material examined. St. 1290, 5450–5410 m, two specimens. HOLOTYPE KIE 1/920.

Description. The two specimens are very similar externally. The triangular body is somewhat laterally flattened and about 2 mm in greatest diameter. Posteriorly the body narrows to a long, thin tapering test process with a few fine branches. Also a few hair-like processes arise directly from the test at the posterior end of the body. The test is otherwise naked and transparent. The apertures, at opposite ends of the horizontal upper surface, are directed away from one another. The border of the branchial aperture has four small and equal triangular lobes. Lobes of the atrial

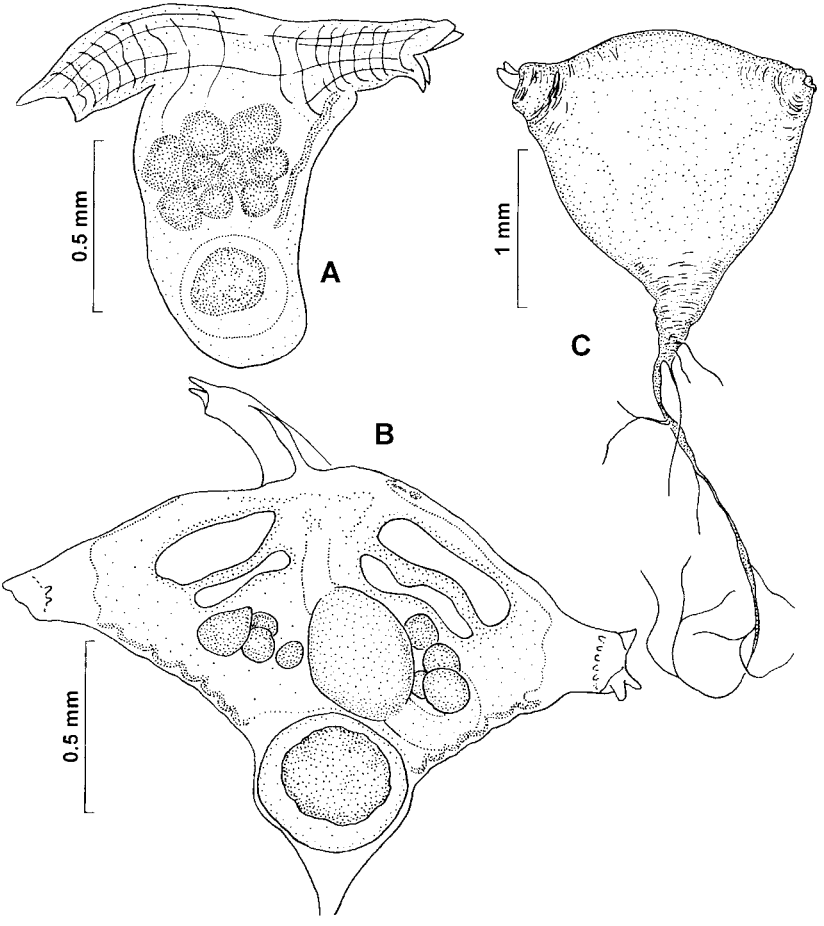

FIG. 27. *Minipera macquariensis* sp.n.: (A) paratype from the right side; (B) holotype opened along mid-ventral and dorsal lines; (C) holotype, external appearance.

aperture are unequal, the two dorsal lobes being much longer than the inconspicuous ventral ones.

The contracted body removed from the test is T-shaped (figure 27A). Thin and equally spaced circular and radial muscles are on the siphons. Some of the radial muscles extend from aperture to aperture, others are shorter. A ring of about eight small simple papilla-like tentacles are close to the branchial orifice. The prepharyngeal band makes a deep and narrow dorsal V around the dorsal tubercle and neural ganglion which are halfway between the siphons. The endostyle is long and undulating. The branchial sac has two large protostigmata on each side. Neither longitudinal vessels nor branchial papillae were detected.

The gut forms a simple, narrow and closed loop. The oesophagus is relatively long and the oval stomach is large and smooth-walled. The holotype has one gonad consisting of several large male follicles on each side, the left one on the gut loop. In another specimen a large male gonad consisting of numerous large follicles is on the right but a left gonad is not developed. A few small oval bodies seen very indistinctly in the gut loop of this specimen may be immature male follicles or oocytes, but otherwise an ovary was not detected in either of the specimens.

The large and almost globular renal sac containing a large spherical concretion is posterior.

Remarks. The genus *Minipera* is now known to contain four minute deep water species. *Minipera macquariensis* differs from the others in having a large, posteriorly situated renal sac. It resembles *M. pedunculata* Monniot and Monniot, 1974 in having only two protostigmata on each side, but is distinguished from it by the absence of papillae on the branchial sac, the presence of more than a single male follicle in each gonad, and in the presence of the gonad on both sides of the body. *Minipera papillosa* Monniot and Monniot, 1974 and *M. tacita* Monniot and Monniot, 1985 have more than two perforations on each side.

Monniot and Monniot (1991) reported a *Minipera* sp. from New Caledonia. It resembles *M. macquariensis* externally but is smaller. Its internal features are not known.

Asajirus indicus (Oka, 1913)

Hexacrobylus indicus Oka, 1913: 6.
Asajirus indicus: Kott, 1989: 521.
Hexadactylus indicus: Monniot and Monniot, 1990: 271 (synonymy).

Material examined. St. 1367, 2520–2755 m, one specimen.

Remarks. The specimen is in agreement with the description given by Monniot and Monniot (1990), but has a constriction in the intestine which may depend on the condition of the gut, although it was used by Monniot and Monniot (1990) to separate certain species.

Oligotrema lyra (Monniot and Monniot, 1973)

Gasterascidia lyra Monniot and Monniot, 1973: 457; 1990: 251.
Oligotrema lyra: Kott, 1989: 526.

Material examined. St. 1358, 5020 m, 14 specimens; st. 1349, 4464 m, one damaged specimen.

Remarks. The specimens are up to 8 mm in length, they have the characteristic branched branchial arms, large stomachs, two clumps of male follicles on each side

of the body and S-shaped tubular ovary. Other features are also in agreement with the several previous descriptions. This is the first record of the species from Australian waters.

Kott (1989) could not find a functional rectum in the large specimen she examined, and suggested that the rectum may not be functional in this species. This was not confirmed in the present specimens as a few faecal pellets were detected in the rectum in two of the 15 examined specimens and there is a distinct opening from the stomach into the rectum.

The specimen described by Kott (1989) shows certain differences from typical specimens of *O. lyra*. It is larger than other known specimens, has more numerous stigmata, lacks transverse (or circular) muscles ventrally and the position of the concretion vesicle is different. The location reported for this giant specimen (Kott, 1989) probably should be 119°44′W rather than 119°44′E.

Acknowledgements

The authors are grateful to Dr A. N. Mironov and Dr K. Tabachnik (Institute of Oceanology) for the material provided. This work was partly supported by personal grant No. 97–04–48067 from the Russian Foundation of Fundamental Research.

References

HARTMEYER, R., 1911, Die Ascidien der Deutschen Südpolar-Expedition, 1901 1903, *Deutschen Südpolar Expedition*, **12**, 403–606.

HERDMAN, W. A., 1881, Preliminary report on the Tunicata of the Challenger Expedition. Cynthiidae, *Proceedings of the Royal Society, Edinburgh*, **11**(3), 52–88.

HERDMAN, W. A., 1882, Report on the Tunicata collected during the voyage of H.M.S. *Challenger* during the years 1873–1876, part 1, Ascidiae simplices, *Report of the scientific results of the voyage of H.M.S. Challenger during the years 1873–76*, **6**(17), 1–296.

HERDMAN, W. A., 1886, Report on the Tunicata collected during the voyage of H.M.S. *Challenger* during the years 1873–1876, part 2, Ascidiae compositae, *Report of the scientific results of the voyage of H.M.S. Challenger during the years 1873–76*, **14**(38), 1–399.

KOTT, P., 1952, The ascidians of Australia. 1. Stolidobranchiata Lahille and Phlebobranchiata Lahille, *Australian Journal of Marine and Freshwater Research*, **3**(3), 206–333.

KOTT, P., 1954, Tunicata, Ascidians, *Reports of B.A.N.Z. Antarctic Research Expedition, 1929–1931*, **1**(4), 121–182.

KOTT, P., 1969a, Antarctic Ascidiacea. A monographic account of the known species based on specimens collected under U.S. Government auspices 1947 to 1963, *Antarctic Research Series*, **13**, 1–239.

KOTT, P., 1969b, A review of the family Agnesiidae Huntsman 1912; with particular reference to *Agnesia glaciata* Michaelsen, 1898, *Proceedings of the Linnean Society of New South Wales*, **93**(3), 444–456.

KOTT, P., 1985, The Australian Ascidiacea part 1, Phlebobranchia and Stolidobranchia, *Memoirs of the Queensland Museum*, **23**, 1–440.

KOTT, P., 1989, The family Hexacrobylidae Seeliger, 1906 (Ascidiacea, Tunicata), *Memoirs of the Queensland Museum*, **27**(2), 517–534.

KOTT, P., 1990, The Australian Ascidiacea, part 2, Aplousobranchia (1), *Memoirs of the Queensland Museum*, **29**(1), 1–226.

LESSON, R. P., 1830, Zoologie, in '*Voyage autour du monde sur La Coquille pendant 1882–1825*', **2**(1), 433–440.

MICHAELSEN, W., 1900, Die Holosomen Ascidien des Magalhaenisch-südgeorgischen Gebietes, *Zologica*, **12**(31), 1–148.

MICHAELSEN, W., 1904, Die Stolidobranchiaten Ascidien der deutschen Tiefsee Expedition, *Wissenschaftlichen Ergebnisse der Deutschen Tiefsee-Expedition*, **7**, 181–260.

MILLAR, R. H., 1955, Ascidiacea, *Reports of the Swedish Deep-Sea Expedition*, **2**(18), 223–236.
MILLAR, R. H., 1959, Ascidiacea, *Galathea Report*, **1**, 189–209.
MILLAR, R. H., 1960, Ascidiacea, *Discovery Reports*, **30**, 1–160.
MILLAR, R. H., 1970, Ascidians, including specimens from the deep sea, collected by R.V. 'Vema' and now in the American Museum of Natural History, *Zoological Journal of the Linnean Society*, **49**, 99–159.
MILLAR, R. H., 1975, Ascidians from the Indo-West-Pacific region in the Zoological Museum, Copenhagen (Tunicata, Ascidiacea), *Steenstrupia*, **3**(20), 205–336.
MILLAR, R. H., 1978, Ascidians from the Guyana shelf, *Netherlands Journal of Sea Research*, **12**(1), 99–106.
MILLAR, R. H., 1982, The marine fauna of New Zealand: Ascidiacea, *New Zealand Oceanographic Institute Memoir*, **85**, 1–117.
MONNIOT, C., 1978, Ascidies phlébobranches et stolidobranches du sud de l'Océan Indien, *Annales de l'Institut océanographique, Paris*, **54**(2), 171–224.
MONNIOT, C., 1994, Quelques ascidies récoltées par le M.S. 'Marion-Dufresne' (Campagne Jasus, Réunion et Brésil), *Vie Milieu*, **44**(3/4), 229–242.
MONNIOT, C. and MONNIOT, F., 1972, Clé mondiale des genres d'Ascidies, *Archives de Zoologie Expérimentale et Générale*, **113**(3), 311–367.
MONNIOT, C. and MONNIOT, F., 1973, Ascidies abyssales récoltées au cours de la campagne océanographique Biaçores par le 'Jean Charcot', *Bulletin du Muséum national d'Histoire naturelle, Paris*, (3), **121**, (Zool. 93), 389–475.
MONNIOT, C. and MONNIOT, F., 1974a, Ascidies abyssales de l'Atlantique récoltées par le 'Jean Charcot' (campagnes Noratlante, Walda, Polygas A), *Bulletin du Muséum national d'Histoire naturelle, Paris*, (3), **226**, (Zool. 154), 721–786.
MONNIOT, C. and MONNIOT, F., 1974b, Ascidies des Iles Kerguelen récoltées par P. M. Arnaud, *Tethys*, **5**(4), 715–734.
MONNIOT, C. and MONNIOT, F., 1976a, Quelques ascidies bathyales et abyssales du Sud-Est Atlantique, *Bulletin du Muséum national d'Histoire naturelle, Paris*, (3), **387**, (Zool. 269), 671–680.
MONNIOT, C. and MONNIOT, F., 1976b, Quelques espèces d'ascidies profondes du bassin du Surinam, *Bulletin du Muséum national d'Histoire naturelle, Paris*, (3), **387**, (Zool. 269), 663–670.
MONNIOT, F. and MONNIOT, C., 1976c, Tuniciers abyssaux du bassin argentin récoltes par l''Atlantis 2', *Bulletin du Muséum national d'Histoire naturelle, Paris*, (3), **387**, (Zool. 269), 629–662.
MONNIOT, C. and MONNIOT, F., 1977, Quelques ascidies abyssales du Sud-Ouest de l'Océan Indien, *Comité national française pour Recherche antarctique*, **42**, 305–327.
MONNIOT, C. and MONNIOT, F., 1982. Some Antarctic deep-sea tunicates in the Smithsonian collections, *Antarctic research series*, **32**, 95–130.
MONNIOT, C. and MONNIOT, F., 1983, Ascidies antarctiques et subantarctiques: morphologie et biogéographie, *Mémoires du Muséum National d'Histoire Naturelle, Paris*, (A), **125**, 1–168.
MONNIOT, C. and MONNIOT, F., 1984, Tuniciers benthiques récoltes au cours de la campagne Abyplaine au large de Madère, *Annales de l'Institut Océanographique, nouvelle série*, **60**(2), 129–142.
MONNIOT, C. and MONNIOT, F., 1985a, Ascidies profondes au large de Mayotte (Archipel des Comores), *Cahiers de Biologie Marine*, **26**(1), 35–52.
MONNIOT, C. and MONNIOT, F., 1985b, Nouvelles récoltes de Tuniciers benthiques profonds dans l'océan Atlantique, *Bulletin du Muséum national d'Histoire naturelle, Paris*, (4), **7A**, 5–37.
MONNIOT, C. and MONNIOT, F., 1985c, Tuniciers profonds de l'océan Indien: campagnes SAFARI du 'Marion Dufresne', *Bulletin du Muséum national d'Histoire naturelle, Paris*, (4), **7A**, 279–308.
MONNIOT, C. and MONNIOT, F., 1987, Les ascidies de Polynésie française, *Mémoires du Muséum National d'Histoire Naturelle, Paris*, (A), **136**, 1–155.
MONNIOT, C. and MONNIOT, F., 1990, Revision of the class Sorberacea (benthic tunicates) with descriptions of seven new species, *Zoological Journal of the Linnean Society*, **99**(3), 239–290.

MONNIOT, C. and MONNIOT, F., 1991, Tunicata: Peuplement d'ascidies profondes en Nouvelle-Calédonie. Diversité des stratégies adaptatives, in A. Crosnier (ed.), *Résultats des Campagnes Musorstom*, 8, *Mémoires du Muséum National d'Histoire Naturelle*, (A) **151**, 357–448.

MONNIOT, C., MONNIOT, F., and R. H. MILLAR, 1976, An account of six species of abyssal Styelidae (Ascidiacea), three of which are new species, *Deep-Sea Research*, **23**, 1187–1197.

OKA, A., 1913, Zur Kenntnis der zwei aberranten Ascidien Gattungen *Dicopia* Sluit und *Hexacrobylus* Sluit, *Zoologischer Anzeiger*, **43**, 1–10.

QUOY, J. and GAIMARD, P., 1834, Mollusques, in *Voyages de découvertes de l'Astrolabe 1826–29, Zoologie*, **3**, 559–626.

SLUITER, C. P., 1890, Die Evertebraten aus der Sammlung des Königlichen Naturwissenschaftlichen Vereins in Nederlandisch Indien in Batavia. Zugleich eine Skizze der Fauna des Java-Meeres mit Beschreibung der neuen Arten. Ascidiae simplices, *Natuurkundig Tijdschrift Nederlandsch-Indië*, **50**, 324–348.

SLUITER, C. P., 1905, Zwei merkwürdige Ascidien von der Siboga-Expedition, *Tijdschrift der Nederlandische Dierkundige Vereeniging*, (2) **9**, 325–327.

TOKIOKA, T., 1952, Ascidians collected by Messrs Renzi Wada and Seizi Wada from the pearl-oyster bed in the Arafura Sea in 1940, *Publications of the Seto Marine Biological Laboratory*, **2**(2): 91–142.

TRAUSTEDT, M. P. A., 1882, Vestindiske Ascidiae Simplices, Forste Afdeling. Phallusiidae, *Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn*, **1881**, 257–288.