

THE AUSTRALIAN ASCIDIACEA, SUPPLEMENT 2

PATRICIA KOTT

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Information from newly examined material and recently published reports supplements that in the continuing review of the Australian Ascidiacea (Kott 1985, 1990a, 1990b, 1992). Recorded ranges of *Sigillina fantasiana*, *Hypsistozoa distomoides*, *Polycitor obeliscus*, *Polycitorella coronaria*, *Exostoma ianthinum*, *Botryllus stewartensis*, and *Pyura rapaformis* are extended; the known depth range of *Pseudodiazona claviformis* increased; *Pycnoclavella aurantia*, *P. elongata*, *Distaplia prolifera* and *Eudistoma aureum* are now recorded from outside their type localities; new colour patterns and morphological variations are recorded for *Clavelina pseudobaudinensis*, *Pycnoclavella diminuta* and *P. elongata*; and larvae of *Pycnoclavella aurantia* and *Polycitor calamus*, described for the first time, are characteristic of their respective genera. A new species of the deep water genus *Protoholozoa* is from 7 to 15m off the southern Australian coast. A new species of *Cystodytes* has unusual spicules in a layer beneath the surface test, and one in *Polyandrocarpa*, indigenous to the central eastern Australian coast, forms colonies to a metre in maximum extent. A new *Cnemidocarpa* species has a large number of gonads, and another has only 3 branchial folds on each side.

Western Pacific species of *Ascidia* (1), *Ecteinascidia* (2), and *Pyura* (1), in the Australian fauna are found to have representatives in the component of the New Caledonian fauna previously supposed to be indigenous. The relationships and geographic range are discussed of a further 13 stolidobranch and phlebobranch species, including 4 believed to be pantropical, and abyssal *Asajirus indicus* and *Oligotrema psammites* of the Hexacrobrylidae.

□ Ascidiacea, Aplousobranchia, Phlebobranchia, Stolidobranchia, Protoholozoa, Hexacrobrylidae, Western Pacific.

Patricia Kott, Queensland Museum, PO Box 3300, South Brisbane, Queensland, 4101, Australia; 13 May, 1992.

Australian ascidians in the suborders Phlebobranchia, Stolidobranchia and Aplousobranchia (excepting the family Didemnidae) have been reviewed by Kott (1985, 1990a and 1992). Morphological, taxonomic, phylogenetic and geographic information additional to that in the first part (Kott 1985) is presented in an initial supplement (Kott 1990b). This, the second supplement, complements parts 1 and 2 (1985 and 1990a). This information is presented only when it expands known geographical range, the known morphological parameters of the taxon, or where new phylogenetic insights are available from newly examined material or recently published accounts of the western Pacific fauna, as in Nishikawa (1984, 1986), Monniot and Monniot (1987, 1990, 1991), and Monniot, C. (1987a,b, 1988, 1989, 1991a,b).

A number of Australia's tropical species are discussed here, specifically in relation to their affinities with New Caledonian populations. The ascidian fauna of the western Pacific has been relatively well studied as evidenced by the works – cited below and in Kott (1985, 1990a, 1990b) –

of Sluiter, Van Name, Tokioka, Nishikawa, Kott, Vasseur, Millar, and C. and F. Monniot. From these works it is clear that Fiji, the Tokhara Is in southern Japan, Indonesia, other western Pacific locations and tropical Australia share a common fauna which sometimes extends into the Indian Ocean (see Kott 1985, 1990a, 1992). In particular, the north eastern Australian coast and the Great Barrier Reef can be said to be part of the western Pacific region.

The reports of C. and F. Monniot (1987–91) on the ascidians taken in the French 'vaste programme d'exploration' (Monniot, C. 1987a, p. 3) around New Caledonia propose new species suggesting a larger indigenous fauna than has been found previously in this or any other western Pacific location. Comparison of a number of these species, however, with related ones in tropical Australia and other western Pacific locations has shown them not to be distinct. Differences reported between New Caledonian and other populations lie within the range of intraspecific variability that is a property of all biological material. This variability is associated with age

differences, intraspecific population differences, differences between genotypes, ecological differences in growth form or pigmentation, and differences due to artefacts associated with the collection and preservation of the material. The status of morphological differences has sometimes been difficult to determine where neither intraspecific variation nor the number of specimens examined is indicated. Thus, in some, but not all, cases intraspecific differences can be confused with the genetic differences indicating isolation and speciation.

A further problem in resolving some of these problems is the relationship between apparently conspecific populations in the tropical eastern Atlantic and western Pacific — where distance and other geographic barriers would appear to preclude gene flow (see *Ascidia archaia*, *Perophora multiclathrata*, *Polycarpa aurita*, and *Cnemidocarpa areolata*, below).

Museum registration numbers are given for all examined material. Abbreviations used are AM (Australian Museum), SAM (South Australian Museum), QM (Queensland Museum), MV (Museum of Victoria). For detailed data on distribution of each taxon the registers of relevant Australian Museums must be referred to.

The following taxa are discussed below:

DIAZONIDAE

- Rhopalaea crassa* (Herdman, 1880)
- Pseudodiazona claviformis* (Kott, 1963)

CLAVELINIDAE

- Clavelina pseudobaudinensis* (Kott, 1976)

PYCNOCLAVELLIDAE

- Pycnoclavella aurantia* Kott, 1990a
- Pycnoclavella diminuta* (Kott, 1957)
- Pycnoclavella elongata* Kott, 1990a

HOLOZOIDAE

- Sigillina fantasiana* (Kott, 1957)
- Sigillina grandissima* Kott, 1990a
- Distaplia prolifera* Kott, 1990a
- Hypsistozoa distomoides* (Herdman, 1899)
- Protoholozoa* Kott, 1969
- Protoholozoa australiensis* n.sp.

POLYCITORIDAE

- Cystodytes ramosus* n.sp.
- Polycitorella coronaria* F. Monniot, 1988
- Polycitor calamus* Kott, 1990a
- Polycitor obeliscus* Kott, 1957
- Eudistoma aureum* Kott, 1990a

- Exostoma ianthinum* (Sluiter, 1909)

ASCIDIIDAE

- Ascidia archaia* Sluiter, 1890
- Ascidia liberata* Sluiter, 1887

PEROPHORIDAE

- Perophora multiclathrata* (Sluiter, 1904)
- Ecteinascidia diaphanis* Sluiter, 1885
- Ecteinascidia nexa* Sluiter, 1904

STYELIDAE

- Cnemidocarpa amphora* n.sp.
- Cnemidocarpa areolata* (Heller, 1878)
- Cnemidocarpa intestinata* Kott, 1990
- Cnemidocarpa tribranchiata*, n.sp.
- Asterocarpa humilis* (Heller, 1878)
- Polycarpa contecta* (Sluiter, 1904)
- Polycarpa aurita* (Sluiter, 1890)
- Polyandrocarpa colemani* n.sp.
- Botryllus stewartensis* Brewin, 1958

PYURIDAE

- Pyura albanyensis* Michaelsen, 1927
- Pyura curvigona* Tokioka, 1950
- Pyura rapiformis* Kott, 1990b
- Herdmania momus* (Savigny, 1816)
- Microcosmus tuberculatus* Kott, 1985

HEXACROBYLIDAE

- Asajirus* Kott, 1989a
- Asajirus indicus* (Oka, 1913)
- Oligotrema* Bourne, 1903
- Oligotrema psammites* Bourne, 1903

Suborder APLOUSOBRANCHIA Lahille, 1887

Family DIAZONIDAE Seeliger, 1906

The family is distinguished from Cionidae by its relatively small thorax, long, straight, vertical gut loop, and epicardial sacs isolated from the pharynx. Further, although only 2 species of *Rhopalaea* are known to form colonies of not more than 2 zooids, other genera of the Diazonidae are colonial, replicating as do some other aplousobranchs by horizontal strobilation of the abdomen across the epicardium.

Lahille (1887) proposed a common ancestor for taxa with complete internal longitudinal branchial vessels, and accordingly included Diazonidae and Cionidae in the suborder Phlebobranchia. Most authors accepted this phylogeny until Kott (1969, 1985, 1990a) drew attention to the rela-

tionships between Cionidae, Diazonidae and other aplousobranch families, based on the presence of entire epicardial sacs and their regenerative role in the process of replication. In Phlebobranchia (but not in Diazonidae or Cionidae) the epicardial sacs are divided into minute vesicles that serve an excretory rather than regenerative function. Further, in phlebobranch ascidians (including Diazonidae and Cionidae) the gut loop is folded up alongside the pharynx while the aplousobranch gut loop, although sometimes horizontal and twisted, is always behind the pharynx. As pointed out by Kott (1985), the loss of internal longitudinal vessels occurs in parallel in all sub-orders of the Ascidiacea as zooids reduce in size with the evolution of replication and a colonial habit (see Perophoridae and Polyzoinae). The morphological relationships between Diazonidae, Cionidae and other aplousobranch (rather than phlebobranch) families is confirmed by their chemistry (see Hawkins *et al.* 1983).

Genus *Rhopalaea* Philippi, 1843

C. Monniot (1991a) believes that *Diazona* and *Rhopalaea* are indistinguishable. However, these genera are readily separated by the relatively primitive characters of *Rhopalaea* including its particularly large branchial sac, and relatively short oesophagus. Although the epicardium is used to regenerate parts of zooids, apparently the process is not one of spontaneous replication, for only 2 species of *Rhopalaea* are known to form colonies (see Kott 1990a). On the other hand, *Diazona* species have smaller thoraces, a generally longer oesophagus, and a prolific replicative capacity resulting in large colonies of numerous zooids.

Rhopalaea crassa (Herdman, 1880)

Ecteinascidia crassa Herdman, 1880, p.723.

Rhopalaea crassa Kott, 1990a, p.26 and synonymy.

Nishikawa, 1991, p.25.

Rhopalaea respiciens Monniot, C. 1991a, p.494.

REMARKS

Monniot (1991a) has suggested that species of *Rhopalaea* can be separated by the colour of the living test, the musculature and relative size of the thorax and abdomen. The significance of the colour differences that occur in living specimens of this species is not resolved. However Kott and Goodbody (1982), Kott (1990a) and Nishikawa

(1991) have reported on a wide range of specimens of *R. crassa* and its synonyms from a wide range of locations, including type locations and have demonstrated similar variations in the musculature associated with contraction, and variations in the relative size of thorax and abdomen, apparently the result of growth, and regeneration of the thorax which appears to occur from time to time.

Colour differences appear partly regional, blue being the usual colour recorded for living specimens in the Philippines, while specimens with colourless, transparent thoraces with yellow, white and black markings, becoming yellow and opaque when the test is thicker, are recorded from eastern Australia (Kott 1990), Hong Kong (Kott and Goodbody 1982), New Caledonia (Monniot 1991a) and Japan (Nishikawa 1991). The colour of all specimens is lost in preservative.

Rhopalaea respiciens Monniot, 1991a falls well within the range of variation recorded for even single populations of *R. crassa*, e.g. from Heron I. (see Kott 1990a).

Genus *Pseudodiazona* Millar, 1963

Pseudodiazona claviformis (Kott, 1963) (Fig. 1)

Protopolyclinum claviforme Kott, 1963, p.72.

Pseudodiazona claviformis: Kott, 1990a, p.31 and synonymy.

DISTRIBUTION

NEW RECORDS: Victoria (off Cape Everard, SAM E2460). South Australia (Spencer Gulf, SAM E2547).

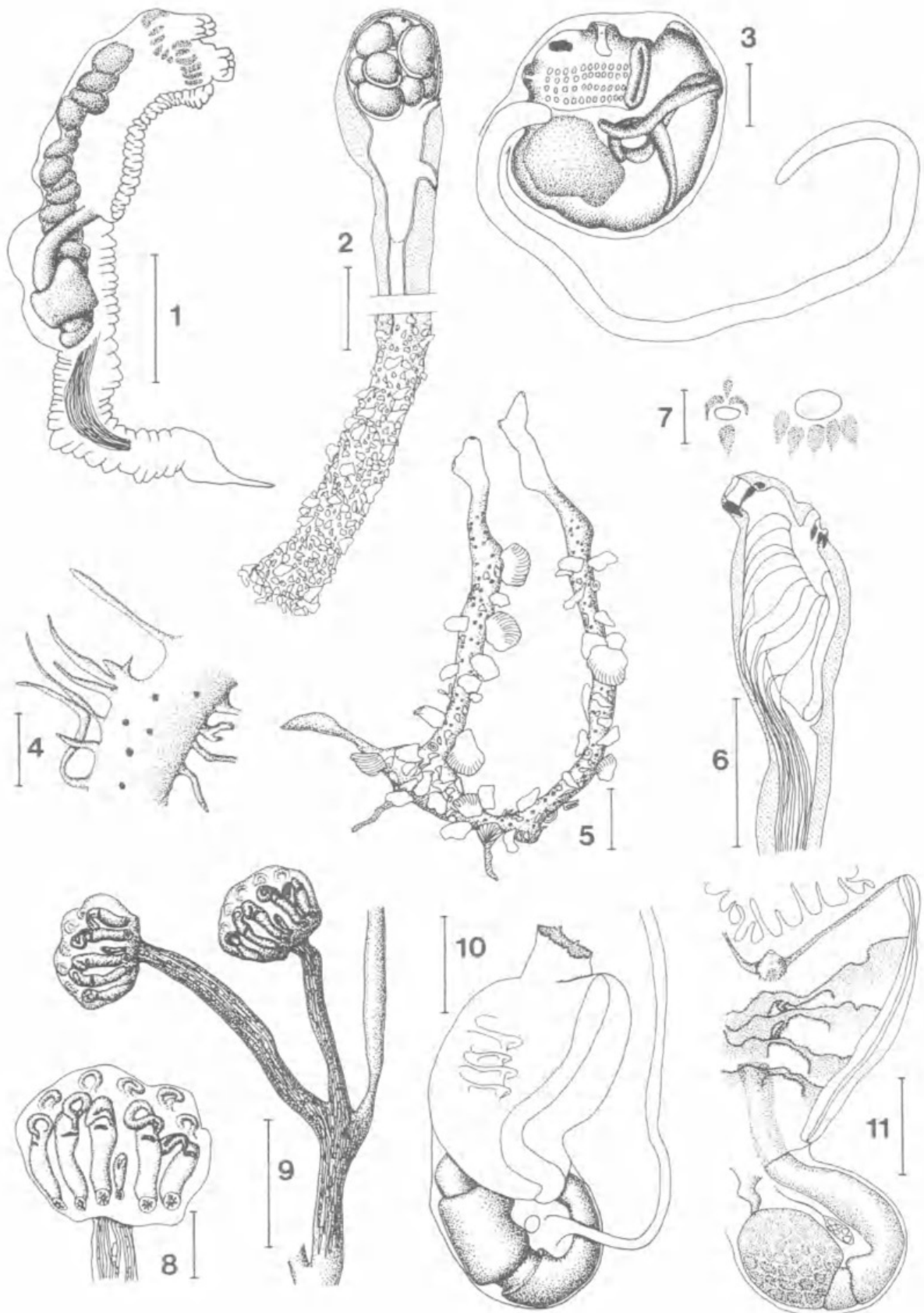
RECORDED RANGE: The species is known from New South Wales and the eastern end of Bass Strait to the northern Great Australian Bight. The newly recorded specimen from Cape Everard increases the known depth range from 100 to 446m.

DESCRIPTION

The newly recorded specimens confirm the morphology of this seldom recorded species.

The specimen from Spencer Gulf retains a pattern of pale grey pigment in vertical petal shaped patches forming a ring around the base of each of the siphons.

In one specimen (SAM E2460) collected in October, the numerous male follicles are bunched in the posterior end of the zooid and eggs are lined up in a single series in the oviduct. In the other specimen gonads are not mature.



Family CLAVELINIDAE Forbes and Hanley,
1848

Genus *Clavelina* Savigny, 1816

***Clavelina pseudobaudinensis* (Kott, 1976)**

Oxycorynia pseudobaudinensis Kott, 1976, p.54.

Clavelina pseudobaudinensis: Kott, 1990a, p.58, and synonymy.

DISTRIBUTION

NEW RECORDS: South Australia (Nuyts Archipelago, SAM E2434 E2471).

RECORDED RANGE: The known range is around the southern half of the Australian continent, from Houtman's Abrolhos to Jervis Bay (NSW).

DESCRIPTION

One of the newly recorded specimens from South Australia (SAM E2434) has a long (3cm) narrow (1.3cm diameter) stalk similar to that of *C. baudinensis* (see Kott 1990a). Otherwise the zooids are characteristic of *C. pseudobaudinensis*, with median pigment patches — one between the siphons and one at the anterior end of the endostyle. Larvae are large, with the trunk 0.9mm long (0.9cm *sic*, Kott 1990a).

Family PYCNOCLAVELLIDAE Kott, 1990

Genus *Pycnoclavella* Garstang, 1891

***Pycnoclavella aurantia* Kott, 1990
(Figs. 2,3)**

Pycnoclavella aurantia Kott, 1990a, p.71.

DISTRIBUTION

NEW RECORD: South Australia (Thorny Passage, SW Hopkins I., SAM E2422).

RECORDED RANGE: The holotype from Franklin I. Nuyts Archipelago was the only previously recorded specimen (Kott 1990a).

DESCRIPTION

Unlike the type specimen, the vertical stalks of the newly recorded one form a sandy aggregated

basal mass similar to that observed previously in *Pycnoclavella tabella* Kott, 1990a. Zooids are a gold colour in preservative.

The thoraces are turned at right angles to the long axis of the abdomen, and have a terminal atrial aperture and the branchial aperture on the side of the transparent head. Stigmata are in 6 instead of the 8 rows in the type specimens.

The newly recorded specimens, collected in October, have up to 12 embryos in the atrial cavity at the terminal end of the zooid. The larvae are large, with an almost spherical trunk about 0.9mm long with the tail wound almost once around it. There is an ocellus but no otolith, 4 rows of stigmata, and 3 characteristic deeply invaginated adhesive organs.

REMARKS

Pycnoclavella arenosa (Kott, 1972b) also has 6 rows of stigmata, but its thoraces are not turned at right angles to the long axis of the zooid, the abdomina are not free of the central common test, and the thorax is narrow (with only 20 rather than 50 stigmata per row). The tropical *Pycnoclavella detorta* (see Kott 1990a) resembles the present species in the orientation of the thorax, and in having 6 rows of stigmata. There is a difference in the number of stigmata, however, *P. detorta* having only about 24 per row.

The larva is also similar to that of *P. detorta*, having the characteristic 3 inverted tubular adhesive organs and lacking an otolith. No more than 4 embryos at a time have been found in the atrial cavity of *P. detorta*, while the newly recorded zooids have up to 12. Also the larvae of *P. detorta* have 1.7mm long trunks, longer than those of the present species (1.1mm).

The newly recorded specimens confirm the separate status of the related species *P. aurantia* and *P. detorta*.

***Pycnoclavella diminuta* (Kott, 1957)
(Figs. 4-7)**

Clavelina diminuta, Kott, 1957, p.89.

Pycnoclavella diminuta: Kott, 1990a, p.73 and synonymy.

FIGS. 1-11: *Pseudodiazona claviformis* (SAM E2547) — 1, contracted zooid; *Pycnoclavella aurantia* (SAM E2422) — 2, zooid in test showing embryos in atrial cavity (1cm excised from oesophageal neck); 3, larva. *Pycnoclavella diminuta* — 4, section of colony stalk showing vesicles and hair-like test processes (SAM E2473); 5, part of colony (SAM E2473); 6, thorax showing pigment patches around apertures (SAM E2492); 7, detail of pigment patches around atrial (left) and branchial apertures. *Protoholozoa australiensis* n.sp. (holotype SAM E2423) — 8, head of colony showing zooid arrangement; 9, part of colony; 10, zooid from ventral surface; 11, zooid, dissected down endostyle showing transverse vessels in thorax. (Scales: 1,4,10,11 — 0.5mm; 2,5,8 — 2mm; 3 — 0.25mm; 6 — 1mm; 7 — 0.2mm; 9 — 5mm).

DISTRIBUTION

NEW RECORDS: South Australia (Nuyts Archipelago, SAM E2473; Lincoln National Park, SAM E2492).

RECORDED RANGE: The species is often encountered in benthic collections from all around the Australian coast and in the Western Pacific.

DESCRIPTION

The newly recorded colonies (SAM E2473), have their stalks aggregated together into a loose sandy mass that readily distintegrates. This mass is formed by hair-like test processes from along the stalks of adjacent zooids adhering to sand particles. The usual oily-looking spheres characteristic of this species are in the test of the stalks. It is probable that the basal sandy mass was buried in the substrate, and that only the thoraces projected above the surface.

The specimen lot SAM E2492 has unusual comma-shaped pigment patches around each smooth-rimmed aperture. In preservative these patches are a brown-orange colour. Around the atrial aperture 3 of these patches are arranged symmetrically in front of the aperture (between the siphons) and one is behind the aperture. Five patches, each with its point directed posteriorly, are in a row around the ventral border of the branchial aperture. These 5 separate patches sometimes are confluent.

Despite this unique pigment pattern, the zooids are characteristic of *P. diminuta*. Similar (but not identical) pigment patches are around the branchial apertures of specimens from Exmouth Gulf (QM GH4083: Kott 1990a, Plate 6d).

***Pycnoclavella elongata* Kott, 1990**

Pycnoclavella elongata Kott, 1990a, p.76.

DISTRIBUTION

NEW RECORD: South Australia (St. Vincent Gulf; SAM E2418).

RECORDED RANGE: The species was previously known only from type localities amongst rocky outcrops around the Nuyts Archipelago. The newly recorded specimen is from a boat ramp at 3 to 5m.

DESCRIPTION

Thoraces are dark coloured in preservative, and naked. The stalks are aggregated together to form a basal mass of parallel, vertical sandy stalks. Zooids have 11 rows of stigmata, while the type material has 14 rows. Specimens otherwise conform with the previous descriptions of this species (Kott 1990a).

Family HOLOZOIDAE Berrill, 1950
Genus *Sigillina* Savigny, 1816***Sigillina fantasiana* (Kott, 1957)**

Eudistoma fantasiana Kott, 1957, p.76.

Sigillina fantasiana: Kott, 1990a, p.92.

DISTRIBUTION

NEW RECORDS: Tasmania (Break Sea I. Port Davey, QM GH5504). South Australia (Spencer Gulf, SAM E2505 E2518–9; Yorke Peninsular, SAM E2485 E2488; St. Vincent Gulf, SAM E2483 E2494; Pearson I., SAM E2537).

RECORDED RANGE: The species is known from Cockburn Sound (WA) and across the southern coast of the continent to Gabo I. off the south eastern coast. The newly recorded specimen from Port Davey, southwestern Tasmania, suggests a range around that island.

DESCRIPTION

Colonies from Tasmania are small cushions with evenly distributed blue zooids and a cloudy test. Larger sheet-like colonies from South Australia, growing along *Zostera* stalks, have almost glassy test and blue pigment around the apertures.

Zooids have a characteristically short abdomen up to 3 times the length of the thorax. A relatively long vascular stolon projects from the posterior end of the abdomen. Three embryos are lined up from the top of the abdomen to the postero-dorsal part of the thorax, where the most advanced projects from the body wall. Tailed larvae are present in February (SAM E2519), July (SAM E2494), September (SAM E2483), and November (SAM E2488 E2518).

***Sigillina grandissima* Kott, 1990**

Sigillina grandissima Kott, 1990a, p.93.

DISTRIBUTION

NEW RECORDS: South Australia (W. Great Australian Bight, SAM E2452 E2457 E2479–81 E2545).

RECORDED RANGE: The species is known from Dampier Archipelago to the Great Australian Bight, although, so far there is a gap in the records between Cockburn Sound and Eucla (SA).

DESCRIPTION

The specimens are fleshy lobes with thick fleshy stalks about the same length as the oval head. They are a very soft, pale lemon in preservative with patches of dark pigment over the neural complex and at the anterior end of the endostyle.

be incorrect, although the type location of the Australian species is off the most southerly part of the Australian continent.

The family Holozoidae is represented in Australian waters by all its known genera, including 2 indigenous ones (*Polydistoma* Kott, 1990a and *Neodistoma* Kott, 1990a). *Sigillina* Savigny, 1816, *Hypodistoma* Tokioka, 1967, *Hypsistozoa* Brewin, 1956, *Sycosoa* Lesson, 1830 and the present genus (with the exception of *P. pigra*) are known mainly from the southern hemisphere (see Kott 1990a). Only *Distaplia* is a cosmopolitan genus.

***Protoholozoa australiensis* n.sp.**
(Figs. 8–11)

DISTRIBUTION

TYPE LOCALITY: South Australia (approximately 1 km NE Margaret Brock Reef off Cape Jaffa, 7 to 15 m dropoff, overhangs, caverns, coll. W. Zeidler, K. Gowlett Holmes 17.2.89, holotype SAM E2423, paratype SAM E2422).

FURTHER RECORDS: None.

DESCRIPTION

EXTERNAL APPEARANCE: The colony consists of almost spherical heads up to 5 mm diameter, each at the end of the terminal branch of a branching stalk up to 1 cm long. The combined length of primary, secondary and terminal branches of the stalk are about 2 cm. However the available specimens are only part of a colony and the total length of the colonies could be greater. Stalks are narrow, cylindrical, about 1 mm diameter, firm and translucent, with a stiff outer cuticle on the lower part.

Zooids are in a single circle, parallel with one another, around the perimeter of the head of the colony. The abdomina of the zooids are uppermost around the top of the head. The atrial apertures are at the posterior end of the thoraces opening to the exterior in a circle around the outer margin of the head just behind its terminal free end. The antero-dorsal branchial apertures are in a circle at the other end of the head, around the top of the stalk. Posterior abdominal vascular stolons extend parallel to one another along the length of the stalk, running back past the endostyle from the centre of the gut loop to enter the top of the stalk.

Vegetative zooids are in the stalk and sometimes in the head in a circle around the top of the stalk near the anterior ends of the adult zooids. However, there is no sign of more than a single

circle of zooids in each head, and the vegetative zooids formed in the stalk may move up to increase the diameter of a head, and/or to form systems in developing terminal branches of the stalk.

INTERNAL STRUCTURE: Zooids are delicate and transparent, 2 to 3 mm long with the gut bend slightly to the left against the posterior end of the thorax. The ventral border of the thorax is longer than the dorsum so that the short branchial siphon turns dorsally. It has fine crenellations around the rim but no lobes. Circular muscles are around the branchial and atrial apertures and short bands extend laterally from each end of the atrial aperture which is a transverse slit at the posterior end of the thorax. Twelve, short, stumpy branchial tentacles are in a circle at the base of the branchial siphon. The branchial wall consists of 4 transverse vessels attached to about the ventral one third of the parietal body wall, and free for the dorsal two-thirds of their length. They are attached to the dorsum where they cross the dorsal sinus as wide transverse membranes, but there are no dorsal languets. A few longitudinal connectives run between the transverse vessels each side of the mid-dorsal line.

The oesophagus is short, and turns to the right to open into an almost horizontal smooth walled, oval stomach. The post-pyloric part of the gut forms a smooth curve from the distal part of the stomach to the anus near the atrial aperture. As in other genera of the Holozoidae (see *Sycosoa*; Kott 1990a) a spherical gastric reservoir is in the gut loop, together with 4 or 5 immature ova. However, the gonads are not mature in the type material.

REMARKS

The type species of this genus, *P. pedunculata* Kott, 1969 (from the Scotia Sea, the South Pacific Basin and the Antarctic Peninsula at from 3000 to nearly 5000 m) differs from the present species in having 2 rather than 4 transverse vessels, an internally ridged stomach, a larger head with a thick fleshy stalk and zooids in rows of about 3 down the length of the head.

Protoholozoa anthos Monniot and Monniot, 1991, and *P. lilium* Monniot and Monniot, 1991 also have a smooth stomach, but 3 rather than 4 transverse vessels, and, in the former species, a long anterior atrial lip (an unusual feature in this genus). *Protoholozoa cantrella* Monniot and Monniot, 1985 differs in its internally ridged stomach and 3 transverse vessels.

Family POLYCITORIDAE Michaelsen, 1904
Genus *Cystodytes* Drasche, 1884

Cystodytes ramosus n.sp.
(Figs. 12–16)

DISTRIBUTION

TYPE LOCALITY: Queensland (Central section Great Barrier Reef, Haslewood I., in bay, 20m, coll. AIMS Bioactivity Group 17.10.87, holotype QM GH5374).

DESCRIPTION

EXTERNAL APPEARANCE: The colony is a knobby mass, basically cylindrical with side branches. Each cylindrical branch is about one to 2cm diameter, to 2cm long. The colony is about 5cm in maximum extent overall.

Zooid systems open into furrows and depressions on the outer surface and circular to oval or irregular raised zooid-free elevations are scattered between the surface openings of the systems. Each system consists of a circle of up to 20 zooids, surrounding a depression (rudimentary common cloacal cavity) in the surface. This depression contains the circle of atrial apertures. The circle of branchial apertures is slightly less than 1cm in diameter.

In life, photographs show the specimens to have a smooth, translucent colourless surface layer covering brownish-pink test. The surface 2mm of test is a translucent, firm and gelatinous layer of bladder cells. It covers a layer of calcareous plate-like spicules, lying parallel to the surface of the colony. The layer is only 1 spicule thick, but the spicules overlap one another slightly around their thickened, scalloped edges. These spicules are relatively pliable, consisting of deposits of granular calcareous material, rather than the hard rigid spicules of *Cystodytes dellachiaiei*. Minute brown pigment cells are scattered through the test, especially in the surface layer. In the holotype the zooids are withdrawn from the surface into the central layer of test through the layer of spicules.

INTERNAL STRUCTURE: Contracted zooids are one to 2mm long. Both the branchial and atrial apertures are 6-lobed, on cylindrical siphons, the atrial siphon larger than the branchial siphon. Strong longitudinal muscles are in the body wall. Stigmata are long, arranged in 4 rows of about 12. The gut loop is vertical, with a large, smooth-walled stomach. About 5 pear-shaped male follicles are in the gut loop.

REMARKS

The species is distinguished from *Cystodytes dellachiaiei* by the layer of spicules beneath the surface bladder cells, and the absence of a capsule of spicules enclosing the abdomen of each zooid.

Genus *Polycitorella* Michaelsen, 1924

Polycitorella coronaria F. Monniot, 1988
(Figs. 17–22, 43)

Polycitorella coronaria F. Monniot, 1988, p.228. Kotl, 1990a, p.184 and synonymy.

DISTRIBUTION

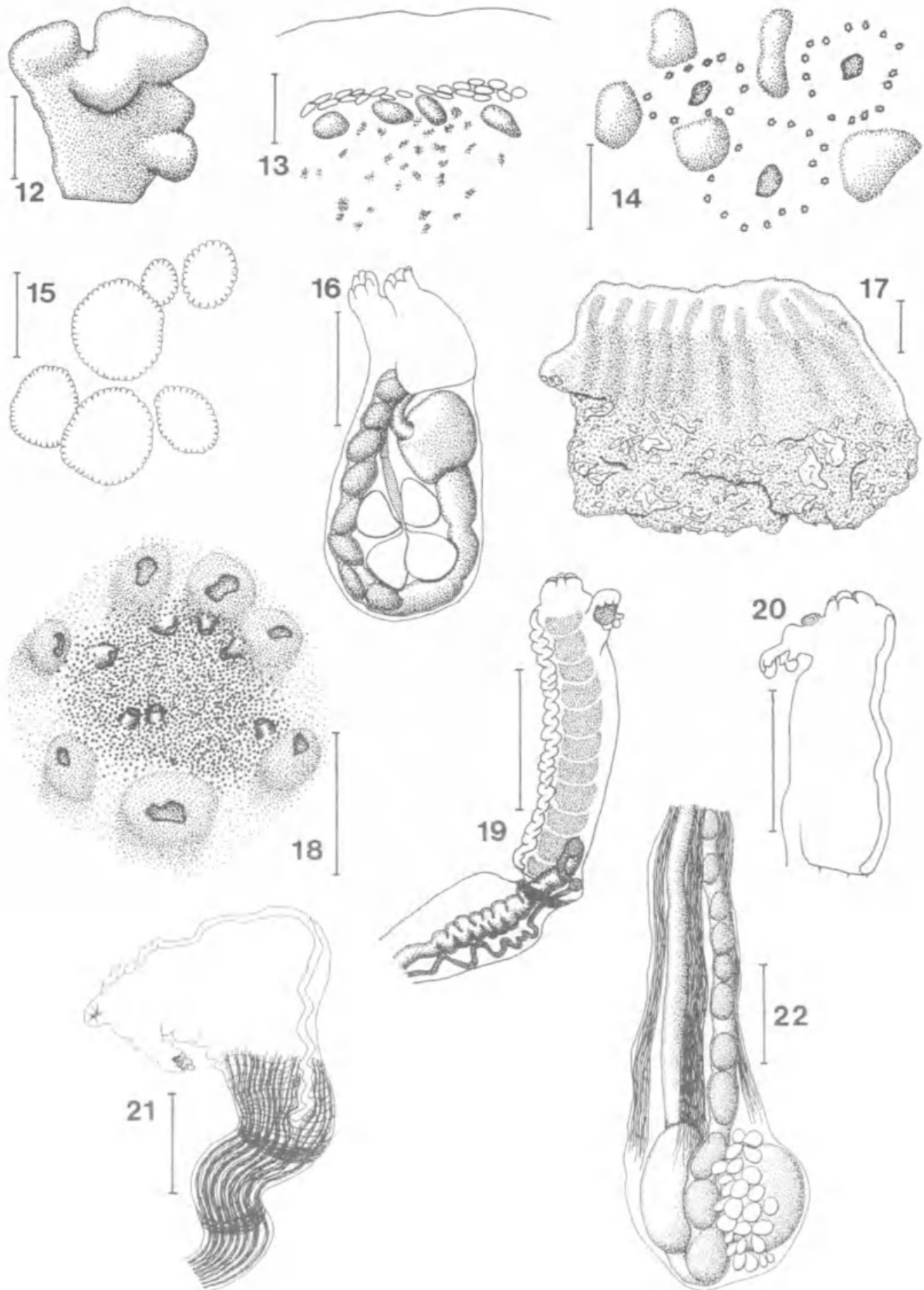
NEW RECORD: Queensland (Heron I. QM GH5616).

RECORDED RANGE: The species is recorded from 3 to 190m from Northwest Cape to Port Phillip Bay. The new record extends this range to the southern tip of the Great Barrier Reef.

DESCRIPTION

EXTERNAL APPEARANCE: The colony is a small thick cushion, about 1.5cm diameter and 1cm deep. Zooids are arranged in 7 circular systems of about 6 per system. Spicules are crowded in the lower half of the colony, at abdominal level. In the upper half, at thoracic level, they are present only in the centre of each circle of zooids, forming a pillar of spicules that reaches to the upper surface. The branchial apertures open around the outside of the upper margin of this white pillar, and the atrial apertures project through the upper edge and open just inside its upper margin. The external surface of the colony, both around the sides and on the flat upper surface is covered with a thick layer of bladder cells, free of spicules and pigment cells.

Pigment cells are black in the living specimen, but brown in preservative. They are crowded in the test lining the zooid compartments, and are evenly distributed elsewhere except where they are excluded by either colourless bladder cells or white spicules. Spicules are 0.025 to 0.07mm. The smaller ones are most plentiful at abdominal level around the zooids. Moderately sized ones are most frequently encountered, and the largest ones are rare. They have about 30 short pointed rays in optical section, although the smaller ones often have rounded rays. The living colony was black and white, the white circular upper surface of the pillars of spicules in the centre of each system contrasting with the rest of the upper surface where spicules are not present to dilute the black pigment cells.



INTERNAL STRUCTURE: Zooids are contained in narrow vertical canals in the test, and in the present colony seem always severed somewhere along the long, narrow oesophageal neck. The rounded, slightly expanded posterior ends of the abdomina appear to have remained in place in their test compartment in the base of the colony and are not very much contracted. The anterior part of the zooids also has remained in place at the surface.

However, both the thorax and the most of the oesophageal neck is very much contracted, and it is this that appears to have caused the zooids to break apart, the abdomina remaining in the base of the colony and the apertures at the surface. The rim of the branchial aperture is divided into 6 small lobes. The atrial aperture is on a moderately long siphon. The upper rim of the opening is produced into a tongue-like lip, its tip divided into 3 round lobes. The posterior rim of the aperture also is divided into 3 lobes.

The thoracic musculature consists of about 16 narrow longitudinal bands, with very fine transverse muscles overlying them to form square meshes. Around the anterior part of the abdomen the longitudinal muscles reorganise themselves into about 8 wider bands on each side. Further posteriorly 4 wide longitudinal muscle bands encase the abdomen, but break up into separate fibres anterior to the gonads and stomach. Fine circular muscles are in one or 2 bands around the anterior part of the abdomen. These appear to be a continuation of the layer of transverse thoracic muscles onto the abdomen. Their arrangement in several bands may be due to the contraction of the longitudinal muscles. These transverse bands do not appear to have become embedded in the test, and there is not a constriction of the test between the thoracic and abdominal compartments, as there is in the large colonies of this species from southern and western Australia (see Kott 1990a).

The branchial sac is long with 13 rows of about 16 stigmata. The stomach is smooth, and located in the posterior end of the abdomen. It is obscured by the large testis consisting of numerous crowded pyriform follicles covering the dorsal side of the pole of the gut loop, and partly covered by a single large ovum.

REMARKS

Although it has been taken from Northwest Cape (Western Australia) this species has not previously been recorded from the eastern tropical coast of Australia or from any other location in the Western Pacific. The species appears to flourish in temperate Australian waters, where large colonies often are taken. This small specimen from the southern tip of the Great Barrier Reef may represent a population at the northern limits of its range. The single specimen does not appear juvenile, despite its small size, having large, mature male follicles and a large ovum. The gonads, branchial sac, circular systems, spicules, pigment cells and other features of the zooid and colony are characteristic of the species. The only significant difference appears to be the absence of a test constriction with a bundle of transverse muscle bands embedded in it between the thoracic and abdominal zooid compartments. However the transverse muscles are present outside the longitudinal ones, behind the thorax, and the fact that they have not become embedded in the test may be associated with the small size of the colony.

Genus *Polycitor* Renier, 1804

Polycitor calamus Kott, 1990
(Figs. 23–25)

Polycitor calamus Kott, 1990a, p. 167.

DISTRIBUTION

NEW RECORD: South Australia (Spencer Gulf, SAM E2530).

RECORDED RANGE: The species is recorded from the Great Australian Bight and Spencer Gulf, South Australia, and from the Kurnell Peninsula (Botany Bay) New South Wales.

DESCRIPTION

The newly recorded colony is characteristic, with its long cylindrical stalk, divided into basal holdfasts that are spread out over sea grass leaves (*Posidonia*). A few epibionts are on the stalk. The expanded head has scattered spots in the surface of the preserved specimen.

FIGS. 12–22: *Cystodytes ramosus* n.sp. (holotype QM GH5374) — 12, colony; 13, section through upper part of colony showing contracted zooids beneath a layer of disc shaped spicules; 14, systems; 15, disc shaped spicules; 16, zooid. *Polycitorella coronaria* (QM GH5616) — 17, colony; 18, system from above; 19, thorax and anterior part of abdomen; 20, thorax showing atrial lip; 21, zooid showing muscle bands on abdomen; 22, gut loop and gonads. (Scales: 12 — 2cm; 13, 17 — 2mm; 14 — 5mm; 15, 16, 20–22 — 0.5mm; 18, 19 — 1mm).

The zooids have the usual long thorax and abdomen. In this colony (collected at the end of September). There are up to 9 embryos in a developmental series in the top of the abdomen. In some zooids the 2 best developed have moved up into the posterior end of the atrial cavity.

The larval trunk is up to 0.9mm long, with the tail wound about three-quarters of the distance around it. Half of the length of the trunk is taken up with a large frontal lobe which, at its anterior end, supports 3 triradially arranged, large adhesive organs. Each consists of a small evertting cone in a depression at the end of a thick cylindrical stalk. The cerebral vesicle contains a large ocellus and otolith. There are 3 rows of stigmata in the larval pharynx.

REMARKS

Larvae of this species previously were unknown. Kott (1990a) suggested that since larvae were not present in the known specimens (collected in January and April) the breeding season could be restricted. The newly recorded speci-

mens contain large numbers of relatively large embryos which appear to have been fertilised at the base of the long abdomen, and to have been developing as they move up the long stalk of the colony. This could be a lengthy process, and it suggests that sexual reproduction in this species could be an event that occurs once only during the year. The larvae, with their triradial adhesive organs and long frontal lobe, resemble the larvae of *Polycitor giganteus*, the tropical *P. annulus*, and *P. circes* (see Kott 1990a).

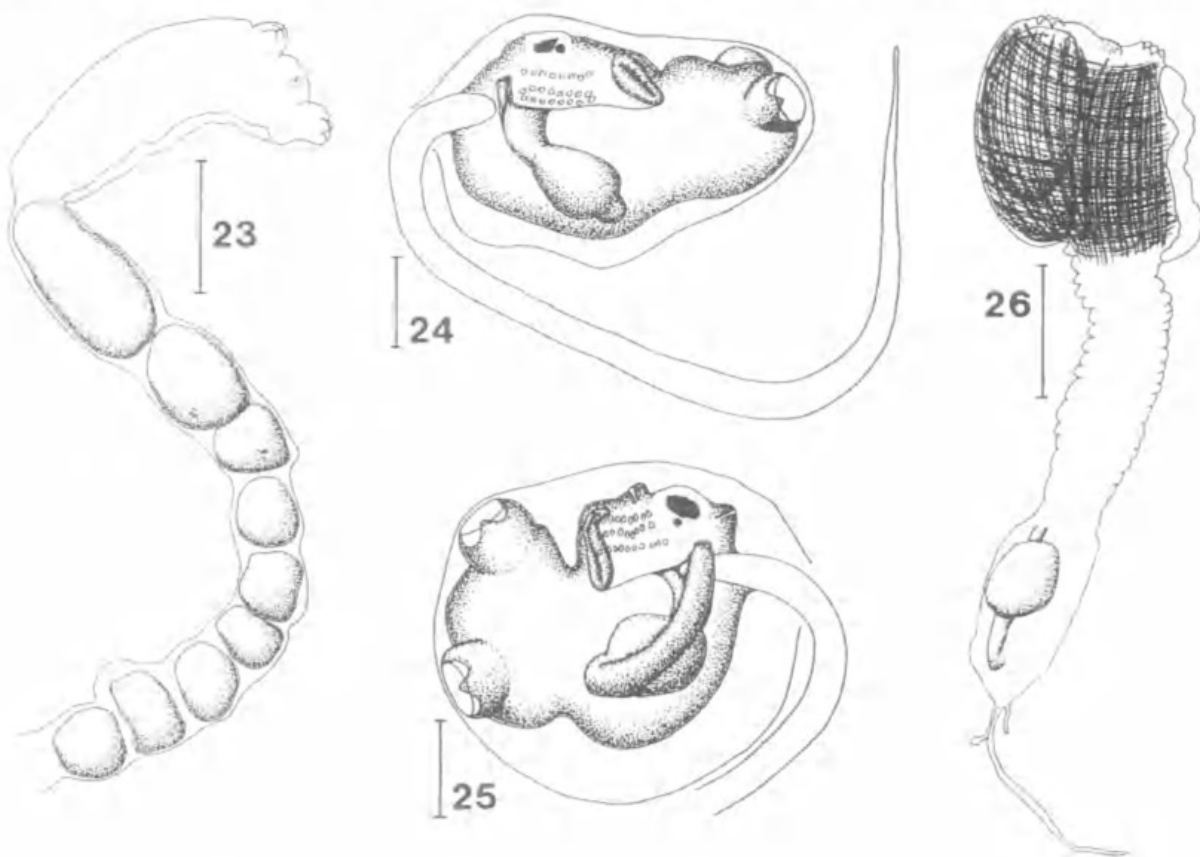
Polycitor obeliscus Kott, 1972

Polycitor obeliscus Kott, 1972b, p.171; 1990a, p.175.

DISTRIBUTION

NEW RECORDS: South Australia (Nuyts Archipelago, SAM E2543-4). Victoria (Bass Strait, MV H454).

RECORDED RANGE: The species previously was known only from its holotype from Investigator Strait. Its range is apparently restricted to the southern coast of



FIGS. 23-26: *Polycitor calamus* (SAM E2530) — 23, zooid showing embryos in abdomen; 24, 25, larvae, *Eudistoma aureum* (SAM E2538) — 26, zooid with two embryos in atrial cavity. (Scales: 23, 26 — 1mm; 24, 25 — 0.2mm).

Australia from the Great Australian Bight to Bass Strait.

DESCRIPTION

EXTERNAL APPEARANCE: The newly recorded colonies are of various shapes. The specimen from Bass Strait (at 70m) is upright, egg-shaped and fixed by its narrow base. The other colonies are fixed by a broad base (to 3cm diameter). One is a wide cone on the upper surface, but the other has a vertical margin and is flat-topped. Sand is present internally. It is absent from the surface of much of the upper part of the colony although occasionally, especially around the margins, or toward the base, some sand is present on the surface around the zooid openings. Atrial and branchial apertures open separately to the surface.

In one colony the zooids seem arranged in pairs, but there are no systems. The test is white and the zooids are reddish-orange to flesh-coloured in preservative.

INTERNAL STRUCTURE: Zooids are large and robust, with almost continuous coat of external longitudinal and internal circular muscles. The longitudinal muscles continue in 2 bands along each side of the abdomen. Stigmata are in 6 or 7 rows of about 20. The stomach, in the expanded posterior end of the abdomen, is smooth-walled. The testis follicles are clustered in a large mass on the dorsal side of the gut loop.

REMARKS

The present species is distinguished mainly by the number of rows of stigmata and the smooth-walled stomach.

Genus *Eudistoma* Caullery, 1909

Eudistoma aureum Kott, 1990
(Fig. 26)

Eudistoma aureum Kott, 1990a, p.199 and synonymy.

DISTRIBUTION

NEW RECORD: South Australia (off Eucla, 170 to 190m, SAM E2538-9).

RECORDED RANGE: The species was known only from its type locality in *Posidonia* beds in St. Vincent Gulf.

DESCRIPTION

EXTERNAL APPEARANCE: The largest colony (SAM E2538) consists of upright lobes, possibly spherical in life, but slightly laterally flattened in preservative, about 4cm diameter. It is fixed to the

substrate by a narrow basal part. Internally the colony contains grey sand throughout. Sand also is present in the surface test on the lower half, which may be buried in the substrate. In preserved colonies, the surface test on the upper part of the colony, which is free of sand, is translucent and greenish black with black zooids showing through it. The arrangement of the zooids is obscure in these colonies.

INTERNAL STRUCTURE: The zooids are robust, with conspicuous muscles, about 50 internal transverse bands and 30 external longitudinal ones. Apertures are both 6-lobed. Stigmata are in 3 rows of 25 (middle row) to 30 (anterior) in each row. The dorsal end of the anterior row extends forwards along each side of the neural complex.

In the large colony taken from off Eucla, up to 2 large embryos (trunk 1.25m long) are being incubated in the atrial cavity. They have 4 lateral ampullae along each side of the median adhesive organs. However, these are crowded, the larvae are opaque and other details could not be determined. The tail is wound two-thirds of the way around the larval trunk.

REMARKS

The pigmentation in the large colony is more intense than in previously recorded specimens, which were said to have red-brown zooids in grey colonies (Kott 1990a). Possibly the colour fades in long-term preservation, for other features of both zooids and colony such as the muscular zooids, and the large number of stigmata per row, with the anterior row inclined along the mid-dorsal line, are identical.

Previously recorded colonies were said to have been yellow in life. Unfortunately the colour of the newly recorded ones is not known.

Genus *Exostoma* Kott, 1990

Exostoma ianthinum (Sluiter, 1909)

Polycitor ianthinus Sluiter, 1909, p.20.

Exostoma ianthinum: Kott, 1990a, p.234 and synonymy.

DISTRIBUTION

NEW RECORD: Queensland (Far northern Great Barrier Reef — Great Detached Reef, QM GH5726).

RECORDED RANGE: The southern limit of the recorded range of this species was previously thought to be Motupore I. New Guinea. It is known also from Palau Is, Philippines, and Bunda (Indonesia).

Suborder PHLEBOBRANCHIA Lahille, 1887

Family ASCIDIIDAE Adams & Adams, 1858
Genus *Ascidia* Linnaeus, 1767

***Ascidia archaia* Sluiter, 1890**

Ascidia archaia Sluiter, 1890, p.346. Kott, 1985, p.26 and synonymy. Monniot and Monniot, 1987, p.92 and synonymy. Monniot, C. 1987a, p.18.

DISTRIBUTION

RECORDED RANGE: The species is known from Norfolk Is, from north of Moreton Bay and northwards up the Great Barrier Reef to New Caledonia, the Philippines, Indonesia, French Polynesia, Fiji, the Marshall Is, and the southern islands of Japan; and from the northwest coast of Australia and south to Shark Bay. The tropical Atlantic species *Ascidia corelloides* (Van Name, 1924) appears to be inseparable from it (see Van Name 1945, Tokioka 1953). Nevertheless, the Western Pacific and Atlantic populations apparently are isolated from one another, neither having a range into temperate waters.

REMARKS

Monniot and Monniot (1987) do not accept the view (Kott 1985) that *A. aperta* Sluiter, 1904 is a synonym of the present species on the grounds that it is large, up to 5cm long, with an open gut loop and with muscles on the right better developed than in the smaller specimens they have assigned to *A. archaia*. None of the characters invoked by Monniot and Monniot are outside the range of variation observed in *A. archaia*, which is one of the most common species on the Heron I. reef flat, under rubble. It is known to reach a size of 5cm in less than 6 months (see Kott 1985).

***Ascidia liberata* Sluiter, 1887**

Ascidia liberata Sluiter, 1887, p.251. Kott, 1985, p.43 and synonymy.

Ascidia solomonensis Nishikawa, 1986, p.61.

Ascidia dorsalis C. Monniot, 1987a, p.9.

Not *Ascidia liberata*: Sluiter, 1904, p.32. C. Monniot, 1987a, p.8.

DISTRIBUTION

RECORDED RANGE: The species is recorded from Norfolk I. and the Great Barrier Reef, Indonesia (Sluiter 1887; Bay of Batavia, ZMA TU244), New Caledonia and Solomon Is.

DESCRIPTION

The species is characterised by the naked, transparent test, pointed papillae on the siphons, the fringe of minute tentacular projections along the edge of the lobes surrounding the apertures, and transverse muscles across the dorsal surface of the generally laterally flattened, short, often triangular body, extending about half to two-thirds of the way across the right side but only about one-third of the way down the left. Short longitudinal muscles extend from along each siphon, those from the branchial siphon crossing the transverse muscles.

The red colour at the anterior end of the body in the living specimens has been referred to by Kott (1985), Nishikawa (1986) and Sluiter (1887).

REMARKS

Monniot (1987a) refers to the poor condition of the type specimen (ZMA TU244). Nevertheless it was this type specimen that Kott (1985) examined before assigning this common species to it. At the time she examined it, the characteristic papillae on the siphons, the tentacular fringe around the apertures, and the transverse muscles on the dorsal part of the right side of the body were all clearly visible. The general shape of this individual, which was figured by Sluiter (1887), closely resembles many of the more recently examined specimens.

Monniot, C. (1987a) examined and figured a specimen from the Siboga collection assigned to *A. liberata* by Sluiter (1904). Although Kott (1985) did not include it in the synonymy of *A. liberata*, Monniot believed the *Siboga* specimen to be identical with the type of *A. liberata*, and since it has characters inconsistent with *A. liberata*: Kott, 1985 he assigned the latter to a new species, *A. dorsalis* Monniot, 1987a. However, the *Siboga* specimen Monniot examined is not conspecific with *A. liberata* Sluiter, 1887. Its muscles, both on the right and left sides, as well as the swollen gut, the remnants of a fringe around the apertures and the foreign particles attached to the test, suggest that the *Siboga* specimen Monniot examined is *A. sydneyensis*.

Kott's specimens, for which *A. dorsalis* was erected, being conspecific with *A. liberata* Sluiter, 1887, *A. dorsalis* becomes a junior synonym of *A. liberata*. Similarly *Ascidia solomonensis* Nishikawa, 1986 has the characteristic features of *A. liberata* Sluiter, 1887.

Family PEROPHORIDAE Giard, 1872
Genus *Perophora* Wiegman, 1835

Perophora multiclathrata (Sluiter, 1904)

Ecteinascidia multiclathrata Sluiter, 1904, p.12.

Perophora multiclathrata: Kott, 1985, p.106 and synonymy (part, not *P. bermudiensis*: pers. comm. I. Goodbody). Nishikawa, 1986, p.30 and synonymy; 1991, p.38. C. Monniot, 1987a, p.88.

DISTRIBUTION

RECORDED RANGE: The species has a wide range in the Western Pacific from the Japan Sea (Sado), in both Micronesia and Melanesia as well as the northeastern coast of Australia, the Great Barrier Reef and Norfolk Island. *Perophora multiclathrata* also occurs on the western coast of Africa (> *Perophora africana* Millar, 1953; fide Nishikawa, 1986) and in the West Indies (although it is not a synonym of *P. bermudiensis*). The record from the Japan Sea is the only one outside tropical locations.

REMARKS

It is of interest that a possible junior synonym of *P. bermudiensis* (*P. fascia* C. Monniot, 1991a) occurs in New Caledonia. Although Monniot has discussed the differences of *P. fascia* from the temperate *P. hutchisoni* and tropical *P. namei*, both with jointed stolons (see Kott 1985), he has not compared the morphology of his new species with either *P. multiclathrata* or *P. bermudiensis*, species with which it has more in common. If *P. fascia* is a synonym of *P. bermudiensis*, both *P. multiclathrata* and *P. bermudiensis* are sympatric in the Western Pacific and the Atlantic.

Genus *Ecteinascidia* Herdman, 1880

Ecteinascidia diaphanis Sluiter, 1885

Ecteinascidia diaphanis Sluiter, 1885, p.168. Kott, 1985, p.90.

Ecteinascidia koumaci C. Monniot, 1987a, p.3.

Ecteinascidia ndouae C. Monniot, 1991a, p.505.

DISTRIBUTION

RECORDED RANGE: The species is known from northern New South Wales, Great Barrier Reef, Northern Australia, Palau Is, Indonesia, and New Caledonia.

REMARKS

Monniot has compared the New Caledonian material with *E. hedwigiae* Michaelsen, 1918 from the coast of Natal, and with the Western

Pacific *E. diaphanis*. The latter, on geographical grounds is a more likely taxon to occur in New Caledonia. Differences between *E. diaphanis* and the 2 species from New Caledonia, viz. *E. koumaci* and *E. ndouae*, appear to be either the result of intraspecific variation, or artefacts such as muscle contraction. They include variations in the red or pink-orange pigmentation at the anterior end of the zooids, which forms rings around the siphons, and sometimes spots as well (see Kott 1985). In *E. ndouae* C. Monniot, 1991a, the colour is described as yellow-gold.

Ecteinascidia koumaci Monniot, 1987a is distinguished from *E. diaphanis* by the interval between the band of transverse muscles behind the atrial siphon and the siphonal muscles. This is affected by contraction of the longitudinal muscles along the length of the siphon. The membrane between the dorsal languets, also said to distinguish the species, is not always present (Monniot, C. 1987a). There seems no valid justification for the assignation of *E. koumaci* and *E. ndouae* to species distinct from *E. diaphanis*.

Ecteinascidia nexa Sluiter, 1904

Ecteinascidia nexa Sluiter, 1904, p.11. Kott 1985, p.94 and synonymy. Nishikawa, 1986, p.42.

Ecteinascidia aequale C. Monniot, 1987a, p.5.

Ecteinascidia imperfecta; Nishikawa 1984, p.42.

DISTRIBUTION

RECORDED RANGE: The species is recorded from Lord Howe Is., the northeastern Australian coast and the Great Barrier Reef, Solomon Is, Indonesia, Philippines, Fiji, Tokhara Is, the Indian Ocean (Sri Lanka), and now from New Caledonia.

REMARKS

C. Monniot (1987a), comparing *E. aequale* with *E. nexa*, was unable to reconcile the descriptions of Kott (1985) and Nishikawa (1986). However, there are not significant differences in these accounts. The species is readily characterised by its muscles, cloudy body wall in preservative, smooth stomach, duodenal and posterior stomach enlargements in the gut loop, hemispherical mass of male follicles and usually yellow colour in life. All of these characters are referred to by both Nishikawa (1986) and Kott (1985).

Ecteinascidia nexa has a range of orientations of the sessile to stalked zooids and a variety of primary and accessory stolons attaching them to the basal stolons or to one another. Apertures are, respectively, terminal and halfway along the

body, sometimes sessile, but usually on conical siphons when living. Kott (1985) describes the preserved zooids as flaccid and distorted, cloudy in preservative, with numerous blood cells. Nishikawa (1986) refers to the 'lustreless' free surface with pale yellowish spherules densely distributed in the body wall. Similar body muscles are described (in some detail) by Kott (1985) and Nishikawa (1986). Stigmata are in 19 (Kott 1985) or 20 (Nishikawa 1986) rows, and there are from 14 to 24 longitudinal vessels on one side of the body.

Both authors, independently, examined the types of *P. hornelli* Herdman, 1906, and proposed its synonymy. Nishikawa (1986) also examined the type of *E. nexa*.

The branchial processes on the prepharyngeal band figured by Kott (1985, fig. 39b) only occur in the most robust zooids and are not characteristic of the species, nor was it suggested that they are.

Ecteinaeiscidia aequale C. Monniot 1987a from New Caledonia appears to fall within the range of variation reported for *E. nexa*.

Suborder STOLIDOBRANCHIA Lahille, 1887

Family STYELIDAE Sluiter, 1895

Subfamily STYELINAE Herdman, 1881

Genus *Cnemidocarpa* Huntsman, 1912

Cnemidocarpa amphora n.sp. (Figs. 27-31)

DISTRIBUTION

TYPE LOCALITY: South Australia (Sir Joseph Banks Group, North Point, Marum I., 200m offshore in sand, rubble, *Posidonia*, 7m, coll. W. Zeidler 13.1.84, holotype SAM E2531; Sir Joseph Banks Group, W. Partney I., Partney Shoal Reef, rubble, sand, *Posidonia*, 5-15m, coll. W. Zeidler and K. Gowlett Holmes 21.8.86, paratypes SAM E2536).

FURTHER RECORDS: None.

DESCRIPTION

EXTERNAL APPEARANCE: Individuals are club-shaped, with an expanded body, rounded anteriorly and posteriorly continuous with a thick, cylindrical stalk about the same length as the body. The branchial and atrial apertures are directed away from one another in opposite sides of the anterior end of the body, the branchial siphon almost terminal, and the atrial one on the dorsal side.

The available specimens are contracted, and behind the large, naked lobes of each aperture is a collar or band of wrinkled test. When the animal is relaxed it is probable that these disappear, and that the siphons are long, projecting out like horns from the anterior end of the body.

Sand adheres to the anterior part of the body around the base of the siphons, and to the fine hairs around the base of the stalk. The hairs aggregate together to form a sandy holdfast. The test is transversely wrinkled over most of the surface. It is particularly thin on the base of the stalk where it is surrounded by the sandy holdfast.

INTERNAL STRUCTURE: The body wall is red, shiny and muscular. Posteriorly it is extended into an inflated stolon which projects down into the stalk. Anteriorly the two siphons are relatively long, the branchial siphon directed obliquely away from the substrate, the atrial one curved over to the side toward the substrate. Attenuated body muscles are confined to the anterior part of the stolon, which is thin-walled and hollow in its distal part. The hollow may be part of the haemocoel, as it does not appear continuous with the atrial cavity, being separated from it by a thin membrane.

Longitudinal stripes line the siphons, and numerous fine branchial tentacles surround the base of the branchial siphon. The dorsal tubercle is a particularly large cushion with a double spiral slit, both horns rolled in, and directed either to the left or anteriorly. A large dorsal ganglion occupies the space between the base of the 2 siphons in these contracted specimens.

The branchial sac has 4 low folds on each side of the body, with crowded internal longitudinal vessels arranged according to the formula $DL0(18)2(10)3(12)3(10)2E$. About 4 stigmata are in meshes in the interspaces, and more are between the endostyle and the first longitudinal vessel on each side.

The gut loop is simple, and vertical, its pole compressed into the V of the posterior end of the body where, in these contracted specimens, it projects slightly into the top of the stalk. The oesophageal opening is halfway down the dorsal side of the pharynx. The oesophagus is short, the stomach long with parallel internal longitudinal folds. The stomach and post pyloric part of the intestine (proximal to the pole of the gut loop) are of about equal length. The rim of the anal opening (at the base of the atrial aperture) is deeply divided into 16 rounded lobes. On each side, up to 10, crowded, parallel gonads lie horizontally (at right angles to the long axis of the body). They

consist of a double rows, each row of about 10 large testis follicles, beneath a long ovarian sac.

A very short oviduct is at the dorsal end of each ovary. The short vas deferens opens on top of the female duct. Irregular, upright endocarps are crowded along the dorsal one third of each side of the atrial cavity (between the dorsal ends of the gonads, and dorsal to them).

REMARKS

Both *Cnemidocarpa floccosa* (Sluiter, 1904) and *C. completa* Kott, 1985 have a similar number of cnemidocarp gonads on each side of the body as the present species. The former tropical species is rounded posteriorly, while the present one narrows to its stalk; the gonads lie vertically, parallel to the long axis of the body in *C. floccosa*, rather than at right angles to it as in *C. amphora*; and the gut loop in the present species lies vertically, extending back from the oesophageal opening, while that of *C. floccosa* curves anteriorly around the ventral margin of the body. *Cnemidocarpa completa* Kott, 1985 is known from temperate waters, although not from South Australia. It also is distinguished from the present species by the curve of the gut loop around its posterior ventral border, the absence of a dorsal band of endocarps, the long stomach, and the loose attachment of gonads to the body wall.

Cnemidocarpa areolata (Heller, 1878)

Styela areolata Heller, 1878, p.26.

Cnemidocarpa areolata: Kott, 1985, p.122 and synonymy. **Not** Monniot, 1983, p.451 (< *C. legali* Gravier, 1955).

Cnemidocarpa valborg Monniot, 1988, p.193; 1991b, p.27 (part, ? not specimen from Dumbéa). **Not** Monniot and Monniot, 1984a, p.577 (< *C. legali* Gravier, 1955); ? 1991, p.400.

Cnemidocarpa irene: Nishikawa, 1991, p.96 and synonymy.

DISTRIBUTION

RECORDED RANGE: The species is known from all around the Australian coast, from Sri Lanka, and the western Pacific to the Marianas, Fiji, Japan and Hong Kong (see Kott 1985). The newly recorded specimens from New Caledonia (Monniot 1991b) are consistent with other records from the western Pacific.

REMARKS

Monniot and Monniot (1984a, p.577), having examined the type specimen of *C. areolata* (from Sri Lanka) found that its vas deferens was divided

and that it opened by 'unbouquet de papilles'. Comparing its gut loop with Herdman's figure of *C. areolata*: Herdman, 1906 (Pl. 4, Fig. 24), Monniot and Monniot assume that Herdman's specimens, also from Sri Lanka, are conspecific with the holotype of *C. areolata*, and separate from the (principally western Pacific) specimens assigned to *C. areolata* Heller, 1878 by various authors (see Nishikawa 1991). Monniot and Monniot (1984a, p.577) contend that 'La synonymie certaine de cette espèce est restreinte au type de l'espèce et à l'échantillon de Herdman'. The specimen recorded by Nishikawa (1991) as '*C. Monniot*'s collected from India' apparently is part of the type of *C. areolata* Heller, 1878 'mounted on a glass slide' (see Nishikawa 1991, p.97). Neither Monniot and Monniot (1984a) nor Monniot (1988, 1991b) refer to the examination of Herdman's specimens, and there is no record that these have the remarkable, and possibly abnormal, replicated openings of the male ducts which they found in the type. Apparently the synonymy of Herdman's specimens with the type is based entirely on the curvature of the gut loop reported by Herdman (1906, pl.4, fig. 24). The curve of the gut loop is variable in the large sample of examined specimens from Australia (Kott 1985), Japan (Nishikawa 1991) and New Caledonia (Monniot 1988). Further, its curvature varies according to the curvature of the body, influenced partly by its state of contractions, and by the size and shape of the adhering surface. The curvature of the gut loop is not on its own a reliable enough character to determine the relationships of the Sri Lankan specimens to one another and to others from the Indo-West Pacific. These relationships will be resolved only when the status of the unusual opening of the vas deferens (known in the one, albeit type, specimen) is established.

Cnemidocarpa valborg: Monniot and Monniot 1991 from 300 to 500m off New Caledonia has different gut loop, branchial sac and endocarps from the present species, and does not appear conspecific. Similarly, the specimen from Dumbéa (Monniot 1991b) with ducts turned ventrally does not appear to belong to this species.

The specimens from the Atlantic (Monniot 1983; Monniot and Monniot 1984a) lack the characteristic yellow and red stripes lining the siphons of living specimens, which turn to black in preservative; the gut loop is narrow, the limbs parallel to one another with endocarps in an irregular row (rather than being bunched together in the open pole of the loop (as they are in *C. areolata*);

the stomach lacks the numerous, regular parallel folds of *C. areolata*; and the posterior gonad on the left is much more branched, or it does not curve over the anterior pole of the gut loop, as in *C. areolata*. Although there are certain similarities in the morphology of these two species, they do not seem sufficiently close to justify their synonymy, especially where there is no reasonable geographic basis for gene flow between them.

***Cnemidocarpa intestinata* Kott, 1985**

Cnemidocarpa intestinata Kott, 1985, p.128.

Not *Cnemidocarpa* aff. *intestinata*: Monniot and Monniot, 1991, p.401.

REMARKS

This species, recorded from northern and north-eastern Australia, is well characterised by its hollow conical overlapping spines (Kott 1985 Fig. 50d), large numbers of stigmata (15) in the meshes between the folds, a narrow gut loop, a gonad directed posteriorly in the second gut loop, and clumps of male follicles constricting the ovarian tubes at regular intervals along each side. Endocarps are not present.

The specimen from 700m depth off New Caledonia (Monniot and Monniot 1991), believed to have affinities with *C. intestinata*, shares only one of these characters — viz. the lack of endocarps. It does not appear to be related in any way.

***Cnemidocarpa tribranchiata* n.sp.
(Fig. 32–35)**

DISTRIBUTION

EXTERNAL APPEARANCE: South Australia (Encounter Bay, Seal Rocks, with bryozoan *Hornera foliacea*, 15m coll. N. Holmes 24.8.88, holotype SAM E2533; Willunga Reef, low tide, coll. I.C. Kowanka 23.11.76, paratype SAM E2534.

FURTHER RECORDS: None.

DESCRIPTION

EXTERNAL APPEARANCE: Individuals are upright and oval, about 2cm long, with fleshy, 4-lobed, sessile apertures, the branchial terminal and the atrial about halfway down the dorsal surface. Irregular extensions of the basal test fix

the animal to the substrate. The test is white, translucent and moderately thick and firm. The surface is slightly rough, and has patches of epibionts and shell and sand particles attached here and there.

INTERNAL STRUCTURE: The body wall has strong longitudinal muscle bands radiating from each siphon and crossing one another over the sides of the body. About 15 are from the atrial siphon and 12 from the branchial siphon. They branch into fine bands forming a delicate inconspicuous network on the postero-ventral part of the body. Circular muscles are around each siphon. A long neural ganglion is between the siphons.

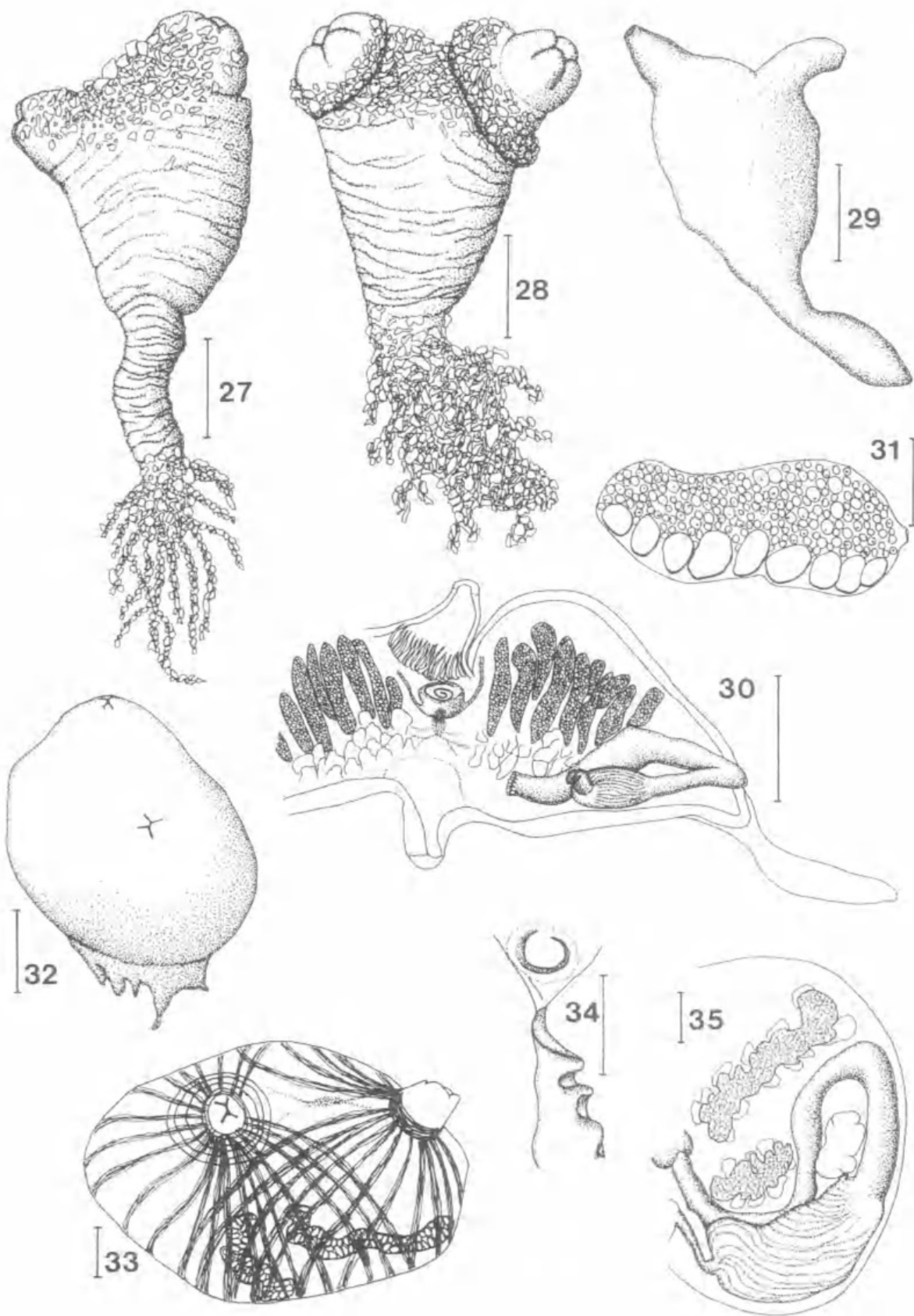
The simple branchial tentacles (about 40) are of various sizes and alternate with rudimentary ones. The dorsal lamina is wide and plain-edged. A long neural ganglion is between the siphons. The dorsal tubercle is a circular slit with a large C-shaped opening, the open interval directed anteriorly.

Three broad, but not overlapping folds are present on each side of the pharynx. Internal longitudinal vessels are thick and project into the pharynx. They are arranged according to the formula $E3(13)3(12)2(13)ODL$. They are not crowded, either on the folds or in the interspaces, there being 8 stigmata per mesh between the folds and 6 per mesh on the folds.

The gut loop is long and narrow, curving at least halfway around the postero-ventral curve of the body. It is open at the pole where it encloses a flat-topped endocarp which is lobed around its margin. The stomach occupies about three-quarters of the ascending limb of the gut loop. It has 11 parallel, slightly oblique folds. These flatten out at its pyloric end, which tapers gradually to the intestine. The oesophagus is short and narrow. The anus is visible through the open atrial aperture. Its margin is divided into 5 shallow lobes.

Two gonads are on each side of the body, converging toward the atrial aperture. The ovarian tubes are sinuous, the curves giving an impression of irregular lobes along each side, an impression that is emphasised by the presence of an endocarp on each outer curve. Crowded testis follicles are in 2 rows beneath each ovary. On the left side of the body the posterior gonad is curved into the secondary gut loop, and the anterior one

FIGS. 27–35. *Cnemidocarpa amphora* n.sp. (27, paratype SAM E2536; 28–31, holotype SAM E2531) — 27, 28, external appearance; 29, body removed from test showing extension into stalk; 30, internal organs; 31, lateral view of gonad. *Cnemidocarpa tribranchiata* n.sp. (holotype SAM E2533) — 32, external appearance; 33, body removed from test; 34, dorsal tubercle and anterior part of dorsal lamina; 35, internal organs on left side. (Scales: 27–29, 31, 32 — 5mm; 30, 34, 35 — 1mm; 33 — 2mm).



extends across the body wall anterior to the pole of the gut loop. Endocarps are scattered on the body wall between the gonads.

REMARKS

Cnemidocarpa tripartita Kott, 1985 from Bass Strait has, like the present species, a rounded body, white (but thin) translucent test, 3 branchial folds on each side of the body, a long stomach with longitudinal folds, an endocarp enclosed in the pole of the gut loop, and 2 gonads on the left and 3 on the right. Its significant differences from the present species are its low branchial folds with only 2 or 3 internal longitudinal vessels (while those of the present species are broad and flat with 12 or 13 longitudinal vessels), its light attachment of the gonads to the body wall by fine ligaments (while in the present species gonads are embedded) and the absence of endocarps on the body wall between the gonads.

Genus *Asterocarpa* Brewin, 1946

Asterocarpa humilis (Heller, 1878)

Styela humilis Heller, 1878, p.26.

Asterocarpa humilis: Kott, 1985, p.141 and synonymy.

Not *Cnemidocarpa* aff. *humilis*: Monniot, 1991b, p.25.

DISTRIBUTION

RECORDED RANGE: This species is known from temperate waters from Albany, across the southern coast of Australia to Tasmania and Victoria, New Zealand, and from South Africa and the eastern Pacific (see Kott 1985).

REMARKS

The specimen from tropical New Caledonian waters which Monniot (1991b) believed to have affinities with this species has 2 long, branched gonads across each side of the body, between the ventral and dorsal mid-line, converging to the atrial aperture. The short, cnemidocarp-type gonoducts are at the dorsal (distal) end of each gonad. This contrasts with the genus *Asterocarpa* which has irregularly branched gonads, with ventrally directed gonoductal openings, around the ventral margin of the right side of the body, and one in a similar (ventral) position anterior to the gut loop on the left. The New Caledonian specimen also has more longitudinal branchial vessels than the temperate species *Asterocarpa humilis*.

Cnemidocarpa lobata Kott, 1985 has undulating branched gonads, like the New Caledonian

specimen, but it has a particularly long gut loop and also is temperate. The New Caledonian specimen appears either a small (1 cm diameter) specimen of *Cnemidocarpa stolonifera*, or the related *C. pedata* which has a short stomach like Monniot's specimen.

Genus *Polycarpa* Heller, 1877

Polycarpa aurita (Sluiter, 1890)

Styela aurita Sluiter, 1890, p.338.

Polycarpa aurita: Kott, 1985, p.152 and synonymy.

Monniot, 1987b, p.294. Nishikawa, 1991, p.92.

Polycarpa insulsa: Monniot 1987b, p.294 and synonymy.

DISTRIBUTION

RECORDED RANGE: The species apparently is pantropical, being recorded from the Caribbean, as well as from the Japan Sea, Indonesia, New Caledonia and the Philippines, north-western and north-eastern Australia, and south to Cockburn Sound and Port Jackson respectively.

REMARKS

Van der Sloot (1969) believed there to be 2 species, a Caribbean one, consisting of *P. insulsa* (Sluiter, 1898) and its synonyms, and a western Pacific one, *P. circumarata* (Sluiter, 1904) which Kott (1985) and Monniot (1987b) believe to be a junior synonym of *P. aurita* (Sluiter, 1890). The distinctions between the Atlantic and Pacific species which were established by Van der Sloot are differences between the type specimen of *P. circumarata* (lacking gonads in the posterior end of the body) and the Caribbean populations. This distinction can be sustained only if specimens from the Western Pacific never have gonads on the posterior part of the body wall. In fact, specimens from Australian waters show a great range in the distribution of gonads. Other distinctions such as the tough lining of the atrial cavity, which is said to occur in *P. insulsa*, occur also in *P. aurita*.

A problem with the separation of the Pacific and Atlantic species, is that specimens of the former have a range in characters, such as the number of internal longitudinal vessels, the consistency of the test and surface projections from it, that transcends any of the currently recognised differences between the species. Thus, although it is always difficult to justify genetic continuity

for pan-tropical species, the present evidence supports such a range for this species.

The occurrence of the specimen from New Caledonia assigned to *P. insulsa*: Monniot, 1987b, which is said to be identical with specimens from the Caribbean, adds support to the view that there is no distinction between these species.

***Polycarpa contecta* (Sluiter, 1904)**

Styela contecta Sluiter, 1904, p.66. Kott, 1985, p.162.
?C. Monniot, 1987b, p.291.

DISTRIBUTION

RECORDED RANGE: The species is recorded from Indonesia, and Townsville, and possibly from New Caledonia.

REMARKS

Monniot (1987b) remarks that his (single) specimen from New Caledonia corresponds well with Kott's (1985) description (based on the Siboga type material and specimens from Townsville). However, it does differ in 3 important respects. The opening of the neural gland is not the deep S-shaped slit — which Kott (1985) believes to be characteristic of *P. contecta*, its gonads are embedded in thick endocarp while those Kott examined are attached by a membrane along the proximal half of each, and the stomach of *P. contecta* is characteristically long, occupying most of the proximal limb of the primary gut loop while that of the New Caledonian specimen is shorter. Thus, there is some doubt about the designation of the New Caledonian specimen.

Genus *Polyandrocarpa* Michaelsen, 1904

***Polyandrocarpa colemani* n.sp. (Figs. 36–41, 44)**

DISTRIBUTION

TYPE LOCALITY: New South Wales, off Queensland border (Cook I., 9m, north side of I., rocky bottom, coll. N. Coleman January 1987, holotype QM GH5724; Arrawarra, 12m, south face of North Rock, coll. AIMS Bioactivity Group 19.2.88, paratype, QM GH5392).

FURTHER RECORDS: New South Wales (Coffs Harbour, photographed specimens; Cook I., QM GH5725).

The species grows along the top of of ridges where it is subjected to maximum current flow.

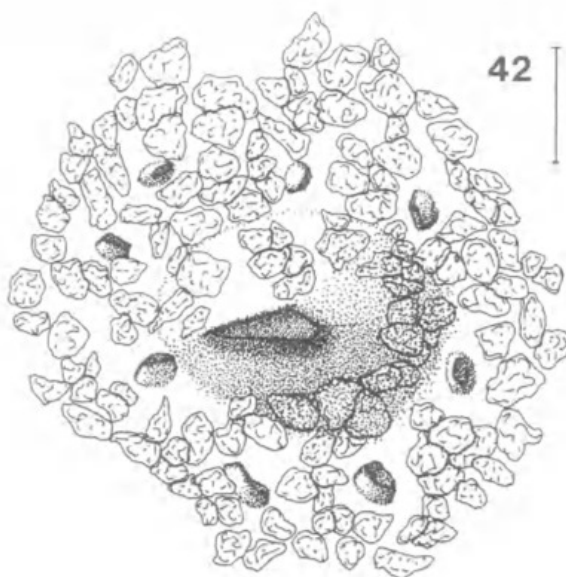
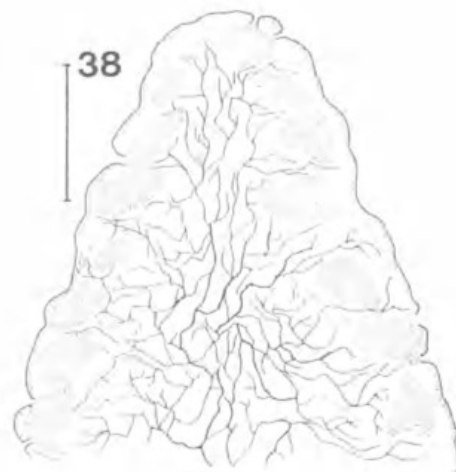
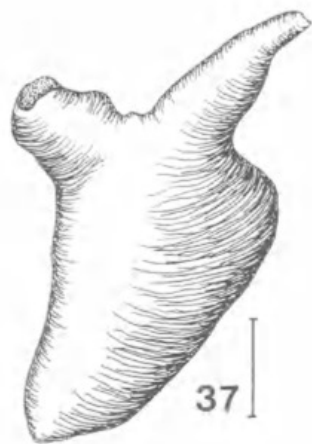
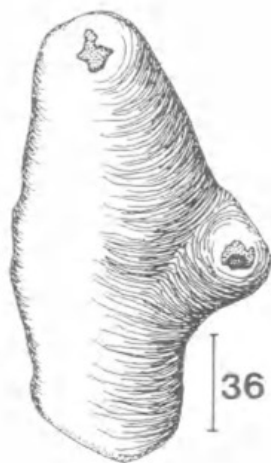
DESCRIPTION

EXTERNAL APPEARANCE: Colonies are firm, massive, to 1m long and about 0.3m wide, opaque and grey, with white rings around the apertures. The apertures protrude from the otherwise smooth surface of the colony on short cylindrical siphons. Branchial apertures are bent over to lie on the surface while the atrial apertures are directed upwards. The apertures appear to have smooth rims, the usual 4 lobes usually characteristic of styelid ascidians not being evident. In preservative the external test is dark grey, but internally the test is whitish, translucent and gelatinous, without embedded nor encrusting sand. The dark zooids are completely embedded in the tough test, and are evenly spaced. They protrude only slightly from the surface of the colony. They lie on their ventral surface with the dorsal surface uppermost, near the outer surface of the colony. Blood vessels anastomose through the thick gelatinous internal test.

INTERNAL STRUCTURE: Zooids are muscular, and much contracted in the available colonies. From the base of the branchial siphon to the posterior end of the contracted body is about 1cm. The siphons are sometimes long and thin, but in other specimens they are withdrawn and the apertures appear sessile. Externally circular muscles form an almost complete layer. The internal longitudinal muscles are less crowded. Branchial tentacles are long and pointed, and number about 50. The peritubercular area is a shallow V. The opening of the neural duct is a long, sessile slit, oriented transversely, longitudinally, or obliquely, and affected by the body's contraction — the transverse slit sometimes being bent into a U- or V shape. The slit often is obscured by the closely papillated and wrinkled lining of the prebranchial area, although this also may be caused by contraction of body wall muscles.

The branchial sac is robust, with conspicuous longitudinal vessels arranged according to the following formula: DL0(4)1(6)1(8)1(5)1E. Stigmata are 6 per mesh in the middle of the branchial sac, and 8 per mesh between the first fold and the plain-edged, long, dorsal lamina. The oesophagus is also long, curving up posteriorly toward the oesophageal opening.

The oesophagus is short. The long stomach, occupying about three-quarters of the ascending limb of the gut loop, is narrow at the cardiac end, gradually increasing in width to its junction with the wide intestine. There are 18 internal longitudinal stomach folds. A small, straight caecum is at the distal end of the stomach, in the inside curve



There is no blue pigment in the epicardial sac as described for the type material.

Zooids and larvae are characteristically large, the larval trunk 3.8mm long with a short tail that reaches only part of the way along the ventral surface. A narrow waist is behind the 2 large adhesive organs. Three broad ampullae are on each side, at the base of the thick stalks of the adhesive organs. Larvae are present in January (SAM E2480).

Genus *Distaplia* Della Valle, 1881

Distaplia prolifera Kott, 1990

Distaplia prolifera Kott, 1990a, p.122.

DISTRIBUTION

NEW RECORDS: Western Australia, (Dampier Archipelago, QM GH5399 GH5409–10 GH5413).

RECORDED RANGE: Only the holotype colony from off Port Hedland was known previously.

DESCRIPTION

The colonies are all robust sheets with spongy test. Zooids are in circular systems, slightly depressed into the surface. They are pink in preservative. Parastigmatic vessels cross each row of moderately numerous stigmata. The vertical stomach has longitudinal striations internally but is smooth externally. The gonads are in a posterior abdominal sac.

Genus *Hypsistozoa* Brewin, 1956

Hypsistozoa distomoides (Herdman, 1899)

Amaroucium distomoides Herdman 1899, p.72.

Hypsistozoa distomoides: Kott, 1990a, p.134.

DISTRIBUTION

NEW RECORD: Tasmania (W. of Mutton Bird I., SAM E2451).

RECORDED RANGE: The species is known from the Great Australian Bight to Port Jackson New South Wales. The new record from Tasmania represents the southern limits of the known range.

Genus *Protoholozoa* Kott, 1969

Type species: *Protoholozoa pedunculata* Kott, 1969.

The genus has the long posterior abdominal stolon characteristic of the Holozoidae. Its short

abdomen with the gonads and gastric vesicle in the gut loop, and its 2 to 4 transverse vessels suggest an affinity with *Sycozoa* and *Distaplia*. The arrangement of the zooids in the colony, opening separately rather than in double rows, is like another holozoid genus *Sigillina*. The colonies with long, soft, cylindrical stalks, also resemble those in other holozoid genera. The genus is separated from others in this family by its reduced branchial sac lacking stigmata.

As with all stalked, separately opening species, in this family (*Sigillina* spp.), as well as in other families (Pseudodistomidae and Clavelinidae: see Kott 1990a and 1992) the atrial apertures are directed toward the terminal free end of the colony while the branchial apertures face toward the base of the stalk. The advantages of this orientation of the apertures are discussed by Kott (1989b).

Six species are now described in the genus *Protoholozoa* (see Monniot and Monniot, 1991). *Protoholozoa pedunculata* Kott, 1969 from the Antarctic and *P. anthos* Monniot and Monniot, 1991 from off New Caledonia each have 2 transverse vessels, while *P. lilium* Monniot and Monniot, 1982 (see also Monniot and Monniot 1991) from the Antarctic and New Caledonia (sympatric with *P. pedunculata* and *P. anthos* respectively) has 3 transverse vessels as has *P. pigra* Monniot, 1974 from the Azores and *P. cantarella* Monniot and Monniot, 1985 off South Africa. Most of these species have internally ridged stomachs (except *P. anthos* and a specimen of *P. lilium*, both from New Caledonia). With the exception of *P. pigra*, the colonies are stalked, with translucent test and flat-topped heads. The long atrial lip of *P. anthos* also appears unique. However many of the other characters formerly used to distinguish species appear variable, and additional material (especially of sympatric species such as *P. lilium* and *P. pedunculata* from the Antarctic, and *P. anthos* and *P. lilium*: Monniot and Monniot, 1991 from New Caledonia) is needed to establish the range of intraspecific variation and the taxonomic significance of the number of transverse branchial vessels.

The absence of stigmata is a characteristic of most ascidian taxa from deep slope to abyssal waters from which previously recorded species of the present genus have been taken. The new species described below is the only one recorded from shallow waters.

The statement that *Protoholozoa* was the only genus of the family Holozoidae not known from Australian waters (Kott 1990a) is now known to

of the loop, crowded between the stomach and the short, comma-shaped, flat-topped endocarp which is enclosed in the pole of the gut loop. The descending limb of the narrow primary gut loop is parallel to the ascending limb, although this could be an artefact resulting from contraction. The rectum is long. Although there is some variation in its length relative to the descending limb of the primary loop, this variation may also be the result of contraction. The anal border has 4 to 6, sometimes subdivided, deep lobes on its dorsal rim. The opposite side is undivided.

Gonads are present only in the holotype colony. They are long, narrow polycarps lying on, rather than embedded in, the body wall. Immature ova fill the ovarian tube, but male follicles are not developed in any of the zooids examined. On the left are up to 4 gonads in a row in the middle of the body wall, sometimes with an additional one dorsal to them in what may represent an incomplete second row. In one zooid a rather irregular clump of 3 polycarps is near the pole of the gut loop, just to the left of the endostyle. On the right, gonads are seldom present, being observed in only 2 of approximately 10 zooids examined. They are in one or 2 incomplete rows on the dorsal half of the body wall, and are directed toward the atrial aperture. The lining of the parietal wall of the atrial cavity is foamy with crowded vesicles about 0.05mm in diameter.

REMARKS

There are several known species of *Polyandrocarpa* with embedded zooids. Of these, *P. abjornseni* Hartmeyer and Michaelsen, 1928 and *P. simulans* Kott, 1972a (respectively from Western Australia and South Australia) have a similar flat-topped endocarp in the gut loop, and similar numbers of branchial vessels to the present species. However, they both lack the great mass of zooid-free test that is characteristic of the present species. *Polyandrocarpa robusta* Sluiter, 1915 (which Kott, 1985, thought may be similar to *P. colligata* Sluiter, 1913) has one to 3 internal longitudinal vessels in the interspaces while the present species never has more than one; and it has a curved stomach caecum, only 14 stomach folds, a smooth anal border, and gonads in a row each side of the endostyle. *Polyandrocarpa maxima*: Van Name, 1918, 1945 from the Philippines

and western (*sic*, eastern, Kott 1985) Atlantic has scattered gonads (which may be in a similar position to the gonads in the present species), and a vestigial gastric caecum. Zooids in Van Name's material, however, are crowded with only thin layers of test between them, longitudinal vessels are more numerous both on the folds and in the interspaces, and although the stomach has a similar number of folds to the present species, it is markedly shorter, and the gonads are only loosely attached to the body wall (possibly tending to be upright: see Kott 1985).

Polyandrocarpa colligata Sluiter, 1913 from the Aru Is has a bulky colony, with protuberant apertures, and it closely resembles that of the present species. Also the zooids are similar with similar slit-like openings of the neural duct, a small stomach caecum, a long stomach with apparently a similar number of folds (see Sluiter 1913, pl. VI, Fig. 14) and long, narrow polycarps. Sluiter's species is distinguished from the present one by the course of the gut, and its position across the posterior end of the zooid (features which Sluiter has emphasised do not necessarily constitute a distinction from *P. robusta* since they are readily affected by contraction). *Polyandrocarpa colligata* is also distinguished by its more numerous longitudinal branchial vessels, both in the interspaces and on the folds, its gonads in a row each side of the endostyle (as in *P. robusta*) and the endocarps on the body wall. Other characters conspicuous in the present species and not observed (but possibly overlooked) in *P. colligata* are the foamy layer of vesicles lining the parietal wall of the atrial cavity, and the lobed anal border.

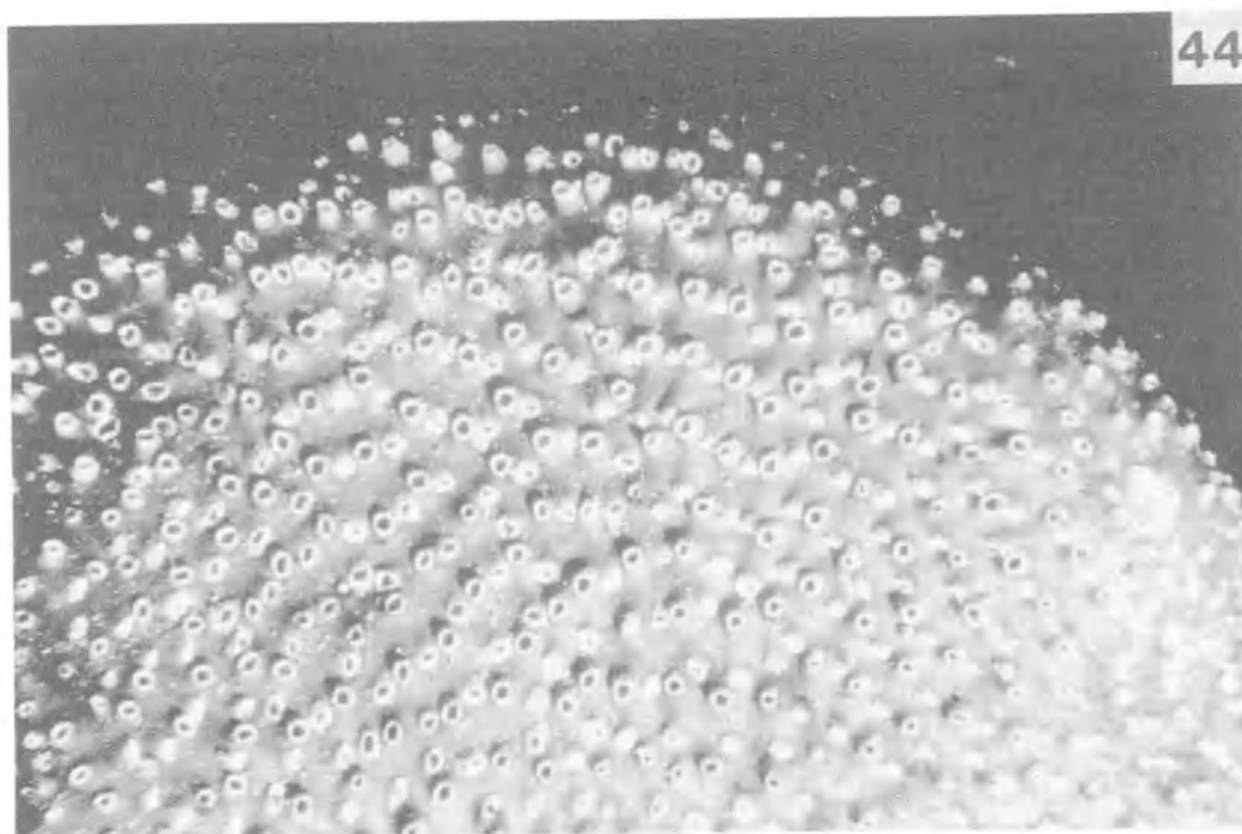
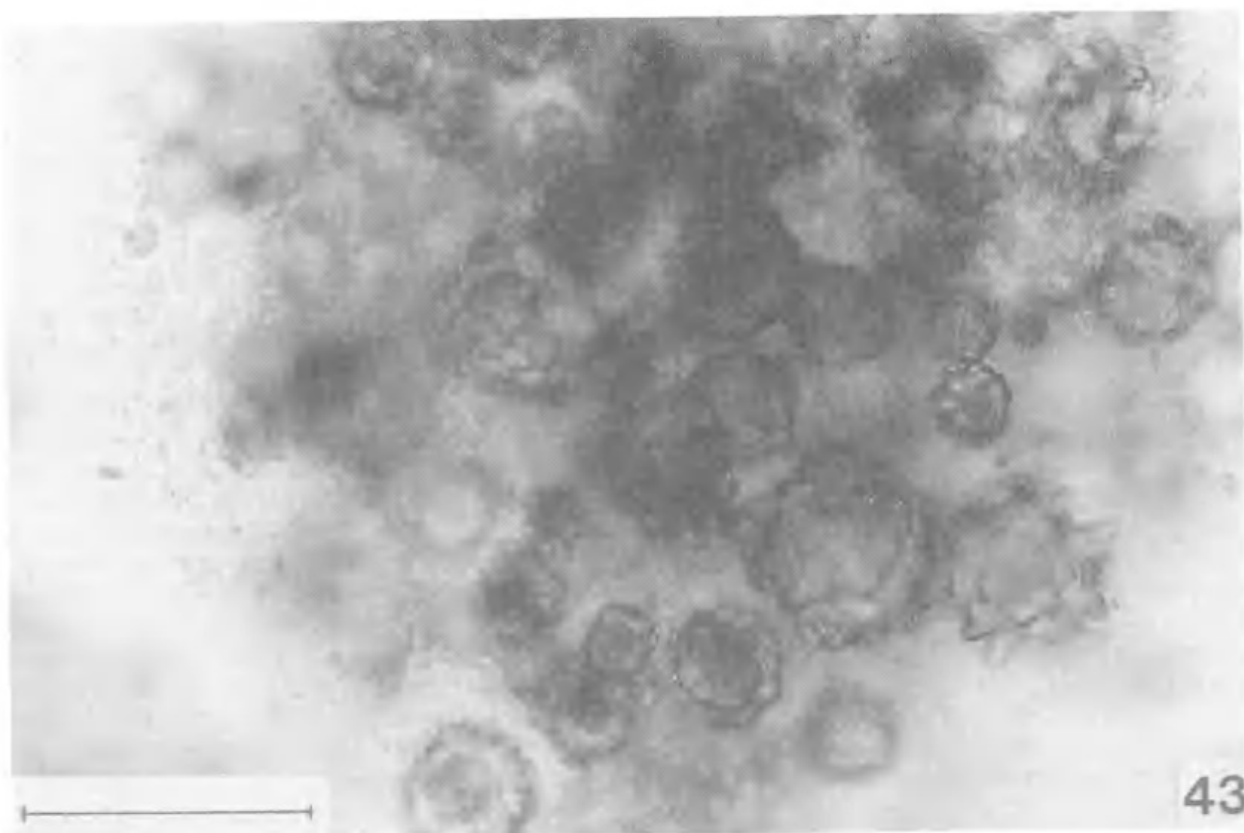
Nevertheless, *P. colemani* has a limited distribution at the boundary of tropical and temperate zones of the eastern Australian coast. It is well isolated from the tropical *P. colligata*.

Subfamily BOTRYLLINAE Adams and
Adams, 1858
Genus *Botryllus* Gaertner, 1774

Botryllus stewartensis Brewin, 1958
(Fig. 42)

Botryllus stewartensis Brewin, 1958, p.444. Kott, 1985, p.269 and synonymy; 1990b, p.286.

FIGS. 36–42: *Polyandrocarpa colemani* n.sp. (holotype QM GH5724) — 36, 37, bodies removed from test; 38, section across colony showing blood vessels and position of zooids; 39–41, internal organs on left. *Botryllus stewartensis* (QM GH5294) — 42, system showing branchial and common cloacal apertures from above. (Scales: 36, 37, 39–41 — 2mm; 38 — 1cm; 42 — 0.5mm).



FIGS. 43, 44: *Polycitorella coronaria* (QM GH5616) — 43, spicules. 44, *Polyandrocarpa colemani* n.sp. — view of colony (photo, N. Coleman). (Scale: 43, 0.1mm).

DISTRIBUTION

NEW RECORD: Queensland (Point Lookout, QM GH5294).

RECORDED RANGE: The species is known from Albany (WA) across the southern coast of Australia to Port Kembla and Port Stephens (NSW) and Moreton Bay (Qld), as well as Stewart I. and South I. (New Zealand).

Previous records from Moreton Bay are from inside the Bay. The new records are from the ocean side of North Stradbroke I. indicating that Moreton Bay is part of the continuous range of this widespread species, rather than being a refuge at the northern limit of its range.

DESCRIPTION

The colonies are irregular sandy slabs to 5 cm or more in maximum dimension, and 1 cm thick. They are subdivided into lobes on the surface. About 5 zooids are in each circular system of about 2.0 m diameter. Two or 3 systems are crowded into each lobe. Sand particles are embedded in the basal test, and adhere all over the surface. However there is little sand in the tough white internal test, around the zooids.

REMARKS

The present colonies do not have quite such long, narrow stalks as have been previously described. They are otherwise characteristic of this species.

Family PYURIDAE Hartmeyer, 1908
Genus *Pyura* Molina, 1782

Pyura albanyensis Michaelsen, 1927

Pyura albanyensis Michaelsen, 1927, p. 193.

Pyura obesa: Kott, 1985, p. 315 and synonymy.

Not *Pyura albanyensis*: Monniot, 1989, p. 492. Monniot and Monniot, 1991, p. 411.

DISTRIBUTION

RECORDED RANGE: The species is known from tropical and temperate waters around the Australian coast, the Arafura Sea, and the Palau Is.

REMARKS

Monniot (1989) distinguishes *Pyura albanyensis* from *P. curvigona* (> *P. vittata*: Monniot, 1989, 1991) only by the presence of the swollen rectum in the latter species. He remarks that 'tous les autres caractères sont peu importants et les différences observées entre les espèces pourraient correspondre à une variabilité'. However, there are significant differences in a number of con-

spicuous and stable characters between these two species. The principal difference is the form of the siphonal spines (Kott 1985). In *P. curvigona* these have a flat scale halfway along them, which is not present in *P. albanyensis*. In *P. albanyensis* the needle-like spines are of two sizes. Further differences are the short dorsal lamina, the long, deeply curved U-shaped gut loop and the distinct longitudinal stripes down the outside of the siphons in *P. albanyensis*. The species are similar only in the crowded endocarps on gut loop and gonads, in the almost pinnate form of the ovarian tube, each short branch with a cap of male follicles, and in the distribution of the siphonal spines, which continue over the outer surface from inside the siphon.

Monniot (1989) assigned 2 specimens from New Caledonia, one 5 cm and one 1.2 cm long, to *P. albanyensis*. In neither were the small spines between the larger ones reported, nor can they be detected in Monniot's scanning electron micrographs. It is possible that these have been obscured by the larger spines, although this does not seem to be the case. The smaller spines, like the larger ones, are on the surface of the test both inside and outside the siphons, and should be apparent if they are present.

Further, although the gut loop and gonads have crowded endocarps on them, and the long ovarian tubes have pinnate branches, each with a cap of terminal testis follicles, the New Caledonian specimens differ from *P. albanyensis* in having a long dorsal lamina and a narrow but gently curved gut loop.

The form of the siphonal armature needs to be established by light microscope examination of cleared preparations in order to accurately assign the New Caledonian specimens.

Monniot (1989) drew attention to the fact that the name Hartmeyer applied to the holotype of this species is preoccupied by the Antarctic *Pyura obesa* Sluiter, 1912.

Pyura curvigona Tokioka, 1950

Pyura curvigona Tokioka, 1950, p. 147. Kott 1985, p. 296 and synonymy.

?*Pyura vittata*: Monniot, 1989, p. 490.

?*Pyura uatio* Monniot, 1991b, p. 33.

DISTRIBUTION

RECORDED RANGE: The species is known from Shark Bay (Western Australia), Heron and Lizard I. (Queensland), the Palau Is, Indonesia (see Kott 1985), and possibly from New Caledonia.

REMARKS

Monniot (1989) has synonymised this species with the Atlantic Ocean *Pyura vittata*. He appears to have overlooked the opalescent scale which is such a feature of the siphonal armature of the present species (see Kott 1985, Figs 5k, 145a,b). Since the New Caledonian specimens assigned to *P. vittata* have the enlarged rectum, pinnate gonads, and endocarps of the present species it is possible that they are conspecific. Examination of cleared preparations of siphonal armature by light, rather than by scanning electron, microscopy, would, if they are present, display the scales of the siphonal spines which are just under the surface of the test.

The green liver and pink body wall of this species is found also in *P. uatio* from New Caledonia which, however, lacks an expanded rectum, and may be a different species.

***Pyura rapaformis* Kott, 1990**
(Figs 45, 46)

Pyura rapaformis Kott, 1990b, p.287.

DISTRIBUTION

NEW RECORD: South Australia (Beachport Jetty piles, SAM E2510).

RECORDED RANGE: The species, previously recorded from the upper surface of a reef at Cottesloe, probably has a continuous range between Cockburn Sound and St Vincent Gulf.

DESCRIPTION

The present specimens are as previously described, with both apertures on the upper, more or less flattened, surface of a turnip-shaped body. The surface test has irregular extensions and papillae to which sand adheres, and sand also is embedded in the test. The body has a posterior stolon projecting down into the test. The siphonal spines are about 0.08mm long, with a long narrow opening and 4 rounded knobs at the posterior end of the shaft. Branchial tentacles are feathery, with long primary branches. The branchial sac has 6 wide, overlapping folds on each side with 7 to 18 internal longitudinal vessels on the folds and up to 3 between. Leafy, irregular endocarps are on the gut and gonads.

REMARKS

Externally the species resembles individuals of *Pyura isobella* Kott, 1985 from Ulladulla (NSW) and internally it has similar endocarps and gut loop and gonads. The siphonal spines lack the

posterior expansion, and the small opening of spines of *P. isobella*, and more closely resemble the spines of *P. tasmanensis* Kott, 1985 (as observed by Kott 1990b).

Genus ***Herdmania*** Lahille, 1888***Herdmania momus*** (Savigny, 1816)

Cynthia momus Savigny, 1816, p.143.

Herdmania momus: Kott, 1985, p.338.

Pyura momus: Monniot, 1989, p.498.

DISTRIBUTION

RECORDED RANGE: The species is pantropical, extending into temperate waters of southern Africa and southern Australia.

REMARKS

Monniot (1989) believes the genus *Herdmania* to be a junior synonym of *Pyura*. In addition to the characteristic long barbed spines, *Herdmania* has a continuous ovarian tube surrounded by male follicles, rather than being broken up into separate gonad blocks as in *Pyura*; and the liver lobules are embedded in the body wall, rather than lying free in the atrial cavity as in *Pyura* (see Kott 1985).

Genus ***Microcosmus*** Heller, 1877***Microcosmus tuberculatus*** Kott, 1985

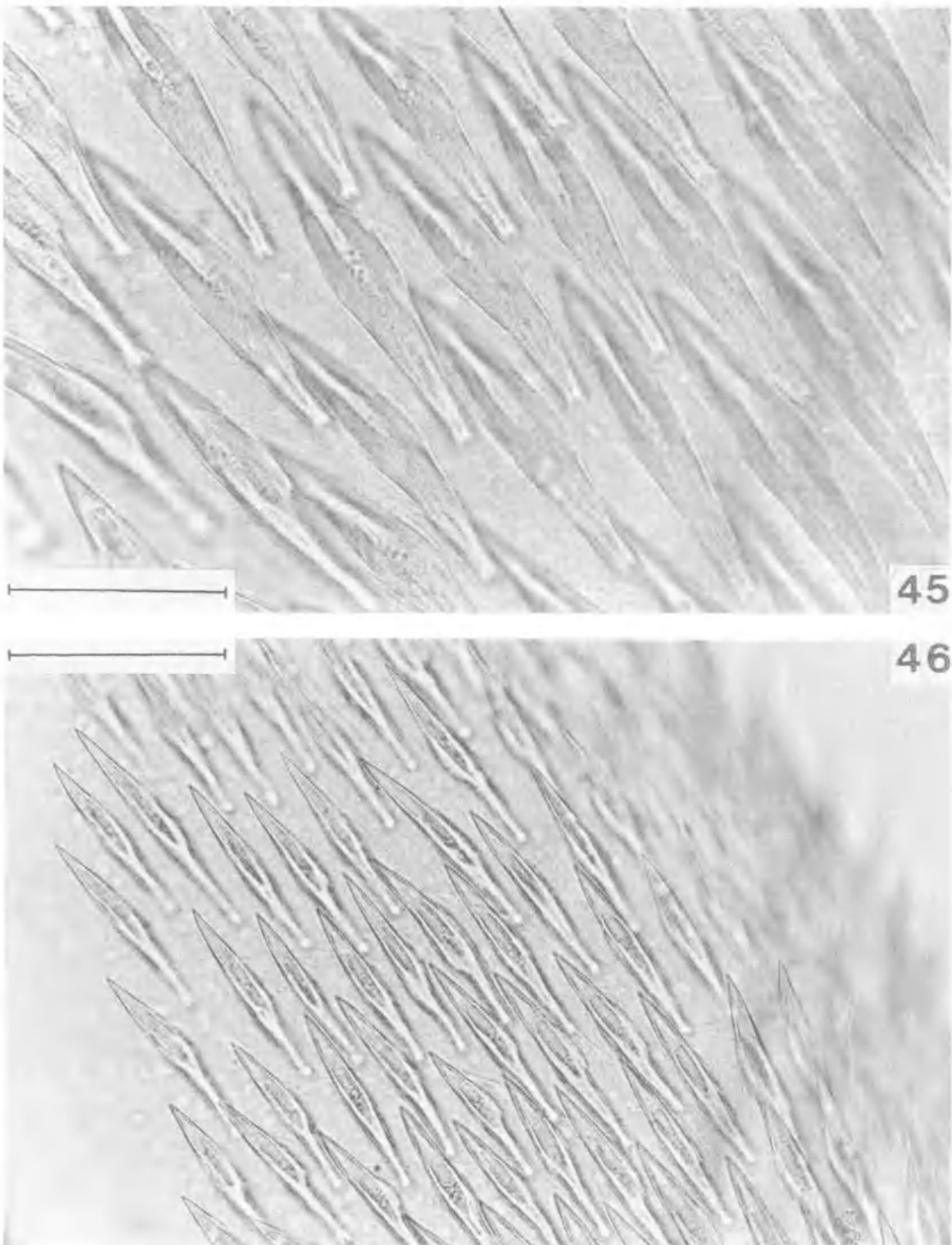
Microcosmus tuberculatus Kott, 1985, p.361. ? Monniot, 1991b, p.31.

DISTRIBUTION

RECORDED RANGE: The species is known for certain only from its type locality in the Swain Reefs.

REMARKS

The species is distinguished from *M. exasperatus* by its large conspicuous conical spines around and lining the apertures (see Kott 1985, Fig. 179b) and the deeply incised anal border. The specimen from New Caledonia (Monniot 1991) has neither of these features. The thick endocarp-like layer of the body wall Monniot observed over the gonads and gut occurs variably in most *Microcosmus* species, including *M. exasperatus*, to which the New Caledonian specimens very likely belong.



FIGS. 45, 46: *Pyura rapaformis* (SAM E2510) — siphonal spines (Scales: 45, 0.05mm; 46, 0.1mm).

Family HEXACROBYLIDAE Seeliger, 1906

The family was reviewed by Kott (1989a), and later, by Monniot and Monniot (1990).

The family is characterised by its large buccal cavity, surrounded by 6, usually large, branched branchial arms, a large kidney, and a reduced perforated pharynx, limited to a short band at the proximal end of the gut. Ciliated stigmata are small and rounded. The gut is well developed with a wide, and often long oesophagus, and there is evidence of adaptation for a carnivorous habit (see Kott 1989a). Although, successively, a new pleurogonid suborder, *Aspiraculata* Seeliger, 1906, and a new tunicate class *Sorberacea* Monniot, Monniot and Gaill, 1975 have been proposed for the family, there appears to be no justification for either of these higher taxa (see Kott 1989a).

The Hexacroblyidae have adaptations for deep water habitats, but their morphology is homologous with that of Molgulidae, with which they appear to have closer affinities than the latter family has with other extant ascidian taxa, even within the Pleurogona (see Kott 1989a).

The view (Monniot and Monniot 1990) that the family name Hexacroblyidae should be abandoned in favour of Oligotrematidae (sic, Oligotremidae Monniot and Monniot, 1990) is incorrect (ICZN Article 40). Further, the type genus is *Hexacroblyus* Sluiter, 1905a, a junior objective synonym of *Oligotrema* Bourne, 1903.

Although Kott (1985) thought the family was not represented in Australian waters, *Asajirus indicus* Oka, 1913 and *Oligotrema psammites* Bourne, 1903 have since been recorded (Kott 1989a).

Genus *Asajirus* Kott, 1989a

Type species: *Hexacroblyus indicus* Oka, 1913.

Kott (1989a) examined and redescribed the type specimen (ZMA TU564) of *Hexacroblyus psammates* Sluiter, 1905a, and found it to be a species of the genus *Oligotrema* Bourne 1903, possibly conspecific with its type species *O. psammites* Bourne, 1903 from New Britain. Thus was corrected a belief that *Hexacroblyus psammates* and *H. indicus* Oka, 1913 were congeneric, and *H. indicus* Oka was found to be a member of an undescribed genus. *Hexacroblyus indicus* Oka, 1913 was therefore designated type species of a new genus *Asajirus* Kott, 1989a (of which *Hexadactylus* Monniot and Monniot,

1990, with the same type species as *Asajirus*, is a junior synonym).

Monniot and Monniot (1990) recognise 12 species in the genus *Asajirus*, distinguished from one another primarily by differences in the length of the vas deferens and in the number and length of testis lobes. It may be difficult to sustain this number of species, in view of the probability that there is some intraspecific variation in taxa which, in many cases, have vast geographic ranges.

The differences are less compelling than the similarities between most of the species Monniot and Monniot (1990) have documented, and many are sympatric in at least part of their range, while some are over their whole range. For instance, *A. longitestis* (Monniot and Monniot, 1990), *A. ovi-rarus* (Monniot and Monniot, 1990), *A. hemisphericus* (Monniot and Monniot, 1990), *A. gulosus* (Monniot and Monniot, 1984b) and *A. indicus* (Oka, 1913) are all recorded from the vicinity of New Caledonia, *Asajirus millari* (Monniot and Monniot, 1991) also is from the West Pacific (the Bali Sea); *A. seeligeri* (Monniot and Monniot, 1990) and *A. gulosus* are from the Comoro Is in the Indian Ocean and some records of *A. indicus* are also from the Indian Ocean; *A. ledanoisi* and *A. eunuchus* are from wide ranges in the Atlantic, and *A. arcticus* is from the Norwegian Sea; while *A. antarcticus* is recorded from around the Southern Ocean and *A. dichotomus* is from the southeastern Atlantic (the Cape Basin).

It is not intended to review this genus in the present work, rather attention is drawn to some of the problems of species definition in this family. These will not be resolved if descriptions do not take account of the homologies of organs, of similarities in morphology as well as morphological differences, of probable artefacts resulting from contraction and distortion, and of differences that most likely arise from growth and maturity.

Asajirus indicus (Oka, 1913)

Hexacroblyus indicus Oka, 1913, p.6. Millar, 1959, p.203; 1969, p.97; 1970, p.146; 1975, p.332. Monniot and Monniot, 1968, p.32; 1970, p.334; 1979, p.564; 1984b, pp.198 (figs 1,2) 203; 1987, p.41. Monniot, F., 1971, p.458.

Asajirus indicus: Kott, 1989a, p.521.

Hexadactylus indicus: Monniot and Monniot, 1990, p.271.

Hexacrobylus arcticus Hartmeyer, 1923, p.133. Monniot and Monniot, 1984b, p.203 (specimens from *Norbi* cruise).

Hexadactylus arcticus: Monniot and Monniot, 1990, p.261.

Hexacrobylus eunuchus Monniot and Monniot, 1976, p.658.

Hexadactylus eunuchus: Monniot and Monniot, 1990, p.265.

Hexacrobylus sp. Monniot and Monniot, 1982, p.128 (part, *Eltanin* cruise 5, station 258).

Oligotrema psammites: Kott, 1969, p.168.

Hexadactylus antarcticus Monniot and Monniot, 1990, p.259.

Hexadactylus longitestis Monniot and Monniot, 1990, p.275.

Hexadactylus millari Monniot and Monniot, 1991, p.277.

Hexadactylus seeligeri Monniot and Monniot, 1990, p.281.

DISTRIBUTION

NEW RECORDS: Coral Sea (12° 05' S 146° 24' E, *Cidaris* 3 site 6.1, 16.2, 92, 3319–3105m, QM G300891; 13° 29' S 147° 13' E *Cidaris* 2 Site 15.1, 5.9.88, 2542–2457, QM G300892).

RECORDED RANGE: The recorded range for *A. indicus* and its probable synonyms is: *A. longitestis* — New Caledonian (both sides of the Norfolk Ridge); *A. indicus* — the Indian Ocean, New Caledonia, off eastern Australia from 151°27' to 148°38' E and 12° to 42° S from the Coral Sea to eastern Tasmania; *A. seeligeri* — the Indian Ocean and Comoro Is.; *A. millari* — the Bali Sea (western Pacific); *A. eunuchus* — southwestern and northern Atlantic; *A. arcticus* — northeastern Atlantic; *A. antarcticus* — South Indian and Pacific Oceans.

The species is found at depths from 1000 to 5000m. The record for the specimen AM Y2125 from off the New South Wales coast, is from 151°27' E, not 51°27' E as reported by Kott (1989a).

DESCRIPTION

The newly recorded specimens are rounded posteriorly, 1.2 cm long, but contracted anteriorly, causing the fine hairlike projections mixed with foraminifers and other particles to appear more crowded than they are posteriorly. Internally the 2 ventral muscle bands are short and broad, the rectum is crowded with hard particles including foraminifers, polychaetes, ostracods, cladocerans, isopods, gastropods and what appears to be particles of ophiurid (including spines). The remainder of the gut (the long oesophagus and stomach) are empty.

REMARKS

Specimens from the northern Atlantic (*A. ledanoisi*) and from the Cape Basin, south-eastern Atlantic (*A. dichotomus*) with long sperm ducts are not included in the above synonymy of *A. indicus*, although *A. eunuchus* (Monniot and Monniot, 1976) from the south-western and northern Atlantic, *A. arcticus* (Hartmeyer, 1923) from the Norwegian Sea, *A. antarcticus* (Monniot and Monniot, 1982) from the southern (polar) Indian and Pacific Oceans and *A. millari* from the Bali Sea have short male ducts as in *A. indicus*, and are here included in its synonymy, as is *A. seeligeri* (with both short on long male follicles) from the Indian Ocean, and *A. longitestis* (with long male follicles) from New Caledonia. *Asajirus indicus* (Oka, 1913) as well as being taken from off the eastern Australian coast, is from the Indian Ocean and New Caledonia.

Also from New Caledonia, and, for the present, excluded from the synonymy of *A. indicus*, are *Asajirus hemisphericus* and *A. ovirarus*, with more or less entire testis; and *A. gulosus* with a long vas deferens like *A. ledanoisi* and *A. dichotomus*.

Genus *Oligotrema* Bourne, 1903

Type species: *Oligotrema psammites* Bourne, 1903.

Although not designated a neotype, Monniot and Monniot (1990) redescribed the species from a specimen taken from near the type locality.

Monniot and Monniot's definition of the genus omits certain significant characteristics described by Bourne, which also are present in the type specimen of *Hexacrobylus psammatus* Sluiter, 1905a (see Kott 1989a). Monniot and Monniot (1990) refer to the widely separated apertures but not to the posterior position and orientation of the atrial aperture; they refer to muscles extending the length of the body wall, but fail to indicate that these are circular muscles, sometimes interrupted; and that longitudinal muscles are very limited; nor do they refer to the flagellated epithelial covering of the branchial tentacles described by Bourne (see also Kott 1989a).

Monniot and Monniot (1990) indicate, as Kott (1989a) had suggested, that the branchial stigmata are circular perforations, rather than the rectangular stigmata described by Bourne. This removes the principal restraint to the synonymy of *H. psammatus* Sluiter, 1905a with the present species. Other characters, viz. the branchial

tentacles, the large endocarps and the large atrial cavity, are as described by Bourne, and by Kott (1989a) for the type specimen of *H. psammotodes* Sluiter, 1905a (ZMA TU564).

There is no additional evidence regarding the proposed synonymy of *Gasterascidia*, *Sorbera* with *Oligotrema* (see Kott 1989a). Nor is there any clarification regarding the apparent degeneration of the rectum in *Gasterascidia lyra*, which, if present, appears to be non-functional (see Monniot and Monniot, 1990 Fig. 5B).

Oligotrema psammites Bourne, 1903

Oligotrema psammites Bourne, 1903, p.233. Monniot and Monniot, 1990, p.253.

Hexacrobylus psammotodes Sluiter, 1905a, p.135; 1905b, p.135.

Hexacrobylidae juv., intermediate between *Sorbera* and *Gasterascidia*: Monniot and Monniot, 1984b, p.212; 1990, p.257.

?*Sorbera digonas* Monniot and Monniot, 1984b, p.209.

Oligotrema psammotodes: Kott, 1989a, p.529. Monniot and Monniot, 1990, p.258.

DISTRIBUTION

RECORDED RANGE: The species is recorded from New Britain (Bourne 1903; Monniot and Monniot 1990), Indonesia (ZMA TU564, Siboga, Station 211, Banda Sea, Sluiter 1905a), west of New Caledonia (Monniot and Monniot 1990); New South Wales coast (Kott 1989a) and the south-east Atlantic (the Cape Basin, Monniot and Monniot 1984b).

Sorbera digonas is recorded from the tropical Indian Ocean.

REMARKS

The specimens all have the shallow ventral groove in the pharynx; vertically flattened branchial tentacles with one or 2 short, pointed, projections anteriorly, an otolith-like black granule in the neural gland, and the parietal wall of the atrial cavity raised into long endocarps on each side of the oesophagus. These endocarps sometimes cover part of the gonads. In the thick pharyngeal wall the interconnected chambers (that the Monniots in 1984 and 1990 refer to as branching tubules) eventually open to the atrial cavity by small, rounded ciliated stigmata which vary in number according to the size of the specimen. The ligament attaching the oesophagus to the body wall (Kott 1989a) appears to be the ventral septum dividing the atrial cavity into two sections (Monniot and Monniot 1990). In fact, the atrial

invagination is always from the dorsal surface and the cavity always is continuous over the dorsum. It never penetrates ventral to the pharynx, past the ventral sinus. The ligament or septum is merely the ventral body wall where it is not interrupted by the atrium.

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INDEX TO TAXA

(Taxon descriptions and figures in **bold**)

- Amaroucium distomoides*, 627
Aplousobranchia, 621 623
Asajirus, **648**
 antarcticus, 648 649
 arcticus, 648 649
 dichotomus, 647 649
 eunuchus, 648 649
 gulosus, 648 649
 hemisphericus, 648 649
 indicus, **648-649**
 ledanoisi, 648 649
 longitestis, 648 649
 millari, 648 649
 ovirarus, 648 649
 seeligeri, 648 649
Ascidia, 634
 aperta, 634
 archaia, 622 **634**
 corelloides, 634
 dorsalis, 634
 liberata, **634**
 solomonensis, 634
 sydneiensis, 634
Ascidiiidae, 634
Aspiraculata, 648
Asterocarpa, 640
 humilis, **640**

Botryllinae, 643 645
Botryllus, 643
 stewartensis, **643 645**

Cionidae, 622 623
Clavelina, 625
 baudinensis, 625
 diminuta, 625
 pseudobaudinensis, **625**
Clavelinidae, 625 627
Cnemidocarpa, 636
 amphora, **636-637 639**
 areolata, 622 **637-638**
 completa, 637
 floccosa, 637
 aff. humilis, 640
 intestinata, **638**
 irene, 637
 legali, 637
 lobata, 640
 pedata, 640
 stolonifera, 640
 tribranchiata, **638 639**
 tripartita, 640
 valborg, 637
Cynthia momus, 646
Cystodytes, 629
 dellachiajei, 629
 ramosus, **629 630**

Diazona, 623
Diazonidae, 622 623
Didemnidae, 621
Distaplia, 627 628
 prolifera, **627**

Ecteinaascidia, 635
 aequale, 635 636
 crassa, 623
 diaphanis, **635**
 hedwigiae, 635
 imperfecta, 635
 koumaci, 635
 multiclathrata, 635
 ndouae, 635
 nexa, **635-636**
Eudistoma, 633
 aureum, **632 633**
 fantasiana, 626
Exostoma, 633
 ianthinium, **633**

Gasterascidia, 650
 lyra, 650

Herdmania, 646
 momus, **646**
Hexacrobylidae, **648 650**
Hexacrobylus, 648
 arcticus, 649
 eunuchus, 649
 indicus, 648
 psammotodes, 648 649 650
 sp., 649
Hexadactylus, 648
 antarcticus, 649
 arcticus, 649
 eunuchus, 649
 indicus, 648
 longitestis, 649
 millari, 649
 seeligeri, 649
Holozoidae, 626 627
Hypodistoma, 628
Hypsistozoa, 627 628
 distomoides, **627**

- Microcosmus*, 646
exasperatus, 646
tuberculatus, **646**
Molgulidae, 648

Neodistoma, 628

Oligotrema, 648 **649 650**
psammotodes, 650
psammites, 648 **649 650**
Oligotrematidae, 648
Oxycorynia, 625
pseudobaudinensis, 625

Perophora, 635
africana, 635
bermudiensis, 635
fascia, 635
hornelli, 636
hutchisoni, 635
multiclathrata, 622 **635**
namei, 635
Perophoridae, 623 635
Phlebobranchia, 621 623 634
Pleurogona, 648
Polyandrocarpa, 641
abjornseni, 643
colemani, **641 642 643 644**
colligata, 643
maxima, 643
robusta, 643
simulans, 643
Polycarpa, 640
aurita, 622 **640-641**
circumarata, 640
contecta, 641
insulsa, 640
Polycitor, 631
annulus, 632
calamus, **631 632**
circes, 632
giganteus, 632
ianthinus, 633
obeliscus, 632
Polycitorella, 629
coronaria, **629 630 631 644**
Polycitoridae, **629**
Polydistoma, 625
Polyzoinae, 623
Protoholozoa, **627**

anthos, 627 628
australiensis, 624 625 **628**
cantarella, 627 628
lilium, 627 628
pedunculata, 627 628
pigra, 627 628
Protopolycrinum, 623
claviformis, 623
Pseudodiazona, 623
claviformis, **623 624**
Pseudodistomidae, 627
Pycnoclavella, 625
arenosa, 625
aurantia, **624 625**
detorta, 625
diminuta, **624 625-626**
elongata, **626**
tabella, 625
Pycnoclavellidae, 625
Pyura, 645 646
albanyensis, **645**
curvigona, **645**
isobella, 646
momus, 646
obesa, 645
rapaformis, **646 647**
tasmanensis, 646
uatia, 645 646
vittata, 645 646
Pyuridae, 645

Rhopalaea, 622 623
crassa, **623**
respicens, 623

Sigillina, 626 627
fantasiana, **626**
grandissima, **626**
Sorbera, 650
digonas, 650
Sorberacea, 648
Stolidobranchia, 621 636
Stylea,
areolata, 637
aurita, 640
contecta, 641
humilis, 640
Styelidae, 636
Styelinae, 636
Sycozoa, 627 628



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