

THE ASCIDIANS OF SOUTH AUSTRALIA I. SPENCER GULF, ST. VINCENT GULF AND ENCOUNTER BAY

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Summary

A large and representative collection of Ascidiacea from St. Vincent Gulf and adjacent locations is discussed. Fifty-nine species are represented, of which *Pyura scoresbiensis* and *Ctenicella antipoda* are new to science. *Ascidia aclara* Kott, previously known from other Australian locations, and *Aplidium colelloides* Herdman, previously known only from South Africa, are recorded from the area for the first time.

The fauna of St. Vincent Gulf is typically of the Flindersian marine biogeographic region, but includes several endemic species. Morphological characteristics accounting for the success of certain species and groups of species sharing a habitat are indicated.

Introduction

This large collection of ascidians, mainly from St. Vincent Gulf, South Australia, was made by Mr. S. A. Shepherd of the Department of Fisheries and Fauna Conservation, South Australia. It is a valuable and representative collection and demonstrates the value of SCUBA collections of this benthic group from otherwise inaccessible localities. Colour notes made by the collector provide most useful data for comparison with the preserved specimens in which colours are generally lost or change completely. The large number of individuals of most species that are available in the collection has demonstrated a wide variability in certain characters and some synonymy has been established.

Information on the environmental conditions operating in various locations, also supplied by the collector, has been related to the morphology of the species present to contribute to an assessment of selective mechanisms affecting the ascidians. Full station lists of species are also given to facilitate consideration of the faunal associations and their ecological relationships.

The specimens are deposited in the South Australian Museum.

The following species have previously been recorded from South Australia (Kott 1952, 1957a, 1962, 1963) but were not in the present collection.

Polyclinum neptunium
Polyclinum marsupiale
Aplidium flavolineatum
Aplidium australiensis
Lissoclinum ostrearium
Didemnum turritum
Didemnum angusti
Didemnum pseudodiplosoma
Trididemnum natalense
Trididemnum cerebriforme
Leptoclinides imperfectus
Symplegma viride
Styela lobata
Asterocarpa cerea
Pyura stoloniifera

Zoogeography

The fauna is typically that of the Flindersian marine region, together with *Distaplia viridis* which is also recorded from Port Phillip Bay, *Ascidia aclara* which has been taken from similar sheltered locations on the Victorian, New South Wales, and Queensland coasts, and *Aplidium colelloides*, previously recorded from South Africa. The new species, *Pyura scoresbiensis* and *Ctenicella antipoda*, may be endemic.

The records of *A. colelloides* from off South Africa and South Australia suggest a circum-polar distribution, as demonstrated for many ascidian species (Kott 1971a). A wide dispersal of larvae, however, does not provide a satisfactory explanation for this pattern of dis-

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tribution since, for successful sexual reproduction, minimal population densities of adults are required. The existence of so many circumpolar species in the extant fauna may be the result of a slow rate of evolution and the persistence of relict forms in certain areas.

Habit of the Ascidian Fauna

In the present collection, ascidians have been taken from a wide variety of locations, especially in St. Vincent Gulf. The terminology qualifying the conditions encountered is partly that described by Shepherd & Womersley (1970) and Womersley & Edmonds (1958), as follows:

(1) "*Rough Coast Subformation*" (R.C.S.) refers to coasts exposed to the southern ocean swell (wave periods 10-12 secs.).

Water movement resulting from this swell is strong and pulsatile on the surface but decays with depth so that surge is moderate at 15 m and slight at 25 m depth.

(2) "*Sheltered Coast Subformation*" (S.C.S.) (see Womersley & Edmonds 1958) refers to sheltered coasts where there is no swell and the coast is subject to waves of short period (up to 5 seconds) which decay rapidly with depth. Much of the coast-line in both Spencer Gulf and St. Vincent Gulf is of this type.

(3) "*Offshore Benthic*" locations are those away from the shore where water movement results from tidal current rather than wave action. In St. Vincent Gulf tidal currents are generally about 1 m/sec., except over Tapley Shoal where they are 1-2 m/sec.

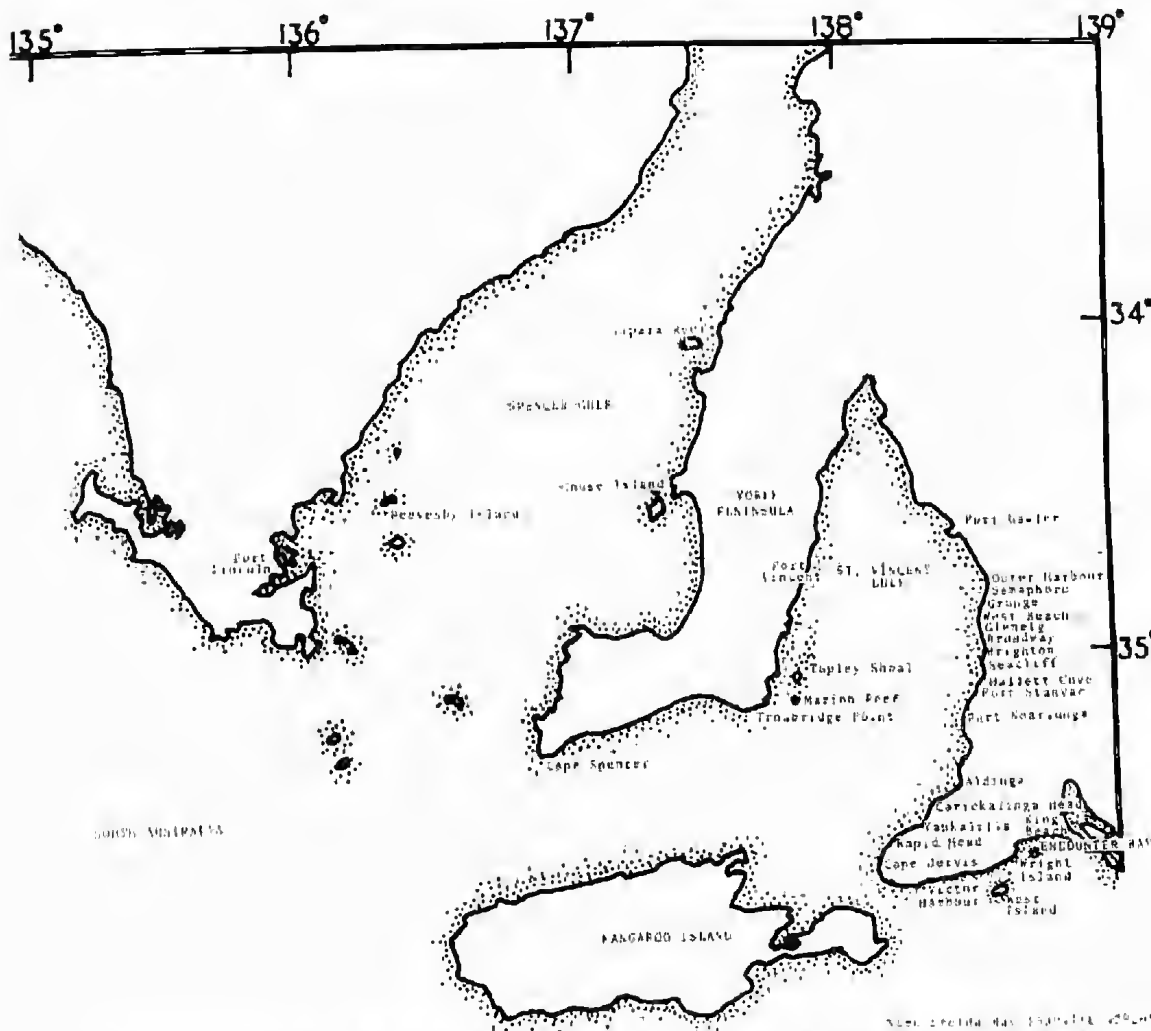


Fig. 1. Map showing locations in and adjacent to Spencer Gulf and St. Vincent Gulf.

These different locations provide environmental conditions favouring an ascidian fauna of very varied habit. For each species its shape, or size, or mode of fixation, or growth characteristics appear to operate as selective mechanisms contributing to its success in the environmental conditions operating:

(1) In Rough Coast Subformations, at depths less than 15 m where surge is moderate to strong (Wright I., West I.), the dominant ascidian fauna is adapted to the conditions by virtue of their colonial form, their viviparous larvae, their usually well-developed cloacal systems, and either

(a) an encrusting habit providing a large surface area for fixation (*Atapozoa fantasma*, *Cystodytes dellechiaiei*, *Didemnum candidum*, *Leptoclinides rufus*, *Lissoclinium* sp., *Ocularia australis*, *Borylloides nigrum*); or

(b) small stalks or sessile habit and cylindrical body form enabling them to occupy sheltered crevices (e.g. on *Ecklonia* holdfasts, under ledges, etc.). The stalks of these species are thick, and the colonies do not move freely with the currents (*Podochlavela cylindrica*, *Pseudodistoma cereum*, *Ritterella herdmania*, *Synoicum papilliferum*).

(2) In Rough Coast Subformations, at 15 m and greater depths (Wright I., West I.), the strong surge at the surface is reduced to moderate to slight water movement. Species with pliable stalks form a dominant component of the ascidian fauna and are best able to exploit the changing direction of the water movements by moving with the water so that their branchial openings are presented to the oncoming current which thus reinforces the ciliary feeding mechanism. Only some of these species have viviparous larvae (*Borylloides magnicoecus*, *B. leachi*, *Polycarpa pedunculata*, *P. clavata*, *Pyura australis*).

(3) In Rough Coast Subformations, at all depths, are large species fixed by a relatively small part of their surface. At shallow depths, they appear to be more often on vertical rock faces or in caves, where firm fixation can be achieved, while at greater depths they are on the bottom (*Polyciror giganteum*, *Styela pedata*, *Cnemidocarpa etheridgei*, *Herdmania momus*).

(4) In Offshore Benthic locations with moderate currents and sandy bottoms and some sediment, there are, again, stalked species that are raised above the substrate and sometimes, by

virtue of a pliable stalk, move with the current so that the branchial aperture is presented to the oncoming flow (*Aplidium colelloides*, *Polycarpa clavata*, *Pyura scoresbiensis*, *P. spinifera*, *P. australis*).

(5) In Offshore Benthic locations with sluggish to slow currents, there are:

(a) Large species lying on or partly embedded in, or fixed to, rocky bottoms or to solid objects in sandy, often mobile, bottoms. These individuals and colonies are oriented to take maximum advantage of the prevailing current flow by differential growth of the colony or of the test, especially in the region of the siphons (*Sycozoa cerebriformis*, *Ascidia* spp., *Phallusia depressiuscula*, *Ctenicella antipoda*, *Herdmania momus*). *Sycozoa cerebriformis*, which is abundant on the bottom, especially in upper St. Vincent Gulf, has its "fans oriented to receive maximum current" (S. Shepherd, pers. comm.). Its stalk is thick, short, and not pliable, and the species adapts to the direction of prevailing current flow by growth of the colony. In large sessile and partly embedded species, the orientation of the siphons in relation to the current is effected by their differential growth (e.g. *Phallusia depressiuscula*). *Ascidia aclara*, which is recorded only from sandy substrates in which it is probably partly embedded, is especially interesting in the presence of cylindrical tubes round the apertures creating a constant micro-environment.

(b) Species with a leathery test sometimes produced into roots, in a sometimes mobile sandy bottom or attached to the fibrous roots of the sea-grass *Posidonia australis*. These species often form aggregates of individuals. (*Polycarpa pedunculata*, *Pyura irregularis*, *P. vittata*, *Halocynthia hispida*, *Microcosmus* spp.).

(6) In Sheltered Coast Subformations with slight wave action at the surface and no sediment, collections have been made from 3 to 25 m. The species present represent all the groups previously distinguished:

(a) Stalked species common in Offshore Benthic locations and in Rough Coast Subformations where there is moderate to slight surge.

(b) Leathery aggregated specimens common at Offshore Benthic locations where the currents are slight to sluggish.

(c) Aplousobranch species which, in more exposed conditions, are present in sheltered niches or crevices or have an encrusting habit (*Podoclavella cylindrica*, *Distaplia viridis*, *Leptoclinides rufus*, *Polysyncrator orbiculatum*, *Echinoclinum verrilli*, *Ritterella herdmanni*, *Synoecium papilliferum*).

(d) The large stolidobranch and phlebobranch species which exploit clean (vertical) rocky substrates or protected locations at Rough Coast Subformations and which are also present in Offshore Benthic locations where the current is slight. These large individuals are more often found at shallower depths and in less protected niches in these Sheltered Coast Subformations than in Rough Coast Subformations (*Ascidia* spp., *Rhodossoma turcicum*, *Corella eumyota*, *Herdmania momus*).

The presence of some of the larger phlebobranch and stolidobranch individuals at shallower depths in certain areas where surge is greater, but where clean stony substrate is available for settlement, suggests that it is the strength of the current flow in relation to the type of fixation which can be achieved that is the critical factor in site selection for these species rather than depth or light conditions. On the other hand, aplousobranch and stolidobranch encrusting species, and others whose shape enables them to exploit narrow crevices, caves and ledges, appear to be affected more by light and their depth range is more limited. These species occur at shallow depths both in turbulent locations and in Sheltered Coast Subformations, and are not often taken in Offshore Benthic locations. They all have viviparous larvae and light sensitive organs which influence their settlement, and efficient adhesive apparatus which is needed where surge and turbulence is great. They are also common in areas of gentle water movement, together with the large phlebobranch species not usually found at shallow depths in more turbulent areas.

Seventy-six species are now recorded from St. Vincent Gulf and Spencer Gulf. This indicates a great diversity of ascidian species and suggests that conditions may be especially favourable for them. Records are more numerous, however, from Gulf regions than from the "open" coast, probably because more collecting has been done in these locations. It is not possible, therefore, with the information available, to compare the faunal diversity on

the open coast with that in Spencer Gulf and St. Vincent Gulf.

Suborder APLOUSOBRANCHIA

Family CLAVELINIDAE

Subfamily CLAVELININAE

Clavelina baudinensis Kott, 1957a: 87. Millar, 1966: 363.

New Records: Carickalinga Head, Rapid Head. *Previous Records:* W. Aust. (Rott-nest Island)—Kott 1957a. Vic. (Balnarring Beach, Laverton Bay, Williamstown)—Kott 1957a; Millar 1966. Recorded from the intertidal to 6 m.

Description: Two or more flat-topped lobes of variable size, joined by a common base that is equal in height to that of the lobes. Height of the colony to 4 cm, maximum diameter of a lobe 0.6 cm. The test is firm, gelatinous and transparent. Zooids are blue. Thorax rounded, 1.5 mm long; abdomen 2.5 mm long, with a well-developed posterior abdominal stolon. Zooids are parallel to the height of the colony. The branchial aperture, from the antero-ventral corner of the thorax, is directed to the side. The atrial aperture from the antero-dorsal corner of the thorax is directed vertically. There are 17 longitudinal muscles on each side of the body radiating from the apertures, 6 ventral to the branchial siphon, 7 extending along it, and 4 extending along the atrial siphon. Dark pigment spots are present, anterior to, posterior to, and on either side of the base of the atrial siphon. There are about 16 rows of about 30 stigmata in the branchial sac. Nine obscure indentations are present around the margin of the branchial siphon, although the border of the atrial siphon is smooth and entire. The transverse vessels of the branchial sac expand into triangular languets as they cross the dorsal line. The oesophagus is long, the stomach two-thirds of the distance down the abdomen is rectangular with 4 folds. Each zooid projects slightly above the flat top of each colony. Gonads are present in the gut loop.

Remarks: *Clavelina arafurensis* Tokioka, from the Arafura Sea, has similar colonies with zooids opening on the upper surface of the lobes, but is distinguished by the presence of distinct transverse muscles. *Oxycorynia fascicularis* Tokioka, 1952, also has similar zooids but there is a smooth stomach and zooids open all around a stalked head, thus distinguishing it from the present species. Two different types of larvae have been described from specimens

previously ascribed to this species, and it has been suggested (Kott 1969) that some colonies may in fact have been colonies of species belonging to the genus *Pycnoclavella*, distinguished from *Clavelina* by the fertilisation of eggs at the base of the oviduct. Those colonies with large numbers of eggs at the same stage of development in the peri-branchial cavity and apparently fertilised there, belong to the genus *Clavelina* as described. No other distinguishing character has been identified and as neither developing eggs nor larvae were present in these colonies, this point has not been clarified.

In St. Vincent Gulf the species is taken from sheltered locations where surge and wave action is slight. The record from Rottneest I. (Kott 1957a) is from the intertidal area where it could sometimes be subjected to surge and wave action typical of the Rough Coast Subformation. In such localities it would be found in sheltered caves and crevices as it forms large soft colonies and is unlikely to occur in areas where it is exposed to sand or wave action. The red colour of the preserved specimen from Rapid Head is probably the result of contamination from a sponge on which the specimen was growing, as all other colonies are bluish in preservative.

Podoclavella cylindrica (Quoy & Gaimard).

Kott, 1957a: 91. Millar, 1960: 64; 1963: 716; 1966: 364.

Polyclinum cylindrica Quoy & Gaimard, 1834: 618.

Clavelina cylindrica. Michaelsen, 1930: 475 and synonymy.

New Records: West Beach, Hallett Cove, Port Noarlunga, Aldinga, West I. (Oedipus Point), Wright I. **Previous Records:** W. Aust. (Albany to Rottneest I.)—Michaelsen 1930; Kott 1957a; Millar 1963. Vic. (Westport, Port Phillip Bay, Bass Strait)—Quoy & Gaimard 1834; Millar 1960, 1963, 1966; MacDonald 1858.

FIG. 2

Description: Zooids separate, joined by common basal test into which posterior abdominal stolons extend. Occasionally zooids branch off around a central common axis (Wright I.). In immature colonies from Aldinga reef "drop off" there is a central vascular stolon extending up into each lobe and very numerous enlarged terminal ampullae surrounding the central vessel along its length. The abdomen may be equal to or less than the length of the thorax. When the thorax is contracted along the dorsal line, the oesophagus originates from half way along the length of the thorax.

There is a dorsal pigment spot at the base of the atrial siphon, and some pigment on either side of the dorsal line at the base of the branchial siphon. The atrial aperture is terminal with a funnel-shaped siphon. The branchial aperture extends laterally from the antero-ventral corner of the thorax. About 20 muscles cross the thorax obliquely from the ventral to the postero-dorsal corner of the thorax and continue along both sides of the abdomen. When the dorsal line of the zooids is strongly contracted, the muscles on the thorax lie almost at right angles to the rows of stigmata. The oesophagus is long and there is a prestomach swelling halfway along its length. The stomach is large and square. Clumps of 18 or more embryos are present in brood pouches formed at the postero-dorsal corner of the thorax. Gonads are present in the gut loop. **Larvae:** About 1.2 mm long. Anteriorly there is a flat frontal plate bearing three adhesive papillae with accessory cup, arranged in a triangle. The larval thorax is characteristically deep.

Remarks: This species is especially common. The relatively short abdomen, the prestomach, the form of the colonies, and the presence of pigment spots on the anterior part of the thorax are characteristic.

The colonies flourish only in protected caves or crevices and generally from vertical faces in areas where there is no silt or sediment. In the Rough Coast Subformation, the species is found at depths of 10–22 m, and in the Sheltered Coast Subformation at 3–10 m deep.

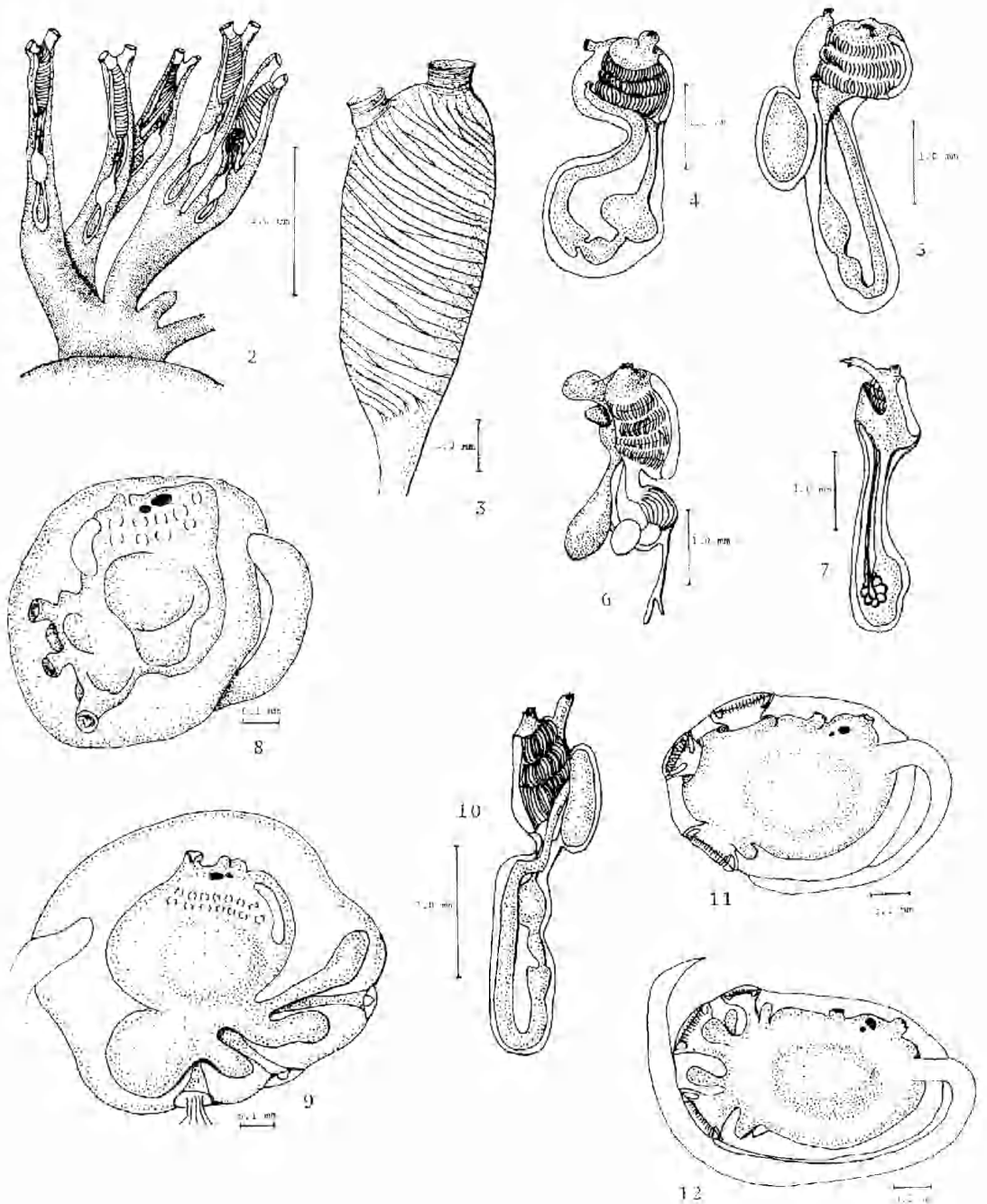
Podoclavella moluccensis Sluiter, 1904: 5. Hastings, 1931: 82 and synonymy. Kott, 1963: 90.

New Record: Tipara Reef (Spencer Gulf).

Previous Records: W. Aust. (Cape Boileau, Garden Island, Rottneest I.)—Sluiter 1895; Kott 1963. S. Aust. (Port Lincoln)—Kott 1963. Qld. (Great Barrier Reef)—Hastings 1931.

FIG. 3

Description: The colonies form extensive mats consisting of a basal membrane supporting a dense array of upright lobes, each consisting of a single zooid enclosed in a soft transparent test. Occasionally the basal half of adjacent lobes is fused. The zooids are pale to dark blue and there is no special accumulation into specific pigment spots around the apertures. The zooids are closely adherent to the test and extend the full length of the free lobe for



- Fig. 2. *Podoclavella cylindrica*, (Hallett Cove, 8 m). Colony.
 Fig. 3. *Podoclavella moluccensis*, (Tipara Reef). Thorax showing muscles.
 Figs. 4, 5. *Atapozoa fantasiana*, (Wright I.). Fig. 4.—Contracted zooid. Fig. 5.—Zooid with brood pouch and embryo.
 Figs. 6, 7. *Distaplia viridis*, (Reef off Hallett Cove, 8 m). Fig. 6.—Zooid with mature ♀ gonads and brood pouch. Fig. 7.—Zooid with mature ♂ gonads.
 Figs. 8, 9. *Polycitor giganteum*, (Port Noarlunga). Fig. 8.—Immature larva. Fig. 9.—Mature larva.
 Figs. 10–12. *Eudistoma renieri*, (Wright I., 10 m). Fig. 10.—Zooid, Fig. 11.—Immature larva. Fig. 12.—Mature larva.

their whole length. The atrial aperture is terminal and the branchial aperture from the antero-ventral part of the thorax is inclined at a slight angle to it but is not recurved. There are about 30 transverse muscles extending from the ventral to the dorsal border of the thorax and anastomosing with one another both ventrally and dorsally. About 6 of the most anterior transverse muscles extend from the short siphons to cross the dorsal line. The most posterior transverse muscles terminate around the region of the oesophagus. No muscles were detected on the abdomen. There are 17 rows of about 50 stigmata. There is a small prestomach enlargement half way down the oesophagus. The stomach is smooth walled, large and rounded half way down the abdomen.

Remarks: The specimens are easily confused with *Podocyclavella cylindrica*, from which *P. moluccensis* is distinguished by the extensive basal membrane, the absence of a recurved branchial siphon, the very large number of transverse muscles which do not extend along the abdomen, by the close adherence of the body wall to the test, and by the absence of distinct pigment spots around the apertures.

Shepherd (pers. comm.) states that this species at Tipara Reef is seasonal, appearing in early winter and dying off during early summer.

Subfamily HOLOZOINAE

Atapozoa fantasiana (Kott)

Eudistoma fantasiana Kott, 1957a: 76; 1967: 187.

New Record: Wright I. *Previous Records:* S. Aust. (Reevesby I.)—Kott 1957a.

FIGS. 4, 5

Description: Flat irregular investing colonies about 0.5 cm thick. Test soft, jelly like, semi-transparent. Both apertures of zooids open separately to the exterior. The postero-dorsal aspect of the peribranchial cavity is expanded into a brood pouch with two embryos at different stages of development. Black pigment is scattered throughout the test, but the colony is a light purplish colour. Zooids up to 3 mm in length. Zooids have 16 to 20 fine longitudinal muscle bands forming a wide open meshwork with the transverse bands on the thorax. There are 3 rows of up to 25 elongate stigmata; the oesophagus is long, the stomach smooth and oval, and there is a rounded posterior stomach. The apertures are small and the 6 lobes of the margins indistinct.

Larvae: Large, as previously described, with

characteristically elongate areas of adhesive cells.

Remarks: Even in the absence of the completely distinctive larvae and brood pouches, the species is characterised by the closely set apertures and short atrial siphon, by the open meshwork of muscles on the thorax, by the comparatively short zooid, and by the very large number of stigmata in each row.

Distaplia viridis Kott, 1957a: 96. Millar, 1966: 365.

New Records: Hallett Cove, Port Noarlunga Reef, Carickalinga Head. *Previous Records:* S. Aust. (Victor Harbour, Reevesby I.)—Kott 1957a. Vic. (Port Phillip Bay)—Millar 1966.

FIGS. 6, 7

Description: Living colonies from Hallett Cove had a transparent matrix with orange zooids, while these specimens are greenish in preservative due to the greenish colour of the enclosed zooids. Preserved colonies from Port Noarlunga are also greenish but the living colonies were blue-black with white markings. Test is semi-transparent and very soft. Zooids closely placed more or less in double rows. Colonies are irregular and investing, about 4 mm thick. The surface is always smooth. There are no sand inclusions. Common cloacal apertures are randomly distributed over the surface of the colony and zooids are arranged on either side of very shallow and narrow common cloacal canals. A brood pouch is developed from the postero-dorsal corner of the thorax and contains only a single embryo. The atrial lip is sometimes tridentate at the tip with a longer median lobe. This, however, may be obscured if the atrial lip is widely extended. In younger colonies the zooids may be in circular systems of 5 to 14 zooids. There are 4 rows of stigmata with para-stigmatic vessels. The stomach has glandular folds internally but externally is smooth. There are about 10 testis lobes in a rosette in the loop of the gut, and a single egg protrudes from the right side of the abdomen. A conspicuous gastric reservoir is also present in the loop of the gut.

The single embryo present in the brood pouch is as previously described. The tail of the larval form is especially short and extends only half way along the ventral surface. The larval test has a foamy appearance.

Remarks: The species conforms with specimens previously taken from Victor Harbour and Reevesby I., South Australia and the pre-

served colonies have the same greenish tinge in formalin resulting from the colour of the zooids. Colours present in the living specimens, however, appear to vary. The single embryo in the brood pouch is apparently characteristic of the species which is common in St. Vincent Gulf and Spencer Gulf although it has not been recorded from other localities.

Sycozoa cerebriformis (Quoy & Gaimard). Brewin, 1953: 58 and synonymy. Kott, 1957a: 99. Millar, 1966: 365.
Aplidie verebriforme Quoy & Gaimard, 1834: 625.

New Records: Off Troubridge I., Orontes Bank (off Port Vincent), upper St. Vincent Gulf, Hallett Cove, Carickalinga Head, West I. (Toad Head), Wright I. *Previous Records:* North-west Aust.—Hartmeyer 1919, S. Aust. (Victor Harbour, Port Lincoln)—Kott 1957a; Caullery 1908. Vic. (Balnarring Beach, Westernport, Point Lonsdale)—Quoy & Gaimard 1834; Caullery 1908; Michaelsen 1924; Kott 1957a; Millar 1966. N.S.W. (Gunnamatta Bay, Jervis Bay, Port Jackson, Port Stephens)—Herdman 1899; Kott 1957a. South Africa—Hartmeyer 1912; Michaelsen 1923a.

Description: Colonies from fan-shaped to curved lamellae. Zooids arranged in double rows down both sides of these lamellae, branchial apertures opening to the exterior. Cloacal apertures, however, as is usual in this genus, open into common cloacal canals extending vertically down both sides of the colony. These cloacal canals open separately around the edge of the narrow flat top of the colony.

Remarks: In *Sycozoa sigillinoides* Lesson, from the Antarctic (see Millar 1960; Kott 1969), it has been found that the common cloacal cavities open into a ring canal round the anterior end of the colony and this ring canal is part of a common cloacal cavity opening by a terminal aperture. Brewin (1953) characterised the genus *Sycozoa* by the condition of the cloacal canals opening separately around the anterior border of the colony. Both Millar (1960) and Kott (1969), working with specimens of *Sycozoa sigillinoides* from the Antarctic, did not accept this interpretation of the cloacal openings and suggested that Brewin's colonies were distended to expose the openings in the cloacal cavity. Brewin's observations for both *Sycozoa cerebriformis* and for *S. tenuicaulis* are accurate. The situation in *S.*

sigillinoides, however, indicates that separate openings of the canals is not a character shared by all species of the genus *Sycozoa*.

Colonies have been observed with their wide fans, from the short, sturdy stalk, oriented toward the oncoming current (S. A. Shepherd pers. comm.). The stalk is not flexible, as in *S. tenuicaulis*, and the orientation of the colony is unlikely to adapt to changes in direction of current flow. The species is most common attached to shell or rock surfaces at locations where there are slow to sluggish currents, and where the light intensity is not great due to depth and sediments. Larvae have an otolith but no ocellus (Caullery 1908). They have relatively short tails, their free swimming existence is short and they are probably not strong swimmers.

The species therefore is well adapted to an existence in locations with slow to sluggish currents where it is most commonly found. The low light intensity at these stations, due to depth or sediment, is coincidental and not likely to directly affect settlement of these light-insensitive larvae.

The species is taken from the Rough Coast Subformation at West I. and elsewhere in conditions of moderate surge, either at depth or in crevices, or under boulders where it is protected. Again, the low light intensity is only coincidental with the occasional occurrence of this species in these situations where light sensitive aplousobranch larvae that are attracted to shade are more common.

Sycozoa tenuicaulis (Herdman). Brewin, 1953: 57. Kott, 1957a: 99. Millar, 1963: 707.

Colella tenuicaulis Herdman, 1899: 64.

New Record: Off Broadway. *Previous Records:* W. Aust.—Millar 1963. Vic. (Port Phillip Bay, Lakes Entrance)—Kott 1957a. Millar 1963. Tas. (D'Entrecasteux Channel, Furneaux Group)—Millar 1963; Kott 1957a. N.S.W. (Botany Bay, Jervis Bay, Broken Bay, Port Stephens, Port Jackson)—Herdman 1899; Millar 1963; Kott 1957a.

Description: A single colony only is available and is the usual flattened inverted cone, fixed by a long stalk with basal hair-like rootlets. Zooids are present in closely set double rows along the length of the head. The longitudinal common cloacal canals extend the length of the head between each double row of zooids and open by a wide opening around the outside margin of the flat top of the head as previously described by Brewin (1953).

Remarks: The observations by Brewin on the separate cloacal openings around the top of the head are confirmed in the present colony. The species is distinguished from the superficially similar Antarctic species, *S. sigillinoides* Lesson, by these separate openings of the common cloacal canals, which, in *S. sigillinoides* open into a terminal chamber with a single common cloacal opening on the centre of the upper free surface of the head (Millar 1960; Kott 1969). The species are also distinguished by the flattened head and by the tuft of hair-like roots in *S. tenuicaulis* (see Millar 1963).

Records of *S. tenuicaulis* are confined to Australia, and at present the species is known only from fairly protected bays. It is possible therefore that its isolation has resulted in speciation separating it from the more widely distributed circum-polar *S. sigillinoides*. The latter is also known from South Australian localities (Kott 1969).

Brewin (1953) states that all records of this species are from deep water. Although this is not strictly accurate, there are indeed no records available from the inter-tidal region. Specimens have been taken from a depth of 4 m (Millar 1963) to 50 m (Kott 1967).

Shepherd (pers. comm.) has observed that it is fairly common at sub-littoral locations in deeper water, with tidal currents up to 0.5 m/sec. (one knot). The larva of this species does not have a light sensitive ocellus (Brewin 1953) and would be at a disadvantage in seeking suitably protected locations for settlement in waters where there is appreciable wave action or surge but, like *S. sigillinoides* (see Kott 1969), is well adapted for an existence on the sea floor.

Family POLYCITORIDAE

Polycitor giganteum (Herdman).

Polycelinum giganteum Herdman, 1889: 79.

Polycelinum globosum Herdman, 1899: 80.

Polycitor gelatinosa Kott, 1957a: 83.

non *Polycitor giganteum* Sluiter, 1919: 10
(*Diazona giganteum* Sluiter).

New Records: Tapley Shoal, Hallett Cove, Port Noarlunga, Aldinga, West I. (Toad Head), Wright I. *Previous Records:* W. Aust. (Rottne I.). S. Aust. (Port Noarlunga). Vic. (Balnarring Beach, Lakes Entrance, North Brighton)—Kott 1957a. N.S.W. (Jervis Bay, Port Jackson)—Herdman 1899; Kott 1957a.

FIGS. 8, 9

Description: Large, fan-shaped or rounded lobes of varying size; sometimes smaller lobes occur together fixed to a common base. The test is firm, gelatinous without sand inclusions, and is semi-transparent and almost glassy in appearance. Zooids can be seen radiating from the basal constriction of the colony to open on the rounded upper surface. Living zooids are cream to bright orange but are pinkish in preservative. The diameter of the colony is gradually reduced toward the base where it is fixed to the substrate. In the colony from Tapley Shoal, two lobes branch from a common base and the test of the upper part of each lobe is coalesced. There are 15 longitudinal muscles per side continuing as 3 bands along each side of the abdomen. The stomach has 4 folds and there are 10-12 rows of 22 to 40 stigmata.

There are 3 to 9 developing embryos in the atrial cavity and in the distal portion of the oviduct. Larvae are large, about 1.2 mm, and large ampullae develop around the base of the 3 median papillae as previously described for *P. giganteum*.

Remarks: A re-examination of the type specimens of *P. gelatinosa* from Rottne I., has shown that the colonies are slightly smaller than most colonies of *P. giganteum*. The zooids and the test are, however, identical with those of *P. giganteum*. Further investigation of larvae from typical colonies of *P. giganteum* has also shown that in the less mature larvae the anterior ampullae are not developed and these larvae appear identical with those described for *P. gelatinosa* (Kott 1957a). As there is so much variation in the shape and size of colonies of *P. giganteum*, from spherical individual lobes to numerous pyriform lobes from a common base, this cannot be regarded as a valid character on which to separate the two species. The gelatinous test, large zooids and larvae are characteristic.

Eudistoma pyriforme (Herdman), Hastings, 1931: 84. Kott, 1957a: 75. Tokioka, 1950: 120; 1967: 110. Vasseur, 1969: 918.

Psammopodium pyriforme Herdman, 1886: 419.

New Record: Off West Beach. *Previous Records:* S. Aust. (Port Noarlunga)—Kott 1957a. Qld. (Great Barrier Reef, Flinders Passage)—Herdman 1886. Pacific (Palau Is., Gilbert I.)—Tokioka 1950, 1967. Indian Ocean (Madagascar)—Vasseur 1969.

Description: Rounded lobes, narrowing towards the base where the test expands into a basal plate from which several heads may rise. Sand is absent from the outer 5 mm of test on the upper half of the colony but is present internally and is also present through the test in the basal half of the lobes. Maximum diameter of head is 4 cm. The test is firm and gelatinous. The colony is grey in preservative. Zooids are present, opening over the upper surface of the head. They are arranged in circular systems, with the atrial apertures opening separately in a circle in the centre of the outer circle formed by the branchial openings. Each atrial aperture is protected by a lobe of test that covers the opening from its dorsal surface and it appears that the excurrent stream from each zooid would be directed towards the centre to reinforce the excurrent stream from zooids in the same circular system. The incurrent ciliary stream is probably drawn from an area immediately adjacent to the branchial aperture. This arrangement of apertures represents a stage before the development of true cloacal systems.

Zooids are 5 to 7 mm long, of which the thorax is only 1 mm. They cross one another in the test. Both siphons are well developed, anteriorly directed, and are surrounded with circular muscles to form a distinct sphincter. The atrial sphincter is especially well developed. There are about 20 longitudinal muscles on the thorax although these may be reduced to 12 in contracted specimens. The transverse musculature is fairly strong.

There are 3 rows of about 9 to 12 stigmata. The stomach is smooth and rounded and in contracted specimens the intestine behind the stomach forms an "S" bend as previously described for this species. The rectum forms the ascending limb of the gut loop.

Remarks: Specimens of *Eudistoma* are notoriously difficult to characterise and the variable condition of the intestine in the present specimens suggests that this feature, previously regarded as a diagnostic feature, is dependent on the degree of contraction of the abdomen. Specimens identified as *E. pyriforme* from Heron I. and North West I. (Capricorn Group) have been examined. Zooids are arranged in similar systems to those described above, although these may be obscured by sand in the surface test; the proximal part of the intestine forms either an "S" bend or a loop, and pigment is present in spherical cells in the surface test. Despite the variation in the external

appearances of these colonies they all appear to belong to *E. pyriforme*, characterised mainly by the condition of the thoracic musculature, the long oesophagus, the atrial sphincters and the arrangement of zooids in the colony. These characters are, to some extent, shared by other species and it is possible that more than a single species is represented by the records ascribed to this species.

Eudistoma renieri (Hartmeyer). Michaelsen, 1923a: 10. Kott, 1957a: 74. Millar, 1962: 160.

Polycitor renieri Hartmeyer, 1912: 309.

New Record: Outside Wight I. *Previous Records:* W. Aust. (Point Peron)—Kott 1957a. South Africa—Hartmeyer 1912; Michaelsen 1923a; Millar 1962.

FIGS. 10-12

Description: Fleishy investing colony, 0.6 cm thick. Test semi-transparent with reddish to black pigment cells in streaks on the surface. The surface of the test is smooth, without foreign bodies or sand, and is depressed over the zooids. Zooids are arranged in circles of about 4 mm diameter, the branchial openings around the periphery of the circle and the atrial openings toward the centre, protected by lobes of test. The atrial openings are in a pigment-free area. The zooids do not cross one another in the test. The abdomen is about twice the length of the thorax. The atrial aperture is on a cylindrical siphon which is about three times the length of the branchial siphon. The body wall is fairly muscular with at least 12 longitudinal muscle bands of 4 to 5 strands crossing numerous transverse bands. The longitudinal bands appear to separate out into separate strands. When not so strongly contracted, the circular muscles around the atrial siphon are strong and conspicuous although they are spread along the siphon rather than forming a large sphincter muscle. There are about 20 long rectangular stigmata in each row. The rounded smooth stomach is halfway down the abdomen. There is a long duodenal area and a short round posterior stomach. The part of the intestine distal to the stomach is sometimes kinked in contracted specimens. The gonads are in the gut loop. There is an expansion from the dorsal aspect of the posterior end of the thorax accommodating a loop of the oviduct with one to two embryos, and although the brood pouch is not separated from the thorax by a narrow stalk as in the true brood pouch of the Holozoinae, it is structurally homologous.

The larvae are about 1 mm long, typically polycitorid, with the 3 median papillae developing on short stalks from depressions in the centre of rounded swellings around the anterior end of the larva. The margins of these depressions become attenuated in the mid-line to form median ampullae at the base of the papillary stalk. The area of adhesive cells in these papillae is lengthened longitudinally to different extents for each papilla. This lengthening is reminiscent of the condition in *Atapozoa* larvae.

Remarks: Distinctions between *Eudistoma* spp. are not altogether satisfactory and many characters such as the body musculature, length of gut, and looping of the intestine, all vary with the degree of contraction of the body. The present species is identified by the gelatinous nature of the test, by the large number of stigmata, by the long oesophagus and the position of the stomach mid-way down the abdomen. The extended adhesive area of the larval papillae was not recognised previously (Kott 1957a). A re-examination of Kott's specimens from Point Peron, Western Australia, has demonstrated that the papillae are identical with those in the present collection. This character therefore appears to be distinctive for the species.

The zooids of the Australian specimens resemble Hartmeyer's (1912) South African specimens, although the colony of the South Australian specimens is thinner. Millar's (1962) specimens appear to differ in many characters, however; notably in the reduced size of the thorax, in the position of the stomach at the posterior end of the abdomen, in the number of muscle bands and rows of stigmata in the length of the atrial siphon, and in the cylindrical form of the colony.

Cystodytes dellechiaiei (Della Valle). Kott, 1954: 154 and synonymy. Tokioka, 1950: 120. Millar, 1953: 284; 1960: 82; 1962: 143; 1963: 713; 1966: 365.

Distoma dellechiaiae, Della Valle, 1877: 40. ? *Aplidium lobatum*, Della Chiaje, 1841: 30 (not Savigny 1816).

Cystodytes dellechiaiae, Kott, 1957a: 68.

Cystodytes Delle Chiajei, Pérès, 1948: 171.

New Record: West I. (near Penguin Rock).

Previous Records: W. Aust. (Dampier Archipelago to Albany)—Michaelsen 1930; Kott 1954, 1957a; Millar 1963. Vic. (Port Phillip Bay, Barwon Heads)—Millar 1966. Tas. (Maria I.)—Kott 1954. Pacific (Palao Is.)—Tokioka 1950. New Zealand (North I. Chatham Is.)—Michaelsen 1924;

Brewin 1948, 1951, 1952a, 1956; Millar 1960. California (Coronado I., Puerto Escondido)—Van Name 1945. Indian Ocean (Ceylon)—Herdman 1906. Mediterranean—Della Valle 1877; von Drasche 1883; Lahille 1890; Harant 1925, 1929. Africa (Mozambique, Gold Coast, Cameroons, Senegal)—Michaelsen 1915; Pérès 1948; Millar 1953, 1962. The species is also known from the Atlantic Ocean, along the east coast of the American continent from Patagonia (Millar 1960) to the Caribbean and from the Azores (Michaelsen 1923a), the Canary I. (Hartmeyer 1912) and Virgin Is. (Van Name 1945). It has been taken intertidally and to a maximum depth of 736 m (off Brazil, Herdman 1886).

Description: Irregular investing colonies. Living colonies purple with colourless "splashes", but in formalin the colonies are brown with white blotches where zooids are present in the test surrounded by the calcareous spicules that are typical of this species. The species is especially constant and the present colonies and zooids conform exactly with previously described specimens. Larvae are present in brood pouches attached to the parent zooid or free in the test. The larvae have the usual large papillae surrounded by ectodermal ampullae which have coalesced distally to form a circle around the papilla as described previously for the species (Kott 1954, 1957a).

Family POLYCLINIDAE

Subfamily RÜHERDMANNIINAE

Ritterella herdmania Kott, 1957a: 102 (nom. nov.); 1963: 78 and synonymy.

New Record: Port Noarlunga. *Previous Records:* W. Aust. (Green Pools)—Kott 1957a. N.S.W. (Newport, Port Jackson, Wattamolla)—Herdman 1899; Kott 1957a, 1963.

FIGS. 13-17

Description: Sandy finger-like lobes joined basally. The lobes are long and slender, spoon-shaped terminally, with 1 to 5 zooids in each lobe. The branchial apertures open into the concavity of each lobe and the atrial apertures open round the convexity of the anterior tip of the lobe. Both apertures are 6-lobed and on very short siphons. The branchial aperture is terminal and the atrial aperture rises from opposite the first row of stigmata. There are circular siphonal muscles, very delicate longitudinal muscles and some weak transverse

muscles on the thorax. There are five rows of 8 to 16 stigmata in the branchial sac; sometimes, in the larger zooids, parastigmatic vessels are present in some of the rows of stigmata and appear to bisect them horizontally to form extra rows. Triangular languets are present in the mid-dorsal line expanded from both the transverse vessels and the parastigmatic vessels. Smaller rounded papillae are also present in the middle of each transverse vessel on either side of the branchial sac. These papillae have not previously been described for this genus. The fact that they do not arise on the parastigmatic vessels suggests that they may be present as relicts of papillae supporting longitudinal vessels in the branchial sac and homologous with the papillae present in the Antarctic genus *Tylobranchion*.

The condition of the stomach varies according to its degree of contraction and when extended there are apparently four to six stomach folds, but these are not always distinct. Four folds sometimes appear to be present only in the anterior part of the stomach. There is also a small posterior stomach as previously described. The posterior abdomen may be very long and thread-like and testis follicles are arranged in it in a single row. The extended thorax and abdomen together measure 4-5 mm. The posterior abdomen is considerably longer.

Larvae are present in the thoracic cavity of some of the zooids. They have 3 anterior papillae in the median line alternating with paired anterior ampullae. Dorsally and ventrally paired rows of ampullary vesicles extend posteriorly. There is an otolith and ocellus.

Remarks: The variations in the number of rows of stigmata resulting from their bisection by parastigmatic vessels and the increase in the size of the zooid-bearing lobes, both of which occur with increasing maturity, suggests that confusion could arise regarding the identity of specimens assigned to this and to related species. Part of the type colony of *Ritterella asymmetrica* Millar, 1966, from Port Phillip Bay, has been examined. The external appearance of the colony resembles *R. herdmania* and the 10 rows of stigmata could have resulted from the bisection of 5 primary rows by parastigmatic vessels, as the triangular dorsal languets are of two alternating sizes. There are no papillae on the transverse vessels in Millar's species, however, and the stomach folds are also distinctive.

Five primary rows of stigmata appear to be characteristic of most *Ritterella* spp. although the number can be increased probably by subdivision with parastigmatic vessels which subsequently are not distinguished from primary transverse vessels. *Ritterella herdmania*, *R. gedunculata* Tokioka and *R. vesitta* Millar, 1960 (from North I., New Zealand) have parastigmatic vessels and sometimes increased numbers of rows of stigmata; *R. proliferus* (Oka) (>*R. dispar* Kott, 1957a) from Japan and from the central east coast of Australia (see Tokioka 1953a; Kott 1957a, 1963), and *R. sigillinoides* Brewin, 1958a, from Stewart I., have only the 5 primary rows of stigmata and no parastigmatic vessels; *R. asymmetrica* Millar has increased numbers of rows of stigmata and apparently no parastigmatic vessels.

The type species of the genus *Euherdmania*, *E. claviformis* (Ritter) (see Van Name 1945), together with *E. solida* Millar, 1953 from the African Gold Coast, *E. vitrea* Millar, 1961 from Brazil, and *E. digitata* Millar, 1963 from northwestern Australia are easily distinguished by a long oesophagus, a large number of rows of stigmata and the absence of parastigmatic vessels and, where their larvae are known, by the modified adhesive organs as described for this genus and for *Placentela* spp. (Kott 1969). *Euherdmania australis* Kott, 1957a, however, from South Australia, Victoria and New South Wales, has a short oesophagus, 12 to 13 rows of stigmata, parastigmatic vessels, and a papilla in the middle of the transverse vessels on each side of the body. It is distinguished from *R. herdmania* by the single zooid in each lobe of the colony, the absence of stomach folds, the number of rows of stigmata and the testis follicles which are bunched in the posterior abdomen.

Larvae are known for *R. proliferus* and *R. herdmania*, and are typically polyclinid with ampullary vesicles.

In the present species and in *E. australis* the papillae on the transverse vessels are reminiscent of *Tylobranchion* and related genera, and probably represent a primitive character.

Pseudodistoma cereum Michaelsen, 1924: 364. Kott, 1963: 77 and synonymy. Monniot, 1969: 437.

New Record: Nora Creina Bay. *Previous Records:* N.S.W. (near Eden)—Kott 1963. New Zealand (Stewart I. (Paterson Inlet), Foveaux Strait, Otago coast, Little Papanui, Great Barrier I.)—Michaelsen 1924; Brewin

1950c, 1958a. Atlantic Ocean (Dakar)—Munziot 1969. The species is known intertidally and down to 87 m.

FIGS. 18, 19

Description: Soft, gelatinous, semi-transparent, rounded or cylindrical heads of slightly greater diameter than the more leathery stalk of up to 5 cm length. In some specimens the stalk is expanded into a thick mat from which numerous heads arise. The zooids are numerous and open all around the head by separate 6-lobed branchial and atrial openings. The contracted thorax and abdomen together measure only 2 cm. Fine longitudinal muscle bands on the thorax number 20 to 30 and these extend along both sides of the abdomen. There are 15 to 20 rows of stigmata in each of the 3 rows. The 4 stomach folds are obscure and may be artefacts resulting from the collapse of the stomach. A duodenal swelling and a rounded posterior stomach are also present. There is a long ovary, with numerous eggs more than halfway down the abdomen, but no testis follicles were present in the colonies from these stations. There is a single developing embryo in a brood pouch from the postero-dorsal corner of the thorax.

Remarks: The general form of the colonies, arrangement of body musculature, the branchial sac, gut and the situation of the ovary some distance down the posterior abdomen, all agree with the previously described specimens. All other species of the genus have a similar situation for the ovary some distance along the posterior abdomen: *P. africanum* Millar, 1954, 1962; *P. fragilis* Tokioka, 1958; *P. cyrusense* Pères, 1952; *P. antinboja* Tokioka, 1949; *P. opaca* Brewin, 1950c; *P. brieni* Pères, 1949. The stalked colonies of *P. africanum* are also reminiscent of the present species in the presence of a single developing embryo in a thoracic brood pouch and are distinguished only by a smaller number of longitudinal thoracic muscles. As there has been considerable variation demonstrated in this character, the distinction is rather doubtful, and the species or its relatives appear to have a wide circumpolar distribution in the southern temperate region as Monziot (1969) has already indicated.

Subfamily POLYCLININAE

Aplidium pliciferum (Redikorzev) Kott, 1963; 106.

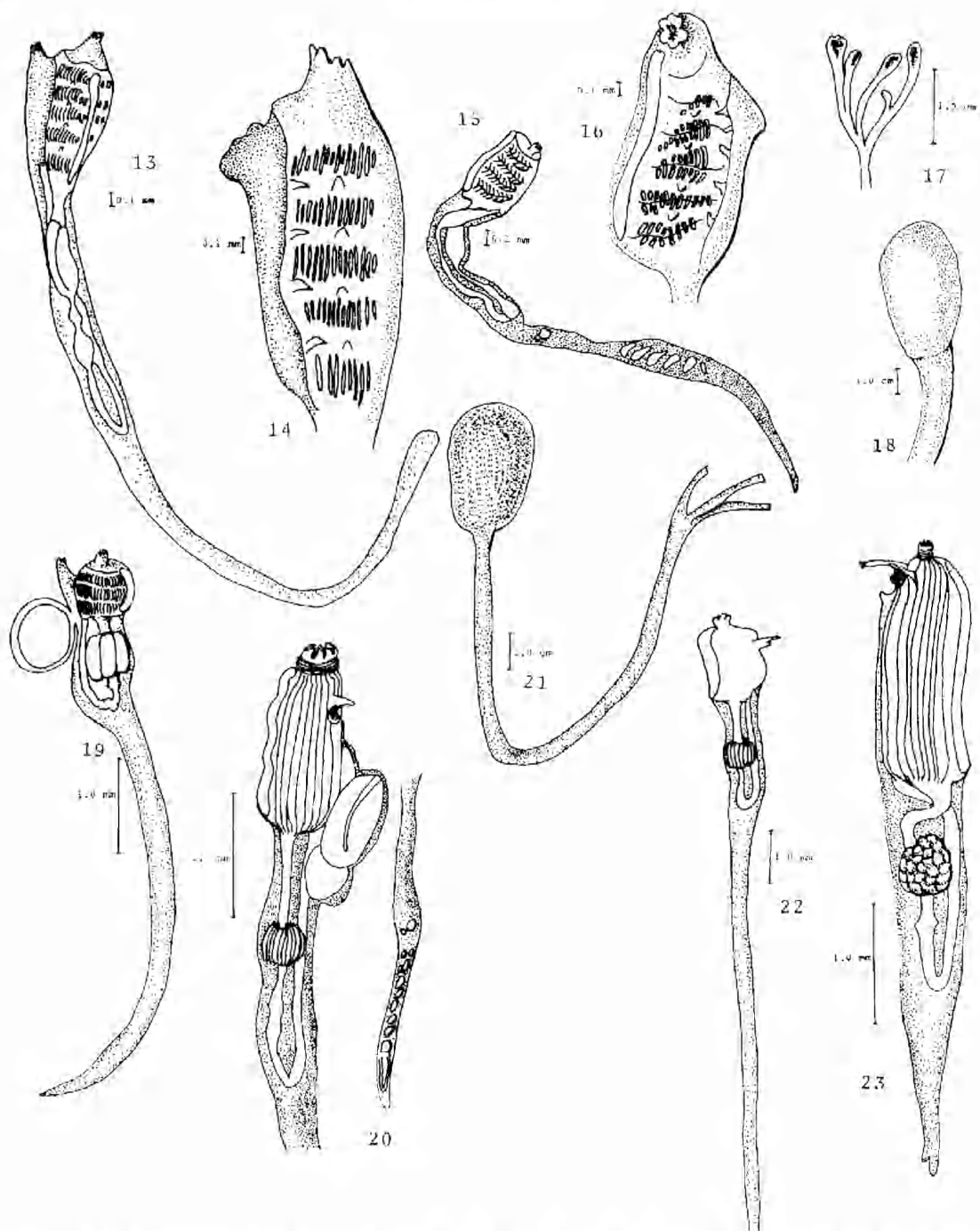
Amaroucium pliciferum Redikorzev, 1927: 390; Tokioka, 1953a: 183; 1962: 2; 1967: 32.
Aplidium phortax, Millar, 1966: 359.

New Records: Troubridge Shoal, Hallett Cove. *Previous Records:* W. Aust. (Point Peron, Rottnest I.)—Kott 1963. Vic. (Port Phillip Bay)—Millar 1966. Japan (coastal water of Honshu, Shikoku and Kyushu and the Inland Sea)—Redikorzev 1927; Tokioka 1953a. Hawaiian Is. (Auau Channel)—Tokioka 1967.

FIG. 20

Description: Rounded, soft, sessile colonies, 2 cm in diameter. In life the colonies are bright yellow. The surface of the colony has deep furrows marking it off into extensive rounded areas with up to 3 common cloacal openings from which double row systems radiate. Test transparent, zooids orange in the living specimen. Thorax and abdomen are of equal length and together measure 2.5 mm. The posterior abdomen is long, up to 8 mm. There are 6 well-defined branchial lobes, a strong circular branchial sphincter and 8 fine longitudinal muscle bands which extend down each side of the thorax. The upper border of the atrial opening is extended into a small pointed lip sometimes tridentate. There are 8–10 rows of about 15 stigmata. The oesophagus is long and the stomach, about half way down the abdomen, has 19 to 25 well defined folds. There is a duodenal swelling and a small posterior stomach. Two developing embryos are present in a brood pouch formed by the expansion of the distal end of the oviduct at the postero-dorsal corner of the thorax. The ovary is present about halfway down the posterior abdomen and a single series of pyriform testis lobes attached to a single duct are present behind the ovary. Larvae have the usual three median suckers with three ampullae between the suckers and many small ampullary vesicles in two rows from each lateral line as described previously for specimens from Western Australia (see Kott 1963).

Remarks: The species is closely related to *Aplidium phortax* (Michaelsen) from New Zealand, which has a similar number of fine longitudinal muscle bands, and stomach folds, and also has a brood pouch. Consequently, there has been some confusion between these species. Unfortunately, Michaelsen (1924) did not describe larvae from his species. *Aplidium pliciferum* (see Kott 1963) from Western Australia has smaller zooids (thorax and abdomen together about 1 mm long, posterior abdomen 2 mm) and are densely distributed in the test, largely obscuring the systems. In *Aplidium phortax* (see Kott 1963) from eastern Australia



- Figs. 13-17. *Ritlerella herdmania*. (Port Noarlunga). Fig. 13.—Young zooid, contracted thorax. Fig. 14.—Extended thorax of young zooid. Fig. 15.—Zooid with contracted thorax showing parastigmatic vessels. Fig. 16.—Thorax of more mature zooid showing parastigmatic vessels successively subdividing rows of stigmata. Fig. 17.—Portion of colony.
- Figs. 18, 19. *Pseudodistoma cereum* (Nora Creina). Fig. 18.—Outline of colony. Fig. 19.—Zooid with brood pouch.
- Fig. 20. *Aplidium pliciferum*. (Hallett Cove, 8 m). Zooid.
- Figs. 21, 22. *Aplidium coelloides*. (Tapley Shoal, off Troubridge Light, 17 m). Fig. 21.—Colony. Fig. 22.—Zooid.
- Fig. 23. *Synoicium papilliferum*. (West I., sheltered coast, 3 m). Zooid (showing muscles on thorax only).

and the Pacific, the larger zooids (thorax and abdomen together 3.5 mm long, and posterior abdomen 1.5 mm long) are arranged in circular systems, sometimes extending into more elongate and double row systems radiating from the common cloacal openings. In all Kott's (1963) specimens the test is gelatinous and semi-transparent with red-purple spherical pigment cells, and the larvae provide the main distinguishing character between the two species. *A. phortax* has larvae with a limited number of ampullary vesicles and a complete absence of median ampullae, while the larvae of *A. pliciferum* retain median papillae and have many small ampullary vesicles from the lateral lines either side of the three median suckers. Millar (1966) described specimens from Port Phillip Bay as *A. phortax*. He points out that *A. phortax* (see in Kott 1963), is not apparently the same species as his colonies although he can only distinguish them by the different larval form. He apparently overlooked the similarity in the size and form of the larvae of his specimen and of *A. pliciferum* (Redikorzev); Tokioka 1953a; Kott 1963; and based his identification on the ratio of length to depth of the larvae of Michaelsen's species and his own specimens from Port Phillip Bay. However, Kott (1963) has already indicated that larvae of *A. phortax* (Brewin 1946) from New Zealand, do have the same rounded form as the larvae of specimens of *A. phortax* (Kott 1963) from eastern Australia. It is apparent, therefore, that specimens from Port Phillip Bay were erroneously identified by Millar.

The adult zooids can definitely be distinguished by the longer posterior abdomen, the smaller size, and the greater crowding of zooids of *A. pliciferum*.

The specimen from Hallett Cove was taken with a specimen of *Distaplia viridis* in which the zooids are the same orange colour. The specimen from Troubridge Shoal was taken from a spiny crab.

***Aplidium rubricollum* Kott, 1963: 103.**

New Record: Upper St. Vincent Gulf. *Previous Records:* W. Aust. (Rottnest I.). S. Aust. (Reevesby I.). Vic. (Balnarring Beach)—Kott 1963.

Description: The single colony is flattened, about 0.7 cm thick and 3.5 cm in maximum diameter. The borders of the colony are

rounded. Sand is present basally and some is enclosed in the common test but the surface is smooth and without sand. The common cloacal apertures with frilled and protuberant lips are present on the surface of the colony about 0.3 cm from one another. Spherical pigment cells are present in the test and zooids show as clear points between the pigmented test. In this preserved specimen the pigment cells are pale pink. Zooids are small, up to 2 mm long. There are 10 longitudinal thoracic muscles. A short pointed atrial languet arises from the dorsal surface just anterior to the atrial opening which is generally on a short protuberant siphon surrounded by a circular sphincter muscle. There are 11 rows of 6-8 stigmata, and 4 stomach folds.

Remarks: The species is distinguished by the form of the atrial aperture and lip, by the narrow branchial sac with relatively few stigmata in each row and by the body musculature and stomach folds. In the present specimen the test is not so thickly invested with sand as previously described for this species.

***Aplidium coeloides* (Herdman), Millar, 1962: 125.**

Amaroucium coeloides Herdman, 1886: 223. *New Record:* Off Troubridge I. *Previous Records:* South Africa (Cape of Good Hope)—Herdman 1886; Millar 1962.

FIGS. 21, 22

Description: Rounded gelatinous heads on a long hard stalk. The head is up to 4 cm in length and 2 cm in diameter. The stalk, up to 20 cm in length, is hardened by dense sand inclusion in the surface test which fades out in the test of the head region. The stalk is branched basally into short root-like processes. Zooids are minute, opening around the surface of the head. Long thread-like posterior abdomina criss-cross in the centre of the head and sometimes extend down into the stalk. Some common cloacal apertures are evident around the head and some longitudinal cloacal canals were identified, although the form of the systems is obscure and difficult to distinguish. The thorax and abdomen are of equal length and together measure only about 1.5 mm. The long, thread-like post-abdomen is at least four times the combined length of the thorax and abdomen. There are about 6 delicate longitudinal muscles on the thorax. The

branchial lobes are distinct and rounded. The atrial aperture is sometimes produced on a fairly long cylindrical siphon but in another colony is sessile, the upper border of the atrial aperture produced into a pointed lappet. There are 18 rows of about 10 short oval stigmata. The oesophagus is long, the stomach is present halfway down the abdomen and has 15 very distinct folds. The gonads are not developed in these specimens and it is not known to what extent they fill the long posterior abdomen in mature zooids.

Remarks: This is the only species of *Aplidium* known with a long stalk. The size and form of the colony, the size of zooids and their arrangements in the present colony are identical with the South African specimens previously described. The delicate longitudinal thoracic muscles and the stomach folds are similar. The present specimens differ from those described from South Africa only in the larger number of rows of stigmata. This does not represent a sufficient difference on which to establish a new species and in view of the great similarity in most characters the specimens probably represent one species with a wide circumpolar distribution in the southern cold-temperate region.

Synoicium papilliferum (Michaelsen). Kott, 1963: 87. Millar, 1966: 360.

Macroclonium papilliferum Michaelsen, 1930: 530.

New Records: Port Noarlunga reef, West I. (near Penguin Rock). *Previous Records:* W. Aust. (Bunbury to Nornalup)—Michaelsen 1930; Kott 1963. Vic. (Nepean Peninsula)—Millar 1966. The species is known intertidally and to 18 m.

FIG. 23

Description: In life the colony is dark red or bright brick red. Flat-topped to rounded colonies, narrowing basally to a common stalk or encrusting. Zooids lie parallel in the test and open on the upper surface. The colony is firm, gelatinous. There are circular systems around protuberant common cloacal apertures. The branchial aperture has 6 small pointed lobes and there is a small circular sphincter muscle at the base of the branchial siphon. The atrial aperture is opposite the first to second row of stigmata. It is surrounded by a well developed circular sphincter muscle, and is extended into a short cylindrical siphon. The anterior border of the atrial aperture is produced into a long muscular lip, broken into 3-4 minute pointed

lobes terminally. There are 10 very fine longitudinal muscle bands on the thorax which is very delicate and transparent. There are 10-12 rows of about 10 stigmata in each row. The body wall below the atrial aperture is produced into the small rounded papillae characteristic of *Synoicium* spp. The wall of the stomach is raised into faint mulberry-like swellings. The posterior abdomen is short and there is no constriction between it and the abdomen.

Remarks: Both colony and zooids conform with previous descriptions in all characters except the reduced number of rows of stigmata. The species has been recorded from south-western Australia along the south coast of Australia to the Nepean Peninsula in Victoria (Millar 1966).

Family DIDEMNIDAE

? *Trididemnum spiculatum* Kott, 1962: 281.

New Record: West I. (near Penguin Rock).

Previous Records: W. Aust. (Rottneest L., Point Peron). S. Aust. (Outer Harbour). Tas. (Wreck Bay). Qld. (Heron I.)—Kott 1962.

Description: Living colonies pale pink, encrusting. Small, almost spherical spicules with up to 12 points in optical transverse section, evenly distributed throughout the test, and occasionally large spicules with fewer rays. There are small thoracic common cloacal cavities. Zooids are small with three rows of stigmata. The atrial aperture is wide, exposing a large part of the branchial sac. Gonads are not mature in the present specimens.

Remarks: Colonies generally conform with specimens previously assigned to this species, although the proportion of smaller burr-like spicules to larger stellate spicules with about 8 rays in optical section, is greater in the present specimen. Colonies with mature zooids are desirable for positive identification.

Leptoclinides rufus (Sluiter). Tokioka, 1952: 92. Kott, 1962: 286 and synonymy. Eldredge, 1967: 221.

Polyxyncrator rufus Sluiter, 1909: 72; 1913: 77.

New Records: Off Port Gawler, Hallett Cove, Port Noarlunga, Rapid Head, West I., Wright I. *Previous Records:* S. Aust. (Port Noarlunga). Vic. (Shoreham). Tas. (Maria I.). N.S.W. (Port Jackson)—Kott 1962. Qld. (Heron I.)—Hastings 1931. New Zealand (?Great Barrier I., *L. sluiteri*)—Brewin 1950b; (?Stewart I., *L. novaezealandiae*)—

Brewin 1958a, (?Chatham Rise, *L. aurantiacus*)—Brewin 1956; (North I.)—Michaelsen 1924; Brewin 1958b; Millar 1960. Indo-Pacific (Arafura Sea, Indonesia, Hawaii)—Tokioka 1952; Sluiter 1909; Eldredge 1967. The species is known intertidally and to 36 m (Sluiter 1909).

Description: Encrusting colonies. Living specimens: white matrix with grey or dark animals, or orange to light fawn (Port Noarlunga); or dark reddish brown (off Hallett Cove), mottled white to uniform light grey colour (Wright I.). In preservative all colonies are white to orange-white or streaked and blotched with grey. The colonies are investing, sometimes extensive. Cloacal cavities radiate from randomly distributed apertures. Zooids are sometimes present in the roof of the common cloacal cavity. Spicules are present in the surface test but basally the test is jelly-like and transparent. There are 9 longitudinal muscles on the thorax. The posteriorly directed atrial siphon has a wide circular sphincter muscle. There are 4 rows of 10 to 12 stigmata. There is a superficial layer of bladder cells and small oval to spherical pigment cells are present amongst the surface layer of spicules. A lateral organ is present opposite the middle of the fourth row of stigmata. Cloacal apertures are present, especially around the borders of the colony. Canals at thoracic level radiate from the cloacal apertures between clumps of zooids although sometimes they extend deeper to abdominal level. The cloacal canals around the border of the colony are often completely sub-abdominal. The spicules are of the usual stellate form, 0.01–0.04 mm in diameter. Larvae are present in some colonies from Hallett Cove. They are of usual form, fairly deep with 4 paired ampullae. In one colony from Hallett Cove (dark reddish brown in life) no common cloacal cavities were present and zooids were not mature, nor were zooid openings to the exterior detected. The arrangement of spicules is characteristic of this species and it is probable that the colony is one in which sexual reproduction is completed and new vegetative buds are developing.

Remarks: The species is distinguished by the complete absence of spicules from the basal layer of the test, sometimes giving the colony a very fleshy appearance. The characteristic common cloacal system and the distinct musculature on the thorax, together with the posteriorly directed atrial siphon and the spherical to oval pigment cells are distinctive.

Leptoclinides kingi Michaelsen.

Polysyncrator dubius. Van Name, 1918: 155. Hartmeyer, 1919: 136.

Leptoclinides dubius f. *kingi* Michaelsen, 1930: 507. Kott, 1962: 289.

New Record: Upper St. Vincent Gulf. **Previous Records:** W. Aust. (Fremantle, Albany)—Michaelsen 1930. Qld. (Sarina)—Kott 1962. Philippines (Jolo Light)—Van Name 1918. The species is known intertidally and to 18 m.

FIGS. 24, 25

Description: The colony is massive with the surface raised into mounds and single cloacal apertures at the apex of each mound. Each mound is formed by thickened basal test often with embedded parasites. Zooids are present in the surface test above the very extensive posterior abdominal spaces around the centre of each lobe or mound. The zooids are large with 4 rows of about 12 stigmata. There are 9 very fine longitudinal muscles on the thorax. The spicules are very small, 0.01 to 0.02 mm, and are ranged in a shallow layer at the level of the branchial siphons. They are only very sparse elsewhere in the test. There is a surface layer of bladder cells.

Remarks: The elevation of the surface of this colony into mounds or lobes with terminal common cloacal apertures characterises this species, which was previously regarded as a form of *Leptoclinides dubius* (Sluiter). *Leptoclinides dubius* is distinguished from the present species by its larger spicules and by the arrangement of common cloacal system with openings around the margins of each colony, as in *L. rufus*. In *L. kingi* large cloacal systems with terminal openings develop from the centre of the colony. As both forms have been recorded more or less over the same geographic range it is unlikely that they represent geographic subspecies of the one species, and in view of the different development of the common cloacal systems it is probable that they represent different species. The long gut loop which is bent anteriorly to form a double loop is a character shared with *Leptoclinides dubius*. Posteriorly directed atrial siphons of the zooids open into the common cloacal cavities and canals. The openings sometimes appear 5 lobed due to the arrangement of spicules around the aperture. The genus *Askanides* Kott, 1962, therefore cannot be distinguished from *Leptoclinides* and *A. imperfectus* and *A. coelenteratus* are distinguished from other species of *Leptoclinides* only by the extent to

which zooids open directly into the common cloacal chamber rather than into cloacal canals. Their relations are set out in the following key:

1. Single systems develop around central common cloacal cavities with terminal openings 2
1. Numerous systems develop around periphery of colony 3
 2. Spicules accumulated in surface layer of test; spicules 0.01–0.02; larvae with 4 paired ampullae; most zooids open into cloacal canals *L. kingi*
 2. Spicules throughout; spicules 0.04–0.08; larvae with reduced ampullae; most zooids open direct into common cloacal cavity *L. coelenteratus* and *L. imperfectus*
 3. Spicules 0.01–0.02; double gut loop *L. dubius*
 3. Spicules 0.02–0.04; simple gut loop *L. rufus*

Leptoclinides reticulatus (Sluiter). Kott, 1962: 285 and synonymy.

Didemnum reticulatum Sluiter, 1909: 60.

New Record: Tipata Reef. *Previous Records*: Qld. (Noosa to Mackay, Heron I., Low Is.)—Hastings 1931; Kott 1962. New Zealand (North I.)—Michaelsen 1924. Japan—Oka 1927; Tokioka 1953a, 1953b. Indonesia—Sluiter 1909. ?Philippines—Van Name 1918. Indian Ocean (Ceylon)—Herdman 1906.

FIG. 26

Description: Young colonies were taken investing *Microcosmus squamiger* and *Pyura irregularis*. Frequent common cloacal openings are scattered over the surface. There is a superficial layer of bladder cells with orange and black pigment in stellate cells forming streaks on the surface. Spicules are present beneath this superficial layer and are reduced in density toward the base of the colony. The spicules are stellate with about 7 conical rays in optical transverse section and from 0.03 to 0.05 mm in optical section.

The primary cloacal canals are deep, but in these specimens do not extend posterior to the zooids. The zooids are small with the usual 4 rows of stigmata and a large posteriorly directed atrial siphon. There are 4 testis lobes and 43 coils of the vas deferens.

Remarks: This is the most southerly record for this conspicuous and widespread species, distinguished by its unique stellate pigment cells which form the characteristic "tiger-like" markings on the surface.

Didemnum lambitum (Sluiter). Kott, 1962: 317 and synonymy, 1971: 19.

Didemnooides lambitum Sluiter, 1900: 18.

New Record: Aldinga "drop off". *Previous Records*: N.S.W.—Kott 1954, 1962. New Zealand (Chatham I., North I., South I.)—Sluiter (1900; Michaelsen 1924; Kott 1971; and unpublished records from Otago (coll. R. Crump) and Stewart I. (coll. E. Batham)).

Description: Two clavate lobes arise from a common base. Maximum diameter 1.5 cm and maximum height 3.0 cm. There are traces of orange pigment in the surface test, but no superficial layer of bladder cells. There is a layer of spicules in the surface test which ceases abruptly at oesophageal level. Thin layers of spicules line the common cloacal canal. Spicules are absent at the abdominal level of the zooids, and in the central test core. They are 0.01 to 0.05 mm and stellate. Terminal cloacal aperture opens into the characteristic common cloacal cavity surrounding the central core of test. Zooids are small and crowded in the surface layer of test. The atrial aperture is wide and open. There are 81 coils of the vas deferens around a single testis lobe.

Didemnum patulum (Herdman).

Leptoclinium patulum Herdman, 1899: 92.

New Record: Aldinga. *Previous Records*: Vic. (Port Phillip Bay)—unpublished record. N.S.W. (Port Jackson) Herdman 1899.

FIG. 27

Description: Tough, investing colonies. In preservative the specimens are white with grey streaks and blotches formed by patches of stellate pigment cells in the surface test, especially in the region of the common cloacal canals. The surface of the colony is marked off into slightly raised rounded areas where solid pillars of test traverse the common cloacal cavity. Zooids are embedded in the periphery of these pillars of test and open to the surface around the raised area. The cloacal cavity is thoracic. The surface layer of test is especially thick and the zooids have especially long and muscular branchial siphons which extend through this surface layer of test. Spicules often form a plug inside the branchial siphon—possibly caused when the superficial layer of test is pulled down into the aperture as it is retracted into the surface of the test. The branchial siphon is almost the same length as the rest of the thorax. The atrial opening is wide, exposing a part of the dorsal surface of the branchial sac. The anterior border of the atrial opening

is produced into a narrow pointed languet, sometimes bidentate at the tip. There are conspicuous circular muscles in the branchial siphon, in addition to the usual longitudinal muscles that extend down the length of the thorax and into the test to form a short retractor muscle. The abdomen, of the usual form for this genus, is especially small. Oesophageal buds are present but the gonads are not mature.

Remarks: The grey veins in the surface identify this specimen with Herdman's species. The long branchial siphon and atrial lip are also distinctive. The species is especially common in Port Phillip Bay, but is not common in St. Vincent Gulf. The species also strongly resembles *D. tabulatum* Sluiter from the East Indies and Aru I. (see Sluiter 1913; Kott 1962).

Didemnum moseleyi (Herdman). Van Name, 1918: 151. Tokioka, 1955a: 212; 1955b: 44; 1959: 226; 1961: 106. Kott, 1957b: 136; 1962: 328 and synonymy. Eldredge, 1967: 213.

Leptoclinium moseleyi Herdman, 1886: 272.
Leptoclinium incautum Herdman, 1899: 90.
Herdman & Riddell, 1913: 888.

New Records: Goose I., Carickalinga Head, West I. *Previous Records:* W. Aust. (Rottneest I., Point Peron, Trigg I.). S. Aust. (Reevesby I.). Vic. (Balmarring Beach)—Kott 1962. Tas. (Spring Bay, Maria I.). N.S.W. (Port Jackson, Port Stephens, Coffs Harbour)—Herdman 1899; Kott 1962. Indian Ocean (Southern Arabia)—Kott 1957b. Indonesia (Arafura Sea)—Sluiter 1909, 1913; Tokioka 1955a. Pacific Ocean (Palau Is., New Caledonia, Philippines, Hawaiian Is., Marshall Is.)—Herdman 1886; Van Name 1918; Tokioka 1955b, 1961; Eldredge 1967.

FIG. 28

Description: Investing sheets. There is a very thin layer of surface test which is often raised into spicule-filled conical papillae between the branchial apertures. The cloacal cavity is thoracic and the thoraces of zooids are enclosed in an independent test sheath. The atrial opening is wide, in all cases exposing the branchial sac to the cloacal canal. Spicules are 0.02 to 0.04 mm in diameter with no more than 10 pointed rays in optical transverse section and are densely distributed throughout. Zooids are colourless. They are minute, the branchial sac especially small with four rows of only 6 stigmata. The vas deferens coils 6½ times around a single undivided testis follicle. In the

specimens from West I. and Carickalinga Head there is a small lateral organ opposite the last two rows of stigmata.

Remarks: Eldredge (1967), discussing the difficulties in distinguishing between the present species and *D. candidum*, has suggested that in *D. candidum* the surface test is always smooth, the atrial aperture is a small slit and lateral organs are always absent. He has not been able to confirm the presence of larger numbers of vas deferens coils for *D. candidum* (Kott 1962) nor is the condition of any of these characters constant in specimens previously ascribed to the species. Only the regularly stellate spicules and dark pigmented zooids of the present specimens appear to distinguish them from *D. moseleyi* which has a variety of different types of spicules.

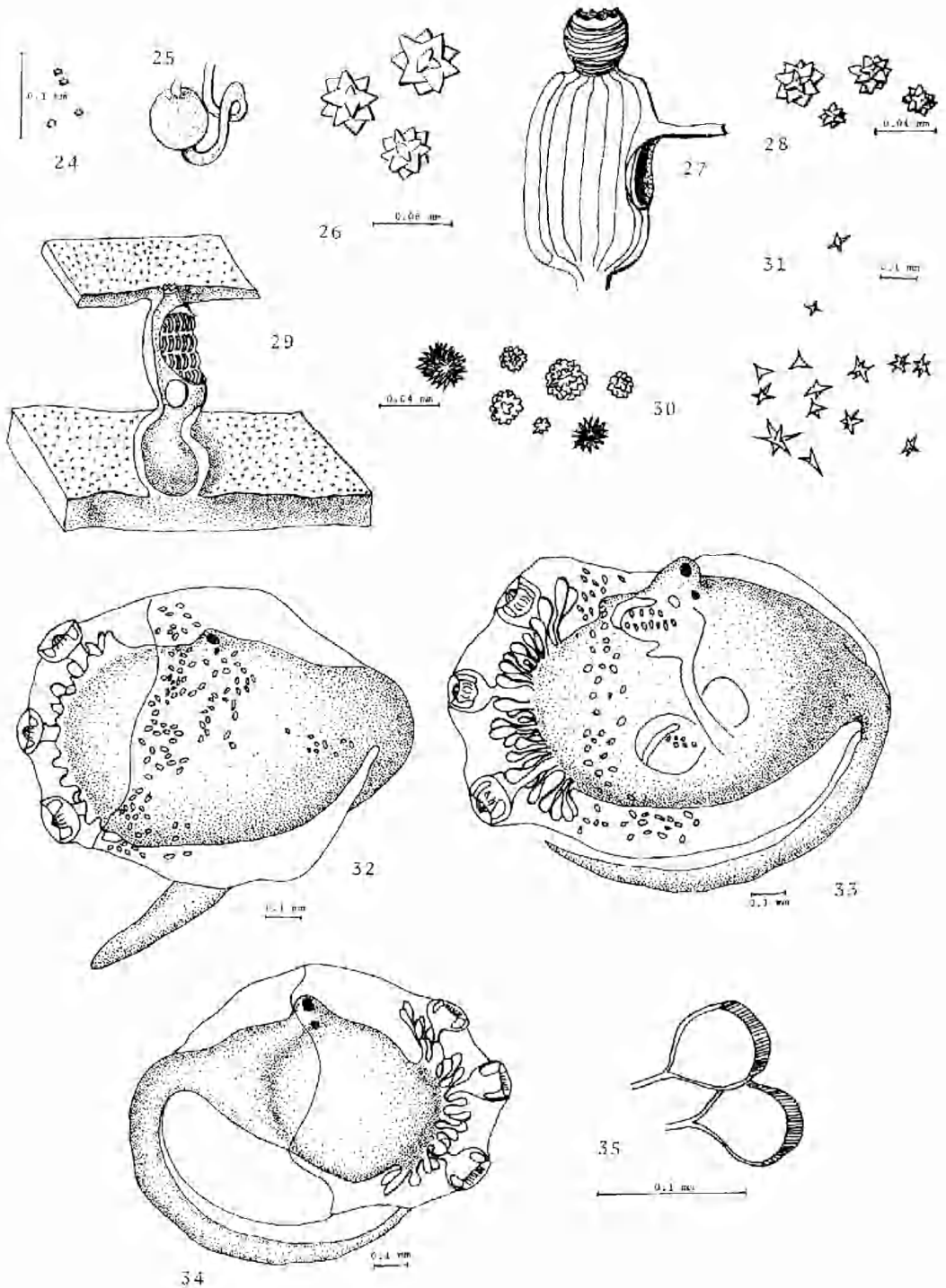
Didemnum candidum Savigny, 1816: 194. Michaelsen, 1924: 358 and synonymy. Van Name, 1945: 83. Hastings, 1931: 94. Brewin, 1946: 98; 1950a: 55; 1950b: 345; 1951: 104; 1952b: 188; 1956: 122; 1957: 577; 1960: 119. Tokioka, 1954a: 246; 1955a: 45. Kott, 1954: 162; 1962: 327. Eldredge, 1967: 213.

The above synonymy refers only to Indo-Pacific records. For full list of synonyms see Eldredge 1967: 213.

New Records: West I., Wright I. *Previous Records:* South-western Australia, Tasmania, north-eastern Australia, the English Channel, Irish Sea, West Africa, South Africa and East Africa, Red Sea, Mediterranean Sea, New Zealand, west and mid-Pacific Ocean (Marshall Is. and Hawaiian Is.), the Caribbean and West Indies and the east coast of the U.S.A. Records are lacking from the north Pacific and west coast of the American continent; but elsewhere the species occurs widely in temperate and tropical regions.

FIGS. 29, 30

Description: Colonies are flat and investing, small and rounded or more extensive sheets. The test has dense spicules throughout. In preservative the zooids are brown and show through the white spicules. The common cloacal cavity is thoracic but extensive and limited only by thin layers of surface and slightly thicker basal test in which the abdomina of the zooids are embedded. Thoraces cross the common cloacal cavity in an independent sheath of test. Spicules are dense throughout. They are 0.02 to 0.03 mm in diameter



and demonstrate the same range in form pre-almost cylindrical marginal rims stiffened by variously described for this species with up to 15 the dense spicules enclosed in the test. Zooids or more rays in optical transverse section. Con-are very small. There are 4 rows of about 8 spicuous common cloacal apertures present on stigmata. No gonads were distinguished in the the surface are surrounded by protuberant, present colonies.

Remarks: The present colonial systems are typical of the species although no gonads appeared to be mature. It was not possible to confirm Eldredge's observations concerning the slit-like atrial opening as, in the extended zooids of the present colonies, these were wide open, exposing a great part of the dorsal aspect of the branchial sac. The variety of spicules, therefore, remain the principal distinguishing character for this species. Carlisle (1954) has characterised specimens of *D. candidum* Savigny from the North Sea, the English Channel, north-west Africa, the Mediterranean and the Red Sea (type locality) by the absence of the third adhesive papilla in the larvae, and Lafargue (1968) confirms the condition for specimens from the French coast. The specimens agree in all other respects with those described from New Zealand, Australia, Malaysia, Japan and the Atlantic coast of America. Carlisle concludes, therefore, that: "*D. candidum* is a tropical and temperate species extending from the West Indies to the East Indies, New Zealand and Japan".

However, later workers have not observed the universal absence of a third adhesive papilla in larvae from these localities, while there are the usual three larval papillae in Australian, New Zealand and Japanese specimens. It is possible, therefore, that two separate species are involved.

Polysyncrator orbiculum Kott, 1962: 300.

New Record: Rapid Head. *Previous Records:* W. Aust. (Rottnest I.), S. Aust. (Port Nairnunga)—Kott 1962.

Description: The preserved colony is light pinkish brown, owing to the darkly pigmented zooids seen through the single layer of spicules present in the thin surface test. The dark coloured zooids are also seen through the branchial openings clearly marked on the surface test. There are the usual vesicular cells arranged in a complete circle around the branchial openings, and interrupting the otherwise even distribution of the spicules in the surface test. There is an extensive thoracic

cloacal cavity, crossed by the thoraces of the zooids, each with a discrete ventral sheath of test. There is a lateral organ about halfway down the thoracic test sheath. The zooids are small, with 4 rows of stigmata. There is a long retractor muscle. These specimens conform with those described previously (Kott 1962) in all respects; however, the gonads are not mature in the present zooids.

Remarks: The condition of the cloacal cavity, the dark pigmented zooids, the rather large stellate spicules and the unique, large transparent vesicles in regular circles in the surface, together, characterise the species.

Echinoclinum verrilli Van Name, 1902: 372, Kott, 1962: 312 and synonymy.

Diplosoma (Lissoclinum) verrilli, Eldredge, 1967: 242.

New Records: Hallett Cove. The species has been observed investing the underside of rocks at a depth of 5–20 m at many locations in St. Vincent Gulf where conditions are quiet. The colonies are so fragile, however, that they usually break up when removed (S. Shepherd, pers. comm.) *Previous Records:* Tas. (West Coast)—Kott 1954. America (West Indies, Florida)—Van Name 1902, 1945; Hartmeyer, 1909–11; Plough & Jones 1937. Africa (Accra)—Millar 1953. Japan (Sagami Bay)—Tokioka 1958.

FIGS. 31–35

Description: Living colony soft, white, jelly-like. In preservative the present colony is delicate and soft. It appears to be investing but is, unfortunately, damaged and its exact form could not be determined. Spicules are mostly 6-rayed, but there are also spicules with 4 and with 3 rays. They form a dense spiny, tough capsule around the abdomina of the zooids but are sparse in the remainder of the colony. Zooids are arranged more or less in the double rows previously described (Van Name 1945) although common cloacal openings were not detected. The cloacal canals spread out beneath the zooids which are retained in the

- Figs. 24, 25. *Leptoclinides kingi*. (Upper St. Vincent Gulf, 10–12 m). Fig. 24.—Spicules. Fig. 25. Gut loop.
 Fig. 26. *Leptoclinides reticulatus*. (West I., under boulder). Spicules.
 Fig. 27. *Didemnum parvum*. (Aldinga "drop-off", 3–8 m). Thorax, diagrammatic, showing musculature.
 Fig. 28. *Didemnum moseleyi*. (Carickalinga Head, 5–6 m). Spicules.
 Figs. 29, 30. *Didemnum candidum*. (Wright I., rough coast, 10 m). Fig. 29.—Diagram of colony. Fig. 30.—Spicules.
 Figs. 31–35. *Echinoclinum verrilli*. (Hallett Cove, 8 m). Fig. 31. Spicules. Figs. 32, 33, 34.—Larvae of increasing maturity. Fig. 35.—Mature anterior ampullae of larvae.

surface test. Zooids are small with large lateral organs on each side of the thorax.

Larvae are large with a short tail which, when extended, is only half the total length of the larva. There is a large ocellus and an otolith. At least one precocious bud is present although the exact number is obscured by the layer of spherical to oval granulate bodies that extend around the posterior half of the body of the larva.

Anteriorly there are the usual three adhesive papillae in the median line and 14 ampullae from the lateral lines on either side of the suckers. Initially these lateral ampullae are very small and sessile. Subsequently they increase in size and become "tear-drop" in shape supported by very narrow stalks from the lateral line.

Remarks: It is unfortunate that the present colony is so damaged that its shape cannot be discerned. Although previously described specimens have been clavate (Kott 1954; Van Name 1945) the present damaged colony is investing and living colonies have been observed investing the under-surface of rocks. It is possible therefore that two distinct species may be involved, characterised by a difference in the consistency of the test and in the shape of the colony.

The soft nature of the colony and its tendency to break up has probably been the cause of the lack of records of this form, which is reported as common in St. Vincent Gulf.

Eldredge (1967) has suggested that the genus is synonymous with *Diplosoma* (*Lissoclinum*), due to the similarity of the cloacal systems and the fact that tetrahedral spicules are not unique in the family Didemnidae. Eldredge's contention cannot be maintained. The common cloacal cavity in the two genera is extensive and extends posterior to the zooids which remain connected to the basal test by strands of test. However, the cloacal system in *Echinoclinum* differs from that in *Diplosoma* (*Lissoclinum*) in the absence of the secondary cloacal spaces around the thoraces of the zooids which remain connected to and in the surface test in continuous rows. In *Diplosoma* (*Lissoclinum*) the secondary cloacal spaces separate either the thoraces, or the whole zooids, from one another. Further, the spicules in *Echinoclinum* are very much larger (0.05–0.1 mm) than those generally found in other genera of the family and, in addition to their unusual form and size, their distribution in the colony

differs entirely from other genera of the Didemnidae. The capsules formed around the zooids by the spicules are reminiscent of the capsules formed in *Cystodytes* spp. and in no other genus of the Didemnidae do the spicules remain in such an intimate relationship with the zooid.

The genus is further distinguished by a unique larval form with a multiplicity of narrow-stalked epidermal ampullae and precocious buds. The larvae of *P. aspiculatum* and *D.* (*Lissoclinum*) spp. show a similar marked increase in the number of lateral ampullae. The ampullae in *Echinoclinum* are unique, however, in their distinct "tear-drop" shape, their narrow stalks and their discrete origin from the lateral line without subsequent subdivision. Precocious budding generally occurs in the larvae of *Diplosoma* spp. and in *D.* (*Lissoclinum*) spp. However, it also occurs in *Didemnum* (*D. pseudodiplosoma*—Kott 1962, and *D. ternatanum*—Kott 1966) and in *Polysyncraton* (*P. aspiculatum*—Kott 1962) so cannot be considered characteristic of any single genus.

The granular bodies present in the larval test are indeed similar to those found in *D.* (*Lissoclinum*) *fragile*—Eldredge 1967 and *D.* (*Lissoclinum*) *ostrearium*—Kott 1962. They do not take up haematoxylin stains (Eldredge 1967) and thus do not appear to be calcareous spicules nor their precursors, as Kott (1962) had suggested. However, despite the relationship with *D.* (*Lissoclinum*) indicated by these enclosed granules, the genus is distinct from other genera in the Didemnidae and entirely justifies its taxonomic position as a monotypic genus in that family.

Didemnum sp.

Record: West I. (near Penguin Rock).

Description: Living colony "yellow, crustose". In preservative the investing colony is a light fawn colour. There are common cloacal apertures with large spicule-filled lips scattered over the surface of the colony. Zooids are suspended between the basal and surface layers of test by connecting columns of test in which the abdomina are embedded in clumps, although the zooids are separated from one another in their own discrete sheath of test, open to the common cloacal cavity on the dorsum. Stellate spicules are thick throughout the test. The branchial siphons are fairly long with distinct circular muscles. There are large oval lateral organs on either side of the thorax. There are four rows of stigmata.

Remarks: The gonads are not developed and a definitive identification of the genus is therefore not possible. The condition of the colony with a well developed posterior abdominal cloacal canal is reminiscent of certain species of *Didemnum*.

Suborder PHLEBOBRANCHIA

Family CORELLIDAE

Subfamily RHODOSOMATINAE

Rhodossoma turcicum (Savigny). Kott, 1952: 317 and synonymy. Tokioka, 1952: 111; 1953a: 230.

Phallusia turcica Savigny, 1816: 102.
Rhodossoma papillosum, Van Name, 1918: 113 and synonymy. Hartmeyer, 1919: 95.

New Record: Hallett Cove. *Previous Records:* N.W. Aust. (Cape Jaubert)—Hartmeyer 1919. S. Aust. (Port Noarlunga). Qld.—Kott 1952. Indonesia—Sluiter 1904; (Arafura Sea)—Tokioka 1952. Indian Ocean (Ceylon)—Herdman 1906. Pacific Ocean (Philippines, California)—Van Name 1918, 1945; (Chile)—Traustedt 1882, 1885; (China)—Stimpson 1855; (Japan)—Oka 1927; Hartmeyer 1906; Tokioka 1953a. Red Sea—Ehrenberg 1828. Mediterranean—Lacaze-Duthiers 1865. The species is also recorded from the Caribbean region (Van Name 1945).

Remarks: Nothing further can be added to the description of this cosmopolitan but rare species. It is never taken in large numbers, nor is it taken very often. The species is, however, not inconspicuous. It is probable that, with its highly developed closing mechanism, it may exhibit a high degree of vivipary. In which case it is probable that relatively few larvae are incubated, and that the free-swimming time of larvae is short. The dispersal of larvae could be, therefore, limited, and the survival of the apparently small populations of the species enhanced by larval settlement close to the parent zooids. The species has been taken from a wide variety of depths. Unfortunately, little is known of the current conditions at locations from which the species has been taken, but it is possible that it favours less turbulent conditions where there is minimal current flow so that the larvae would be even less exposed to dispersal.

Only a single specimen is present in this collection.

Subfamily CORELLINAE

Corella cumyota Traustedt, 1882: 271, Kott, 1969: 84 and synonymy; 1971: 20.

New Records: Hallett Cove, King Beach. *Previous Records:* W. Aust. (Trigg I.)—Kott 1952. Vic. (Balnarring Beach, Frankston)—Kott 1952; Millar 1966. Tas. (D'Entrecasteaux Channel). New Zealand (North and South Is.)—Sluiter 1898; Michaelsen 1922; Brown 1946, 1948, 1950a, 1957, 1960. South Africa—Sluiter 1898; Michaelsen 1915; Millar 1955, 1962. The species also has a wide circumpolar distribution in the Antarctic (Kott 1969).

FIG. 36

Description: The living specimens were noted as transparent and no colour was recorded. There are both separate individuals and individuals aggregated together more or less in a line. Zooids are generally fixed to one another or to the substrate by almost the whole of the right side. The test is thick, gelatinous and semi-transparent. On the right side of the body where it is fixed to the substrate the body wall is especially thin and there are no muscles except those which radiate a short distance from the branchial siphon. On the upper or left side of the body there are mostly transverse muscles branching and ramifying and some short and more regular transverse muscles in a single row extending around the ventral border. The branchial siphon is terminal and on a short cylindrical siphon. The atrial aperture is sessile and from the posterior third of the dorsal border. The branchial sac, gut and gonads are of the usual form characteristic of the genus.

Remarks: These specimens do not differ in any way from other specimens of this ubiquitous species which has been recorded in very large numbers from open sea locations in circumpolar waters of the Antarctic and the sub-Antarctic (Kott 1969, 1971). The northern extent of the recorded range is at Trigg I. (Kott 1962) on the western coast of Australia, but the species has not been taken on the eastern coast of the Australian mainland; the most easterly record on the Australian coast is at Frankston in Victoria (Millar 1966).

Family ASCIDIIDAE

Phallusia depressiuscula (Heller). Kott, 1972: 8 and synonymy.

Ascidia depressiuscula Heller, 1878: 5. Herdman, 1906: 305.

Ascidia julinea, Vasseur, 1967: 129.

New Records: Tapley Shoal, off Port Gawler, off Grange, off West Beach, Hallett Cove, off Port Stanvac, Wright I. *Previous Records:* W. Aust. (N.W. Aust., Shark Bay, Fremantle)—Hartmeyer 1919; Michaelsen & Hartmeyer 1928; Millar 1963. N.S.W. (Port Jackson)—Herdman 1899. Qld. (Great Barrier Reef)—Hastings 1931; Kott 1952, 1966. Bass Strait (East Monocour I.)—Herdman 1882. Pacific (Philippines, Palao Is., New Caledonia)—Van Name 1918; Tokioka 1950; Vasseur 1967. Indo-Malaya (Ceylon, Indonesia, Arafura Sea)—Heller 1878; Herdman 1906; Sluiter 1919; Tokioka 1952. The species is known intertidally and to 52 m.

Description: Living specimens from off Hallett Cove are noted as large, white or transparent, and common on sandy bottom. Many living specimens, however, are bluish, with black and yellow markings. The preserved specimens may be whitish, or blackish grey and may have black spots in the surface test. The test is thick and firm, smooth on the surface with rounded ridges and swellings. The individuals reach a large size. The present specimens exhibit the range of variation described by Kott (1966) for the species.

Remarks: The relationship of *Phallusia julinea* Sluiter to the present species remains in doubt. The specimens in the present collection have the atrial aperture from the anterior third of the body while specimens of *P. julinea* have been distinguished by the position of the atrial aperture from the posterior third of the body.

Ascidia sydneyensis Stimpson (?part), 1885: 387, Kott, 1972 and synonymy.

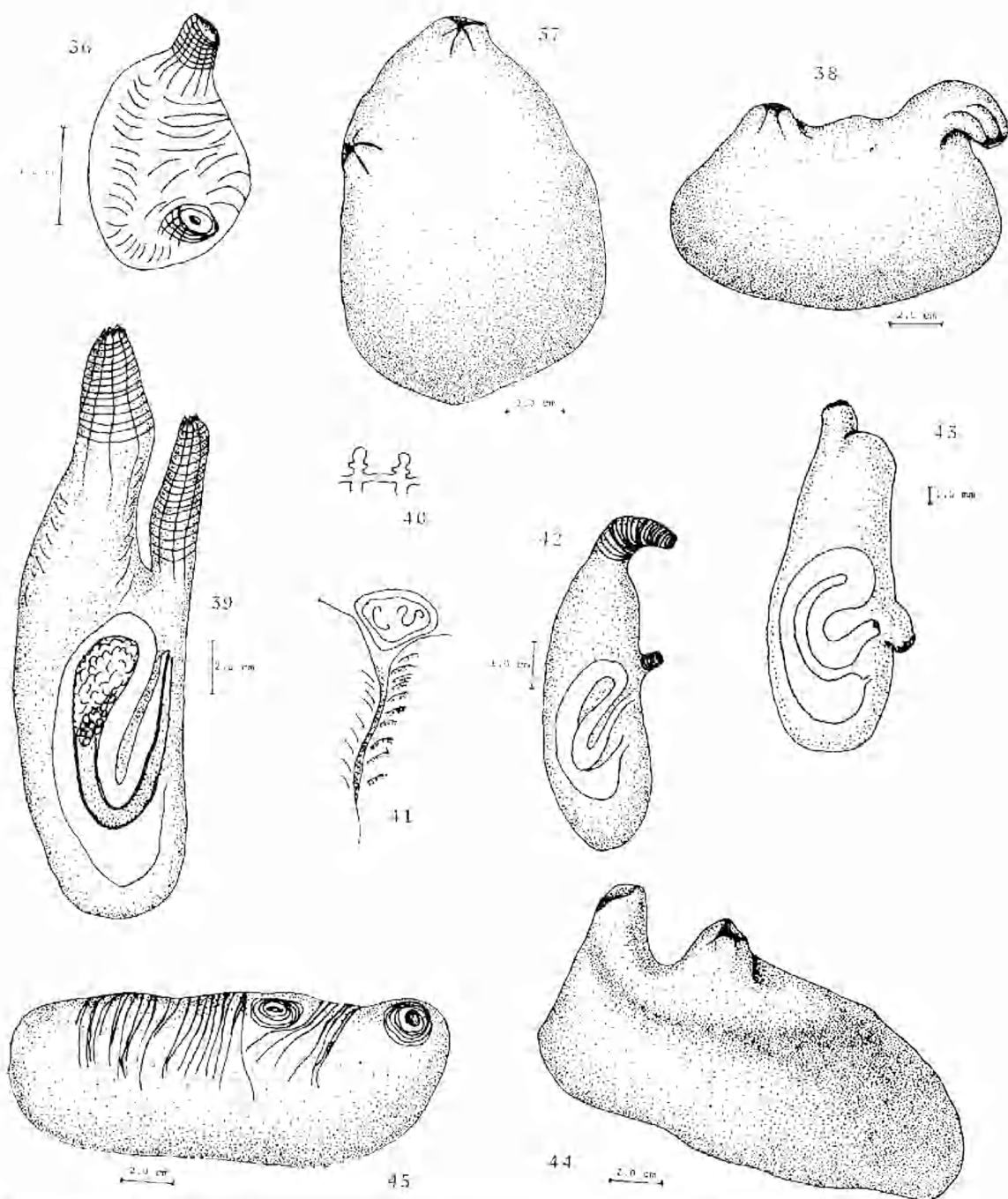
New Records: Tapley Shoal, Hallett Cove, Port Noarlunga, Wright I. *Previous Records:* W. Aust. (Cape Joubert to Albany)—Hartmeyer 1919; Michaelsen & Hartmeyer 1928; Millar 1963. S. Aust. (Victor Harbor, Port Noarlunga). Vic. (Balmarring Beach, Point Leo, Port Phillip Bay)—Kott 1952; Millar 1960; 1963; 1966. Tas. (Spring Bay). N.S.W. (Port Jackson)—Stimpson 1855; Herdman 1882, 1899. Qld. (Caloundra to Townsville)—Schmeltz 1879; Kott 1962, 1966. Indonesia (Arafura Sea)—Sluiter 1886, 1904; Tokioka 1952. Pacific Ocean—Traustedt 1885; (Palao Is., New Caledonia)—Tokioka 1950; Vasseur 1967. Japan—

Hartmeyer 1906; Tokioka 1953a, 1954b. Indian Ocean (Seychelles)—Michaelsen 1918; (Zanzibar)—Traustedt & Weltner 1894; (East Africa)—Millar 1956. South Africa—Heller 1878; Hartmeyer 1911, 1913; Sluiter 1898; Millar 1955, 1962. The species is also recorded from the Caribbean region (Van Name 1945). It is taken intertidally and to 30 m.

FIGS. 37, 38

Description: The living specimens are transparent and fleshy. The largest specimens in the present collection are 20 cm long and 12 cm wide. The test is thin, but firm and tough, and in larger specimens slightly leathery. There is sometimes, especially on the larger specimens, a very sparse encrustation of weed and worm tubes. Both the branchial and atrial apertures are on short cylindrical siphons and are usually about half the body length distant from one another. Specimens may be fixed to the substrate by the posterior, ventral, or left side of the body. The branchial siphon is turned away from the atrial siphon to varying extents. There is a row of short transverse muscle bands around the dorsal and ventral borders of the right side of the body. The gut is always filled with mud, which appears to accumulate during the life of the individual until in larger specimens the gut is so swollen with mud that the branchial sac is occluded and confined to a small area to the right and dorsal to the mud-filled gut. This mud begins to collect, in smaller specimens, in the descending limb of the primary gut loop, beyond the stomach, and it extends from there into the rectum and continues to accumulate in these sections of the intestine.

Remarks: The physiological significance of the mud-filled gut which appears to be characteristic of this species is not known. It has been noted in specimens from all parts of the Pacific. Abbott (pers. comm. 1955) noted that it appears to be associated with the termination of the typhlosole at the top of the gut swelling instead of extending further down the intestine. The stomach appears to be free from the mud accumulation, but distal to the stomach the gut becomes so distended and the whole body inside the test becomes so compressed by it that it is difficult to imagine normal feeding and respiratory functions proceeding. Some of the mud must be lost through the anus and



- Fig. 36. *Corella eumyota*. (Hallett Cove, 25 m). Individual removed from test.
 Figs. 37, 38. *Ascidia sydneyensis*. Fig. 37.—Individual from Tapley Shoal, 13 m. Fig. 38.—Individual from Wright I., 10 m.
 Figs. 39, 40. *Ascidia gemmata*. (Upper St. Vincent Gulf, 10–12 m). Fig. 39.—Individual removed from test. Fig. 40.—Diagrammatic section through branchial papillae.
 Figs. 41–43. *Ascidia thompsoni*. Fig. 41.—Dorsal lamina. Fig. 42.—Individual removed from test (Carickalinga Head, 5–6 m). Fig. 43.—Individual in test (off West Beach, 8 m).
 Figs. 44, 45. *Ascidia aclara*. (Off Seacliff, 16 m). Fig. 44.—Whole individual. Fig. 45.—Individual removed from test.

atrial opening and until observations are made on living specimens, it must be assumed that the property of the distal part of the gut to distend itself in this way is characteristic of the species and results in the accumulations of gut contents at a greater rate than they are removed from the body.

Ascidia gemmata Sluiter, 1895: 177. Kott, 1966: 296 and synonymy. Tokioka, 1967: 140.

New Records: Upper St. Vincent Gulf, off Port Gawler, off Glenelg. *Previous Records:* W. Aust. (Cape Jaubert to Albany)—Hartmeyer 1919; Michaelsen & Hartmeyer 1928; Kott 1952. Vic. (Port Phillip Bay)—Kott 1952; Millar 1966. N.S.W. (Port Jackson, Ararawarra)—Herdman 1899; Kott 1952. Qld. (Hervey Bay)—Kott 1966. Indo-Pacific (Indonesia)—Sluiter 1904; Tokioka 1952; (Palao Is., New Caledonia, Marianas Is., Caroline Is., Wake Is.)—Tokioka 1950, 1961, 1967.

FIGS. 39, 40

Description: Externally the test is fairly thin and flaccid and is slightly irregular. The branchial aperture is terminal on a short cylindrical siphon. The atrial aperture is on a similar but generally shorter siphon from the anterodorsal aspect of the body. Both siphons are regularly grooved externally along their length. Individuals are attached by almost the whole of the left side. Internally the atrial siphon arises from half way down the body and is especially long. The branchial siphon is also long internally. There are circular and longitudinal muscles around both the siphons and these extend only a short distance posterior to the siphons on the left side of the body where there is no musculature. On the right side of the body the longitudinal muscles from the siphons mingle with the irregular meshwork of muscles which occupy the whole body wall on the right side. There is only a very narrow prebranchial area terminated anteriorly by very numerous branchial tentacles, and covered with minute papillae. The dorsal tubercle is a fairly large circular cushion with a U-shaped slit turned to the right and with the posterior horn turned in. The peritubercular area is shallow and is completely filled by the dorsal tubercle. The dorsal lamina is a broad, single membrane, strongly ribbed on both sides. The ribs of the dorsal lamina extend into pointed languets on the free margin. There is a long neural gland almost one-third of the body distant from the

dorsal tubercle. The branchial sac is simply folded between each longitudinal vessel and has 4 to 8 stigmata in each mesh. There are large spatulate papillae at the junctions of the longitudinal and transverse vessel and these are expanded into rounded expansions on either side of their base. The gut forms a deep double loop enclosing the gonads in the primary loop. The pole of the gut loop in the large specimens available in this collection does not extend anterior to the base of the atrial siphon and is level with the anus. There is, however, some variation according to the size of the specimens and in smaller specimens (Michaelsen & Hartmeyer 1928; Millar 1966) the gut loop extends anterior to the atrial siphon and occupies a relatively larger portion of the left side.

Remarks: This species has been recorded often from locations around Australia extending north to Indonesia and into the Pacific (Tokioka 1967). The species is distinguished by the absence of intermediate papillae in the branchial sac, by the heavily ribbed broad dorsal lamina, and by the origin of the atrial siphon from the middle of the body. Although in the present specimens the atrial siphon is long and directed anteriorly, in specimens previously described there is a great variation both in the length of the atrial siphon and in its orientation (Michaelsen & Hartmeyer 1928). Specimens have been described with sessile external apertures and it is probable that the present specimens with short grooved cylinders represent more mature individuals. Externally the species resembles both *A. sydneyensis* and *A. thompsoni* and it is probable that in all these species the test is firmer and relatively thicker and the external siphons less evident in the younger specimens, while in older specimens the test becomes rougher externally and less transparent, and the external siphons develop as short grooved cylinders. The body musculature, concentrated on the right and on the siphons, is so arranged that the left side, fixed to the substrate, does not contract over the voluminous gut. In these species the gut occupies a relatively smaller proportion of the body wall as the individual increases in size. In *A. gemmata* growth appears to increase the proportion of the body anterior to the gut, and although the point of origin of the atrial siphon remains about one half to two thirds of the distance down the body, the gut does not appear to increase in size at the same rate as the rest of the body. The orientation of

the rectum and the curvature of the gut loop is therefore reduced as growth proceeds. It is also possible that this differential growth causes the variations that have been observed in the length and orientation of the atrial siphon, although this may also be affected by the orientation of the body on the substrate.

Ascidia malacca australiensis Hartmeyer, 1928, resembles the present species in the presence of a broad ribbed dorsal lamina with the free margin produced into pointed projections corresponding to the ribs. However, the species is distinguished by the specially long external siphons, by the dorsal ganglion which is only one-ninth to one-thirteenth of the body length from the dorsal tubercle, and by the small stumpy cone-like branchial papillae as opposed to the spatulate papillae of *A. gemmata*. Hartmeyer's subspecies was recorded from a seasonally brackish environment in Freshwater Bay, a considerable distance up the Swan River estuary from Fremantle Harbour and he regarded it as an isolated endemic species.

Ascidia thompsoni Kott, 1952: 312.

New Records: Off West Beach, Hallett Cove, Carickalinga Head. *Previous Records:* Tas. (Great Taylor Bay)—Kott 1952.

FIGS. 41-43

Description: In smaller specimens the test is firm and almost glassy and transparent. Anteriorly, expanded terminal ampullae of the test vessels are clearly visible through the test. Individuals from 2 to 7 cm long are available in the present collection. Both apertures are sessile, the branchial aperture terminal and the atrial aperture two-thirds of the distance down the dorsal surface. Most individuals are firmly fixed by the whole of the left side, however the specimen from Carickalinga Head is fixed posteriorly. The body musculature is present only on the right side, consisting of a mesh of transverse and longitudinal vessels. Internally the atrial aperture is on a siphon of variable length rising opposite, anterior or posterior to the external opening. The atrial siphon shows the same variations in length and orientation as have been described previously for *A. gemmata* (Michaelson & Hartmeyer 1928; Millar 1966). Both siphons are well equipped with circular and longitudinal muscles. There are about 40 branchial tentacles, a papillated prebranchial area, a shallow peritubercular area completely filled by the dorsal tubercle which generally has a simple

U-shaped opening. In an especially large and opaque specimen from West Beach (at 8 m) there is a second opening to the right of the larger U-shaped opening. The dorsal ganglion is about half the body distant from the dorsal tubercle. The dorsal lamina is a wide membrane, double for about one-sixth of its length. The right section of the double membrane is plain, the left section is ribbed on the left. For the remainder of its length the dorsal lamina is a single membrane ribbed on the left side, although these ribs do not extend to the outer margin of the membrane. There are minute and irregular papilla-like expansions from the free border of the membrane in its posterior extent. Intermediate branchial papillae are generally present, especially in the posterior part of the branchial sac. The intermediate branchial papillae are half the size of the primary papillae, and both are pointed. The gut is voluminous and forms a deep double loop which varies slightly in relation to the atrial siphon as the individual grows, as in *A. gemmata*.

Remarks: The double dorsal lamina with slightly irregular membranous border posteriorly and the form of the intermediate and primary branchial papillae distinguish this species from the very similar *A. gemmata* with which its geographic range overlaps. The origin and the variable orientation of the atrial siphon are shared by the two species, and in both, owing to differential growth of the body, the gut loop is confined to the posterior half of the left side in larger specimens. It is of considerable interest that the present species has been recorded only from fairly sheltered coastal environments (subject however to some wave action) in the present collections, while *A. gemmata* was taken only from Offshore Benthic locations subject to currents in middle and upper St. Vincent Gulf.

Ascidia aelara Kott, 1952: 309. Millar, 1963: 721.

New Record: Off Sealiff. *Previous Records:* Vic. (Lakes Entrance, Port Phillip Bay)—Kott 1952; Millar 1963. Qld. (Moreton Bay)—unpublished records.

FIGS. 44, 45

Description: There are two specimens in the present collection, maximum length 17 cm and 10 cm high. The body is slightly dorso-ventrally flattened. The test is rigid and encrusted with sand and shell particles and is produced into two rigid cylindrical tubes from around

the branchial and atrial apertures at the anterior end of the dorsal surface and from about one-third of the distance along the dorsal surface respectively. The apertures are completely sessile and lie at the base of these tubes. The body musculature, within this rigid test, is reduced to strong bands across the dorsal surface posterior to the atrial aperture and between the atrial and branchial apertures. Internally the specimens are exactly as previously described with the branchial sac forming a fold across the dorsal tubercle. The gut forms the usual simple open loop, opening adjacent to the atrial aperture.

Remarks: This unusual species appears to be highly specialised for an existence on a sandy bottom, with the rigid tubes extending vertically from the apertures forming a permanently open channel through the layer of sand in which the species is probably buried. It is probable that the immediate environment outside the apertures is modified by these permanently open chambers to facilitate a less interrupted feeding process and confer distinct advantages in locations where steady flowing currents and absence of sedimentation pertain. The species is also of considerable interest in that its records are confined to the semi-enclosed waters indicated above. It is possible that there is a wider, more continuous distribution on the continental shelf or, alternatively, that it represents a relict population of a species which once had such a continuous distribution on the open coast.

Suborder STOLIDOBRANCHIA

Family STYELIDAE

Subfamily POLYZOINAE

Stolonica australis Michaelsen, 1927: 202.
Michaelsen & Hartmeyer, 1928: 352.
Kott, 1952: 253.

New Records: Tipara Reef, Port Noarlunga.
Previous Records: W. Aust. (Albany)—
Michaelsen 1927; Michaelsen & Hartmeyer
1928. Tas. (Spring Bay)—Kott 1952.

FIG. 46

Description: Rounded, sandy, stalked or sessile individuals connected to basal stolons, 0.6 to 0.7 cm maximum diameter. The colonies in the present collection are encrusting specimens of *Pyura irregularis* and *Polycarpa pedunculata*. The apertures are both sessile on the upper surface. There are two folds on either side of the branchial sac with 6 to 9 internal longitudinal vessels. The gut loop is simple

and open with a gastro-intestinal ligament enclosing a rounded endocarp in the pole. The short stomach has about 18 folds. It is reduced in diameter at either end and has a thick pyloric caecum of moderate length. Gonads are not mature in the present specimens and their arrangement could not be determined. The ligaments anchoring the gut to the body wall extend in a row along the lateral aspect of the intestine. There are also large ligaments anchoring the stomach and the pole of the gut loop.

Remarks: This species appears to be confined to the southern coast of Australia, but has been recorded only from locations away from the open coast. It is inconspicuous, however, and it is possible that its occurrence in protected locations on the open coast has been overlooked. In the absence of mature gonads the species may be distinguished from *Amphicarpa diptycha* by the low rounded branchial folds, the presence of a curved pyloric caecum and the less developed musculature.

Stolonica carnososa Millar, 1963: 734.

New Record: Tipara Reef. *Previous Record:* W. Aust. (Cottesloe).

FIG. 47

Description: The colony is oval, 3 cm long, 2 cm wide and 1 cm thick and, as in the type specimen, has developed around an algal stem. The 4-lobed apertures of zooids are close together on slight swellings all around the outer surface which is encrusted with sand. There is no sand inside the colony. Each individual is dorso-ventrally flattened and most of its left side is directed toward the centre of the colony. There are 2 folds on each side of the branchial sac with internal longitudinal vessels according to the following formula: E O(5)4(6)1 DL. There are only 5 stigmata between the endostyle and the ventral fold.

The gut forms a rounded loop and the rectum turns anteriorly and dorsally at a sharp angle. The stomach is pyriform, narrowest at the cardiac end, has 15 narrow folds and a very long, curved pyloric caecum in the pole of the gut loop. There is a gastro-intestinal ligament and ligaments connecting the gut loop to the body wall as in *Distomus diptycha* (see Kott 1952). The anus is 2-lipped. The gonads are in single rows on each side of the endostyle. The testes are flask-shaped and the ovaries contain 3 eggs of varying sizes, and a testis and an ovary are generally loosely associated so that there are 6 to 7 hermaphrodite gonads on each side of the body.

Remarks: Although in Millar's specimen the testes and ovaries appeared often to be separate, the condition and the arrangement of the gonads in the present colony suggest that this is more apparent than real, and may depend on the relative stages of development of the ovary.

In Millar's specimen the stomach is folded internally but externally the folds were probably obscured by the membrane covering them. The course of the rectum in the present specimen also differs from Millar's specimen and is bent back against the gut loop, probably by dorso-ventral flattening of the individual. The extent of this dorso-ventral flattening, therefore, is an individual, rather than a specific character.

Oculinaria australis Gray, 1868: 564. Kott, 1952: 251 and synonymy. Millar, 1963: 734; 1966: 369.

New Records: West I. (Seal Rock), Wright I. *Previous Records:* W. Aust. (Fremantle to Albany)—Gray 1868; Michaelsen & Hartmeyer 1928; Kott 1952; Millar 1963. Vic. (Port Phillip Bay)—Millar 1966.

Description: Colonies of the usual form with numerous zooids closely coalesced, identified only by the paired apertures on wart-like siphons from the anterior surface of each zooid which project slightly from the otherwise compact colony. The test is very brittle and completely impregnated with sand. There are 4 branchial folds on each side of the body with 4 to 8 longitudinal vessels on each fold and about 4 between the folds. The gut loop is as previously described, with about 18 spiral folds in the stomach wall. No pyloric caecum has been detected. There is an elongate gastric gland reservoir extending between the stomach and the intestine. There are up to 9 long gonads on the right side of the body, a larger number than has previously been recorded for this species. There is a single row of testis lobes beneath each short ovary.

Remarks: The species is well adapted, by its compacted form, for the occupation of turbulent locations and, in fact, it has been recorded only from the exposed open coast. Externally it resembles colonies of *Polyandrocarpa* spp. from which it is readily distinguished not only by the location of the gonads on one side of the body, but also by the spiral course of the stomach folds, the presence of a gastro-intestinal reservoir and the form of the gut loop

Subfamily BOTRYLLINAE

Botrylloides leachi (Savigny). Michaelsen & Hartmeyer, 1928: 341 and synonymy. Millar, 1952: 24; 1962: 177. Kott, 1952: 258; 1966: 297.

Botryllus leachii Savigny, 1810?: 7.

New Records: Tipara Reef, Port Noarlunga, West I., Wright I. *Previous Records:* W. Aust. (Geraldton to Albany)—Michaelsen & Hartmeyer 1928; Kott, 1952. N.S.W. (Port Jackson)—Herdman 1899. Qld. (Moreton Bay)—Kott 1952; (Sarina)—unpublished record, Northern Territory (Darwin)—Kott 1966. New Zealand (Hauraki Gulf)—Michaelsen 1921; Brewin 1948; (Stewart I.)—Michaelsen 1921; (French Pass)—Sluiter 1900; (Otago Harbour)—Brewin 1946; (Auckland I.)—Bovien 1922. South Africa—Hartmeyer 1912; Millar 1962. The species is also known from the North Atlantic, the North Sea and the Mediterranean and Adriatic (see Hartmeyer 1923, Årnåbäck 1923, and Millar 1952).

Description: Living colonies from Oedipus Point, West I. have a colourless matrix and red zooids, while in those from Port Noarlunga the matrix is transparent and the zooids yellow-bright orange. All the colonies have translucent test and purple zooids in preservative. Colonies form flattened, long, lobes with a short stalk. There are circular to oval systems of closely packed zooids. The test is firm and transparent. The system of zooids are arranged in rows along the length of the head. These systems may appear to be confluent and form almost continuous rows, but in fact separate cloacal openings remain in the centre of a limited number of zooids and discrete circular to oval systems are maintained. There are 9 to 12 rows of about 20 stigmata. The stomach is long, with 10 folds and a very short caecum.

Remarks: The form of the colonies is very similar to those of *B. magnicoecum* but the circular systems and firm test, with common cloacal openings along the sides of the lobes are distinctive. The shape of the stomach and the form and length of the pyloric caecum is similar to the condition found in *B. nigrum*. However, the smaller number of rows of stigmata with more stigmata in each row also distinguishes this species from both *B. magnicoecum* and from *B. nigrum*. Records for this species extend from the North Atlantic to the Mediterranean and Pacific Oceans, and from all around Australia. It is not known from the

Indian Ocean beyond the West Australian coast nor is it known from the South Atlantic.

Botrylloides nigrum Herdman, 1886: 50. Van Name, 1945: 227 and synonymy. Kott, 1952: 257.

Sarcobotrylloides jacksonianum Herdman, 1899: 102.

Sarcobotrylloides pannosum Herdman, 1899: 105.

New Records: Port Gawler, off West Beach, off Sencliff, Carickalinga Head, Rapid Head, West I. (near Penguin Rock, Seal Rock), Wright I. *Previous Records:* W. Aust., S. Aust. Vic.—Kott 1952. N.S.W. (Port Jackson)—Herdman 1899; Kott 1952. Qld.—Kott 1952. Indo-Malaya (Ceylon)—Herdman 1906; (Red Sea)—Michaelsen 1919. East Africa—Sluiter 1898; Michaelsen 1918. South Africa—Hartmeyer 1912. The species is also recorded from the Caribbean region (Van Name 1945).

Description: Colonies investing sheets sometimes extended into irregular lobes. The zooids are arranged in long double row systems well separated from one another with transparent test between. In preservative the zooids are purple-black with the pigment contained in cells in the body wall. The colour of the preserved specimens does not reflect the variations in colour of the living specimens which are: "dark blue and bright purple" zooids (West I.); or "yellow and mustard" (off West Beach). There are 16 rows of about 12 stigmata with 3 internal longitudinal vessels on each side of the branchial sac. The atrial opening exposes the anterior half of the dorsal surface of the branchial sac, but the lip from the anterior border of this opening is not especially pronounced. The stomach is the usual long organ characteristic of this species, with 10 folds. It is wider at the cardiac end and reduced in width at the pyloric end where there is a very short caecum.

Remarks: Although the variation in colour and the irregularity of the colonies make this species difficult to identify in the field, the shape of the stomach with its short caecum and the widely spaced double rows of zooids are distinctive. Its recorded distribution is wide in the Indian Ocean and from the West Indies. At this stage there is no known character available to indicate that all these records refer to more than the one species with an almost circumpolar distribution, in the southern temperate region, absent only from the middle and eastern Pacific Ocean.

Botrylloides magnicoecum Hartmeyer, Kott, 1952: 258. Millar, 1966: 368.

Botrylloides nigrum var. *magnicoecum* Hartmeyer, 1912: 271.

Botryllus magnicoecus. Michaelsen, 1923b: 50; 1923c: 6. Michaelsen & Hartmeyer, 1928: 331 and synonymy. Hastings, 1931: 79. Brewin, 1951: 109. Millar, 1955: 195; 1962: 175. Tokioka, 1967: 153.

Botryllus auceps Michaelsen & Hartmeyer, 1928: 335. Millar, 1963: 736.

Polycyclus rufus Oka, 1927: 608.

Botryllus rufus. Tokioka, 1953b: 240.

New Records: Off West Beach, West I., Wright I. *Previous Records:* W. Aust. (Shark Bay)—Michaelsen & Hartmeyer 1928; S. Aust., Tas.—Kott 1952. Vic. (Port Phillip Bay)—Millar 1963, 1966. N.S.W. (Port Jackson)—Herdman 1891; Millar 1963. Qld. (Great Barrier Reef)—Hastings 1931. New Zealand (North I.)—Michaelsen 1921; Brewin 1951. Japan—Tokioka 1952; Oka 1927. China (Hong Kong)—Michaelsen 1923a; Tokioka 1967. Indian Ocean (Paumotu)—Michaelsen 1923a. South Africa—Hartmeyer 1912; Millar 1955, 1962. South West Africa—Hartmeyer 1913; Michaelsen 1915. Natal—Michaelsen 1918, 1921. Europe (Portugal) ?var.—Michaelsen 1923b; (Mediterranean) ?var.—Michaelsen 1923b.

Description: The living colonies from West I. are "bright yellow" although other specimens are "greyish with pale zooids". In preservative, however, all the colonies are purple owing to the pigmentation of the zooids which shows through the very soft transparent test. The colonies in this collection always consist of soft, long, narrow, flattened, stalked lobes with zooids arranged in closely set double rows running parallel to the length of the lobes. Zooids are absent from the stalks. In preserved specimens there is always an accumulation of dark pigment at the top of the endostyle and on either side of the base of the branchial aperture. Common cloacal openings are always present around the free end of the lobe as in *Sycozoa* spp.

There are 14 rows of stigmata in the present specimens with 3 to 4 stigmata between the longitudinal vessels. The stomach is short and rounded with 9 folds and a long caecum curving into the pole of the gut loop.

Remarks: Millar (1963) regards the form of the colony of the Australian specimens (long stalked lobes) as providing a character which distinguishes it from the South African forms which are irregularly lobed and investing, as

are Brewin's specimens from New Zealand. The closely set double row branching systems are present in all the specimens represented in the synonymy above and all these specimens have the characteristic short, rounded, stomach with a long curved caecum, distinguishing them from other species of the genus. It is possible that the Australian members of this species may represent a geographic subspecies characterised by the particular form of the colony with terminal cloacal apertures and close-set double rows of zooids parallel to the longitudinal axis of the head. *Botrylloides leachi* colonies are similarly lobed but the cloacal apertures are present along the side of the head between the double row of zooids.

Botryllus schlosseri (Pallas). Van Name, 1945: 220 and synonymy. Kott, 1952: 259 (part).

Alcyonium schlosseri Pallas, 1766: 355.

Non *Botryllus schlosseri*. Kott, 1952, from Hamelin Bay and Green Pools, W.A.

New Record: Off Hallett Cove. **Previous Records:** W. Aust. (Shark Bay, Fremantle)—Hartmeyer & Michaelsen 1928; Kott 1952. Vic. (Port Phillip Bay)—Millar 1966. Elsewhere the species has a wide distribution from the Faeroe Is. and southern Norway, the British Isles, the North Sea, the Mediterranean, Adriatic and Black Sea; from the eastern and western seaboard of the U.S.A. and from New Zealand (see Van Name 1945).

The local abundance of this species and its occurrence on wharf piles, ship hulls, buoys, etc. in shallow water has been pointed out by Van Name (1945). This wide cosmopolitan distribution suggests that, like *Ciona intestinalis*, the species favours sheltered locations and is transported largely by ships.

Description: The specimens are delicate and invest the sea grass *Posidonia australis*. The test is almost completely transparent and the zooids are pale grey. Zooids form small circular systems which are crowded close together in the test. The zooids are relatively short, with only about 8 rows of stigmata. The atrial aperture is on a siphon produced to a varying extent and the upper margin of the aperture is produced into a lip. There is a conspicuous pyloric caecum with a large bulb-like expansion on its free end. The stomach has about 10 very fine folds, is longer than wide, and is only of slightly greater diameter than the rest of the gut. Developing embryos are present in the peribranchial cavity of some

of the zooids, but on the right side of the body only.

Remarks: The zooids in a colony of the present specimens are identical with those described for *Botryllus gracilis* Hartmeyer & Michaelsen, 1928; Millar, 1966, from Shark Bay, Western Australia and from Port Phillip Bay. Millar (1966) regards this type of thin transparent colony as a species distinct from *B. schlosseri*. Juvenile colonies of *B. schlosseri* as described by Verrill (Verrill & Smith 1873) are identical with the present colony and the zooids are identical with those previously described for this species especially in regard to the atrial opening, stomach and pyloric caecum, and it is unlikely that *B. gracilis* is distinct from *B. schlosseri*.

Subfamily STYELINAE

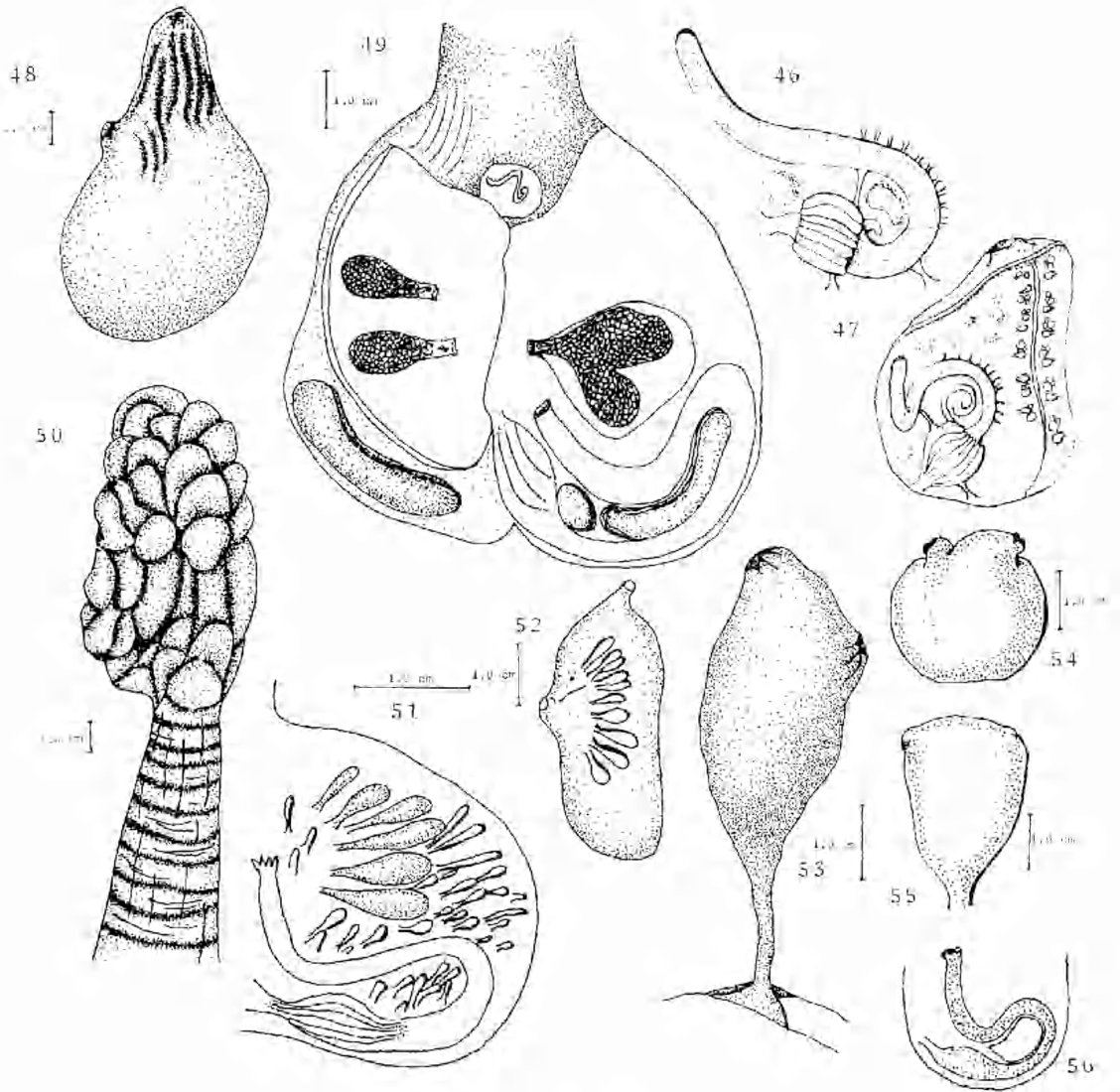
Cnemidocarpa etheridgii (Herdman)

Styela etheridgii Herdman, 1899: 38. Kott, 1952: 219 and synonymy; 1964: 139 (*f. personata*). Millar, 1966: 370.

New Records: Tapley Shoal, off West Beach, West I. (off Oedipus Point), Wright I. **Previous Records:** W. Aust. (Trigg I.). S. Aust. (Spencer Gulf and St. Vincent Gulf). Vic. (Phillip I.)—Kott 1952. (Port Phillip Bay)—Millar 1966. Tas. (D'Entrecasteaux Channel)—Kott 1952. N.S.W. (Port Jackson, Port Stephens)—Herdman 1899. Qld. (Moreton Bay)—Kott 1964. The species is known intertidally and down to 30 m. It is abundant in St. Vincent Gulf on sandy bottoms at 7–20 m with slow currents, and on open coasts in deeper water of 20–30 m (Shepherd, pers. comm.).

FIGS. 48, 49

Description: Individuals are large, up to 11 cm high, rounded and of greatest diameter posteriorly, gradually reducing in diameter to the terminal branchial aperture. The terminal branchial aperture is sometimes curved. The atrial aperture is on a slight rounded projection from about half way along the dorsal surface. Colour of living specimens varies from pale cream to bright yellow (most often the latter). In preservative the test is white and opaque, with longitudinal furrows converging to the branchial aperture on that part of the body anterior to the atrial aperture. The test is thin and leathery. There are up to 25 internal longitudinal vessels on the folds and up to 7 between, although in some specimens there are as few as 4 internal longitudinal vessels between the folds. There are 6 stigmata per mesh.



- Fig. 46. *Stolonica australis*. (Tipara Reef). Gut loop.
 Fig. 47. *Stolonica carnosa*. (Tipara Reef). Right side of body removed to show organs on left body wall.
 Figs. 48, 49. *Cnemidocarpa etheridgii*. (Tapley Shoal, 13 m). Fig. 48.—Whole individual. Fig. 49.—Individual bisected along the ventral surface, branchial sac removed, showing gonads and endocarps in body wall.
 Fig. 50. *Polyscarpa clavata*. Whole individual.
 Figs. 51, 52. *Polyscarpa papillata*. (Off Glenelg, 15 m). Fig. 51.—Body wall on left showing gut loop, gonads and endocarps. Fig. 52.—Individual showing gonads on right side of the body.
 Figs. 53–56. *Polyscarpa pedunculata*. Fig. 53.—Individual from Aldinga (10–25 m). Fig. 54.—Individual from Tapley Shoal (24 m). Fig. 55.—Individual from West I. (25 m). Fig. 56.—Gut loop and endocarp.

The gut forms a gently curved, fairly narrow loop across the left side of the posterior end of the body, enclosing a long narrow curved endocarp which is continuous with the body wall on both the right and left side. The gut loop is almost entirely posterior to the bran-

chial sac; the elongate stomach and proximal part of the intestine forming the proximal limb of the gut loop lie almost in the mid line postero-ventrally and the distal limb of the gut loop passes to the left of the posterior end of the branchial sac. The gut loop is almost

entirely embedded in the thickened body wall and is covered by endocarp which encloses the left gonad (in the curve of the gut) and extends ventrally across the pole of the gut loop to join the thickened body wall ventrally and posteriorly. The pole of the gut loop thus projects into a pocket in the thickened body wall. The oesophagus is short and the stomach is long and elliptical with internal longitudinal glandular folds. The anal opening has a smooth border.

There are one or two flask-shaped gonads on the right side of the body. On the left the gonad is embedded in a single large endocarpal thickening of the body wall. Here there may be a single branched gonad with single ♂ and ♀ ducts emerging from the endocarp and directed to the atrial aperture. This condition may have resulted from the fusion of two gonads. In another specimen there are two discrete gonads embedded in the left side of the body with their own sets of ♂ and ♀ ducts emerging from the endocarp. The testis lobes are enclosed by the ovarian tube as is characteristic of this genus.

Remarks: The present large specimens conform with those ascribed (Kott 1952) to the "etheridgii" condition of this species. It is most probable that this distinction relates only to the stage of maturity of the individual, where the "persimata" condition represents less mature individuals. Both forms have been taken from the same locations in both east and western Australia.

Polycarpa clavata Hartmeyer, Millar, 1963: 723.

Polycarpa clavata (Quoy & Gaimard) f. *clavata* Hartmeyer, 1919: 40. Michaelsen & Hartmeyer, 1928: 363. Kott, 1952: 236. Tokioka, 1961: 123. Vasseur, 1967: 133.

New Records: Tapley Shoal, near Marion Light, off Troubridge Light. *Previous Records:* W. Aust. (Bathurst I. to Rottnest I.)—Hartmeyer 1919; Kott 1952; Millar 1963. Pacific (Noumea, New Caledonia)—Tokioka 1961; Vasseur 1967.

FIG. 50

Description: Large stalked specimens from fawn to reddish-brown. The test is very soft and gelatinous and the surface is marked with rounded longitudinal ridges which are sometimes interrupted horizontally. The branchial aperture is on a short siphon from the basal one third of the dorsal surface, directed to-

ward the substrate. The atrial aperture is sessile and inconspicuous from the middle third of the dorsal surface. The upper, or posterior, end of the head is high and rounded. The stalk, about the same length as the head, is also thick and fleshy, wider toward the base in the larger specimen, and bulbous, or, in smaller specimens (Marion Light) fairly narrow. In the smaller specimens there are randomly distributed concavities, surrounded by well defined lips, on the sides and base of the stalk. These concavities are richly supplied with blood vessels which end in terminal ampullae in the base and lips of the concavity. It is possible that these organs are involved in the fixing of these individuals to the substrate, especially as they do not appear to be present in the larger specimen where the surface test of the stalk is uniformly transversely ridged.

The musculature is rather diffuse in the thick body wall which is produced into a tongue-like projection extending about one third of the distance down into the stalk. The stalk is composed of solid test material for the remainder of its length. The dorsal tubercle is large, completely filling the peritubercular area and has a complicated, convoluted and interrupted opening. There are 4 branchial folds on either side of the body, sometimes only apparent as an accumulation of longitudinal vessels. The branchial sac does not project into the anterior tongue of the body wall where it projects into the stalk.

The gut forms a double loop confined to the posterior part of the body. The anal border has small rounded lobes. Endocarps enclosed in the gut loop may be subdivided terminally into two or more branches. Gonads, more or less in 3 rows down each side of the body wall, are "foot" shaped, fixed to the body wall by the metaphorical "ankle", with the "toe" pointing toward the atrial aperture.

There are numerous upright endocarps scattered over the body wall between the gonads.

Remarks: The dorsal tubercle of *Polycarpa pedata* Herdman (*Styela pedata*) which Hartmeyer (1919) listed as a synonym of the present species is distinguished by the presence of numerous pit-like openings while the dorsal tubercle of the present species, although complicated, has a convoluted slit-like opening interrupted several times along its length. The present species appears closely related to *Polycarpa longiformis* Tokioka (Kott 1966).

which has similar gonads and appears to be distinguished only by the orientation of the body, the absence of the distinctive stalk and the simple opening of the neural gland. *Polycarpa atollens* Herdman (1899) has a similar convoluted opening on the dorsal tubercle, sometimes broken into several openings along its length. The gonads in *P. atollens*, however, are upright.

Millar (1963) drew attention to the difference between *P. aurata* (Quoy & Gaimard) and the present species first described as *P. aurata clavata* Hartmeyer.

P. aurata; Hastings, 1931, is described as agreeing well "with Hartmeyer's (1919) and Herdman's (*P. sulcata*; Herdman 1886) descriptions". Hartmeyer's description, however, is of *Polycarpa aurata* f. *clavata* (<*P. clavata*) and it is with *P. aurata* (>*P. sulcata*) that Hasting's specimen is identical. A re-examination of the type specimen of *P. aurata* var. *plana* Herdman, 1899 from Port Jackson has shown that its gonads are also the usual short polycarps of *P. aurata* which is now known from Port Jackson and the Great Barrier Reef and from the Indian Ocean, Malaya, and Indonesia. The range of *P. aurata*, therefore, does not overlap that of *P. clavata*.

Polycarpa papillata (Sluiter).

Styela papillata Sluiter, 1886: 192. Tokioka, 1952: 117. Vasseur, 1969: 925.

Polycarpa intestinata Kott, 1952: 238.

New Records: Tipara Reef, off Port Gawler, off Glenelg, Aldinga "drop-off". *Previous Records*: N.S.W. (Port Jackson)—Kott 1952. Indian Ocean (Madagascar)—Vasseur 1969. Indonesia—Sluiter 1886; (Arafura Sea)—Tokioka 1952.

FIGS. 51, 52.

Description: Small aggregates of individuals, the posterior test sometimes extended into a short stalk. The branchial aperture is terminal, the atrial aperture one third to one half of the distance along the dorsal surface. Both apertures are sessile. The test is tough, rough and wrinkled externally, with some sand and algae irregularly adhering but generally the surface test is naked. The body musculature consists of a moderately thick continuous external coat of circular muscles with longitudinal bands internally. The dorsal tubercle is a large blister-like swelling with a simple U-shaped opening; it completely fills the V of the peri-tubercular area. There are 4 wide overlapping folds with about 15 internal longitudinal vessels on each

fold and 3 to 4 between folds. There are 4 to 8 stigmata in each mesh. Anteriorly the endostyle follows a winding course, which is effected by the subdivision of transverse vessels and multiplication of the number of rows of stigmata ventrally, in a localised region along the anterior extent of the endostyle. The gut forms a horizontal loop in the posterior end of the body. The stomach is elliptical with longitudinal striations. The rectum extends anteriorly toward the atrial opening. The anal border is broken up into 14 long finger-like lobes. Tall endocarps are present in the gut loop and scattered over the body wall. Seven to 12 oval to elongate polycarps are present in 1 to 2 rows in the centre of each side of the body, directed toward the atrial aperture. These polycarps are fixed to the body wall along their whole length. In smaller specimens with smaller immature gonads there are more often 2 rows of polycarps, and, as the gonads increase in length and the body length increases, these rows appear to merge into a single irregular row, while in a single specimen with well developed gonads there is only a single regular row.

Remarks: The present species resembles *Polycarpa clavata* (Hartmeyer), *P. longiformis* Tokioka and *P. atollens* Herdman, in the tall endocarps enclosed in the gut loop, but is distinguished by the rows of recumbent gonads fixed along their whole length to the body wall. The anal lobes also resemble those of *P. atollens* and *P. longiformis*.

The form of the body, the position of the atrial aperture, the form of the dorsal tubercle, and the form and arrangement of the gonads are similar to *P. circumarata* (Sluiter); Vasseur, 1967, which is distinguished by its short oval stomach, greater number of rows of gonads and greater number of internal longitudinal vessels between the branchial folds.

Cnemidocarpa madagascariensis madagascariensis Hartmeyer from Madagascar and *C. madagascariensis regulix* Michaelsen from New Zealand (see Kott 1971a) also resemble the present species in external appearance and in the arrangement of gonads, and are distinguished principally by the greater length of the gut loop and greater number of internal longitudinal vessels between the branchial folds. The papillae on the branchial sac described by Sluiter (1886) are not present either in the South Australian specimens or in the specimens from the Arafura Sea (Tokioka 1952). It is possible that Sluiter mistook particles adhering to the branchial sac for papillae.

The species has a wide geographical distribution from Indonesia and apparently around the east coast of Australia, from rocky substrates in sheltered localities, or in Offshore Benthic locations where there are slight currents.

Populations of this species do not appear to be dense and records are few.

Polycarpa pedunculata Heller, 1878: 106. Kott, 1952: 232 and synonymy. Millar, 1966: 369.

Polycarpa obscura. Kott, 1952: 245 and synonymy.

Polycarpa stephenensis Herdman, 1899: 45. Kott, 1952: 232. Millar, 1963: 726.

Polycarpa moehli. Kott, 1952: 244 and synonymy; 1966: 299. Vasseur, 1967: 136.

Polycarpa obtecta. Kott, 1952: 242 (not *P. obtecta* Traustedt).

New Records: Tipara Reef, Tapley Shoal, near Marion Light, upper St. Vincent Gulf, off Port Gawler, off Semaphore, off Grange, off West Beach, off Glenelg, off Broadway, off Hallett Cove, Port Noarlunga, Aldinga, Carickalinga Head, Rapid Head, West I., Wright I. **Previous Records:** W. Aust. (Cape Joubert to Bunbury)—Hartmeyer 1919; Michaelsen & Hartmeyer 1928; Kott 1952. S. Aust. (Reevesby I.). Vic. (Balnarring Beach)—Kott 1952; (Bass Strait)—Heller 1878; Michaelsen 1905; (Port Phillip Bay)—Millar 1966. N.S.W. (Port Jackson, Two-fold Bay)—Herdman 1881. Qld. (Moreton Bay)—Kott 1964. The species has also been recorded from New Caledonia (Vasseur 1967).

FIGS. 53-56

Description: This is by far the most common ascidian in St. Vincent Gulf and is very variable in external appearance. The colour of living specimens from Port Noarlunga has been described as "bright to pale yellow". These specimens are black to greenish in preservative. Most often living specimens are sandy with a "reddish tinge" to "reddish brown" becoming brown to purplish brown when preserved in formalin. They are slightly laterally flattened and almost oval shaped, and are most often 3 to 4 cm long and 2 to 3 cm wide. Larger specimens up to 8 cm long are usually greenish-black in preservative. The apertures are sessile, the branchial aperture terminal but directed slightly to the side, away from the dorsal surface, and the atrial aperture one-third of the distance down the dorsal surface.

The test is firm and gelatinous and the surface is generally smooth and naked. There is often, however, a light encrustation of sand

or the test may be more heavily encrusted, or may become almost brittle with included sand. In larger specimens the test becomes thinner, more flaccid and leathery.

Posteriorly the test may be produced into a narrow stalk up to half the length of the body, or the body may taper gradually from a straight upper or anterior surface where the branchial aperture is central and the atrial aperture is on the antero-dorsal corner. The posterior end of the body, with or without a stalk, may be produced into root-like structures, or the individual may be fixed to the substrate by the postero-ventral surface.

The body wall is light to dark brown, brownish-green, greenish-black, or black. It is not very closely adherent to the test and is thick, firm and very muscular with internal longitudinal bands and a continuous thick external coat of circular muscles. Both layers of musculature are often embedded in fleshy non-muscular tissue and generally spherical vesicles are embedded in the muscle layers interrupting the regularity and continuity of the fibres. The body wall is more flaccid in larger specimens.

There are about 100 simple tentacles of at least 4 orders. The prepharyngeal area has small papillae and is of moderate width. The dorsal tubercle varies and is sometimes small, in the centre of a fairly large peritubercular area. It is sometimes much larger but never completely fills the peritubercular area. The opening forms a U with horns turned in or out and directed to the side, anteriorly or posteriorly and in larger specimens may be interrupted. The dorsal lamina is a plain edged narrow membrane. The branchial folds are low and rounded with 2 to 3 thick internal longitudinal vessels between the folds and 11 to 13 on the folds. There are 6 to 8 stigmata in each mesh between the folds but on the folds the internal longitudinal vessels are more crowded together. There are often vesicles, similar to those embedded in the body wall, embedded in the branchial vessels and in the dorsal tubercle. The gut is confined to the posterior end of the body distal to the atrial aperture. The intestine forms a short rounded loop enclosing a circular endocarp. The stomach itself is elliptical with pronounced folds. There may be a second small endocarp separating the rectum from the oesophagus as the former extends anteriorly toward the base of the atrial opening. In smaller specimens the anal border is broken into 7 sometimes subdivided rounded

lobes. In larger specimens there are up to 25 lobes. The circular endocarp enclosed by the gut appears to be the major mechanism anchoring the gut loop to the body wall and is confluent with the connective tissue surrounding the gut. There are 20 to 50 short oval polycarps on the left and 25 to 60 on the right. These are sometimes, but not always, embedded completely in the body wall. When completely embedded only the openings of the ducts are apparent as holes in the inner surface of the body wall. Primarily there appear to be about 3 longitudinal rows of polycarps on each side of the body. As each polycarp increases in length it sub-divides and new gonoducts open from the proximal half to form secondary rows of gonads overlapping the primary row closest to the atrial opening. It is possible that this process, resulting in increases in the number of polycarps present, explains the great variation in the number recorded for this species.

Remarks: Michaelsen & Hartmeyer (1928) drew attention to the similarity between species listed in the synonymy above and suggest that *P. obscura* is a variety of *P. pedunculata* (*P. viridis*). Michaelsen regarded *Polycarpa moebii*, however, as a distinct species characterised by differences in the gut and gonads. In this collection there are individuals demonstrating every condition previously described for *P. pedunculata*, *P. moebii*, *P. obscura* and *P. stephenensis*. There are specimens demonstrating every condition from stalked or rooted to sessile individuals; every colour and every condition of the test is found and there is considerable variation in the number of polycarps and the extent to which they are embedded. The gut loop is always constant and encloses the circular endocarp which has a pointed tip dorsally. The thick internal longitudinal vessels of the branchial sac, their crowding on the narrow folds, the spherical vesicles embedded in the branchial sac and body wall, the thick layer of circular muscle, and the papillated pre-branchial area can be regarded as characteristic of this otherwise highly variable single species. The extent to which gonads are embedded in the body wall, and the extent to which the body wall is marked off into areas probably indicates more mature specimens.

Polycarpa maculata Hartmeyer, 1906, has a similar endocarp enclosed by the gut loop and the same type of vesicles embedded in the body wall. It is distinguished from the present species, however, by the weaker musculature

which also distinguishes it from the West Indian species *P. obtecta* Traustedt.

P. pedunculata is the most common ascidian in St. Vincent Gulf and generally both greenish and reddish brown specimens occur. Large black specimens were also taken from Seal Rock, West I, from Hallett Cove, and from Tapley Shoal. There is no apparent correlation between the type of environment and the colour of the individuals at each Station. A case of genetic polymorphism in Ascidiacea has been described for *Boltenia ovifera* (L.) (Plough 1969). This dominant in the ascidian population of the Gulf of Maine, has colours ranging from white to crimson red in a single haul, and variations in test texture and in muscle band colour and thickness can be related to these colour variations. It has been suggested that the species demonstrates genetic segregation of the ability of individuals to accumulate pigments. The situation in *Polycarpa pedunculata* may indicate a similar genetic segregation.

Family PYURIDAE

Pyura scoresbiensis n.sp.

Type Location: Off Semaphore: 18 m. in sparse *Posidonia*, 27.1.69 (Holotype: South Australian Museum; registration number E876). *Further Records:* Off Tapley Shoal, 18 m. 22 m.

FIGS. 57-59

Description: Rounded heads on stalks of varying length, sometimes thick and no longer than the head, but sometimes long and narrow (up to 20 cm), supporting a head 8 cm long and 3 cm wide. The head is more or less egg-shaped with its greatest diameter basally before narrowing abruptly to the stalk. The apertures are both sessile, either side of a more or less pointed projection forming the anterior apex of the head. The atrial aperture is slightly more posterior than the branchial aperture.

The test is thin, hard and tough with a dense sandy encrustation on the outer surface of the head and the stalk. The body wall is thin and semi-transparent with moderately developed fine and diffuse musculature, with muscle bands most closely placed around the anterior part of the branchial sac and siphon.

The branchial tentacles have a large flanged axis, fairly short primary branches, stumpy secondary branches and minute tertiary branches and are not very bushy. The siphons are lined with long needle-like spines, closely set, up to 0.275 mm long. There are no spi-

cules in either the test or the body wall. The dorsal tubercle is a simple U-shaped opening with both horns turned inwards. The dorsal lamina has pointed languets but is very short owing to the close-set branchial and atrial siphons and contracted dorsum. The branchial sac is delicate with 6 high, overlapping folds on each side of the body with up to 20 internal longitudinal vessels on the folds and only 2 or 3 between. There are 4 to 6 stigmata in each mesh.

There is a simple and fairly narrow gut loop enclosing the gonad on the left. The gonad on the right occupies a corresponding position. There are very arborescent liver lobules in the region of the stomach. The gonad may consist of an undulating ovarian tube with fringing testis follicles along both sides with the testis ducts extending along the mesial surface of the ovary. In some specimens the undulations of the ovarian tube extend out into pinnate branches with testis follicles around their extremities. These pinnate branches may subsequently separate off into separate polycarp sacs on either side of a ventral duct. The anal border is divided into 3 large shallow lobes.

Remarks: Specimens demonstrate the development of the polycarp sacs of the pyurid gonad from the continuous tubular styelid type of gonad. All stages of this development can be observed in the specimens available and it may be that the condition of the gonad indicates the age of the individual. The stalk of this species also shows great variation in length and thickness. Despite these variations the species is characterised by the relatively smooth test, sand encrusted, but without tubercles or furrows, and by the constant position of the apertures. The position of the apertures, on the upper end of the head, fairly close together, with the branchial and atrial openings on opposite sides of the apex, is unusual in a stalked species of the Ascidiacea, where, more generally, both apertures are on the dorsal side of the head with the branchial aperture directed downwards, and the atrial aperture uppermost and directed upwards.

The relationships of this species are indicated by the siphonal spines, which resemble those described for *Pyura albanyensis* Michaelsen & Hartmeyer, 1928, from Oyster Harbour, Albany, Western Australia, in which apertures are also separated by a cushion of test in the middle of the upper surface and in which the dorsal surface of the body is very much contracted and the dorsal lamina consequently very

short. *Pyura albanyensis* has, however, characteristic papillae on the convex border of the scabre-shaped stem and primary branches of the branchial tentacles.

Pyura curvigena Tokioka, 1967, from the Palao Is. is a similar closely related species, sometimes stalked, with a similar arrangement of endocarps, gonads and gut. The anus, however, has many lobes and the long (2.75 mm) siphonal spines extend outside the siphons onto the lobes surrounding the apertures, as in *Pyura vittata* (present in this collection). The needle-like siphonal spines found in the present species are not found in the various forms of the *Pyura pachydermatina* group of stalked species. In a specimen from Tapley Shoal (Station 6) there are barnacles growing around the branchial aperture.

Pyura vittata (Stimpson). Pérès, 1949: 195. Tokioka, 1952: 134; 1953a: 273; 1967: 202. Millar, 1960: 126. Kott, 1964: 142; 1966: 300; 1969: 133. For further synonymy and literature to the species in the Atlantic and West Indies see Van Name 1945: 321.

Cynthia vittata Stimpson, 1852: 230.

Pyura jacobrensis. Kott, 1952: 273; 1954: 127. Millar, 1960: 125.

New Records: Tapley Shoal, off Troubridge Light. *Previous Records:* W. Aust. (S.W. Aust.)—Kott 1952, Tas.—Kott 1954, Qld.—Kott 1964, 1966, Pacific (Arafura Sea)—Tokioka 1952; (Palao Is.)—Tokioka 1967; (Japan)—Tokioka 1953a; Van Name 1945, Atlantic—Van Name 1945; Pérès 1949; Millar 1960, Sub-antarctic (Macquarie I.)—Kott 1954, 1969; (Kerguelen I.)—Kott 1954; (Marion I.)—Millar 1966.

The species has a wide circumpolar distribution in the southern hemisphere and extends north through the Indo-Malayan region to Japan. It is also found in the Atlantic and in the Caribbean (see Van Name 1945).

FIG. 60

Description: Only a single individual is available, 3 cm long with a terminal branchial aperture and the atrial opening half the distance along the dorsal surface. Both apertures are almost sessile. The external surface of the test is rough and has sand and foreign particles adhering. The siphons are lined with long needle-like spines, 0.1 mm to 0.2 mm long, overlapping. These extend onto the outer surface of the siphons, cover the lobes bordering the siphons and extend onto the outer layer of test. The spines have a slight inflexion

which confers on this outer siphonal area a greenish tinge. The siphon is lined with red stripes in the preserved specimen.

The test is thin, leathery and firm. The dorsal tubercle is a rounded cushion filling the peritubercular area with a simple U-shaped slit with both horns turned in. The branchial tentacles are not bushy and have only primary branches and very short secondary branches. The internal siphons are fairly long. Longitudinal muscle bands radiate from both siphons but do not extend very far down the body on the left. Circular muscles form a fairly irregular network over the right side of the body, becoming more sparse posteriorly. They are practically absent from the posterior half of the body on the left side, over the gut loop. The branchial sac is fairly delicate. It has 18 internal longitudinal vessels on each fold and 4 between. There are 6 stigmata per mesh. The gut forms the usual loop enclosing the left gonad. The anal border is smooth and bilabiate. The gonads consist of the usual central ovarian tube with pinnate branches on both sides terminating in polycarp-like sacs. Endocarp-like tissue is present on the free surface of the gonads where it is broken up into lobes.

Remarks: The synonymy of this widespread species has been very confusing owing to the variation in the length of the siphonal spines and the variation in the condition of the anal border. It appears, however, that Sluiter's species from Indonesia and Northern Australia (*P. jacatrensis*), with very much smaller siphonal spines that do not extend onto the outer surface of the apertures, may be a distinct species despite the spines of intermediate length that are present in specimens from the Palau Islands (Tokioka 1950; see Kott 1971). *Pyura curvigona* Tokioka, 1967, from Palau Is., is another closely related species in which the very long (2.75 mm) siphonal spines extend onto the outer surface of the apertures. In *Pyura alhanyensis* Michaelsen & Hartmeyer, 1928, and *P. neoreshiensis* n.sp. the siphonal spines extend up to 0.275 mm, only slightly longer than the present species. However, these siphonal spines do not extend onto the outer surface of the apertures.

Pyura irregularis (Herdman), Kott, 1952: 271. Millar, 1963: 739; 1966: 370.

Cyathia irregularis Herdman, 1881: 60; 1882: 141.

New Records: Tipara Reef, off Beach Hut, 1 km off Port Vincent, upper St. Vincent Gulf, off Grange, off West Beach, off Glen-

elg, Port Noarlunga, Aldinga "drop-off", Carickalinga Head. *Previous Records:* S. Aust. (Outer Harbour), Vic. (Port Phillip Bay)—Millar 1963, 1966. Tas. (D'Entrecasteaux Channel)—Kott 1952. N.S.W. (Port Jackson)—Herdman 1882. The species has not previously been taken in waters of less than 25 m in depth.

Description: Living specimens are red, orange to light fawn. Externally the test is very hard, leathery and wrinkled and thickened into small octagonal plates. There are also wart-like protuberances, especially anteriorly.

Individuals are usually clumped together in tight aggregates and the shape of the body is consequently very irregular. The maximum body length is about 2.5 cm. Both apertures are present at the end of fairly long siphons which are generally oriented away from one another. The test is very strong with internal longitudinal and outer circular muscle bands as in all species of *Pyuridae*.

Delicate cup-shaped scales, 0.02 mm long, line the siphons. There are 15 branchial tentacles with short sparse primary branches and minute secondary branches. The primary opening from the neural gland is U-shaped with horns turned in or out. The dorsal tubercle is blister-like and there is often an accessory opening from the neural gland. The tubercle is not always longitudinally attenuated, however the peritubercular arc is always a very deep V-shape and generally the tubercle does extend down into it. The neural ganglion is especially long, extending most of the distance along the dorsal lamina. The dorsal lamina has a double row of languets. These are fine and pointed, closely set on the left, and on the right they are stouter and more sparsely arranged.

There are from 6 to 10 branchial folds on each side of the body with about 12 longitudinal vessels on the folds and 2 between. There are 6 to 8 stigmata in each mesh crossed by parastigmatic vessels. The gut loop is simple and curved and encloses the left gonad which is subdivided into 15 to 20 separate polycarp sacs arranged on either side of central male and female ducts. There is a corresponding gonad on the right.

Remarks: This species resembles very closely the Antarctic species *Pyura discoveryi* Herdman (see Kott 1969). The tough, wrinkled external test with embedded polygonal thickenings is also reminiscent of the Antarctic *Pyura squamata* Herdman although the polygonal

scales and the body shape of *P. squamata* are more highly specialised than in either *P. discoveryi* or in the present species. The branchial tentacles with their sparse branches and the long siphons are also similar to those of *P. discoveryi* and it is possible that the protection afforded the individual by these long siphons may be associated with the absence of the more bushy tentacles usually found in this genus.

The individuals are never very large and their leathery test and habit of occurring in aggregates suggests a species adapted for very turbulent conditions. The present records do not support this, however, as they are either from Offshore Benthic locations in St. Vincent Gulf, or from reefs in sheltered coastal locations.

***Pyura australis* (Quoy & Gaimard) s.sp. australis Quoy & Gaimard.**

Aeidia australis Quoy & Gaimard, 1834: 614.
Pyura australis f. *typica*, Kott, 1952: 266 and synonymy.

Pyura australis, Millar, 1963: 739.

New Records: Tipata Reef, Tapley Shoal, near Marion Light, off West Beach, off Broadway, off Hallett Cove, off Yankalilla Bay, West I., N.W. of Robe. **Previous Records:** W. Aust. (Geraldton to Albany)—Quoy & Gaimard 1834; Michaelsen & Hartmeyer 1928; Kott 1952; Millar 1963. Vic. (Westernport, Flinders)—Quoy & Gaimard 1834; Kott 1952. Tas. (D'Entrecasteaux Channel, Tinderbox)—Kott 1952.

FIG. 61

Description: Specimens of all sizes up to a maximum of 4 cm long head with a stalk of 30 cm. The test is usually without foreign bodies adhering, though in one specimen there are some cirripedes growing on the stalk. The surface of the test is marked with variable longitudinal furrows and ridges but is sometimes almost smooth. In preservative the specimens are pinkish-fawn, although living specimens are usually dark red and, occasionally, yellow. Both apertures are close together on the dorsal surface, the atrial aperture directed upwards and the branchial aperture directed basally. The lobes of the atrial aperture are clearly continuous with the ridges in the dorsal part of the test.

There are stellate spicules of about 0.02 mm diameter with 6 rays in optical transverse section in the body wall, and the siphons are lined by conical spines of 0.02 mm maximum height from base to apex.

The branchial sac, gut loop and gonad are as previously described and there are 18 long flattened characteristic lobes fringing the anal border (see Kott 1952).

Remarks: Nothing can be added to previous descriptions of this constant species which appears to occupy a wide range of conditions in exposed to sheltered locations from Geraldton, in Western Australia, to Flinders in Victoria. It is common in wave beaten areas from the low water mark to 22 m.

***Pyura spinifera* (Quoy & Gaimard), Kott, 1952, 269 and synonymy.**

Aeidia spinifera Quoy & Gaimard, 1834: 617.
Cynthia multiradicata Herdman, 1899: 30.

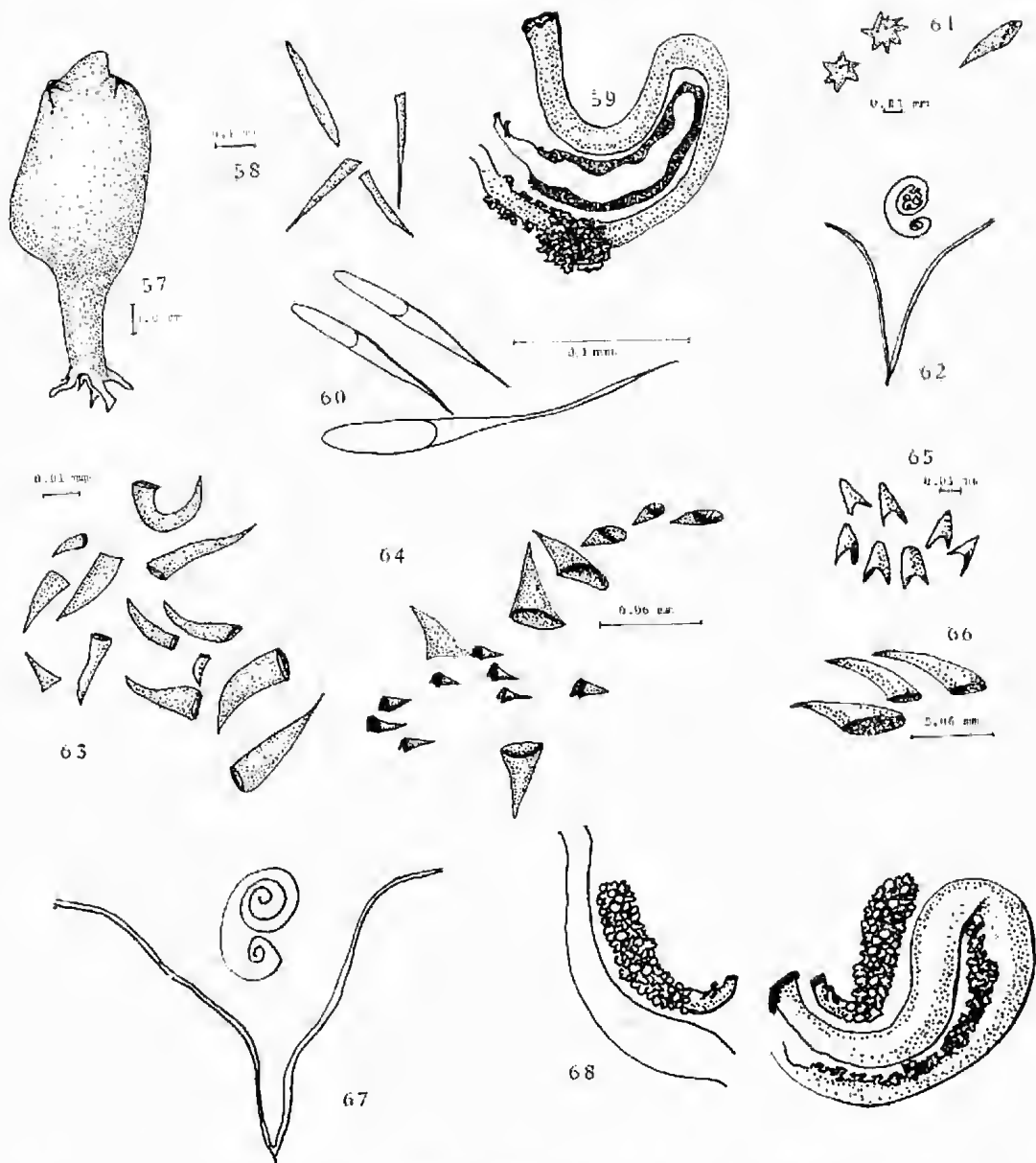
New Records: Upper St. Vincent Gulf, off Hallett Cove, Aldinga. **Previous Records:** W. Aust. (Albany)—Quoy & Gaimard 1834. Vic. (Bass Strait)—Michaelsen 1905; Heller 1878. N.S.W. (Port Jackson, Port Hacking)—Herdman 1891, 1899; Kott 1952.

FIGS. 62, 63

Description: Specimens with head to 8 cm long and 4.5 cm wide. Stalk is of very variable length, maximum 20 cm. Externally the test is smooth without longitudinal furrows, but with characteristic tubercles, varying in their density, and sometimes, especially in larger specimens, absent altogether. The head is often completely enveloped by an investing sponge which in specimens from off Hallett Cove has been noted in the field as yellow.

Minute overlapping scales, 0.05 mm maximum length from posterior part of the base to their apex, line localised areas where thickened lobes of the test project into the siphons. Otherwise, there are no spicules in the test or in the body wall. There are 7 branchial folds on either side of the body wall in the larger specimen but only 6 on each side in average-sized to smaller specimens. There are about 25 branchial tentacles alternating with rudimentary tentacles. The larger tentacles have regular pinnate primary branches with secondary branches and minute tertiary branches and are very bushy. The dorsal tubercle has a double coiled opening, both horns coiled inwards and the inner spirals of each coil are slightly convoluted. There is a short dorsal lamina with pointed languets.

There are up to 30 internal longitudinal vessels on the folds and 2 to 3 between. In larger specimens the under sides of all the major



- Figs. 57-59. *Pyura scoresbiensis*. Fig. 57.—Individual (off Semaphore, 18 m). Fig. 58. Siphonal spines. Fig. 59.—Gut and gonads.
 Fig. 60. *Pyura vittata*. (Tapley Shoal, off Troubridge Light, 17 m). Siphonal spines.
 Fig. 61. *Pyura australis*. (Hallett Cove, 8 m). Spicules embedded in siphonal lining, and siphonal spine.
 Figs. 62, 63. *Pyura spinifera*. (Upper St. Vincent Gulf, 10-11 m). Fig. 62.—Dorsal tubercles. Fig. 63.—Papillae from inner body wall.
 Fig. 64. *Microcosmus nichollsi*. (Off Yankalilla Bay, 20m). Siphonal spines and scales.
 Fig. 65. *Microcosmus squamiger*. (Off Semaphore, 18 m). Siphonal scales.
 Fig. 66. *Microcosmus stolonifera*. (Port Noarlunga, 5-6 m). Siphonal spines.
 Figs. 67, 68. *Ctenicella antipoda*. (Yankalilla Bay, 12-20 m). Fig. 67.—Dorsal tubercle. Fig. 68.—Inner body wall showing gonads and gut loop and heart on left and right respectively.

blood vessels and the transverse vessels (but not the parastigmatic vessels) support minute

pointed languets to form a fur-like covering. These projections also cover the gonads and

the whole inner surface of the body wall extending into the base of the atrial siphon although here they are reduced in density.

The gut forms a narrow curved loop enclosing the left gonad. The right gonad forms a corresponding curve on the right side of the body. The anus is bordered by 12 shallow lobes. There is a mass of orange arborescent liver lobes. In larger specimens there is a blister-like structure on either side of the atrial opening, extending into the curve of the gut loop and into the curve of the gonad on the left and right sides of the body respectively. This also has a fur-like surface formed by dense, small, pointed projections. The inner cavity of this blister-like organ is continuous into the lumen of the atrial siphon and, presumably, if swollen or distended could occlude the lumen of the siphon. There are also two flaps of tissue, anterior and posterior to the atrial opening to form an atrial velum.

Remarks: This distinctive species, in which variation in external appearance involves only the number of tubercles on the test and the length of the stalk has, in St. Vincent Gulf, only been taken from fairly sheltered situations. Other records, however, suggest that the species could occupy greater depths in offshore situations from which it was uprooted only with turbulence occurring during storms. The large head supported on the thin but tough stalk does not appear to favour very rough conditions, although it could be an advantage in locations where there is steady current flow or surge.

Halocynthia hispida (Herdman). Kott, 1968: 77 and synonymy.

Cynthia hispida Herdman 1882: 146.

Halocynthia cactus. Vasseur, 1967: 144.

New Records: Tipara Reef, Tapley Shoal, near Marion Light, off Beach Hut, Port Vincent, upper St. Vincent Gulf, off Outer Harbour, off West Beach, off Glenelg, off Port Stanvac ("The Barges"), Aldinga, Carickalinga Head, off Yankalilla Bay, Rapid Head. *Previous Records:* See Kott, 1968.

Remarks: This species apparently occupies a wide variety of conditions but generally favours sheltered bays or estuaries (see Kott 1968, for description and further discussion of this and related species).

Herdmania momus (Savigny) Michaelsen, 1919: 30 and synonymy.

Cynthia momus Savigny, 1816: 143.

Pyura momus f. *kyamarensis* Michaelsen, 1919: 31.

? *Pyura momus* f. *palana* Michaelsen, 1919: 31.

Pyura momus f. *complanata*. Michaelsen, 1919: 54.

Pyura momus f. *galei* Michaelsen & Hartmeyer, 1927: 194; 1928: 443.

Pyura momus Savigny f. *grandis*. Michaelsen & Hartmeyer, 1928: 441.

Herdmania momus. Van Name, 1945: 341.

Herdmania momus f. *galei*. Kott, 1952: 281, Tokioka, 1961: 132; 1967: 208.

Herdmania momus f. *grandis*. Kott, 1952: 279; 1964: 142; 1966: 301. Millar, 1960: 126; 1963: 740; 1966: 374. Tokioka, 1949: 61; 1952: 137; 1953a: 277; 1967: 206.

? *Herdmania momus* f. *curvata* Kott, 1952: 282; 1964: 143.

New Records: ("grandis" type)—Tipara Reef, off West Beach, off Glenelg, Carickalinga Head, N.W. of Robe. ("galei" type)—Goose L., upper St. Vincent Gulf, Aldinga Reef, West L., Wright I. *Previous Records* ("grandis" type): W. Aust. (Fremantle to Albany)—Michaelsen & Hartmeyer 1928; Millar 1963. Vic. (Port Phillip Bay, Westernport)—Millar 1960, 1963, 1966. N.S.W. (Port Jackson)—Heller 1878; Herdman 1882; von Drasche 1884; Tokioka 1967; Millar 1963. Qld. (Bowen)—Kott 1952. Indonesia (off West Irian)—Herdman 1886; Arafura Sea)—Tokioka 1952. Japan—Tokioka 1949. Pacific (Piji Is.)—Herdman 1882; Palao, Tahiti)—Heller 1878. Indian Ocean (West Indian Ocean)—Michaelsen 1908; Heller 1878. (Red Sea)—Michaelsen 1919; Savigny 1816; (Dar-es-Salaam)—Michaelsen 1905; (Ceylon) Herdman 1906. Africa (Cape of Good Hope, Simons Bay)—Herdman 1882. West Indies (Jamaica)—Heller 1878. ("galei" type)—W. Aust. (Shark Bay, Point Charles, Dirk Hartog I.)—Michaelsen & Hartmeyer 1927, 1928. Tas. N.S.W. (Port Stephens). Qld. (Bowen, Nelson's Bay)—Kott 1952. Pacific (Melanesia)—Tokioka 1961; (Marianas Is.)—Tokioka 1967; (Japan)—Tokioka 1967. (For records of specimens recorded as "pallida" form, see Van Name 1945).

Michaelsen (1919) has considered, in some detail, the distribution of all the forms of this species. Apart from certain forms represented by single records, many of the ranges overlap and no separate geographic ranges can be assigned. The range of the species, represented by the range of the form *pallida*, for which there are most records, is circum-tropical, and extending south to the Cape of

Good Hope. Forms from the south coast of Australia have been described as forma *grandis*. This form is not, however, distinct from *f. pallida* (see below) and it is doubtful whether there is justification for separating any of the specimens assigned to the species. Their morphological variations are most probably indicative of different stages of maturity.

Description: The distribution of the several forms, *H. momus* f. *grandis*, *H. momus* f. *pallida* and *H. momus* f. *galei*, overlaps and in the present collection all forms have been taken from the same location and it is apparent that *H. momus* f. *grandis* with an opaque whitish test, a convoluted dorsal tubercular opening and with testis follicles covering the ovary, represents mature individuals of a species in which the juvenile specimens have a transparent to translucent test with the testes follicles arranged regularly around the periphery of the ovary (f. *galei*). Sometimes in intermediate sized specimens the ovarian tube undulates along its length and the testis follicles may remain close to the ovary (as described for *f. pallida*; Van Name, 1945). In other specimens in this collection (3 km off Glenelg) the testis follicles form an even border around an area in which the ovarian tube is undulating. In the smallest specimens the anal lobes are rudimentary, later develop into even fingerlike flattened lobes, which become less regular and may be absent in larger specimens, but are sometimes present in two clumps at either side of the opening.

Remarks: It is apparent from the present collection that the *galei*, *grandis* and *pallida* forms of this species represent different stages of maturity of a single species. The relationship of the present forms, in which the ovaries undulate with the testes follicles which sometimes cover it, to *H. momus* f. *typica* Savigny (\rightarrow *H. momus* f. *curvata* Kott, 1952; 1964) in which the testes follicles are arranged in an undulating line along the ovary, is problematical. However, it is probable that the undulation of the ovarian tube could have forced the testes follicles into a similarly undulating line.

***Microcosmus nicholli* Kott, 1952: 290.**

New Records: Off Beach Hut, 1 km off Port Vincent, off West Beach, off Hallett Cove, Aldinga, Carickalinga Head, West I., Wright I. *Previous Records:* Vic. (Flinders)—Kott 1952.

Description: Test generally thick, whitish and coriaceous with pinkish colour around siphon but sometimes tough and almost leathery externally with rounded ridges or thin, stiff, rough and embedded with sand, uneven and marked by horny scale-like areas. Externally both apertures are sessile and close together on the upper surface, each surrounded by raised, rounded projections of the test. Posteriorly the test may be produced into root-like processes. There is a network of longitudinal and rectangular muscles.

The siphons are long and the siphonal musculature is especially strong. Outer circular sphincter muscles surround the base of each siphon and the longitudinal muscles extend across the body but are absent from the region over the gut. Pointed conical spines and smaller spines and more numerous scales line the siphons. There are sometimes calcareous spicules embedded in the body wall and in the tentacles and branchial sac. Branchial tentacles have primary, secondary and minute tertiary branches. The dorsal tubercle is U-shaped with horns turned in. The dorsal ganglion is elongate, half the length of the wide, plain-edged dorsal lamina. There is a pronounced branchial velum. On each side of the body wall there are high overlapping branchial folds with up to 20 internal longitudinal vessels on the folds and 1 to 3 between. There are about 10 stigmata per mesh, between the folds, crossed by parastigmatic vessels. The gut forms a simple closed and narrow loop around the ventral border of the body enclosing the terminal lobe of the gonad in its loop. The descending limb is crossed by gonad. There is a stomach enlargement obscured by liver lamellae which are smaller at the pyloric end of the stomach. Minute finger-like projections from the surface of the liver lamellae give it a furry appearance. The anus is bordered by 12 rounded lobes.

On the right, the gonad curves around the ventral border and on the left curves into the loop of the gut just distal to the liver lobes. The gonads are broken into 2 rounded clumps on the right and 3 on the left, often covered by endocarp.

Remarks: The small siphonal scales and the gonad across the gut loop, together with the whitish and more gelatinous test of the smaller specimens, distinguish the species from *M. stolonifera*.

Microcosmus squamiger Michaelsen.

Microcosmus claudicans sub. sp. *squamiger* Michaelsen & Hartmeyer, 1928: 405.

Microcosmus exasperatus sub. sp. *australis* Michaelsen, 1908: 272; 1918: 63 (in part, excluding *M. australis* Herdman, and *M. ramsayi* Herdman).

New Records: Tipara Reef, off Semaphore, off West Beach, off Glenelg. *Previous Records*: W. Aust. (Shark Bay to Albany)—Michaelsen & Hartmeyer 1928. N.S.W. (Sydney)—Michaelsen 1908. Qld. (Bowen, Rockhampton)—Michaelsen 1908, Red Sea—Michaelsen 1918.

FIG. 65

Description: Small, leathery, pinkish specimens, aggregated together. The surface of the test is raised into ridges and mounds. The body wall is very muscular. The dorsal tubercle is large with a double spiral opening. There are the usual 8 branchial folds on each side of the body and the left gonad crosses into the gut loop. The gonad on each side of the body is divided into 3 clumps. There are close-set liver lamellae. Closely set curved scales 0.02 mm long line the branchial siphon.

Remarks: There has been some confusion between *M. exasperatus*, *M. australis*, and the present species, all common around the Australian coast and all demonstrating a fairly wide diversity in external appearance. The reddish colour and aggregated habit, the large number of tough branchial folds, the deeply curved gut loop and the gonad crossing into the gut loop, are characters shared by all three species. *Microcosmus squamiger* is distinguished by flattened scale-like siphonal scales, while both *Microcosmus australis* Herdman and *M. exasperatus* have pointed spines.

Microcosmus stolonifera Kott, 1952: 291.

New Records: Tipara Reef, Port Noarlunga.

Previous Record: Tas. (Tiny Is., east coast)—Kott 1952.

FIG. 66

Description: Only two specimens are available. They are very irregular externally, and posteriorly are produced into root-like processes. The apertures are on siphons of variable length, turned away from one another and, in the largest specimen available (2 cm greatest dimension) the siphons are especially long. The test is very tough, hard and leathery. There are large (about 0.1 mm) pointed spines, arranged in fairly regular horizontal rows, lining the siphons. The branchial tentacles are bushy. The branchial sac has 7 high and deli-

cate overlapping folds, with a single internal longitudinal vessel in the interspace. The gut forms a narrow curved loop with the usual elongate liver lamellae with short finger-like papillae from its surface. The gonads form a single rounded mass in the curve of the gut loop on the left but do not extend into the primary gut loop. On the right there may be a corresponding single rounded mass or the right gonad is sometimes divided into two rounded lobes joined by the central ducts.

Remarks: The test of this species is harder and less regular than all other species of this genus. It is further distinguished by the long siphonal spines, the large rounded gonad that does not develop inside the gut loop, and the high delicate overlapping folds of the branchial sac.

It does not appear to be a very common species and the only two records are from the southern coast of Australia. However, the tough and roughened test, forming a very strong attachment, causes the species to be inconspicuous and difficult to collect.

Microcosmus helleri Herdman, 1880: 54; 1882: 131. Sluiter, 1895: 184. Hartmeyer, 1919: 19. Michaelsen & Hartmeyer, 1928: 397. Kott, 1952: 292; 1972: 12. Millar, 1963: 742.

Microcosmus goanus Michaelsen, 1918: 12.

New Records: Tapley Shoal, off Beach Hut (1 km off Port Vincent). *Previous Records*: W. Aust. (Cape Jaubert to Fremantle)—Hartmeyer 1919; Michaelsen & Hartmeyer 1928; Kott 1952; Millar 1963. Qld. (Great Barrier Reef)—Kott 1952; (Torres Strait)—Herdman 1882. Malaysia—Sluiter 1895. Portuguese East Africa (Delagoa Bay)—Michaelsen 1918.

Description: The single spherical specimen from Tapley Shoal is 6 cm in diameter. This large diameter is contributed to by a 1 cm thick coating of sand held together by terminally branching and coalescing projections from the test to form a thick dense layer enclosing a space around the body. This coating is interrupted to form a single opening above the apertures. The specimen from off Beach Hut is more typically rough externally and is a purple colour. The apertures are sessile, one-third of the body circumference apart. At the base of the branchial siphon there are 3 flap-like projections.

The body musculature is of the usual pyurid type with muscle bands from each of the siphons crossing one another on both sides of

the body. There are very strong circular muscles circling each siphon.

Branchial tentacles have primary and secondary branches and wide, flat, membranous extensions from their anterior or concave border. The dorsal lamina is plain. There are 6 high, overlapping folds on each side of the body with up to 18 internal longitudinal vessels on the folds and 3 between. The gut forms the usual long, narrow attenuated loop, typical of the species, and the proximal lobe of the 3 lobed left gonad is accommodated in the open pole of the otherwise closed gut loop.

Remarks: The tough flap-like projections in the branchial siphon sometimes appear as cones. These structures, together with the gut loop and branchial sac, distinguish the species.

The sandy coating has not been described previously for this species, but has been described for *Pyura cancellata* Brewin from New Zealand (see Kott 1971) and for *Pyura tunica* Kott, 1969 from the Antarctic. This condition demonstrates the versatility of the ascidian test which in this specimen responds to the substrate by growing out to entangle sand grains as there is no firm substrate onto which it can directly be fixed.

***Ctenicella antipoda* n.sp.**

Type Locality: Off Yankalilla Bay, at 12 to 20 m (2 specimens); in *Amphibolis* community with limestone outcropping occasionally. *Holotype:* South Australian Museum (reg. no. E877). *Further Record:* Tipara Reef.

FIGS. 67, 68

Description: Specimens are up to 10 cm long, slightly dorso-ventrally flattened. Externally they are very irregular and covered with nodules which also protect the sessile apertures on the dorsal or upper surface. The test is up to 1.5 cm thick, gelatinous but entirely impregnated with sand so that it is hard and rigid. It is sometimes produced into a ridge surrounding the siphons. There are hard brown papillae around the sessile apertures but there are no spines lining the siphons.

The body musculature is strong on the upper half of the body with longitudinal bands radiating from the siphons and inner circular bands around the siphons and at their base. However, on the lower half of the body the musculature is almost entirely absent and is represented by two vertical rows of very short parallel bands.

There are 15 large compound branchial tentacles with primary, secondary, and minute tertiary branches alternating with rudimentary tentacles. The dorsal tubercle is at the base of the tentacles anterior to the V of the peritubercular area. The opening is a double spiral slit turned to the left. The dorsal lamina is very short and has close-set slender, pointed languets.

The branchial sac has 6 high, overlapping folds on each side of the body, widely spread at their base. Longitudinal vessels are arranged as follows:

DL 3(26)3(33)5(28)4(26)3(24)2(15)3 E

There are about 12 stigmata in each mesh. They are rectangular, and crossed by parastigmatic vessels. The meshes are wider than long and there is no sign of irregularity in the stigmata which do not coil nor form infundibula.

The gut forms a narrow, closed and deeply curved loop with branched liver lobules extending along the inside of the gut loop for its whole length. The liver is spongy with short rounded finger-like papillae projecting from its surface, and supporting tissue between the liver lobules.

The intestine is filled with mud. The anal border has about 30 or more rounded lobes. On the right side of the body there is a long curved hypertrophical heart in the position occupied by the kidney in *Molgulidae*. There is a single gonad on each side of the body parallel to and lying against the long conspicuous heart on the right, and on the left extending parallel to the descending line of the primary gut loop. The left gonad descends into the secondary gut loop where its short ducts turn dorsally toward the atrial aperture. The ovary is central and tubular, while the especially small pyriform testis lobes extend into folds in its wall, giving the appearance of being embedded in the ovary. In one of the specimens from Tipara reef the gonads are immature and groups of very minute testis lobes are arranged around the upper and outer surface of both sides of the ovary. Vasa efferentia from each group of follicles join together to open into the vas deferens along the median surface of the ovary.

Remarks: *Ctenicella* Lacaze Duthiers (*Type Species: Ctenicella appendiculata* (Heller), from the Mediterranean), has few known species, although a number of *Molgula* spp.

have been erroneously ascribed to it. The genus is characterised by the presence of dorsal languets, straight stigmata, a kidney on the right, and the left gonad outside the primary gut loop. In addition to the type species which is distinguished by its long recurved siphons, *Ctenicella undulata* Tokioka, 1949, from Japan, has a posterior stalk and a folded stomach.

Hartmeyeria Ritter was also thought to be intermediate between Pyuridae and Molgulidae, with pyurid branchial sac, siphonal spines, a smooth dorsal lamina and the left gonad partly in the gut loop (as in certain species of *Microcosmus*). Monniot (1969) has shown, however, that what was thought to be a kidney, is in fact an hypertrophied heart and that *Hartmeyeria* is without doubt a pyurid genus related to *Microcosmus* and with a liver similar to that of *Halocynthia* with longitudinal plications proximally and branched tubules distally. *Hartmeyeria* differs from the present species in its smooth dorsal lamina and siphonal spines, and in the position of its left gonad which crosses into the gut loop. It is probable that

the kidney, which has been described for *Ctenicella undulata* and *C. appendiculata* is, in fact, an hypertrophical heart, as described for *Hartmeyeria* and as demonstrated for the present species.

The identity of *Ctenicella undulata* Tokioka is puzzling as it has dorsal languets and the gonads on the left and right respectively in the usual position for the genus, outside the gut loop and adjacent to what has been described as an excretory organ. However, the stomach appears to have proximal glandular folds and distal arborescent lobes as described for *Hartmeyeria* and *Halocynthia* and it has a *Hartmeyeria* type of stalk. Therefore, both *Ctenicella* and *Hartmeyeria* appear to be genera of the Pyuridae, distinguished from *Pyura*, *Halocynthia* and *Microcosmus* by an hypertrophied heart. They appear to be distinguished from one another only by the absence of siphonal spines, the presence of dorsal languets and by the position of the gonad outside the primary gut loop in *Ctenicella* spp. The relationships of these pyurid genera are shown in the following Table.

TABLE 1
Comparison of Characteristics of the Genera of the Family Pyuridae.

	<i>Pyura</i>	<i>Halocynthia</i>	<i>Ctenicella</i>	<i>Hartmeyeria</i>	<i>Microcosmus</i>
Siphonal spines	present	present	none	present	present
Dorsal lamina	languets	languets	languets	smooth	smooth
Liver tissue	arborescent lobes	long folds and arborescent lobes	arborescent lobes (1 species with long folds and arborescent lobes)	long folds and arborescent lobes	arborescent lobes
Gonads	in primary gut loop	cross gut loop	outside gut loop	cross gut loop	cross gut loop

Family MOLGULIDAE

Molgula mollis Herdman, 1899: 54. Kott, 1952: 298; 1964: 144.

Molgula sydneyensis Herdman, 1899: 55.

Molgula janis Kott, 1952: 295. Millar, 1966: 374.

New Record: Carickalinga Head. *Previous Records*: N.S.W. (Port Jackson, Sydney)—Herdman 1899; (Twofold Bay)—Kott 1952. Qld. (Gladstone to Moreton Bay)—Kott 1964.

Description: Small, rounded, laterally flattened specimen of 0.6 cm diameter. The apertures are present anteriorly in a depressed, sand-free area of test, surrounded by sandy protuberances and hairs from the thin test.

The dorsal tubercle is oval with a longitudinal, more or less S-shaped slit. The neural gland is conspicuous beneath the tubercle.

The branchial sac has 7 folds on each side of the body with only 2 internal longitudinal vessels along the top of each fold. Stigmata coil to form infundibula projecting into the folds and subdividing into two in the summit of the fold. Between the folds there are some interstitial stigmatal coils but no primary infundibula. The spirals of the primary coils are interrupted in their median longitudinal and transverse planes and their arrangement, especially at the base of the spiral between the folds, is obscured.

The gonads are flask-shaped and the testis follicles form a circle around the proximal end of the ovary, with a connective from the centre of this circle as previously described (Millar 1966).

Remarks: The species is characterised by the

small number of longitudinal vessels on one side of the branchial folds. There is some variation in the development of the hollow extensions of the test which Kott (1952) had thought distinguished *M. janis*. It is clear, however, that the species is synonymous with *M. mollis*.

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Appendix I—Station List

A. ROUGH COAST SUBFORMATION

WEST ISLAND: on granite usually on vertical faces or in caves.

- Region A: rough (Shepherd & Womersley 1970); depth indicated for each species.
 - Podoclavella cylindrica* 25 m
 - Leptoclinides rufus* 16 m
 - Botrylloides magnicoecus* 22-25 m
 - Botrylloides leachi* 16-25 m
 - Botrylloides nigrum* 12-20 m
 - Oculinaria australis* 12-25 m
 - Cnemidocarpa etheridgii* 25 m
 - Polycarpa pedunculata* 16-25 m
 - Pvura australis* 12-20 m
 - Microcœmus nichollsi* 22 m
 - Herdmania momus* 16-22 m
- Region B: moderately rough (Shepherd & Womersley 1970); depth 15 m.
 - Sycozoa cerebriformis*
 - Polycitor giganteum*
 - Botrylloides leachi*
- Region D: sheltered (Shepherd & Womersley 1970); depth 2-5 m; 27.xi.66.
 - Podoclavella cylindrica*
 - Cystodytes dellechiaiei*
 - Synocium papilliferum*
 - Didemnum candidum*
 - Didemnum moseleyi*
 - Trididemnum spicatum*
 - Didemnum sp.*
 - Leptoclinides rufus*
 - Botrylloides nigrum*

WRIGHT ISLAND: rough coast, strong surge; on vertical granite faces; depth 10 m; 28.xi.66.
Podoclavella cylindrica

Sycozoa cerebriformis
Atapozoa fantasiana
Polycitor giganteum
Eudistoma renieri
Didemnum candidum
Leptoclinides rufus
Phallusia depressiuscula
Ascidia sydneyensis
Botrylloides leachi
Botrylloides nigrum
Oculinaria australis
Cnemidocarpa etheridgei
Polycarpa pedunculata
Microcosmus nichollsi
Herdmania momus

KING BEACH, Encounter Bay: under boulder on intertidal reef.

Corella eumyota

NORA CREINA BAY, near Robe: on roof of cave; strong surge; depth 10 m; 11.i.67.

Eudistoma sp.

Pseudodistoma cercum

24 KM NORTH-WEST OF ROBE, South Australia: on acolianite; slight surge; attached to red algae; depth 40 m.; 20.xi.68.

Pyura australis

Herdmania momus

B. SHELTERED COAST SUBFORMATION

OFF HALLETT COVE, on reef: rocky bottom; depth 8 m; 26.xii.66.

Podoclavella cylindrica
Distaplia viridis
Sycozoa cerebriformis
Polycitor giganteum
Aplidium pliciferum
Leptoclinides rufus
Echinoclinium verrilli
Rhodosoma turcicum
Corella eumyota
Phallusia depressiuscula
Ascidia thompsoni
Ascidia sydneyensis
Polycarpa pedunculata
Microcosmus nichollsi

INSIDE PORT NOARLUNGA REEF: moderate surge; in caves or on vertical faces; depth 2-5 m; 20.xi.66.

Podoclavella cylindrica
Distaplia viridis
Ritterella herdmania
Synoicium papilliferum
Leptoclinides rufus (sometimes investing *Pyura irregularis* and *Microcosmus stolonifera*)
Ascidia sydneyensis
Botrylloides leachi
Stolonica australis
Polycarpa pedunculata
Pyura irregularis
Microcosmus stolonifera

ALDINGA REEF AT "DROP-OFF": rocky bottom; slight surge; depth 10-25 m; 12.xii.66.

Podoclavella cylindrica
Polycitor giganteum
Didemnum lambitum
Didemnum patulum
Polycarpa papillata
Polycarpa pedunculata
Pyura irregularis

Pyura spinifera
Halocynthia hispida
Herdmania momus
Microcosmus nichollsi

CARICKALINGA HEAD: in caves and on vertical rock faces; moderate surge; depth 5-6 m; 18.ii.67.

Clavelina baudinensis
Distaplia viridis
Sycozoa cerebriformis
Didemnum moseleyi
Ascidia thompsoni
Botrylloides nigrum
Polycarpa pedunculata
Pyura irregularis
Herdmania momus
Halocynthia hispida
Microcosmus nichollsi
Molgula mollis

RAPID HEAD: on vertical faces and under ledges; slight to moderate surge; depth 10 m; 25.iv.66.

Clavelina baudinensis
Polysyneton orbiculum
Leptoclinides rufus
Botrylloides nigrum
Polycarpa pedunculata
Halocynthia hispida

OFFSHORE BENTHIC LOCATIONS

GOOSE I., Spencer Gulf: on rocky bottom; depth 3-5 m; 1.x.66.

Didemnum moseleyi
Herdmania momus

TIPARA REEF, Spencer Gulf:

1. on travertine vertical faces and under ledges; depth 6 m; 24.v.69.

Podoclavella moluccensis
Stolonica australis (aggregates)
Polycarpa pedunculata
Pyura irregularis
Herdmania momus
Microcosmus squamiger

2. on surface of rocks; slow current; depth 6m; 24.v.69.

Leptoclinides reticulatus
Phallusia depressiuscula
Ascidia sydneyensis
Stolonica carnosa
Polycarpa papillata
Polycarpa pedunculata
Pyura australis
Pyura irregularis
Halocynthia hispida
Microcosmus stolonifera
Microcosmus squamiger
Ctenicella antipoda

3. epizoic on *Amphibolis antarctica*; moderate current. 2 m/sec.; depth 12 m; 19.v.71.

Botrylloides leachi
Pyura australis
Herdmania momus

OFF BEACH HUT, 1 km off Port Vincent: on travertine; no wave action; slight current; depth 4 m; 24.ii.69.

Ascidia sydneyensis
Pyura irregularis
Halocynthia hispida
Microcosmus nichollsi
Microcosmus helleri

ORONTES BANK, off Port Vincent: 20 m; 26.iii.66.
Sycosoa cerebriiformis

TAPLEY SHOAL, St. Vincent Gulf: depth indicated for each species; Feb. 1969.

1. Sluggish current, sandy bottom.
Phallusia depressiuscula 16 m
Ascidia sydneyensis 12 m
Polycarpa pedunculata 16 m
Cnemidocarpa etheridgei 12 m
Pyura scoresbiensis 16 m
Halocynthia hispida 12 m, 16 m
Microcosmus helleri 12 m
2. Moderate current (to 1m/sec); travertine bottom covered by shallow sand; depth indicated for each species.
Aplidium colelloides 18 m
Polycarpa clavata 20 m
Polycarpa pedunculata 18 m, 20m, 22 m
Pyura australis 20 m
Halocynthia hispida
Pyura scoresbiensis 22 m
3. Mostly sand with some travertine outcrops; depth 23 m.
Sycosoa cerebriiformis (on rock)
Aplidium colelloides
Polycarpa clavata
Pyura vittata
4. Strong current (to 2m/sec); sheet travertine; depth 24 m.
Polycitor giganteum
Aplidium pliciferum
Polycarpa pedunculata
Pyura australis

UPPER ST. VINCENT GULF: on sandy bottom in *Posidonia australis* community; moderate current (to 1 m/sec.); depth 10-11 m; 4.i.67.

Leptoclinides kingi
Pyura spinifera
Pyura irregularis
Halocynthia hispida
and growing on razor shell *Pinna dolabrata*:
Sycosoa cerebriiformis
Aplidium rubricollum
Ascidia gemmata
Polycarpa pedunculata
Herdmania momus

OFF PORT GAWLER, St. Vincent Gulf: growing on *Pinna* and on *Cellepora* spp; slow current; depth 18-20 m; 11.ii.67.

Sycosoa cerebriiformis
Leptoclinides rufus
Phallusia depressiuscula
Ascidia gemmata
Botrylloides nigrum
Polycarpa papillata
Polycarpa pedunculata

OFF OUTER HARBOUR, St. Vincent Gulf: on *Pinna*; slow current; depth 8 m; 2.xii.68.

Halocynthia hispida

OFF SEMAPHORE, St. Vincent Gulf: in sparse *Posidonia* community, silty bottom; slow current; depth 31 m; 27.i.69.

Polycarpa pedunculata
Pyura scoresbiensis
Microcosmus squamiger

OFF SEMAPHORE, St. Vincent Gulf: silty bottom; slow current; depth 24 m; 28.xii.68.

Polycarpa pedunculata

OFF GRANGE, St. Vincent Gulf: rocky bottom; slow current; depth 18 m; 7.xii.68.

Phallusia depressiuscula
Polycarpa pedunculata

OFF GRANGE, St. Vincent Gulf: in *Posidonia* community on shell; depth 6 m; 7.xii.68.

Pyura irregularis

OFF WEST BEACH (about 3 km), St. Vincent Gulf: on rocky bottom; depth 10 m; 8.vi.68.

Ascidia thompsoni
Botrylloides magnicoecus
Polycarpa pedunculata
Cnemidocarpa etheridgei
Halocynthia hispida
Pyura australis
Pyura irregularis (aggregates)
Microcosmus squamiger
Microcosmus nichollsi

OFF WEST BEACH (about 7 km), St. Vincent Gulf: in *Posidonia* community, slow current; depth 12-20 m, 27.xii.66.

Eudistoma pyriforme
Phallusia depressiuscula
Botrylloides nigrum
Polycarpa pedunculata
Pyura australis
Herdmania momus
Halocynthia hispida

OFF WEST BEACH (about 9 km), St. Vincent Gulf: on silty bottom; slow current; depth 20-25 m; 27.xii.66.

Phallusia depressiuscula

OFF BROADWAY OR GLENELG (several stations), St. Vincent Gulf: on sandy bottom; slow current; depths indicated for each species; 10.xi.68.

Sycosoa tenuicaulis (on scallop shell; 22 m)
Polycarpa pedunculata 6, 16 m
Pyura australis 12 m
Halocynthia hispida 6 m

OFF GLENELG (5 km), St. Vincent Gulf: rocky bottom; slow current; depth 13 m; 13.v.67.

Ascidia gemmata
Polycarpa papillata
Polycarpa pedunculata
Herdmania momus

OFF GLENELG (1.5 km), St. Vincent Gulf: on *Posidonia* roots; depth 6 m; 30.v.70.

Polycarpa pedunculata
Pyura irregularis
Halocynthia hispida
Microcosmus squamiger

OFF GLENELG (18 km), St. Vincent Gulf: depth 35 m; 4.ix.69.

Herdmania momus

OFF SEACLIFF, St. Vincent Gulf: in *Posidonia* community, on sandy bottom, fair sediment, slow current; depth 16 m; 21.i.69.

Ascidia aelara

OFF SEACLIFF, St. Vincent Gulf: on *Amphibolis antarctica*; slow current; depth 9 m; 28.ix.68.

Botrylloides nigrum—with sponge

OFF HALLETI COVE (3–5 km), St. Vincent Gulf: on silty bottom; slow current; depth 15–22 m; 27.xii.66.

Phallusia depressiuscula

Botryllus schlosseri
Polycarpa pedunculata
Pyura australis
Pyura spinifera

OFF PORT STANVAC (6.4 km), St. Vincent Gulf: on steel wreckage ("The Barges"); slow current; depth 30 m; 26.iii.66.

Phallusia depressiuscula
Halocynthia hispida

OFF YANKALILLA BAY, St. Vincent Gulf: in *Amphibolis* community, sandy bottom; slight surge; depth as indicated: 18.ii.67.

Pyura australis 20 m
Halocynthia hispida 20 m
Ctenicella antipoda 15 m

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