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**The Marine Fauna of New Zealand :
Spirorbinae
(Polychaeta : Serpulidae)**

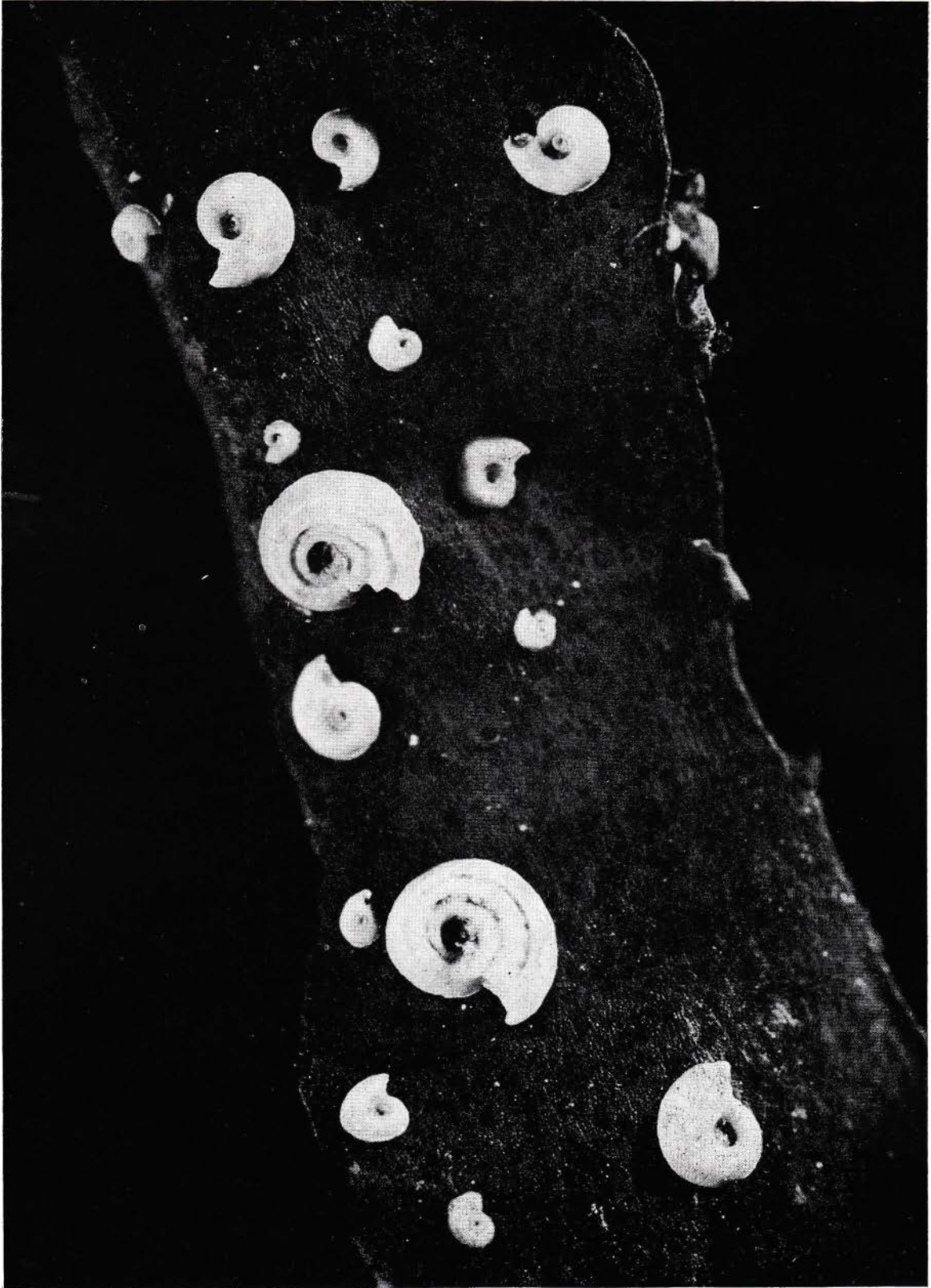
by
PETER J. VINE



New Zealand Oceanographic Institute Memoir No. 68

1977

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Frontispiece Spirorbinae on a piece of alga washed up on the New Zealand seashore.

NEW ZEALAND
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

**The Marine Fauna of New Zealand:
Spirorbinae
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by
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The Marine Fauna of New Zealand : Spirorbinae (Polychaeta : Serpulidae)

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ABSTRACT

Twenty-four species in eight genera are described from the New Zealand region. Nine species are new; *Metalaeospira armiger*, *M. clansmani*, *Paralaeospira parallela*, *Protolaeospira augeneri*, *P. gracei*, *Romanchella solea*, *Pileolaria (Pileolaria) tegwyni*, *Pileolaria (Simplicaria) ovata*, and *Pileolaria (Duplicaria) pocillator*. A single specimen, not assignable to genus, is described as Sp. A. Of the recorded species, *Pileolaria (Duplicaria) koehleri*, *P. (Simplicaria) pseudomilitaris*, *Janua (Dexiospira) steueri*, *J. (D.) pseudocorrugata*, and *J. (Janua) pagenstecheri* are also known from tropical and warm temperate seas, whereas *Romanchella perrieri*, *Paralaeospira levinseni*, *P. monacanthus*, *Protolaeospira capensis*, and *P. lebrunii* are previously recorded from antarctic and cold southern ocean waters. *Protolaeospira ambilateralis*, *P. translucens*, and *Spirorbis bidentatus* have previously been found in more northerly regions of the Pacific. *Amplaria spiculosa* is an aberrant species with parapodial rudiments equivalent to four and a half thoracic segments. Before collection of two specimens at the Poor Knights Islands it was known only from the holotype collected in South Australia.

Ecology and distribution of the species are discussed and the importance of sea surface temperatures is emphasised. New Zealand straddles the critical temperature range where a transition occurs between mainly opercular-brooding species (abundant in warm seas) and mainly tube-incubating species (favoured in colder seas).

Introduction

Tube-worms of the subfamily Spirorbinae are well represented on New Zealand seashores, and also sub-littorally. There have been few previous records of them, however, from New Zealand. Marine ecology papers dealing with New Zealand have referred to "*Spirorbis* sp." and have not attempted to identify or describe the different species. Recently, the detailed study "The New Zealand Sea Shores" by Morton & Miller (1968) refers to *Spirorbis australis*, a species which I have been unable to trace in the literature. *Spirorbis zelandica* Gray, 1843 was recorded on shells of *Patella* sp. from Great Barrier Island, but the original description and absence of satisfactory material make this an inadequately documented species. Several species have been recorded from subantarctic islands south of New Zealand, and prior to this study some of these isolated islands had been better studied with respect to Spirorbinae than had the main islands of New Zealand.

Two visits to New Zealand, each of four weeks duration, were made in February 1969 and February 1970, using the Marine Laboratory facilities at Goat Island Bay, Leigh, as a base. A 4-day expedition to the Poor Knights Islands was made in 1969, and the trimaran yacht *Clansman*, owned and skippered by Mr Gerry

Hunter, was used for ferrying four SCUBA divers and equipment to the islands.

In 1970 a second visit was made to the Poor Knights Islands when collections of substrata were made at various depths down a transect line, and a short visit was made to South Island. Spirorbinae were thus collected from littoral and sub-littoral zones at the Poor Knights Islands, in the vicinity of Goat Island Bay and in Whangateau Harbour on North Island; and at Kaikoura and Christchurch on South Island. Most collections were made using SCUBA or snorkelling. Spirorbinae were carefully scraped off their substrata using a sharp scalpel, and were preserved in 5% seawater formalin.

A brief visit to the N.Z. Oceanographic Institute in Wellington enabled me to take samples of Spirorbinae from several preserved collections made in deep water off New Zealand and at several localities south of New Zealand. Five species from these collections are included in this memoir although they may not normally occur on the main islands of New Zealand.

Live material was examined under a binocular microscope and descriptions of tubes, opercula, numbers of branchiae, and lengths of terminal filaments were made

from live animals. Where possible, observations were also made on methods of incubation and embryo retention (Knight-Jones, Knight-Jones & Vine 1972).

Body colours of live specimens were compared with colour charts in the Methuen Colour Book (Kornerup & Wanscher 1967) and references in parentheses refer to their colour plates. Descriptions were completed by

studying preserved specimens between one and 18 months after collections were made. Details of setation were studied on specimens mounted in polyvinyl lactophenol and viewed under phase-contrast with quartz-iodide illumination. Drawings were made using squared eyepiece graticules and squared paper.

Systematics

The problem of genera in Spirorbinae

The present memoir deals with 24 species, 10 of which were previously undescribed. Taxonomy of the subfamily has been revised recently by several authors (Gee 1964; Bailey 1969b; Pillai 1970; Knight-Jones 1972). Most workers agree that different genera may be recognised within the subfamily and the system adopted here follows that of Knight-Jones (1972) which generally represents a compromise between the views of Pillai and Bailey. A summary of the genera now recognised by the present author is given in Table 1. The genus *Spirorbis* Daudin, 1800 includes only a small proportion of the species which have usually been referred to under that generic name, and only one species described below belongs to this genus.

Ecologists wishing to identify New Zealand Spirorbinae are recommended to use the following generic key and then to refer to the descriptions of species within the relevant genus.

Key to genera recorded from New Zealand

1	Tube coils sinistrally (mouth faces clockwise)	..	..	2
	Tube coils dextrally (mouth faces anticlockwise)	..	..	<i>Janua</i> (p. 50)
2	Embryos incubated in tube	..	..	3
	Embryos incubated in operculum	..	..	7
3	2 thoracic tori on concave side	..	..	4
	3 thoracic tori on concave side	..	..	5
4	Collar setae of fin and blade type	..	..	<i>Spirorbis</i> (p. 9)
	Collar setae simple blades	..	..	<i>Romanche!la</i> (p. 34)
5	Collar setae of fin and blade type	..	..	6
	Collar setae simple blades	..	..	<i>Metalaeospira</i> (p. 11)
6	Embryos incubated in a pouch attached to worm by a stalk arising from dorsal side of thorax	..	..	<i>Protolaeospira</i> (p. 23)
	Embryos incubated in string possibly adhering to worm, but not attached by stalk	..	..	<i>Paralaeospira</i> (p. 17)
7	2 thoracic tori on concave side	..	..	<i>Pileolaria</i> (p. 39)
	4 thoracic tori on concave side	..	..	<i>Amplaria</i> (p. 50)

Table 1 Genera recognised within the subfamily Spirorbinae

	Approximate Number of species
<i>Spirorbis</i> Daudin, 1800 [= <i>Laeospira</i> Caullery & Mesnil, 1897]: includes subgenus <i>Spirorbella</i> Chamberlain, 1919. Type-species: <i>Spirorbis</i> (<i>Spirorbis</i>) <i>spirorbis</i> (L., 1758) [= <i>Spirorbis borealis</i> Daudin, 1800]	12
<i>Circeis</i> ¹ , ² Saint-Joseph, 1894. Type-species: <i>Circeis armoricana</i> Saint-Joseph, 1894	2
<i>Paradexiospira</i> ¹ , ² Caullery & Mesnil, 1897: (includes <i>Spirorbides</i> Chamberlain, 1919). Type-species: <i>Paradexiospira vitrea</i> (Fabricius, 1780)	3
<i>Metalaeospira</i> Pillai, 1970. Type-species: <i>Metalaeospira pixelli</i> (Harris, 1969) [new name and designation for <i>Spirorbis antarcticus</i> Pixell, 1913]	4
<i>Eulaeospira</i> Pillai, 1970. Type-species: <i>Eulaeospira orientalis</i> (Pillai, 1960)	2
<i>Paralaeospira</i> Caullery & Mesnil, 1897. Type-species: <i>Paralaeospira aggregata</i> (Caullery & Mesnil, 1897)	7
<i>Anomalorbis</i> Vine, 1972a. Type-species: <i>Anomalorbis manuatus</i> Vine, 1972a.	1
<i>Protolaeospira</i> Pixell, 1912 [= <i>Marsipospira</i> Bailey, 1969b; <i>Pixellia</i> Pillai, 1970]; includes subgenus <i>Dextralia</i> Knight-Jones, 1973. Type-species: <i>Protolaeospira ambilateralis</i> (Pixell, 1912)	13
<i>Romanchella</i> Caullery & Mesnil, 1897. Type-species: <i>Romanchella perrieri</i> (Caullery & Mesnil, 1897)	5
<i>Helicosiphon</i> ³ Gravier, 1907. Type-species: <i>Helicosiphon biscoensis</i> Gravier, 1907	1
<i>Pileolaria</i> Claparède, 1868; includes subgenera <i>Simplicaria</i> Knight-Jones, 1973 and <i>Duplicaria</i> Vine, 1972a. Type-species: <i>Pileolaria militaris</i> Claparède, 1868	26
<i>Amplaria</i> Knight-Jones, 1973. Type-species: <i>Amplaria spiculosa</i> Knight-Jones, 1973	1
<i>Janua</i> Saint-Joseph, 1894; includes subgenera <i>Dexiospira</i> Caullery & Mesnil, 1897 [= <i>Neodexiospira</i> Pillai, 1970], <i>Leodora</i> Saint-Joseph, 1894, <i>Fauveldora</i> Knight-Jones, 1972, and <i>Pillaiospora</i> Knight-Jones, 1973. Type-species: <i>Janua</i> (<i>Janua</i>) <i>pagenstecheri</i> (Quatrefages, 1865)	20
Incertae sedis	19
Total number of species	116

¹See Pillai (1970)

²See Bailey (1969b)

³See Knight-Jones, Knight-Jones & Bregazzi (1973)

Genus *Spirorbis* Daudin, 1800 (emended)

Coiling usually sinistral; thorax with 2 pairs of tori; collar folds unfused; collar setae with basal fin and distal blade, which may be cross-striated; sickle setae present in 3rd fascicles, thoracic uncini with several longitudinal rows of teeth and broad anterior pegs; arrangement of abdominal tori without any marked bilateral asymmetry; abdominal setae smaller than collar setae; embryos incubated in egg-string attached posteriorly to tube; larvae with single attachment gland.

TYPE-SPECIES: *Spirorbis (Spirorbis) spirorbis* (Linnaeus) [= *Spirorbis borealis* Daudin.]

Subgenus *Spirorbis* Daudin, 1800

As above but always coiled sinistrally thus differing from subgenus *Spirorbella* Chamberlain, 1919.

TYPE-SPECIES: *Spirorbis (Spirorbis) spirorbis* (Linnaeus) [= *Spirorbis borealis* Daudin.]

Spirorbis (Spirorbis) bidentatus Bailey in Bailey & Harris, 1968

Figures 1, 2a, 6b

Spirorbis bidentatus Bailey in Bailey & Harris, 1968

MATERIAL EXAMINED: 3 specimens, 2 mounted in polyvinyl lactophenol, and 4 empty tubes.

LOCATION: Landing Bay, Poor Knights Is.

HABITAT: On stones at 50 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, with 3 well-defined longitudinal ridges prolonged into teeth above aperture. Somewhat oblique sides form rather wide base of attachment (Fig. 1a). 2 whorls; coil diameter about 1.0 mm.

Operculum with slightly convex plate, brown, appears chitinous. Talon massive, with median longitudinally thickened ridge on dorsal side (Figs 1c, d, e).

Thorax. 5 radioles only, unusual in having few long pinnules. Collar folds not fused dorsally. 2 tori and 3 fascicles on each side. Collar setae with broad proximal fan and distal blade with small teeth and no cross-striations. Virtually no gap between teeth in fan and those at base of blade (Fig. 1f). Smooth capillary setae associated with collar setae (Fig. 1g). 2nd and 3rd fascicles bear simple setae (Fig. 1h), also sickle setae (Fig. 1i) in 3rd fascicles. Distal section of latter about 4 times as long as short proximal portion. Uncini (Fig. 1k) with broad

anterior peg and about 4 longitudinal rows of teeth arranged in transverse rows.

Asetigerous region about 4 times as long as distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 9 segments. Distribution of setae and uncini on each side not markedly asymmetrical. Setae (Fig. 1j) geniculate with rather broad rounded teeth, each seta associated with a capillary seta (Fig. 1j).

Uncini (Fig. 1m) have about 9 longitudinal rows of teeth arranged in transverse rows, like those of thoracic uncini.

Incubation. Only one specimen found to contain an egg-string. Appeared to be attached to tube rather than to animal. The approximately symmetrical arrangement of uncini in abdominal tori (Fig. 2) like that in other species in genus *Spirorbis* sensu stricto (which incubate embryos in strings attached posteriorly to tube).

Body colours of live specimen. Radioles, collar, and thorax, colourless; abdomen tinged orange (Pl. 5, A6*).

REMARKS: Since Daudin established the genus *Spirorbis* with *S. borealis* as the type-species, many species have been described which have several features in common with *S. borealis*. Some authors have preferred to retain a single genus while others have created new genera and elevated the group to a subfamily within the Serpulidae. Caullery & Mesnil (1897) created the subgenus *Laeospira* with the same type-species (i.e., *S. borealis*) that Daudin designated as the type for the genus *Spirorbis*, but Chamberlain (1919) pointed out that *Spirorbis* takes precedence over *Laeospira*. Recently Pillai (1970) reviewed the taxonomy of Spirorbinae and elevated the subgenus *Laeospira* to a generic rank, arguing against a strict application of the rules of precedence. Following the rules, however, requires that the genus *Spirorbis* sensu stricto should still be recognised by that name, and that the type should retain its old name *Spirorbis spirorbis* (Linnaeus).

The genus *Spirorbis* sensu stricto includes approximately 20 species, only five of which have tubes with longitudinal ridges. These are *S. bidentatus* Bailey in Bailey & Harris, 1968, *S. cuneatus* Gee, 1964, *S. flabellus* Harris, 1969, *S. indicus* Sterzinger, 1909 (sensu Harris 1969), and *S. tridentatus* Levinsen, 1883. Although tube patterning is not of great significance taxonomically, the characteristically sharp longitudinal ridges of the species described here serve to separate it from the majority of *Spirorbis* species.

The form of the operculum and details of setation suggest close affinities between *S. bidentatus*, *S. cuneatus*, and *S. indicus* (sensu Harris). An unusual character linking *S. cuneatus* with the form described here is the strictly transverse direction of the rows of teeth on the uncini. *Spirorbis cuneatus*, however, has cross-striated collar setae, whereas the other two have collar setae

*1ⁿ Methuen Colour Book (Kornerup & Wanscher 1967)

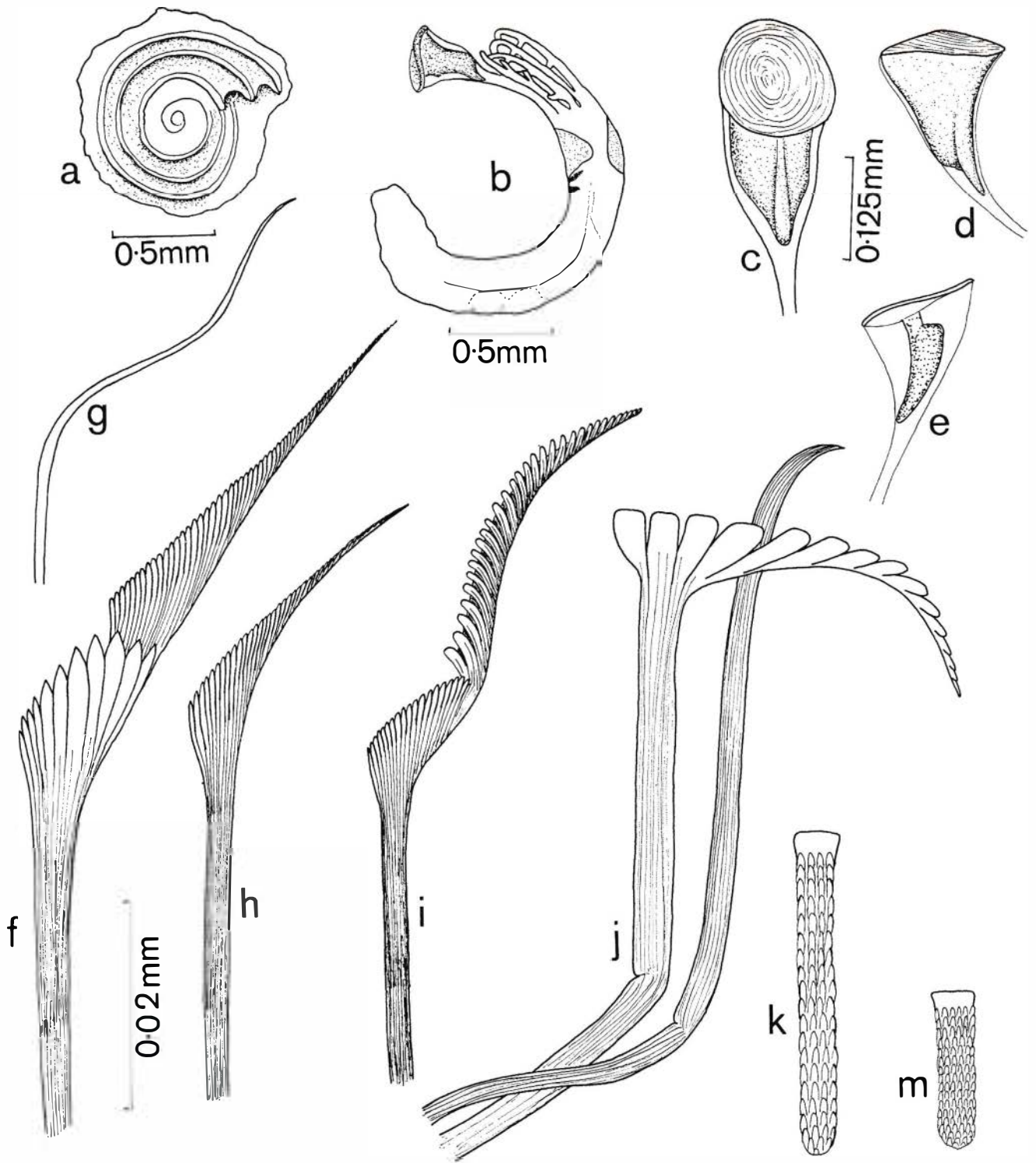
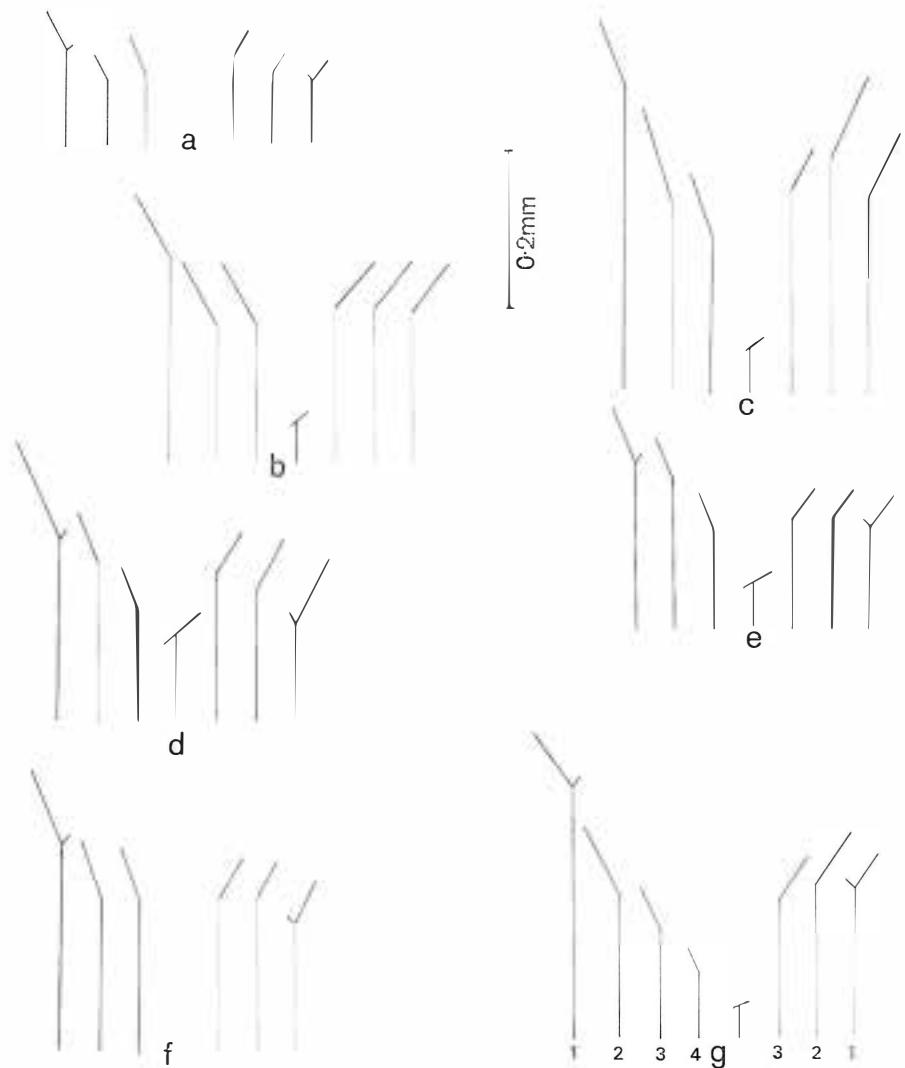


Figure 1 *Spirorbis (Spirorbis) bidentatus* a tube; b worm, dorsal side uppermost; c operculum of first specimen, dorsal view; d operculum of first specimen, side view; e operculum of second specimen, side view; f collar seta; g capillary seta associated with collar seta; h simple seta from second thoracic fascicle; i sickle seta from third thoracic fascicle; j abdominal setae; k thoracic uncinus; m abdominal uncinus.

Figure 2 Relative sizes of setal shafts and blades in **a** *Spirorbis* (*Spirorbis*) *bidentatus*; **b** *Metalaespira* *clansmani*; **c** *Metalaespira* *armiger*; **d** *Paralaeospira* *monacanthus*; **e** *Paralaeospira* *levinsenii*; **f** *Paralaeospira* *parallela*; **g** *Protolaeospira* *augeneri*.

The stick diagrams represent relative lengths of setal shafts and blades. The numbers in Fig. 2g indicate the arrangement of setae in other diagrams. Numbers 1, 2, 3, and 4 represent seta from collar, second, third, and fourth fascicles respectively. In sinistral species (such as all those in Fig. 2) the concave side is represented by the stick setae on the observer's right whereas in dextral species (see Fig. 32) the concave side is on the observer's left.



like those described here. *Spirorbis indicus* sensu Harris has a less regularly coiled tube than *S. bidentatus* or *S. cuneatus*, and the longitudinal ridges appear to be less prominent.

As Harris (1969) emphasised, the species which he identified as *S. indicus* showed several characters of tube and operculum which differed from Sterzinger's description. The original species from the Red Sea had collar setae with a wide gap between fin and blade, whereas Harris's species from the South Atlantic had collar setae like those of *S. bidentatus* (i.e., without a gap). It seems that the species studied by Harris is either a new species, a juvenile *Paralaeospira*, or perhaps the same as *S. bidentatus*, but in any case, different from *S. indicus*.

Investigation of mounted specimens identified by Bailey as *S. bidentatus* from the Galapagos Islands indicated that this species has uncini with somewhat similar transverse rows of teeth and that a capillary seta is associated with each geniculate abdominal seta. Until more material from both regions is available for close comparison it seems best to identify the New

Zealand species as *S. bidentatus*, although its operculum is not markedly bidentate.

OTHER RECORDS: Intertidal on the Galapagos Islands (Bailey & Harris 1968).

Genus *Metalaespira* Pillai, 1970 (emended)

Sinistral coiling; 3 rows of thoracic tori on concave side; embryos incubated in a groove along convex side of body, but without specialised thoracic attachment stalk; collar setae with simple blades; sickle setae present; thoracic uncini slender and with a blunt anterior peg; thoracic and abdominal uncini much more numerous on concave side; tori large throughout most of setigerous region; abdominal setae less than $\frac{1}{4}$ length of collar setae, with vestigial brush-like blades; larvae probably lacking white attachment glands.

TYPE-SPECIES: *Metalaespira pixelli* (Harris, 1969) [= *Spirorbis antarcticus* Pixell, 1913].

***Metalaeospira armiger* new species**

Figures 2c, 3, 4, 17c

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.249.

PARATYPES: British Museum (Natural History) Reg. No. ZB.1971.250.

MATERIAL EXAMINED: 3 specimens, 2 mounted in polyvinyl lactophenol.

LOCATION: Cape Hallett, Ross Sea, 72°17.7'S, 170°13.1'E, NZOI Stn E186, 20 January 1965.

HABITAT: On bryozoan, about 59 m depth.

DESCRIPTION OF SPECIES

Tube (Figs 3a, b, 4b). Sinistral, porcellanous, heavily calcified, with 3 longitudinal ridges, median one being most pronounced. Sides of tube smooth and oblique forming a wide base of attachment. Coil diameter 3.0 mm.

Operculum with flat plate. Broad translucent shield extends over dorsal side, split longitudinally (Fig. 3d). On ventral side (Fig. 3c), operculum open and forms chamber; no eggs seen, seems likely that this species incubates in tube, like other species of genus.

Thorax. Collar folds not fused dorsally (Fig. 4a). 3 tori on concave side; no other parapodial rudiments representing a 4th segment. Collar setae (Fig. 4c) with long narrow finely striated blades, lack fins, not cross-striated. Narrow capillary setae associated with them. 2nd and 3rd fascicles have simple setae with longer and narrower blades than those of collar setae. Sickle setae (Fig. 4e) have broad, somewhat bifid anterior pegs and 2 or 3 longitudinal rows of teeth along most of length.

Asetigerous region fairly short, about twice distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 17 segments. Distribution of uncini extremely asymmetrical, few on convex side. Setae (Fig. 4g) of 2 types; somewhat fan-shaped blades bearing rounded teeth, and simple setae with short blades. Uncini (Fig. 4d) with broad anterior pegs and about 7 longitudinal rows of teeth.

Incubation. Markedly asymmetrical distribution of uncini in abdomen (Fig. 2) supports supposition that this is a tube-incubating species. No remnants of stalk or funnel for attachment of embryos found, seems likely that embryo mass held, loosely attached, to convex side of abdomen, as in other species of *Metalaeospira*.

REMARKS: This species differs quite markedly from the two previously described species of *Metalaeospira*, *M. pixelli* (Harris, 1969) and *M. tenuis* (Knight-Jones, 1973).

The operculum is similar to those of two species recorded by Bush (1904) from the North Pacific, i.e., "*Spirorbis*" *validus* Verrill, 1874 and "*Spirorbis*" *verruca* Fabricius, 1822. Bush, however, stated that *S. verruca* incubated embryos in the operculum. *Spirorbis verruca* has some collar setae with "an obscure posterior notch" whereas *S. validus* is smooth, and there appear to be only two thoracic tori on the concave side. There is a closer resemblance between *M. armiger* and *Helicosiphon* (Knight-Jones, Knight-Jones & Bregazzi 1973). The name "armiger" relates to the shield-like talon.

***Metalaeospira clansmani* new species**

Figures 2b, 5, 6a

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.251.

PARATYPES: British Museum (Natural History) Reg. No. ZB.1971.252.

MATERIAL EXAMINED: Approximately 100 specimens.

LOCATION: Landing Bay, Poor Knights Is.

HABITAT: On red-brown alga, depth approximately 10 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, slightly porcellanous, smooth, with thickened translucent lip around mouth (Fig. 5a). Subsequent growth sometimes leaves thickened band short distance back from mouth aperture. Sometimes coils helically. Coil diameter 1.0–2.8 mm.

Operculum with lightly calcified slightly concave plate, lacks talon. Ampulla with minutely pitted transparent walls bulges beneath plate (Figs 5c, d, e).

Thorax has 5 or 7 branchiae with short terminal filaments (about 3 times as long as distal pinnules). Collar folds not fused. 3 rows of tori on concave side. Collar setae (Fig. 5f) similar to setae from 2nd and 3rd fascicles, having simple blades with fine teeth. Sickle setae (Fig. 5h) present in 3rd fascicles. Uncini (Fig. 5i) on first investigation appeared to have single row of teeth, but closer study showed that most uncini orientated in side view, and 2 or 3 longitudinal rows of teeth present.

Asetigerous region long, but only 4 times as long as distance between widely spaced 1st and 2nd abdominal tori on concave side.

Abdomen, about 20 segments. Few uncini on convex side, long tori on concave side (Figs 2, 6). Setae (Fig. 5j) with short, brush-like blades, uncini (Fig. 5k) with broad anterior pegs and about 10 longitudinal rows of fine teeth.

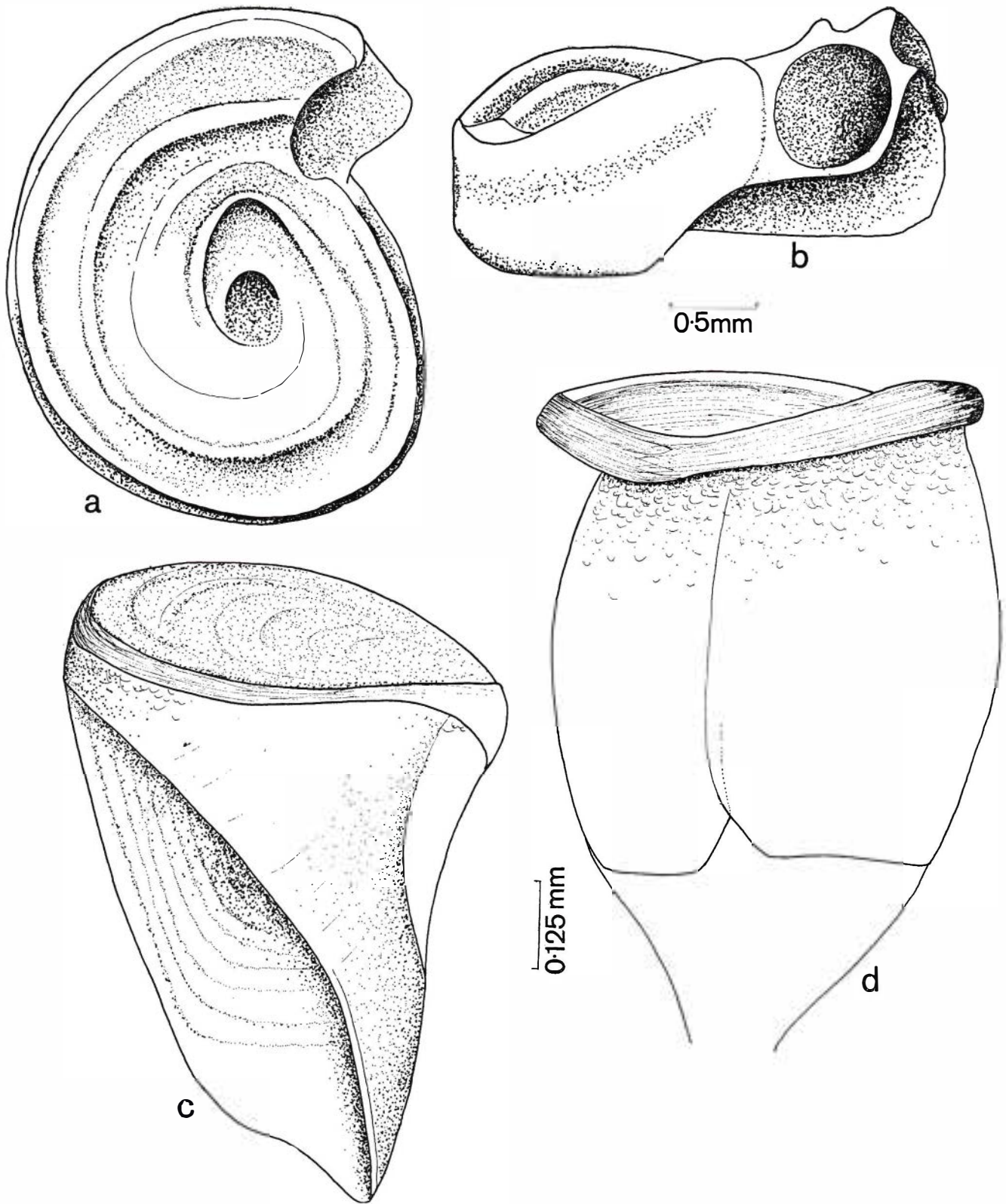


Figure 3 *Metalaeospira armiger* a tube; b tube; c ventral and side view of operculum; d dorsal view of operculum.

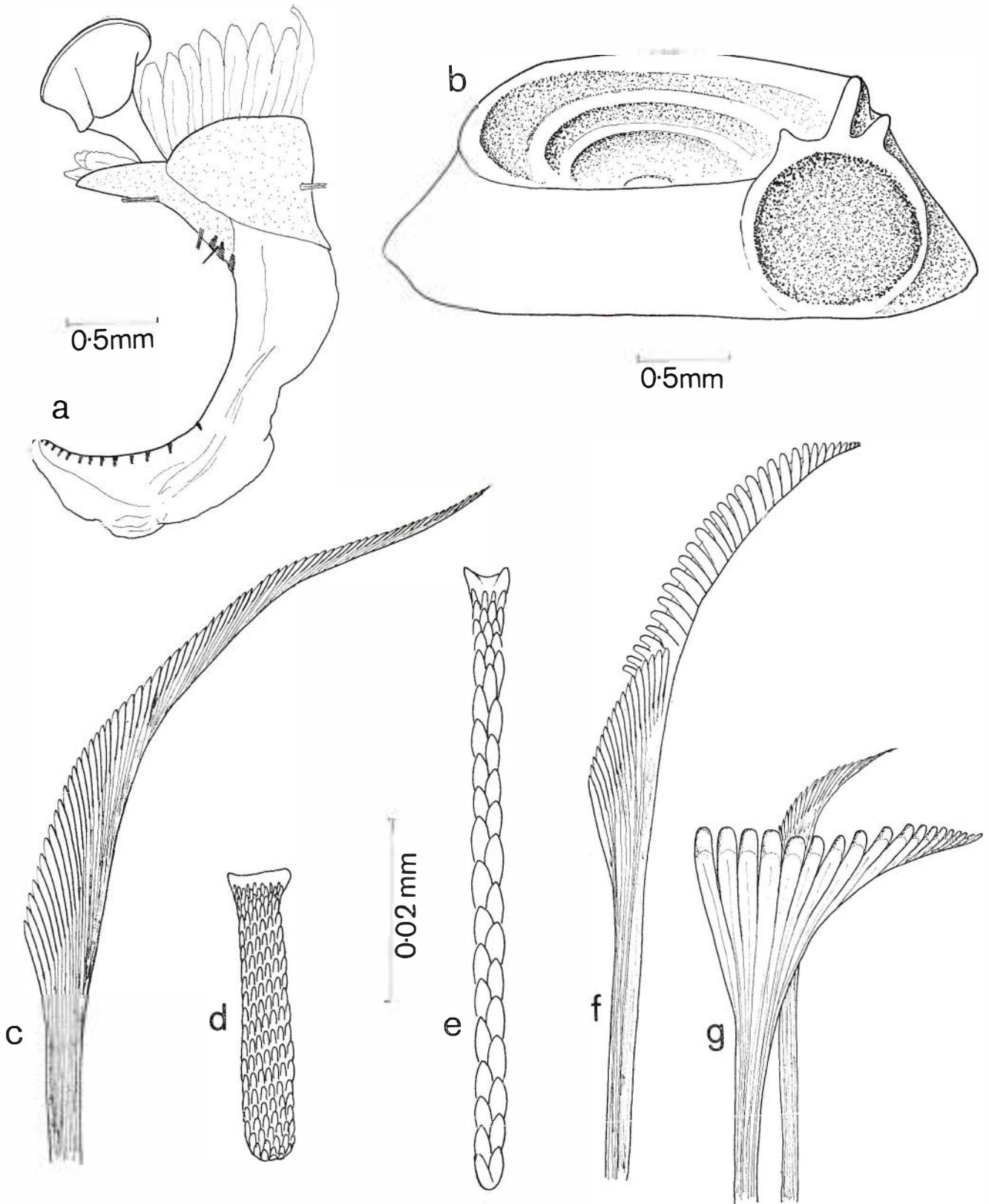


Figure 4 *Metalaeospira armiger* a dorsal view of worm; b tube (side-view); c collar seta; d abdominal uncinus; e thoracic uncinus; f sickle seta; g abdominal setae.

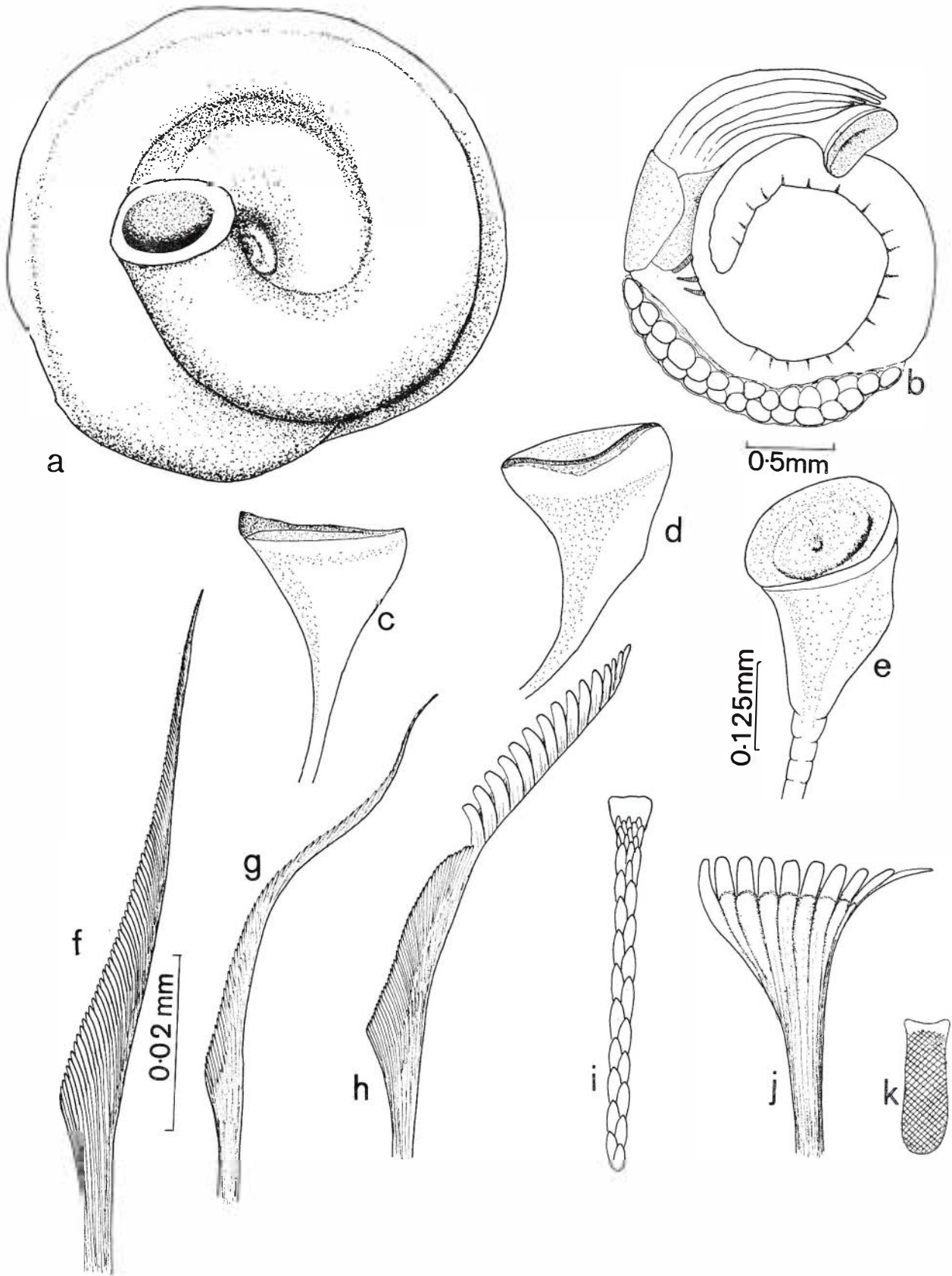


Figure 5 *Metalaeospira clansmani* a tube; b ventral view of worm; c, d, e operculum; f collar seta; g simple seta from second thoracic fascicle; h sickle seta; i thoracic uncinus; j abdominal seta; k abdominal uncinus.

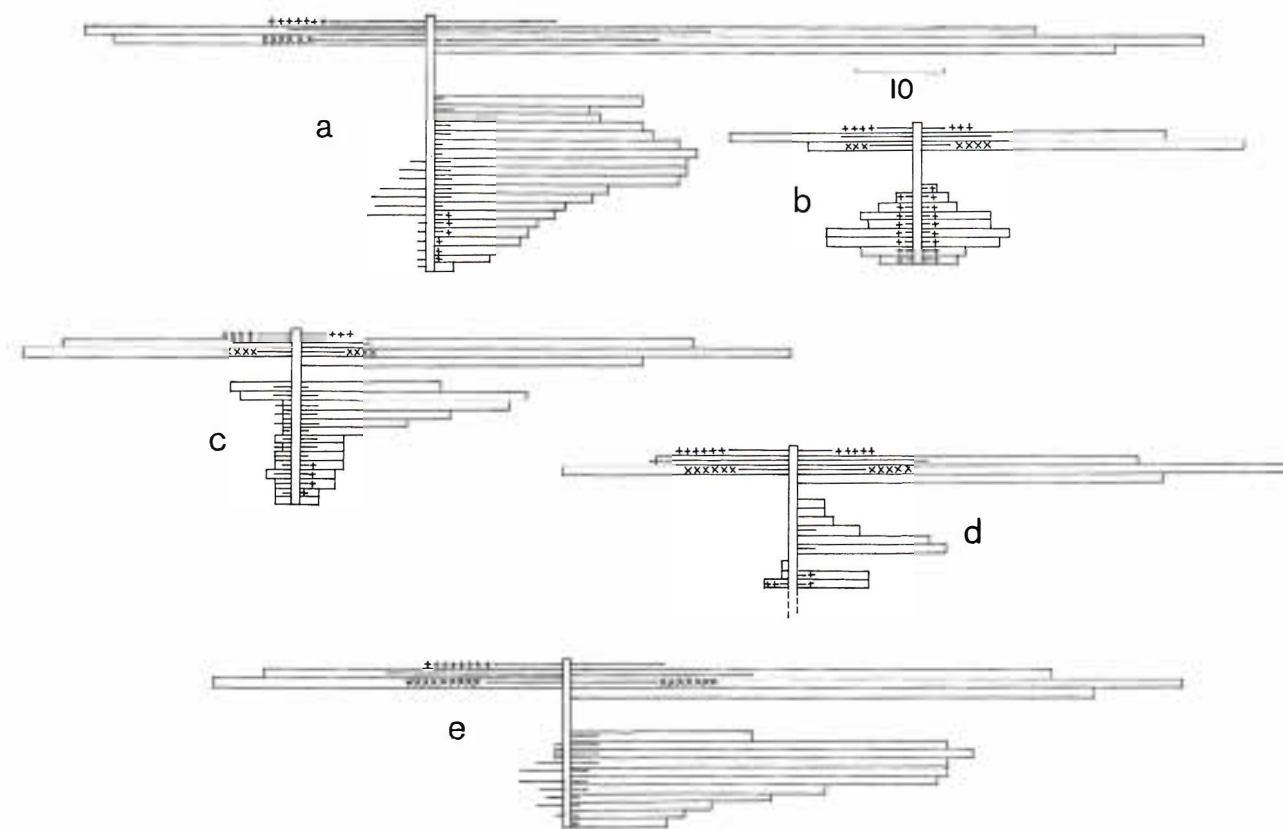


Figure 6 Chart showing distribution of setae and uncini in **a** *Metalaeospira clansmani*; **b** *Spirorbis (Spirorbis) bidentatus*; **c** *Paralaeospira levinseni*; **d** *Paralaeospira parallela*; **e** *Paralaeospira monacanthus*.

The histograms indicate the number of uncini per torus on the concave and convex sides of the animal. Continuous lines within these indicate the number of setae in each fascicle, and symbols represent various kinds of ancillary setae, viz:

- + = capillary setae
- x = sickle setae
- = secondary setae with rudimentary shafts (applies to Fig. 25 only).

Species are shown as they appear *in situ*, so that in sinistral species the concave side of the animal is on the observer's right and in dextral ones on the observer's left.

The length of the asetigerous region is represented as a multiple of the distance between the first and second abdominal tori on the concave side. The distance between tori on the histograms is standardised, and thus the histograms do not necessarily give a true indication of the length of the asetigerous region in relation to that of the whole animal. In some species the anterior abdominal tori are themselves unusually far apart and this will result in the asetigerous region appearing relatively shorter in the histogram.

Each figure represents single adult specimens, but it has been found that there is good agreement between adult specimens of the same species. The exact distribution of paired setae and capillary setae in the abdomen tends to vary somewhat. Generally speaking, it is the overall pattern of the histogram which characterises a particular species rather than separate details which vary with age and show slight variation within a species, even between individuals of the same size.

Incubation. In one specimen, an egg-string attached to body by membranous strands arising dorsally at approximate level of thoracic torus on concave side. Egg-string, containing about 30 eggs, continues along grooved convex side of abdomen.

Body colours of live specimen. Radioles and collar colourless; orange tinges around thoracic tori; stomach red/brown (Pl. 8, B8*); abdomen colourless on concave side, but creamy or orange on convex side. Larvae without white attachment glands.

REMARKS: This species appears closely related to *Metalaeospira tenuis* Knight-Jones, 1973 from South

*In Methuen Colour Book (Kornerup & Wanscher 1967)

Australia. The latter species however has an operculum like a truncated cone, whereas *M. clansmani* has a concave opercular plate. Other differences between the two species are slight: the abdominal uncini in *M. tenuis* have fewer longitudinal rows of teeth, and the longest thoracic uncini are about half as long as in *M. clansmani*. The latter appears to be less closely related to *M. pixelli*, an antarctic form which has an operculum bearing minute spines.

This species is named after the yacht *Clansman* owned by Mr Gerry Hunter, and skippered by him on our 4-day expedition to the Poor Knights Islands in February 1969.

Genus *Paralaeospira* Caullery & Mesnil,
1897 (emended)

Coiling usually sinistral; 3 rows of thoracic tori on concave side; no embryonic attachment stalk; embryos incubated in region of faecal groove along convex side of abdomen but attached neither to body nor tube; collar margins not fused dorsally; collar setae with proximal fin, blade lacking cross-striations; sickle setae present in 3rd thoracic fascicles; thoracic uncini with broad anterior peg and usually several longitudinal rows of teeth; uncini in thoracic and abdominal tori more numerous on concave side, longest abdominal tori lie anteriorly; abdominal setae strongly geniculate with rather short blades; larvae lacking white attachment glands.

TYPE-SPECIES: *Paralaeospira aggregata* (Caullery & Mesnil, 1897).

Paralaeospira monacanthus (Augener, 1922)

Figures 2d, 6e, 7

Spirorbis monacanthus Augener, 1922

MATERIAL EXAMINED: 14 specimens, 3 mounted in polyvinyl lactophenol.

LOCATION: Port Ross, Auckland Islands, 50°31.1'S, 166°17.3'E, NZOI Stn D62.

HABITAT: On stones, 22 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, smooth, non-porcellanous. Often forms aggregations. Coiling tight and helical, or more loose depending on how closely tubes aggregated. Coil diameter 2.0–3.0 mm.

Operculum with prominent glassy recurved spine arising from flat central region of calcified plate. Edges of plate slightly flared, surrounded by narrow transparent rim. Beneath plate, side walls of operculum calcified in narrow band (Fig. 7d).

Thorax. Collar folds not fused, collar extended on convex side to form a cloak (Fig. 7c). 3 tori on concave side, but no other rudiments of a 4th thoracic segment. Collar setae (Fig. 7e) with proximal fin and distal blade, not cross-striated. Narrow bladed simple setae associated with them. 2nd and 3rd fascicles have simple setae (Fig. 7f), sickle setae (Fig. 7g) also present in 3rd fascicles. Uncini (Fig. 7j) with somewhat bifid broad anterior peg and 2 longitudinal rows of large teeth. Posterior end of uncini, appears to be single row of teeth.

Asetigerious region, about 4 times as long as distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 17 segments. Setae (Fig. 7h) strongly geniculate with rather broad blades bearing rounded teeth. Uncini (Fig. 7i) have broad anterior pegs, about 12 longitudinal rows of fine teeth.

Incubation. Egg-string incubated in tube and lying along convex sides of abdomen, apparently held within faecal groove (of preserved specimens). No specialised thoracic attachment stalk.

REMARKS: *Spirorbis monacanthus* was originally described from the same locality as the present specimens. It has not been described in detail since Augener's account. From the present study it is clear that this species should be included with others in the genus *Paralaeospira*.

OTHER RECORDS: Known only from Auckland Islands (Augener 1922).

Paralaeospira levinseni (Caullery & Mesnil, 1897)

Figures 2e, 6c, 8

Spirorbis (Paralaeospira) levinseni Caullery & Mesnil, 1897
Paralaeospira levinseni: Knight-Jones & Walker 1972

MATERIAL EXAMINED: 12 specimens (6 mounted in polyvinyl lactophenol).

LOCATION: South-eastern side of Goat Island, in Whangateau Harbour and at Poor Knights Islands; Kaikoura Bay; McCormick's Bay Culvert and Taylor's Mistake, near Christchurch.

HABITAT: On the ascidian *Cnemidocarpa bicornuata* (authority) at 30 m; on shells of *Paphies (Paphies) australis* (Gmelin) at LWS and on tubes of the spirorbiniid *Romanchella solea* n.sp. at the Poor Knights Is.

DESCRIPTION OF SPECIES

Tube. Sinistral, smooth, or with slight transverse thickenings, but no longitudinal ridges (Fig. 8a). Coiling may be helical or quite loose, tubes often aggregated. Those settling on tubes of *R. solea* at Poor Knights Islands produce circular-saw shape, often so numerous that they obscure longitudinally ridged tube of *R. solea* (Fig. 8a). Coil diameter 1.5–2.5 mm, depending on how loosely tube coiled.

Operculum. Juvenile operculum with thinly calcified oval plate and slightly domed region centrally (Fig. 8d). A transparent papilla often protrudes from dome, but may be extremely difficult to distinguish. Adult operculum may have unevenly thickened plate, talon somewhat hook-shaped (Figs 8b, c, e).

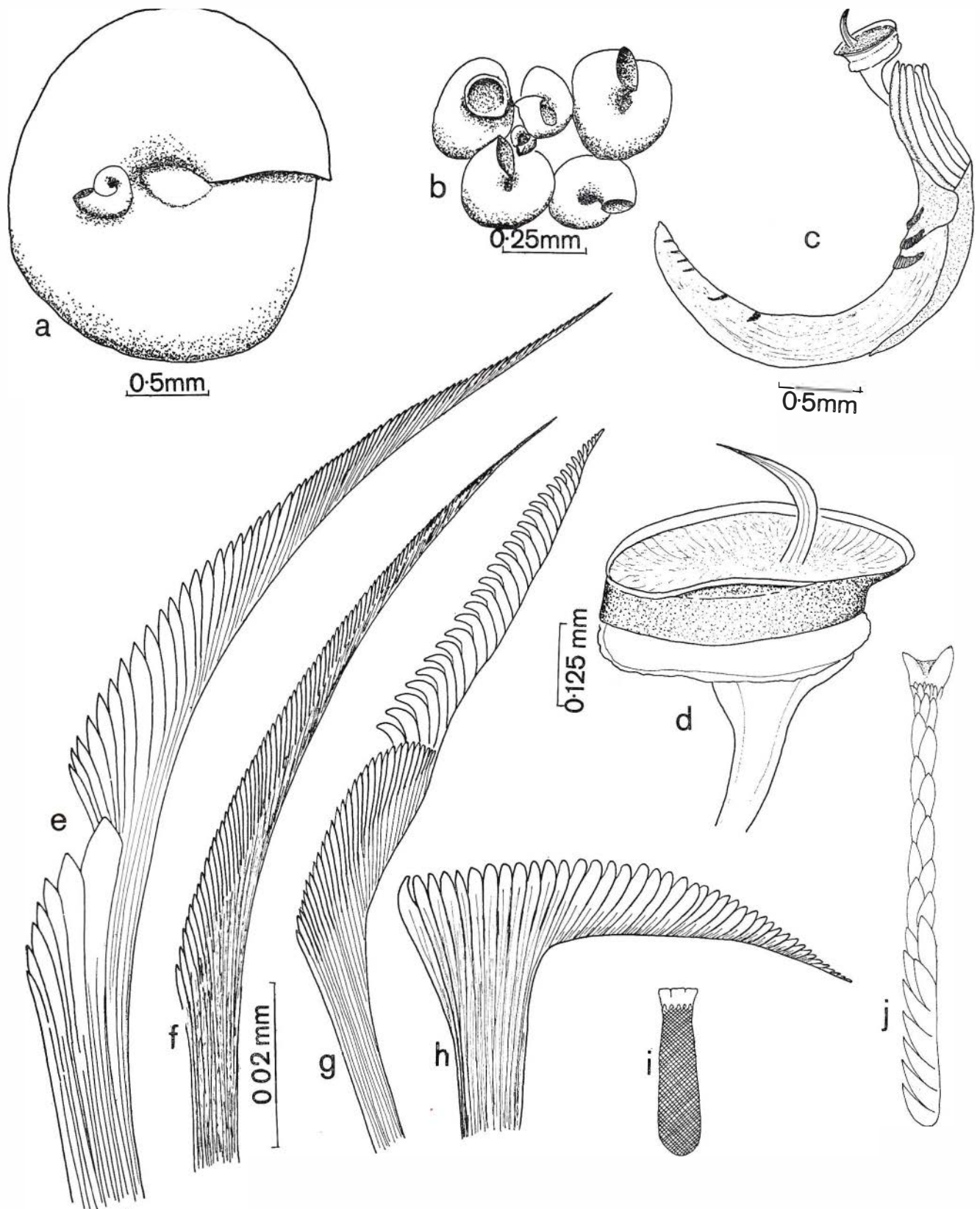


Figure 7 *Paralaeospira monacanthus* a tube; b aggregation of tubes; c worm (dorsal view); d operculum; e collar setae; f simple seta from second thoracic fascicle; g sickle seta from third thoracic fascicle; h abdominal seta; i abdominal uncinus; j thoracic uncinus.

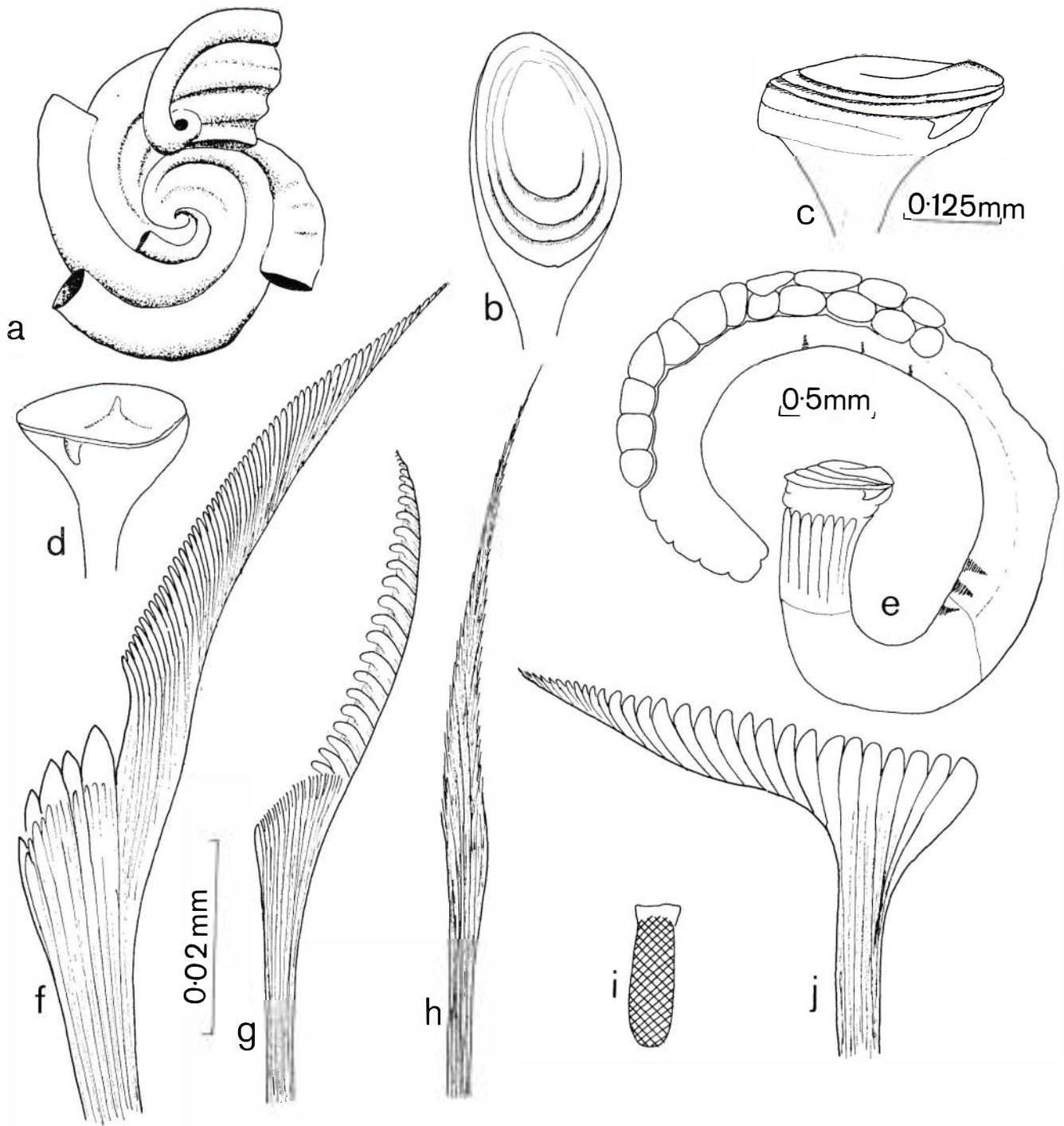


Figure 8 *Paralaeospira levinseni* a aggregated tubes obscuring tube of *Romanchella solea* on which they frequently settle; b adult operculum from above; c side view of adult operculum; d side view of juvenile operculum; e ventral view of worm; f collar seta; g sickle seta; h simple seta from second thoracic fascicle; i abdominal uncinus; j abdominal seta.

Thorax. Collar folds not fused. In very young specimens, only 2 tori on each side, whereas adults have a 3rd torus on concave side. Collar setae (Fig. 8f) with proximal fin containing several large teeth, distal blade with many narrow teeth and no cross-striations. Capillary setae associated with collar setae. 2nd and 3rd fascicles have simple setae with almost smooth-edged

blades (Fig. 8h), sickle setae (Fig. 8g) also present in 3rd fascicles. Proximal portions of sickle setae blades short compared with distal portions. Uncini have broad anterior pegs and 2 or 3 longitudinal rows of teeth.

Asetigerous region, 4 or 5 times as long as distance between 1st and 2nd abdominal tori on concave side.

Abdomen, up to 15 segments. Setae geniculate, with prominent heel (Fig. 8j). Blades with about 20 rounded teeth. Uncini (Fig. 8i) have broad anterior pegs, fine teeth arranged in about 12 longitudinal rows. Distribution of abdominal uncini very asymmetrical, few present on convex side. 2nd torus on concave side frequently divided into 2 unequal portions, may be related to considerable length of this torus and position of faecal groove.

Incubation. Egg-strings, each consisting of a single row of eggs (5 to 7 in specimens examined) incubated in tubes, but not attached to tubes. Although no attachment stalk or membrane between animal and egg-string observed, egg-strings frequently adhered to worm during dissection.

Body colours of live specimens. Radioles and operculum colourless; thorax and abdomen tinged with orange (Pl. 7, A7, A5*); oesophagus, stomach, and part of gut brown (Pl. 5, D4), but in those specimens collected from Whangateau Harbour stomach dark green (Pl. 28, E8), being filled with phytoplankton. Larvae light brown (Pl. 5, B8), lack white attachment glands.

REMARKS: Recent studies of Caullery & Mesnil's original material and of specimens from Cape Town and the Antarctic have shown that the operculum of this species displays great variability, ranging from a flat plate sometimes with a 'hole' and sometimes both 'hole' and a minute talon, to those with a thickened plate bearing a dorsal convexity and a small talon (Knight-Jones, Knight-Jones & Walker 1972). The specimens described by Harris (1969) fall within this pattern of variability.

In juveniles, a transparent papilla often protrudes from the dome of the operculum. It is possibly the base of this papilla which gives rise to the tiny hole in the plate of the adult operculum described by Caullery & Mesnil: ". . . il se compose uniquement d'une plaque terminale, assez mince, sensiblement plane, sur laquelle on distingue, plus ou moins excentriquement, une cicatrice qui correspond probablement à un talon. . .". Whereas the position of the papilla and the hole correspond in position, the slight talon present in the adult operculum is more eccentric in position.

In some specimens it was possible to locate the third torus still in the process of development. It is located some distance back from the other two tori on the concave side and in a more posterior position than that occupied by the third torus in mature worms. In the young specimens examined it was approximately midway between the second torus on the concave side and the first abdominal torus on that side. Nevertheless, it seemed clear that it was a thoracic torus, because the uncini were longer and had fewer rows of teeth than abdominal uncini.

OTHER RECORDS: Patagonia (Caullery & Mesnil 1897); Cape Denison, Antarctica (Harris 1969); South Orkneys; Talcahuano (Chile) and Cape Town (South Africa) (Mrs Phyllis Knight-Jones, pers. comm.)

*In Methuen Colour Book (Kornerup & Wanscher 1967)

Paralaeospira parallela new species

Figures 2f, 6d, 9

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.253a.

PARATYPES: British Museum (Natural History) Reg. No. ZB.1971.254.

MATERIAL EXAMINED: 3 specimens, 1 mounted in polyvinyl lactophenol.

LOCATION: Port Ross, Auckland Islands, 50°31.1'S, 166°17.3'E, NZOI Stn D62.

HABITAT: On stones, at about 10 m depth.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, very hard to break. Mouth wholly overlies previous whorl (Fig. 9a). 2 whorls, but only upper one visible. Coil diameter 2.0 mm.

Operculum with biconvex plate, rather unevenly calcified. (Fig. 9b). Plate lies with its long axis more or less parallel to tentacles (Fig. 9c).

Thorax. Collar folds not fused. 3 tori on concave side, but no other rudiments of a 4th thoracic segment observed. Collar setae (Fig. 9d) with proximal fin and distal blade, not cross-striated. Several capillary setae associated with them. 2nd and 3rd fascicles with simple setae (Fig. 9f), also sickle setae (Fig. 9e) present in 3rd fascicles. Uncini (Fig. 9i) with broad anterior peg and 2 or 3 longitudinal rows of teeth.

Asetigerous region extremely short, about twice distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 17 segments. In holotype uncini widely spaced and tori disarranged. Setae strongly geniculate, with short blades (Fig. 9g). Curved capillary setae associated with them in posterior segments (Fig. 9g). Uncini (Fig. 9h) have broad anterior pegs and many longitudinal rows of fine teeth.

Incubation. Embryos incubated in egg-string which is loosely attached anteriorly to dorsal side of worm at approximate level of 1st abdominal torus. It lies along convex side of worm, possibly retained in faecal groove. Egg-string contained 10 eggs in single row, posterior end terminated at about level of 10th abdominal torus.

REMARKS: This species is distinguished by its oval operculum, biconvex in transverse view, which is held parallel to the radioles rather than perpendicular to them. In other details it closely resembles other *Paralaeospira* species.

A similar specimen was found in a collection from Cape Horn originally studied by Caullery & Mesnil. None of their descriptions covers this species, however.

The name refers to the operculum being held with the plate more or less parallel to the tentacles.

OTHER RECORDS: Cape Horn (*see above*).

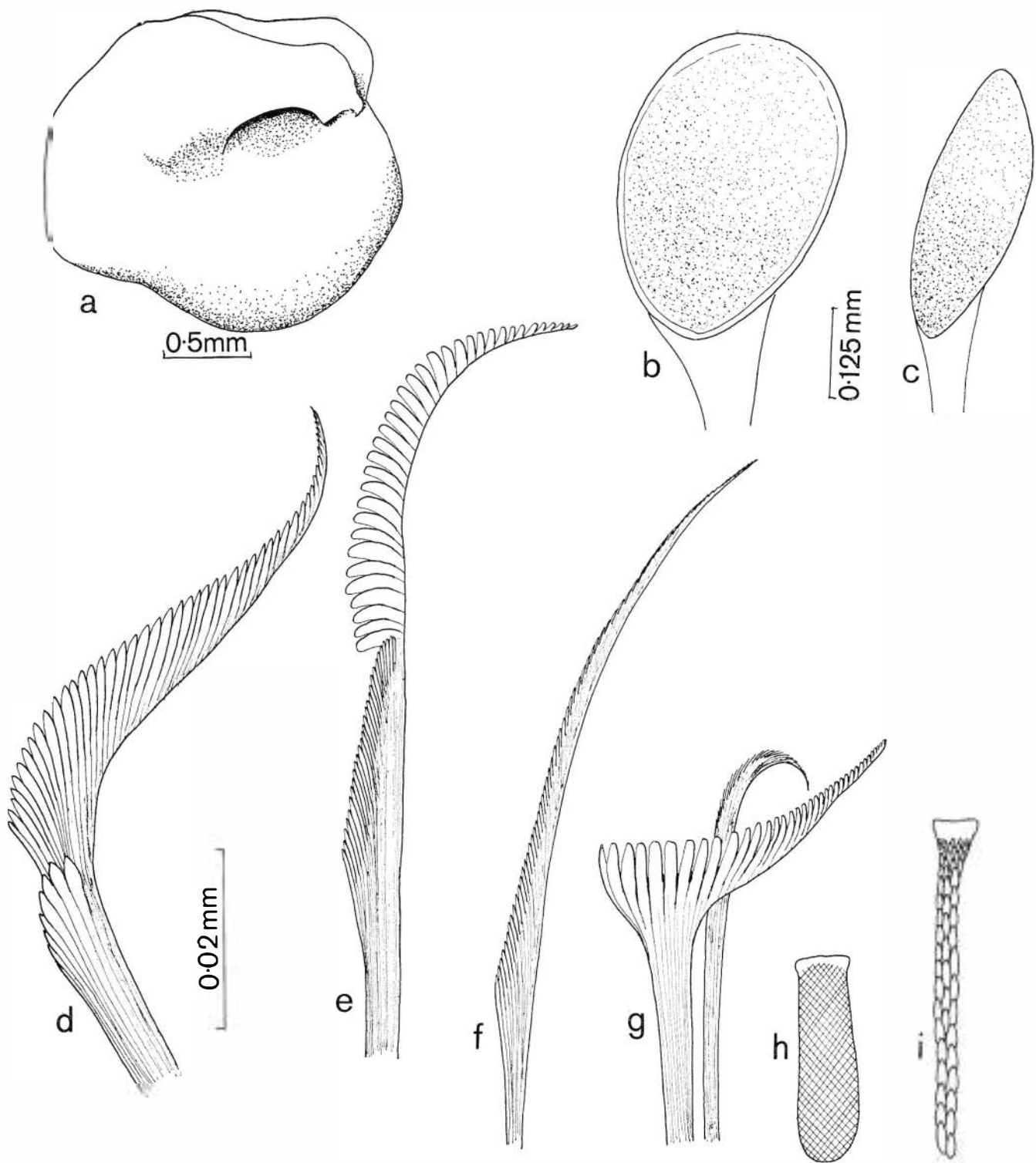


Figure 9 *Paralaeospira parallela* a tube; b dorsal view of operculum; c lateral view of operculum; d collar seta; e sickle seta from third thoracic fascicle; f simple seta from second thoracic fascicle; g abdominal setae; h abdominal uncinus; i thoracic uncinus.

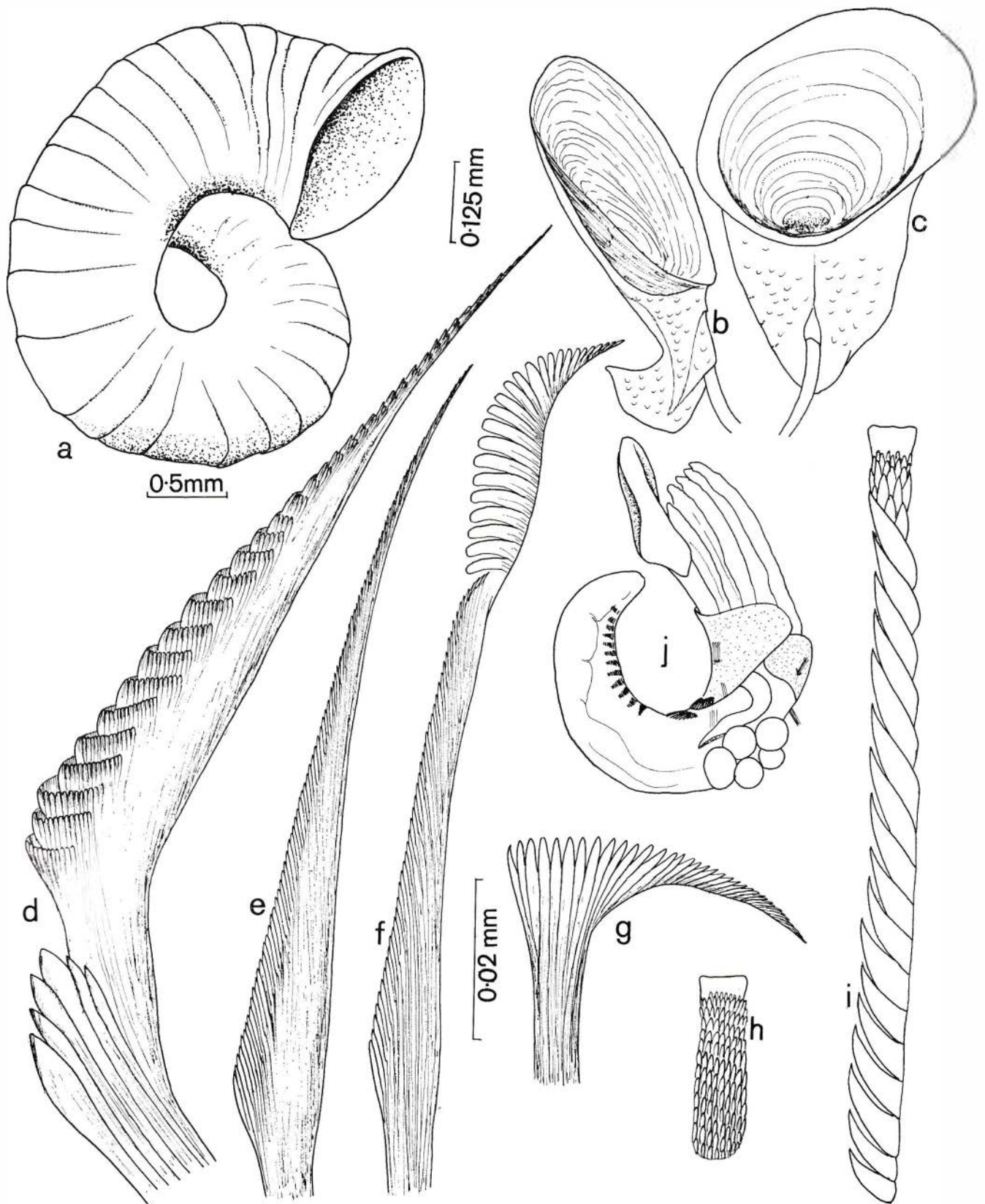


Figure 10 *Protolaeospira ambilateralis* a tube; b operculum (side view); c operculum (dorsal view); d collar seta; e simple seta from second thoracic fascicle; f sickle seta from third thoracic fascicle; g abdominal seta; h abdominal uncinus; i thoracic uncinus; j worm in dorsal view.

Genus *Protolaeospira* Pixell, 1912
(redefined Knight-Jones, 1973)

Protolaeospira ambilateralis (Pixell, 1912)
Figures 10, 11a, 12a

Marsipospira Bailey, 1969; includes *Pixellia* Pillai, 1970

Spirorbis (*Protolaeospira*) *ambilateralis* Pixell 1912

Coiling usually sinistral; 3 rows of tori on concave side of thorax; other traces of a 4th thoracic segment may not be present, embryos incubated in faecal groove, attached to stalk which arises dorsally from floor of groove in thoracic region and towards left side; collar setae with separate fins and blades, usually cross-striated; sickle setae present in 3rd fascicle; thoracic and abdominal uncini much more numerous on concave side; thoracic uncini usually very long and slender, with blunt, bilobed anterior peg; abdominal setae less than $\frac{1}{4}$ length of collar setae, with vestigial brush-like blades; opercular talon massive, usually bearing lateral projections; single white larval attachment gland (rectal type) may be present.

MATERIAL EXAMINED: 17 specimens.

LOCATION: NZOI Stn F905, 32°27'S, 175°48'E, about 480 km north of Auckland.

HABITAT: On stones at 157–161 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, porcellanous, and opaque. Round in cross-section, with many growth striae but without prominent corrugations (Fig. 10a), 1 whorl. Coil diameter 2.0 mm.

Operculum. Oblique, concave, translucent plate with somewhat horny rim. Talon translucent, triangular in dorsal view. Sides of talon without prominent lobes.

TYPE-SPECIES: *Protolaeospira ambilateralis* (Pixell, 1912).

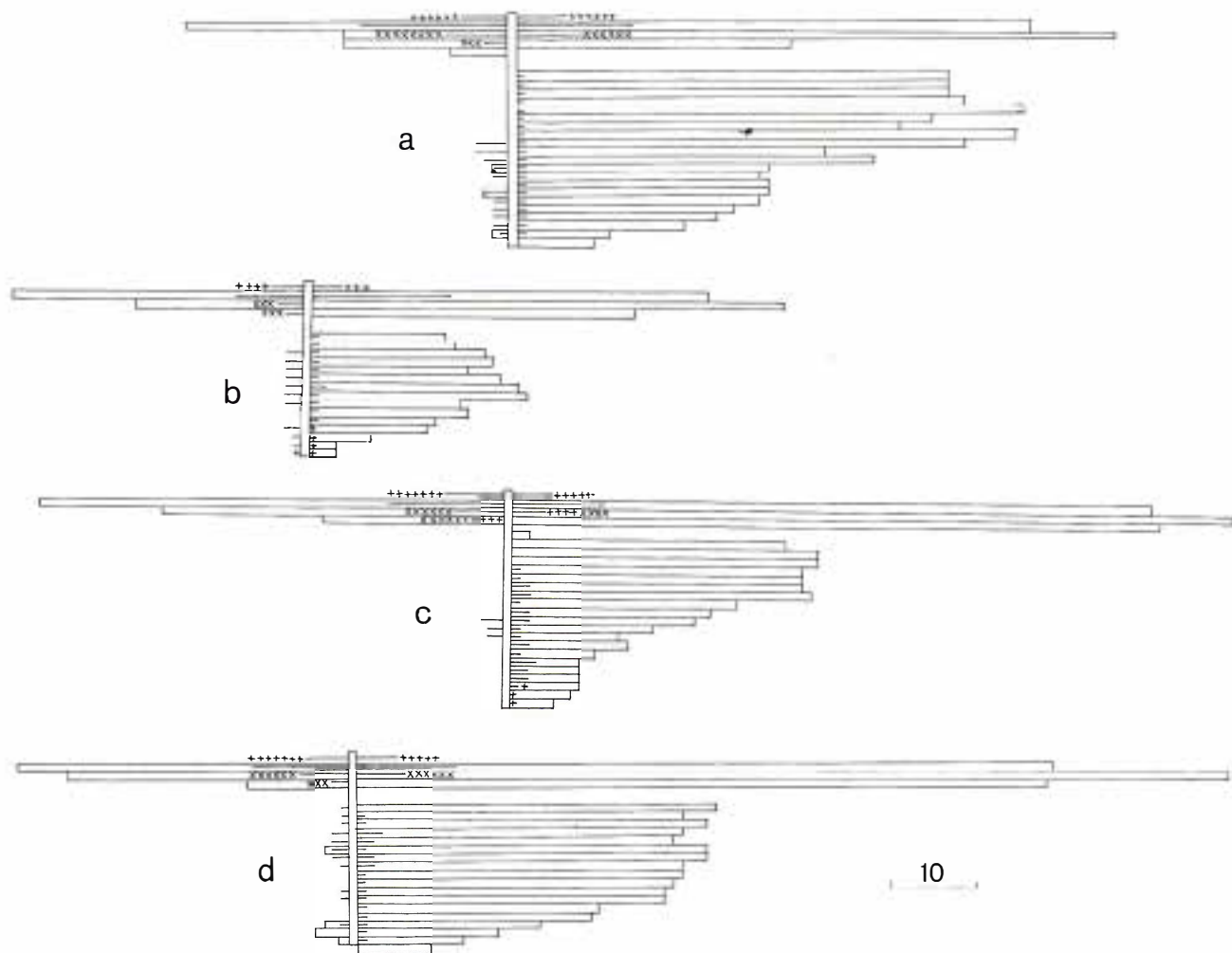
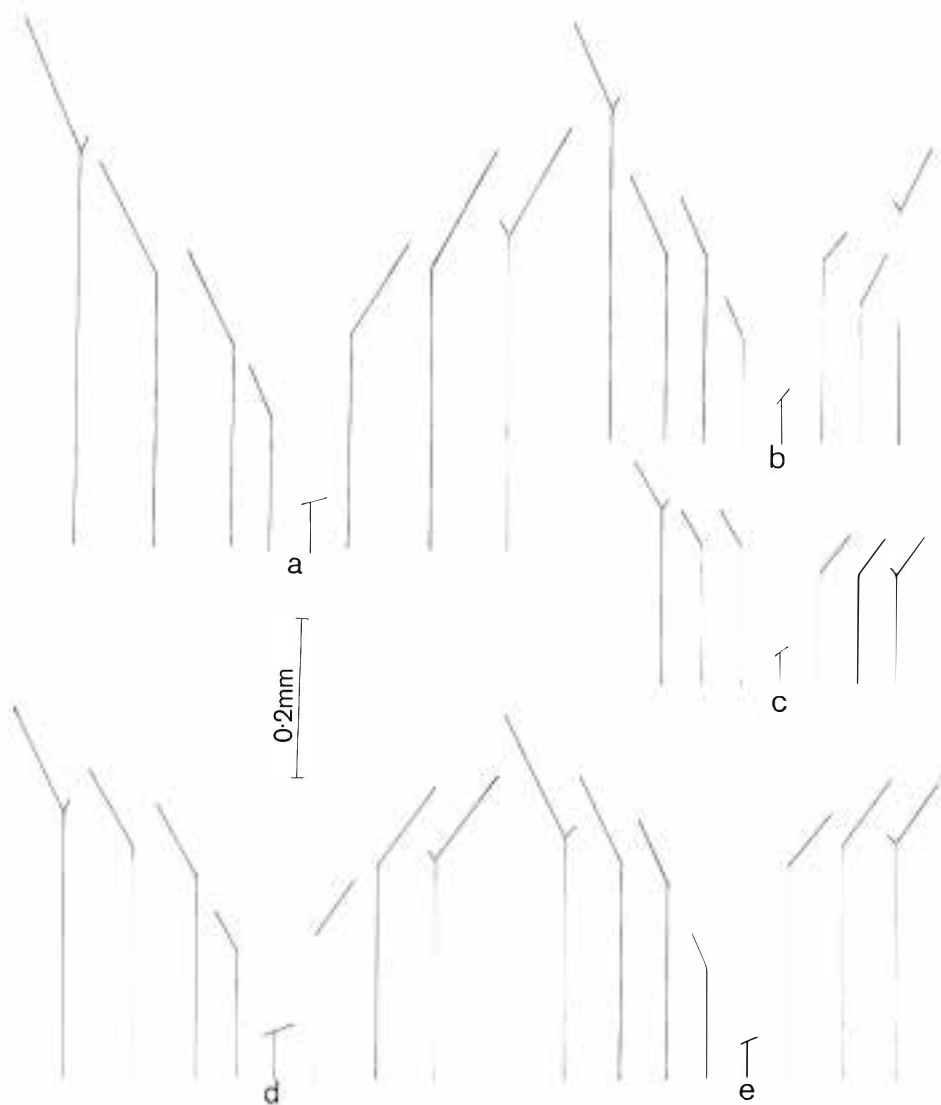


Figure 11 Distribution of setae and uncini in a *Protolaeospira ambilateralis*; b *Protolaeospira augeneri*; c *Protolaeospira capensis*; d *Protolaeospira graeci*. (See Fig. 6 for explanation of histograms.)

Figure 12 Relative sizes of setal shafts and blades in **a** *Protolaeospira ambilateralis*; **b** *Protolaeospira capensis*; **c** *Protolaeospira lebruni*; **d** *Protolaeospira gracei*; **e** *Protolaeospira translucens*. (See Fig. 2 for explanation of stick diagrams.)



On dorsal side, a tough fibrous strand arises medially from a thickened region. Surface of talon minutely pitted. End of talon curved ventrally into spur (Fig. 10b).

Thorax. Collar folds not fused dorsally. 3 tori on each side. fascicle of setae associated with 3rd torus on convex side but not with that on concave side. Collar setae (Fig. 10d) with fin and distinctly cross-striated blade. Capillary setae associated with them. 2nd, 3rd, and 4th fascicles have simple setae with smooth-edged blades (Fig. 10e); sickle setae (Fig. 10f) present in 3rd and 4th fascicles. Long uncini on concave side (Fig. 10i) have broad anterior pegs and, for most of their length, a single row of teeth; whereas shorter uncini on concave side and many of those on convex side have 2 or 3 longitudinal rows of teeth.

Asetigerous region short, about twice distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 22 segments. Longest tori towards anterior end (Figs 11, 12), many more uncini in those on concave side. Setae (Fig. 10g) strongly geniculate with

short blades bearing ovate teeth. Uncini (Fig. 10h) have broad anterior pegs and about 10 longitudinal rows of fine teeth.

Incubation. Embryo mass attached to thorax by stalk which arises from dorsal side at approximate level of 1st thoracic tori.

REMARKS: This description substantially agrees with that of *Protolaeospira ambilateralis*. Lateral projections on the talon are, however, less pronounced than in the specimens originally described by Pixell. This species has parapodial rudiments equivalent to three and three-quarter thoracic segments as in *P. racemosus* (Pixell, 1912) but possession of an extra fascicle is not sufficient to justify separating *P. ambilateralis* from *P. racemosus* since rudiments may increase during ontogeny.

The species described here differs from *P. gracei* in tube structure and in fine details of opercular structure. In addition, sickle setae in the third fascicles of *P. ambilateralis* seem to have shorter terminal portions than in those of *P. gracei*. It can be separated more readily from

P. translucens with its vitreous tube and *P. capensis* which has tubes with two or three longitudinal ridges.

OTHER RECORDS: Vancouver Island (Pixell 1912; Berkeley & Berkeley 1952).

***Protolaeospira augeneri* new species**

Figures 2g, 11b, 13

Spirorbis nordenskjoldi Ehlers, 1901 sensu Augener, 1922

HOLOTYPE: British Museum (Natural History) Reg. No. ZB. 1971. 255a.

PARATYPES: British Museum (Natural History) Reg. No. ZB. 1971. 256a.

MATERIAL EXAMINED: 27 specimens, 3 mounted in polyvinyl lactophenol.

LOCATION: Southern Cave, Poor Knights Islands.

HABITAT: On undersides of stones at about 15 m, in fairly well sheltered locality but not in particularly dark region of cave.

DESCRIPTION OF SPECIES

Tube. Sinistral, porcellanous, somewhat translucent (Fig. 13a). Sometimes slight longitudinal ridges towards outside of whorl, but usually well worn and not clearly visible. Faint transverse striations more constant feature. Coiling may be helical and tube round in cross-section, often with ascending terminal section; or tube may be rather wide and coils may lie more or less flush with substrate. In specimens from deeper water, mouth of tube often had thickened translucent lip (Fig. 13c). Tube strong, difficult to break. Coil diameter about 2.0 mm.

Operculum of mature worms with convex plate, constructed from series of stacked plates, each slightly smaller than one on which it rests. Thin transparent rims extend vertically from edge of each plate. Talon large with median rod on dorsal side to which is attached a strong strand associated with opercular stalk, connected posteriorly to 1st and 2nd tori on concave side. Central region of talon bifid at extremity, lateral wings with irregularly indented edges and bear many tubercles. Few tubercles on median section of talon except where it joins plate and lateral wings merge underneath plate. Operculum must be cleared in clove oil to show all these details but characteristic convex plates easily distinguished on live or preserved specimens.

Thorax. 11 radioles with terminal filaments about twice length of rather long distal pinnules. Collar folds not

fused, and collar is elongated posteriorly on convex side forming a short cloak. 3 tori on each side, fascicle of setae associated with 3rd torus on convex side but not with that on concave side. Thus parapodial rudiments equivalent to $3\frac{3}{4}$ segments. Collar setae (Fig. 13g) have proximal fin and distal blade with cross-striations. Capillary setae (Fig. 13h) associated with them. 2nd and 3rd fascicles with simple, finely serrated setae, 3rd and 4th also have sickle setae (Fig. 13j). Distal portion of sickle setae from 3rd fascicle about $\frac{1}{3}$ length of blade, whereas in those of 4th fascicle on convex side, it is about $\frac{1}{2}$ length of blade. Most uncini (Fig. 13n) have broad anterior pegs with 2 or 3 longitudinal rows of teeth and many small teeth projecting to extremity.

Asetigerous region about twice distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 20 segments. Setae (Fig. 13k) have short brush-like blades with teeth which appear sharp under microscope. Uncini (Fig. 13m) have broad anterior pegs and many longitudinal rows of fine teeth.

Incubation. Embryo mass retained by a stalk arising from dorsal side of thorax at about level of 1st thoracic torus on concave side (Fig. 13d).

Body colours of live specimen. Radioles and collar, colourless; stomach and gut, dark brown. Anterior end of abdomen contains bright orange eggs. Larvae in brood pouch lack white attachment glands.

REMARKS: Augener (1922) recorded "*Spirorbis nordenskjoldi*" Ehlers, 1901 from the Auckland Islands on stones or shells from the lower shore. He described the sinistral tubes as smooth or with a slight longitudinal vein. He described two types of opercula which he believed belonged to the same species. One type had a slightly concave terminal plate and five closely packed brown rings. The other had eight closely packed rings and formed the shape of a truncated cone. Thus his description of tube and opercula compare closely with those of the species described above. Collections from 20 m at Port Ross, Auckland Islands, obtained from the N.Z. Oceanographic Institute, included several specimens of the species described above and they agree closely with Augener's description of "*S. nordenskjoldi*" from the same locality.

This is clearly different, however, from the opercular incubating species originally named *S. nordenskjoldi* by Ehlers (1901) which had long abdominal setae and can be placed, tentatively, in the genus *Pileolaria*.

The species is named after Augener who first described it but erroneously identified it as *S. nordenskjoldi*, and did not clearly distinguish it from *Protolaeospira lebruni* (which was also present in the collections recently studied from the Auckland Islands). Its operculum resembles that of *P. lebruni* in being laminated distally, but that species lacks talon tubercles and has an extraordinarily large first abdominal torus (Fig. 16).

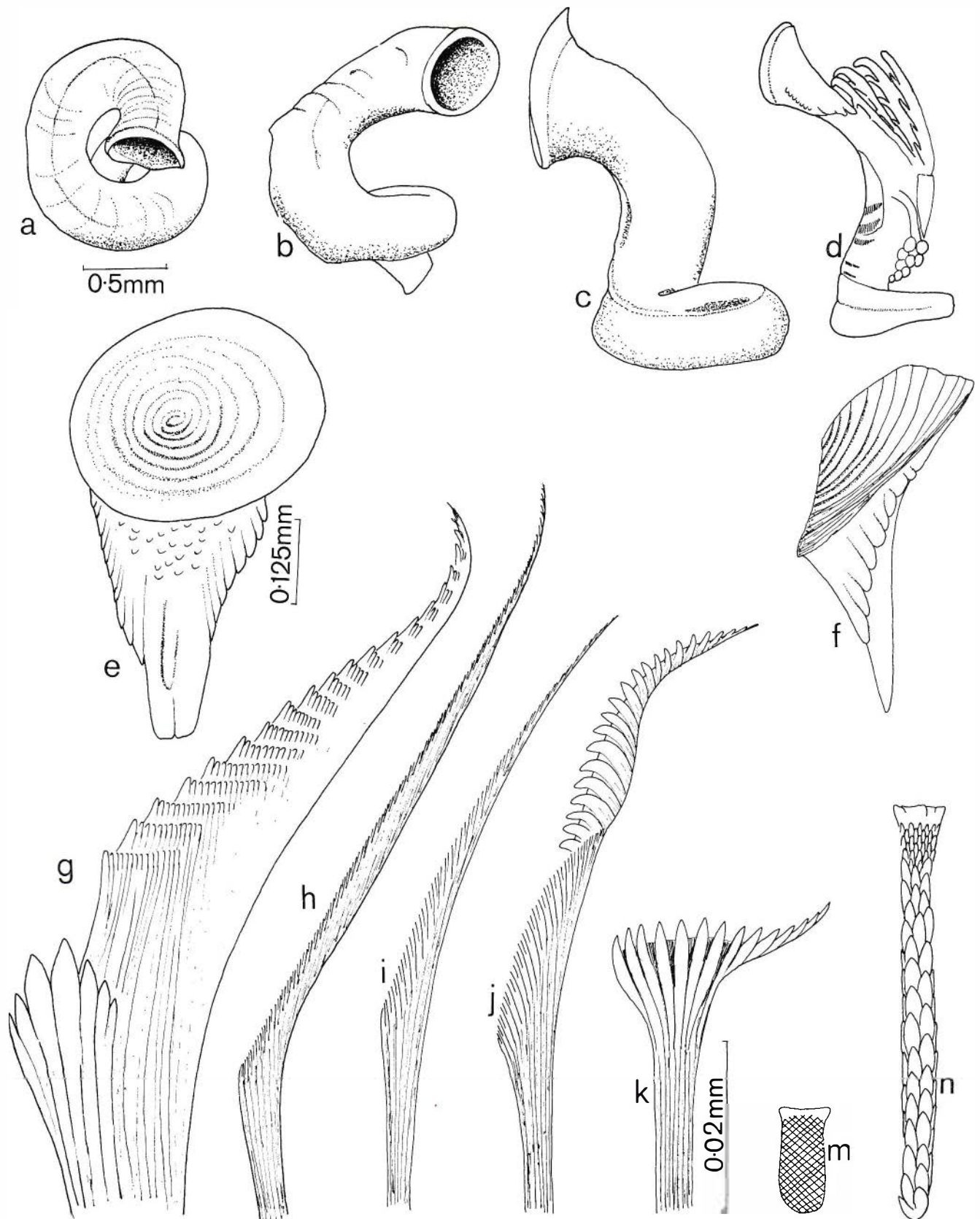


Figure 13 *Protolaospira augeneri* a tube of holotype from above; b tube of holotype from side; c tube of paratype from side; d paratype worm out of tube (dorsal view of thoracic region); e operculum (dorsal view); f operculum (side view); g collar seta; h simple seta associated with collar seta; i simple seta from second thoracic fascicle; j sickle seta from third thoracic fascicle; k abdominal seta; m abdominal uncinus; n thoracic uncinus.

Protolaeospira capensis (Day, 1961)

Figures 11c, 12b, 14

Spirorbis capensis Day, 1961

MATERIAL EXAMINED: 7 specimens, 2 mounted in polyvinyl lactophenol.

LOCATION: Little Barrier Island.

HABITAT: On carapace of the spiny lobster *Jasus edwardsi* (Hutton).

DESCRIPTION OF SPECIES

Tube. Sinistral, somewhat porcellanous, with 2 or 3 longitudinal ridges, most prominent in terminal section of tube (Fig. 14a). Tightly coiled, mouth partly overlies previous whorl. Inside of tube shiny. Tube thick, difficult to break. 4 whorls, but only 1 visible from above. Coil diameter 1.5 mm.

Operculum with slightly concave calcified plate, massive talon with lateral wings bearing blunt projections. Dorsal side, a thickened rod, but talon without a ventral spur. More or less translucent, bifurcated at its extremity (Figs 14b, c).

Thorax. Collar folds not fused dorsally. 3 tori on each side, fascicle of setae associated with 3rd torus on convex side, but not with that on concave side. Thus parapodial rudiments equivalent to $3\frac{3}{4}$ segments. Collar setae (Fig. 14d) with proximal fin and broad distal blade, coarsely toothed and cross-striated. Associated with collar setae, simple setae with narrow, finely serrated blades. 2nd, 3rd, and 4th fascicles with simple setae with more or less smooth blades (Fig. 14e), 3rd and 4th fascicles also with sickle setae (Fig. 14g). Terminal portion of blades of sickle setae from 3rd fascicles short compared with proximal portion, whereas those from 4th fascicle comparatively longer. Most uncini on concave side (Fig. 14i) have broad anterior pegs and single row of teeth for much of their length, whereas smaller uncini and those on convex side have 2 or 3 longitudinal rows of teeth.

Asetigerous region only slightly longer than distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 19 segments. Setae (Fig. 14f) somewhat brush-like, with short strongly geniculate blades bearing teeth which appear, under a microscope, to be pointed. Uncini (Fig. 14h) numerous and widely spaced in tori on concave side. With broad anterior pegs and about 10 longitudinal rows of fine teeth. Uncini and setae distributed very unevenly between concave and convex sides (Fig. 11c).

Incubation. Embryos incubated in a mass attached to animal by short stalk arising from faecal groove at level of 3rd tori. "Brood sac" large, in live animals tip may lie posterior to end of abdomen. Not held within faecal groove, only point of attachment via anterior stalk.

Body colours of live specimens. Radioles and collar, tinged with orange (Pl. 7, A7*); stomach and intestine, red/brown (Pl. 7, D7); eggs in "brood pouch", rich orange (Pl. 7, A8).

REMARKS: Most *Protolaeospira* species have prominent transverse ridges and lack longitudinal ridges. *Protolaeospira lebruni*, *P. (Dextralia) falklandicus* Pixell, 1912 (see Knight-Jones 1973 for definition of *Dextralia*), and *P. capensis* have longitudinal ridges. The latter species described from specimens collected off South Africa agrees closely with that described here. Day observed a third thoracic torus on the concave side only, but a study of material kindly supplied by Professor Day indicates that this species may also have a third torus and fourth fascicle on the convex side. These are somewhat reduced and would easily be overlooked, or perhaps they are not developed in small specimens. Day described thoracic uncini with two or three longitudinal rows of teeth, and while this is true of many uncini on the convex side, the longest uncini on the concave side have a single row for most of their length. A close comparison of mounted specimens of the South African and New Zealand species revealed no significant differences, and the New Zealand species described here is therefore identified as *P. capensis*.

OTHER RECORDS: False Bay, South Africa (Day 1961).

Protolaeospira gracei new species

Figures 11d, 12d, 15

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.257a.

MATERIAL EXAMINED: 17 specimens, 4 mounted in polyvinyl lactophenol.

LOCATION: Landing Bay, Poor Knights Islands.

HABITAT: On the bryozoan *Hipellozoon novaezealandiae* Waters 50–70 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, somewhat porcellanous, large and strong with single longitudinal ridge on outer edge of top (Fig. 15a). Sides have faint narrow transverse growth bands. 1 or 2 whorls visible from above, deep central concavity. Coil diameter 2.8 mm.

Operculum. A deeply concave "horny" cup forms plate. Talon large, calcified, and "scaly" in appearance (Figs 15c, d), with lateral protruberances and ventral spur. From dorsal side of talon, strand of tough fibrous tissue connects operculum with 1st and 2nd thoracic tori on concave side.

*In Methuen Colour Book (Kornerup & Wanscher 1967)

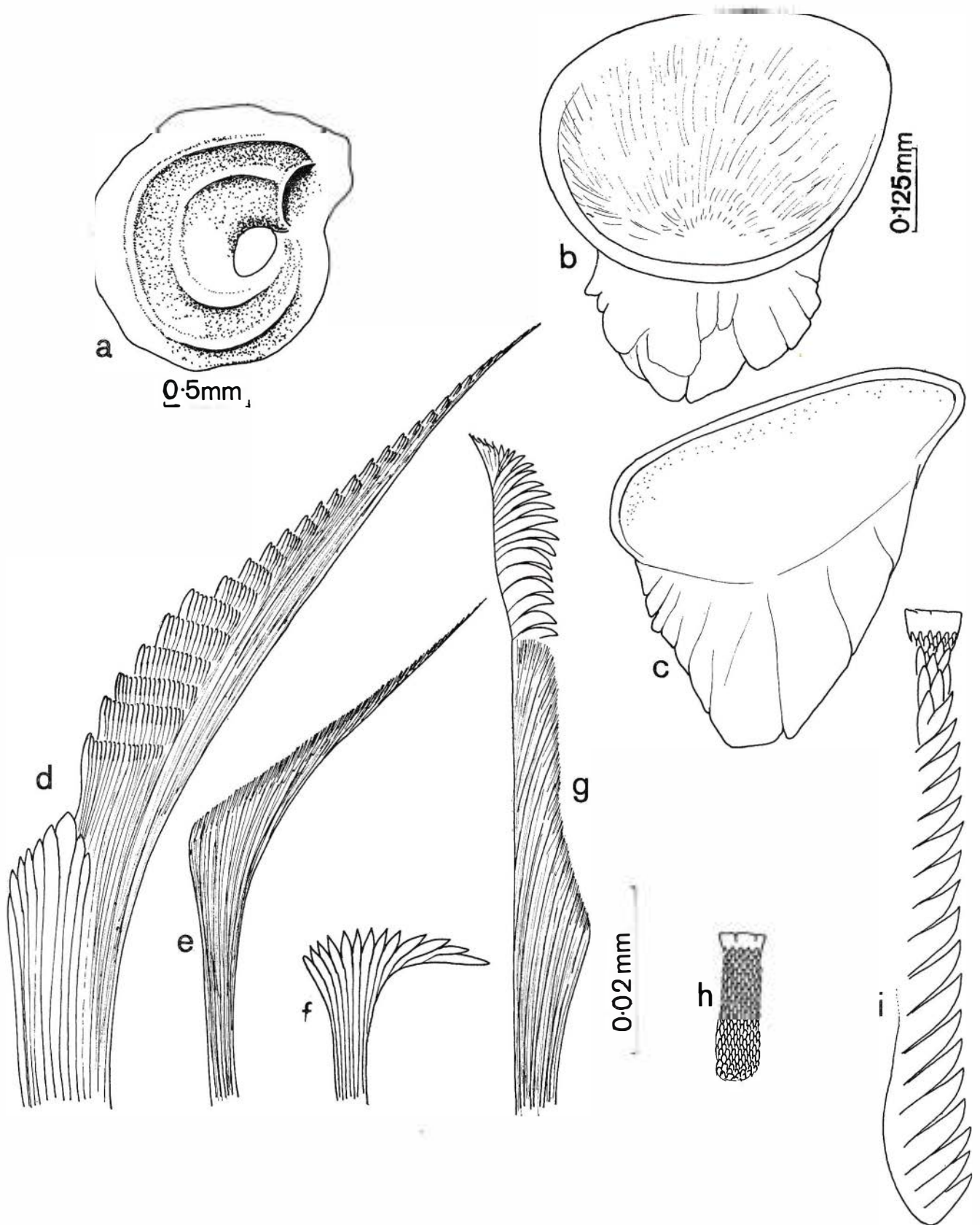


Figure 14 *Protolaeospira capensis* a tube; b operculum (dorsal view); c operculum (ventral view); d collar setae; e simple seta from second thoracic fascicle; f abdominal seta; g sickle seta from third fascicle; h abdominal uncinus; i thoracic uncinus.

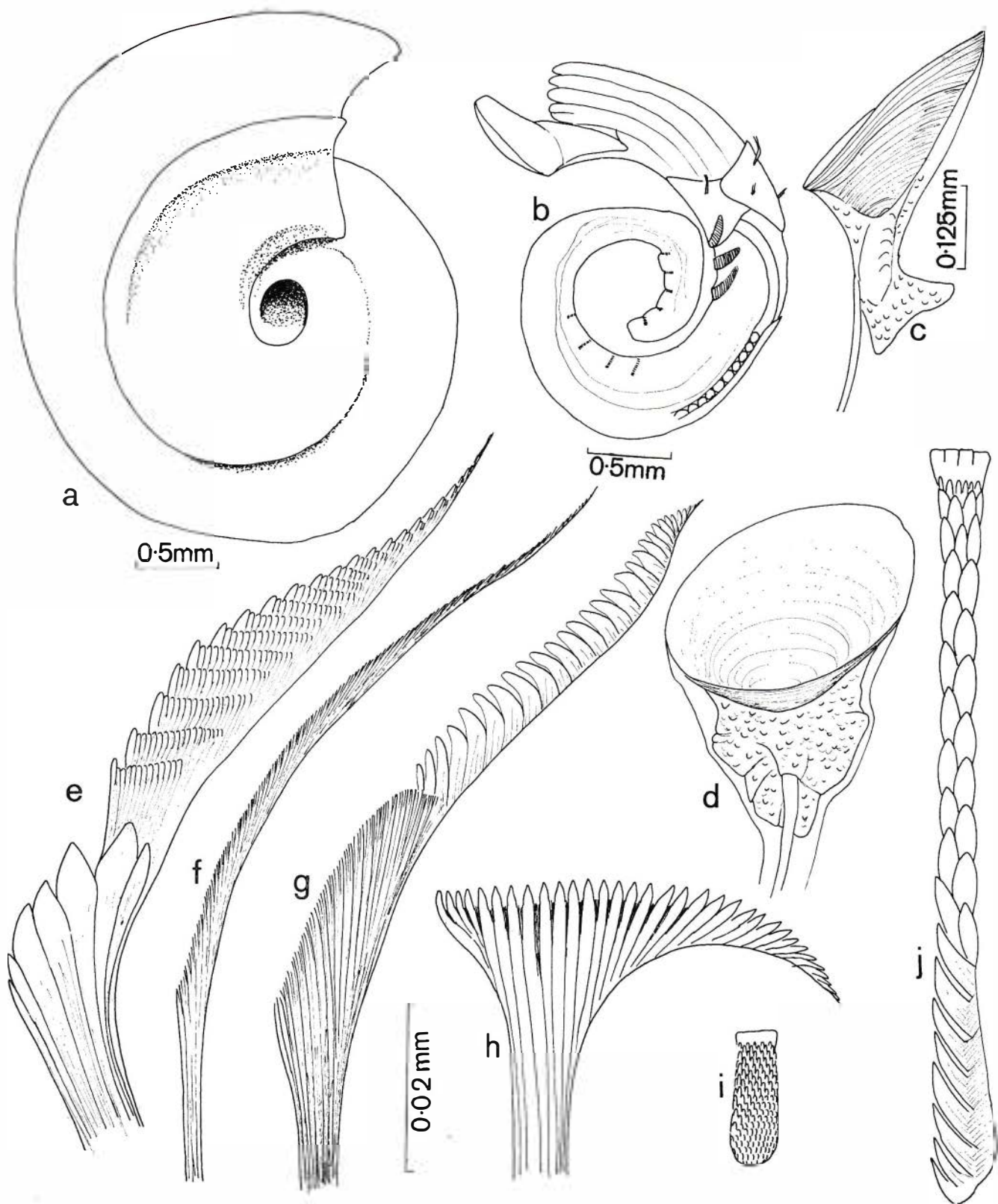


Figure 15 *Protolaeospira gracei* a tube; b worm showing dorsal side with thoracic attachment stalk and eggs held in a groove; c operculum in side view; d operculum (dorsal view); e collar seta; f fine seta associated with collar seta; g sickle seta from third thoracic segment; h abdominal seta; i abdominal uncinus; j thoracic uncinus.

Thorax. 9 branchiae. Collar folds not fused dorsally (Fig. 15b). 3 tori on each side, fascicle of setae associated with 3rd torus on concave side but not with that on concave side. Collar setae (Fig. 15e) with proximal fin and distal blade, coarsely toothed and cross-striated. Capillary setae associated with them (Fig. 15f). 2nd, 3rd, and 4th fascicles have simple finely striated setae with almost smooth-edged blades, sickle setae (Fig. 15g) present in 3rd and 4th fascicles. Sickle setae from 3rd fascicles; distal portion of blade about $\frac{1}{2}$ length of blade, whereas in those from 4th fascicle distal portion longer than proximal section. Uncini (Fig. 15j) have broad anterior pegs and 1, 2, or 3 longitudinal rows of teeth.

Asetigerous region short, about twice distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 18 segments. Setae rather brush-like (Fig. 15h), with ovate teeth. Uncini (Fig. 15i) with broad anterior pegs, about 8 longitudinal rows of fine teeth.

Incubation. Embryos held in mass, attached by transparent stalk, arising dorsally at level of 1st thoracic tori. In specimens examined, embryo mass embedded in groove in anterior portion of dorsal side of abdomen (Fig. 15b).

Body colours of live animals. Radioles and collar, rich reddish brown (Pl. 8, A8*); stomach, brown (Pl. 8, C8); anterior of abdomen, orange (Pl. 7, A8); remainder of abdomen, colourless. Opercular plate "horny", brown. Eggs embedded in groove, yellow.

REMARKS: In details of opercular structure and setation this is similar to *P. ambilateralis*, but the pronounced longitudinal ridge and absence of clear growth striae on the tube together with slight differences in structure and distribution of setae and uncini tend to suggest that it may be a different species.

This species is named after Dr Roger Grace, Auckland University, to whom I am indebted for help in making collections of Spirorbinae in New Zealand.

Protolaeospira lebruni (Caullery & Mesnil, 1897)

Figures 12c, 16, 17a.

Spirorbis (*Paralaeospira*) *lebruni* Caullery & Mesnil, 1897

Protolaeospira lebruni: Knight-Jones, Knight-Jones & Bregazzi 1973

MATERIAL EXAMINED: More than 100 specimens, 5 mounted in polyvinyl lactophenol.

LOCATION: Goat Island channel, near Leigh Marine laboratory.

*In Methuen Colour Book (Kornerup & Wanscher 1967)

HABITAT: On undersides of stones, about 5 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, thick, somewhat porcellanous, with 2 longitudinal ridges, 1 on each side of top of tube and deep indentation between them (Fig. 16a). Outer longitudinal ridge demarcates top from oblique sides. Coil diameter about 2.0 mm.

Operculum. In juveniles, opercular plate slightly concave, with massive talon (Figs 16b, c). Plate delaminates, forms truncated cone in older specimens (Figs 16d, e). Massive talon has lateral lobes and dorsal median longitudinal ridge, connected with strong strand of tissue attached posteriorly to 1st and 2nd thoracic tori on concave side. In live individuals, operculum usually with conspicuous narrow red band around it, at junction between opercular plate and talon. Prominent characteristic feature in most live specimens.

Thorax. 6 radioles. Collar folds overlap but not fused dorsally. 3 tori on concave side, but no other rudiments of 4th thoracic segment observed. Collar setae (Fig. 16g) with proximal fin, distal blade with coarse teeth and cross-striations. Capillary setae associated with them. 2nd and 3rd fascicles contain simple setae with almost smooth blades (Fig. 16h), also sickle setae (Fig. 16i) in 3rd fascicles. Most uncini long, with broad slightly bifurcate anterior peg and single row of teeth (Fig. 16k). Smaller uncini on convex side and at tapered end of tori on concave side have 2 or 3 rows of teeth.

Asetigerous region short, about same length as distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 16 segments. Setae strongly geniculate with short broad blades and few rounded teeth (Fig. 16j). 1st abdominal torus on concave side extremely long, its uncini different from other abdominal uncini, being about twice length and having fewer longitudinal rows of teeth. Uncini extremely unevenly distributed, few present in tori on convex side (Fig. 17); with broad anterior pegs and about 10 longitudinal rows of fine teeth.

Incubation. Embryo-mass attached to dorsal side of thorax by stalk arising from faecal groove at level of 2nd thoracic tori. In specimens not incubating, stalk clearly seen; in 1 or 2 cases, end of stalk appeared to be hollow suggesting that eggs transported via stalk to development chain.

Body colours of live animals. Most of body colourless except for: stomach, brown (Pl. 6, C8*); eggs in brood mass, red (Pl. 8, A8), and red ring around operculum (Pl. 8, A8). Larvae without white attachment gland.

REMARKS: This description agrees well with that by Caullery and Mesnil of *S. lebruni* from Cape Horn. It has recently been described from East Falkland Is by Harris (1969). However, these authors did not observe

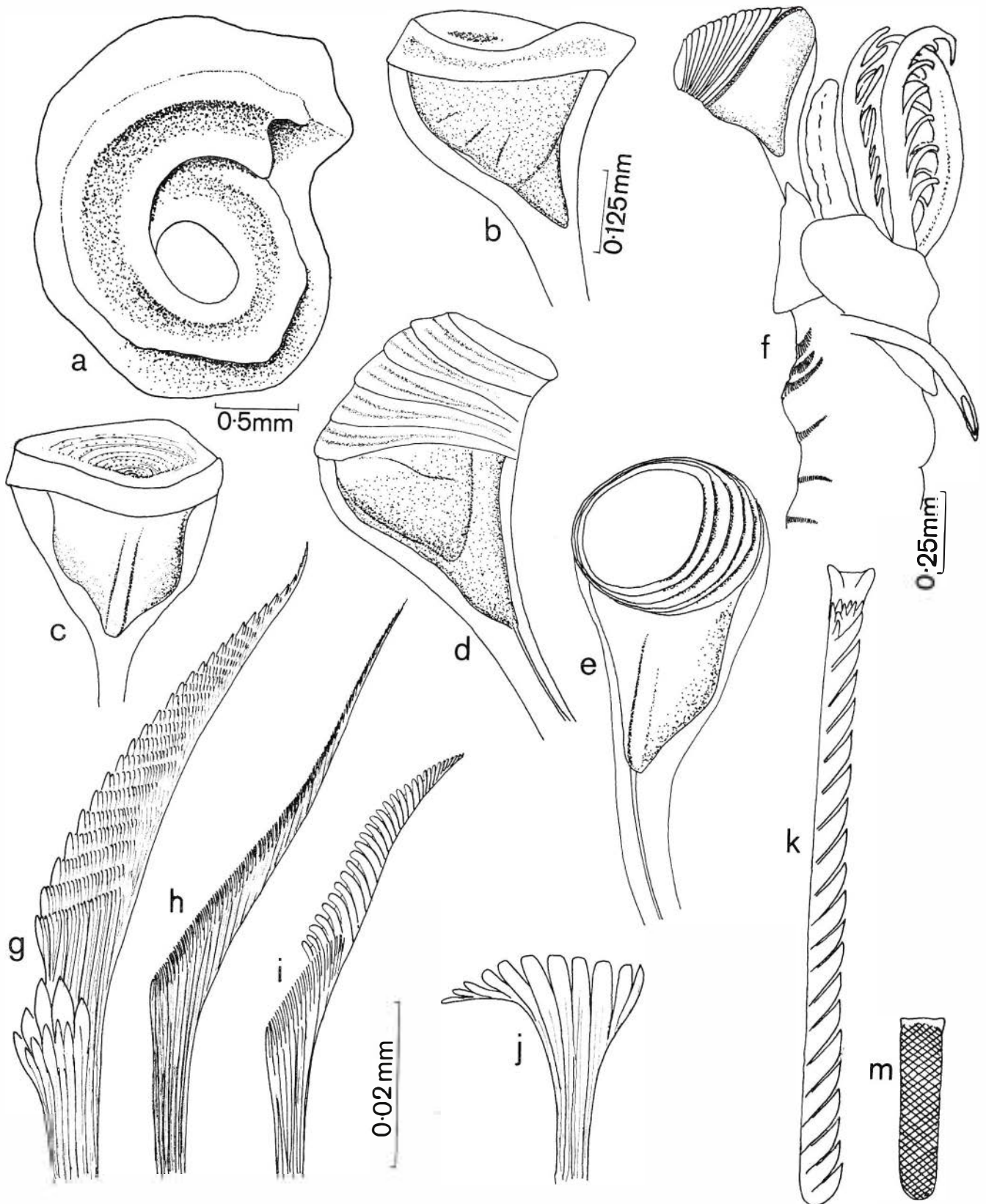


Figure 16 *Protolaeospira lebruni* a tube; b juvenile operculum (side view); c juvenile operculum (dorsal view); d adult operculum (side view); e adult operculum (dorsal and from above); f anterior region of worm (dorsal view); g collar seta; h simple seta from second thoracic fascicle; i sickle seta from third thoracic fascicle; j abdominal seta; k thoracic uncinus; m abdominal uncinus.

that the embryos are retained by a thoracic stalk, and therefore that this species is best grouped with others in the genus *Protolaeospira*.

OTHER RECORDS: Patagonia (Caullery & Mesnil 1897); Strait of Magellan (Ehlers 1900, 1901); Falkland Islands (Fauvel 1916; Harris 1969); Heard and Kerguelen Islands (Monro 1939).

Protolaeospira translucens (Bailey in Bailey & Harris, 1968)
 Figures 12e, 17b, 18

Spirorbis translucens Bailey in Bailey & Harris, 1968

MATERIAL EXAMINED: 5 specimens.

LOCATION: NZOI Stn F905, 35° 25' S, 175° 48' E, about 240 km north of Auckland.

HABITAT: On stones, 157–161 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, vitreous, translucent, with prominent growth ridges (Fig. 18a). Inside, tube very smooth and shiny. Round in cross-section, 2 whorls visible from above. Coil diameter 1.5–2.0 mm.

Operculum. Oblique plate concave, translucent, like rest of operculum. Beneath plate, ampulla may be quite convex or rather flat. Talon triangular and elongate (Fig. 18c), surface pitted. On dorsal side, a slightly thicker median longitudinal ridge forms point of attachment for a strong strand of tissue which is associated with stalk, connects operculum with 1st and 2nd thoracic tori on concave side. No ventral spur.

Thorax. Collar folds not fused dorsally. 3 tori on each side, fascicle of setae associated with 3rd torus on convex side but not with that on concave side. Thus parapodial rudiments equivalent to $3\frac{3}{4}$ thoracic segments. Collar setae (Fig. 18e) have fin with a few teeth and broad blade with relatively narrow band of cross-striations (in side view). Capillary setae associated with them. 2nd, 3rd, and 4th fascicles have simple setae with smooth edged blades (Fig. 18f), sickle seta (Fig. 18g) also present in 3rd and 4th fascicles. Uncini (Fig. 18i) with broad, somewhat bifid, pegs, most have 2 longitudinal rows of teeth.

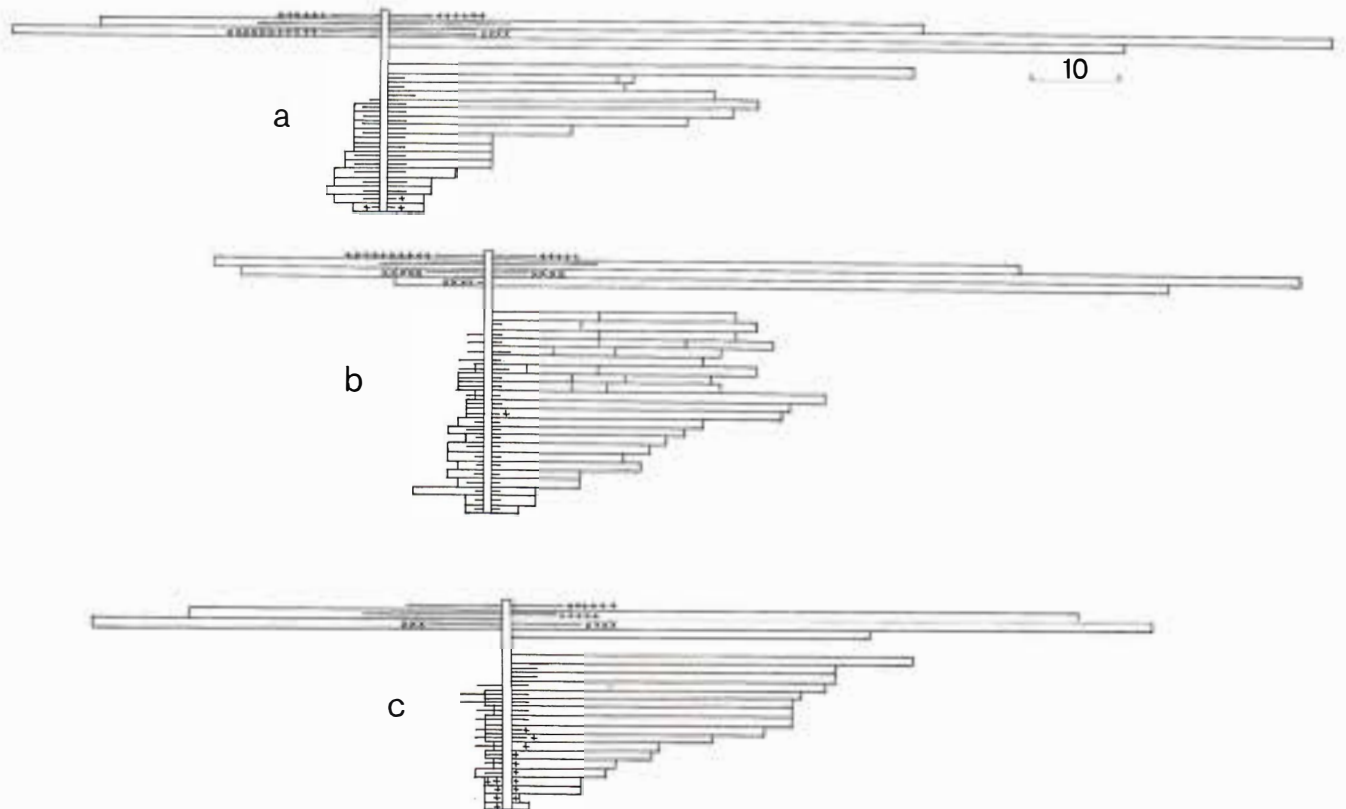


Figure 17 Distribution of setae and uncini in a *Protolaeospira lebruni*; b *Protolaeospira translucens*; c *Metalaeospira armiger*. (See Fig. 6 for explanation of histograms.)

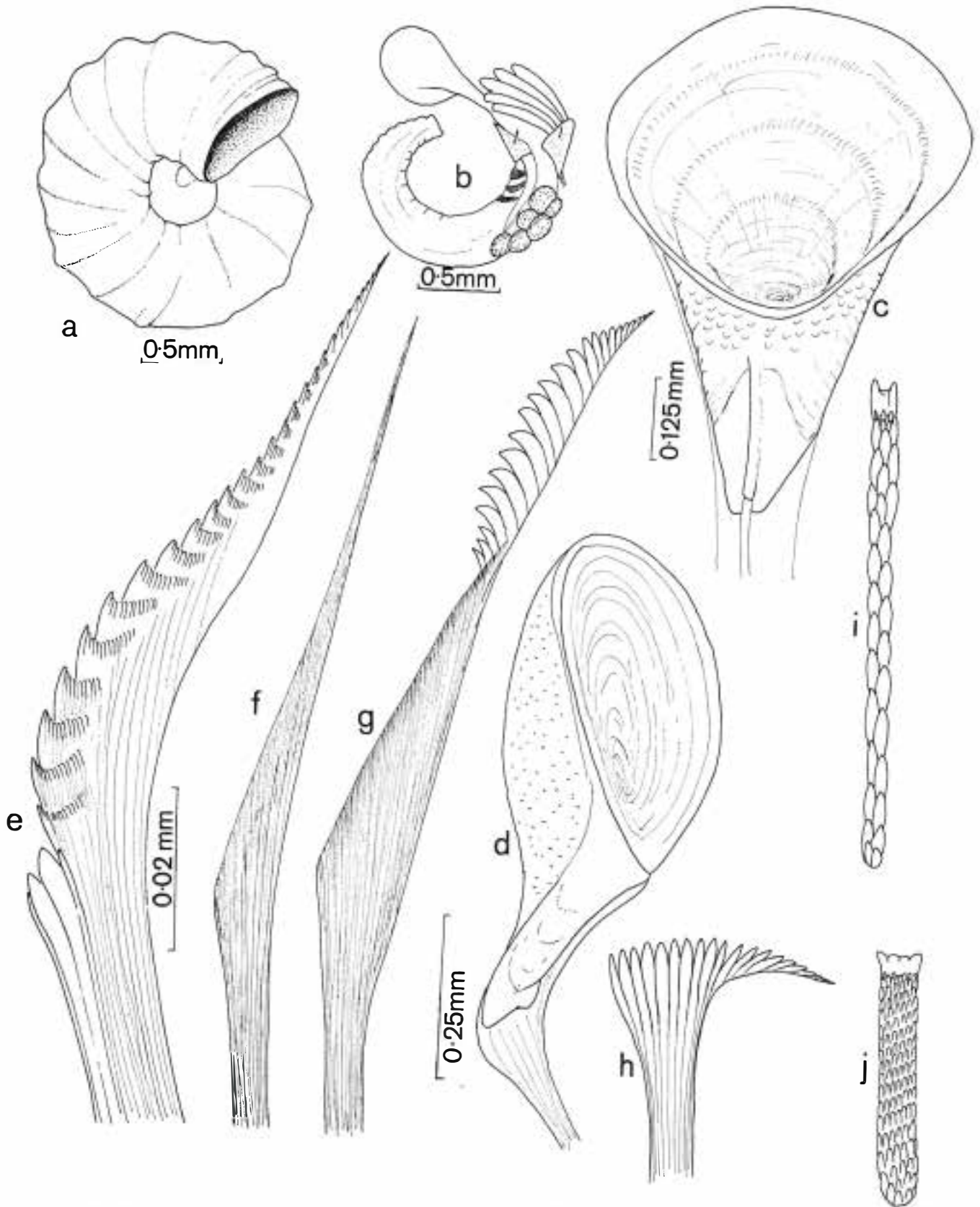


Figure 18 *Protolaeospira translucens* a tube; b worm (dorsal view); c operculum (dorsal view); d operculum (side view); e collar seta; f simple seta from second thoracic fascicle; g sicklet seta from third thoracic fascicle; h abdominal seta; i thoracic uncinus; j abdominal uncinus.

Asetigerous region short, about equivalent to 3 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 23 segments. Tori on concave side contain many uncini, whereas very few present in those on convex side. Setae with short brush-like blades (Fig. 18h) with ovate teeth. Uncini (Fig. 18j) have broad anterior pegs and 5 or 6 longitudinal rows of teeth.

Incubation. Embryos incubated in mass attached by stalk which arises from dorsal side of thorax in position slightly anterior to 1st thoracic torus on concave side (Fig. 17b).

REMARKS: The description agrees with that of "*Spirorbis*" *translucens* except that the sides of the talon appear to be smoother than those figured by Bailey & Harris (1968). It appears to be closely related to *P. calypso* (Zibrowius, 1970) but differs from it since the latter species has an opaque tube and the talon has a ventral medial keel, absent from *P. translucens*. A specimen described from Hawaii (Vine *et al.* 1972) may also belong to this species.

OTHER RECORDS: Galapagos Islands (Bailey & Harris 1968).

Genus *Romanchella* Caullery & Mesnil, 1897 (emended)

Sinistral coiling, incubation in embryo mass attached by stalk to thorax; simple collar setae small on concave side, few in number; only 2 pairs thoracic tori; sickle setae present in 3rd fascicles; abdominal setae usually less than $\frac{1}{4}$ size of collar setae, strongly geniculate with small tapered blade, often paired, 1 of each pair may be a hooked capillary seta; thoracic uncini with blunt gouged-shaped anterior pegs; abdominal uncini numerous on concave side, sparse on convex side; largest tori near anterior end of setigerous region; white larval attachment glands probably not present. Margins of collar fused to form tunnel over mid-dorsal thoracic groove.

TYPE-SPECIES: *Romanchella perrieri* (Caullery & Mesnil, 1897).

Romanchella perrieri (Caullery & Mesnil, 1897)

Figures 19, 20a, 21a

Spirorbis (*Romanchella*) *perrieri* Caullery & Mesnil, 1897
Spirorbis perrieri: Harris 1969

MATERIAL EXAMINED: Approximately 50 specimens.

LOCATION: Landing Bay, Poor Knights Islands.

HABITAT: On green *Bugula* sp. at 5–40 m depth.

DESCRIPTION OF SPECIES

Tube. Sinistral, somewhat porcellanous, 3 well-defined longitudinal ridges prolonged into 3 teeth over mouth of tube (Fig. 19a). Between longitudinal ridges narrow oblong indentations, on inner edge of outer ridge perforate ridge. Indentations on furrow between median and inner ridges not as well developed. Sides of tube with narrow vertical indentations, more or less vertical. 2 whorls visible from above. Coil diameter 1.0–1.5 mm.

Operculum. Several concave plates stacked inside each other. In 1 specimen examined, 11 plates, but often only 2 or 3. Basal plate with large talon, more or less bilaterally symmetrical, triangular in dorsal view, with median longitudinal ridge to which is attached a strand of strong tissue within opercular stalk. Operculum not densely calcified, generally translucent except where several layers of plates render it opaque.

Thorax. Dorsal folds of collar fused (Fig. 19c). 2 tori and 3 fascicles on each side of thorax. Collar setae with simple finely striated blades (Fig. 19f), small capillary setae (Fig. 19g) associated with them. 2nd and 3rd fascicles with simple setae, blades as long as or longer than those of collar setae. Sickle setae (Fig. 19h) present in 3rd fascicles. Uncini (Fig. 19m) with broad anterior pegs, 4 or 5 longitudinal rows of teeth.

Asetigerous region about 3 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 12 segments. Few uncini in tori on convex side (Fig. 20a), longest tori towards anterior end of concave side (Fig. 21). Setae (Fig. 19i) strongly geniculate, with short blades and few teeth. Associated with these in most fascicles are simple setae with short, curved, finely striated blades (Fig. 19j). Uncini (Fig. 19k) with broad anterior pegs, about 10 longitudinal rows of fine teeth.

Incubation. Embryo mass loosely attached to thorax by narrow, apparently hollow, stalk originating on dorsal side at about level of 2nd thoracic tori. When embryos not being brooded, stalk may be observed.

Body colours of live specimen. Radioles and thorax, colourless; collar, pale orange. (Pl. 6, A3*); stomach, reddish-brown (Pl. 8, A6); abdomen, tinged with orange (Pl. 6, A7).

*In Methuen Colour Book (Kornerup & Wanscher 1967)

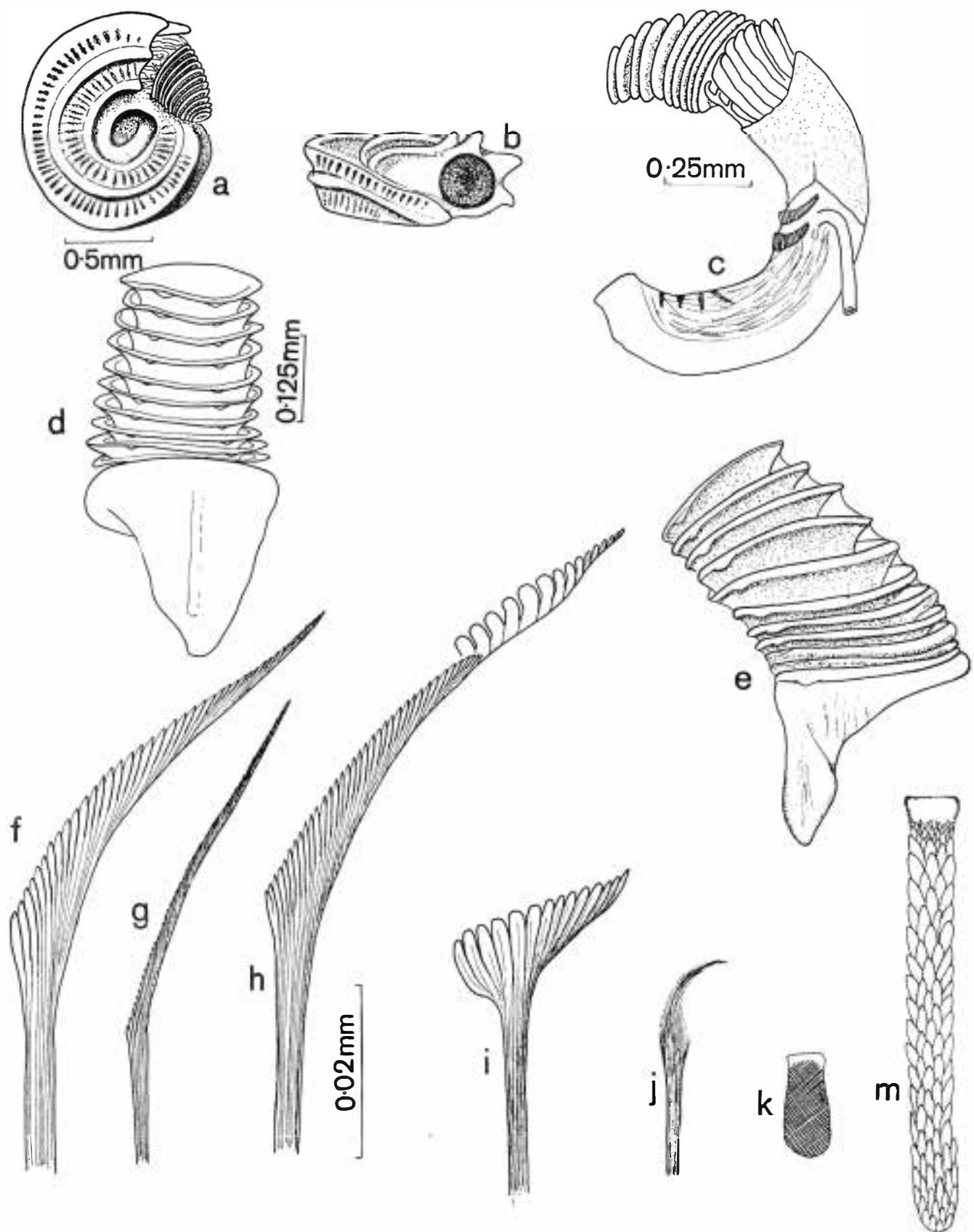


Figure 19 *Romanachell perrieri* a tube containing worm whose operculum is protruding from the aperture; b side view of tube; c worm (dorsal view); d operculum (dorsal view); e operculum (side view); f collar seta; g seta associated with collar seta; h sickle seta from third thoracic fascicle; i abdominal seta; j hooked capillary seta from posterior abdominal fascicle; k abdominal uncinus; m thoracic uncinus.

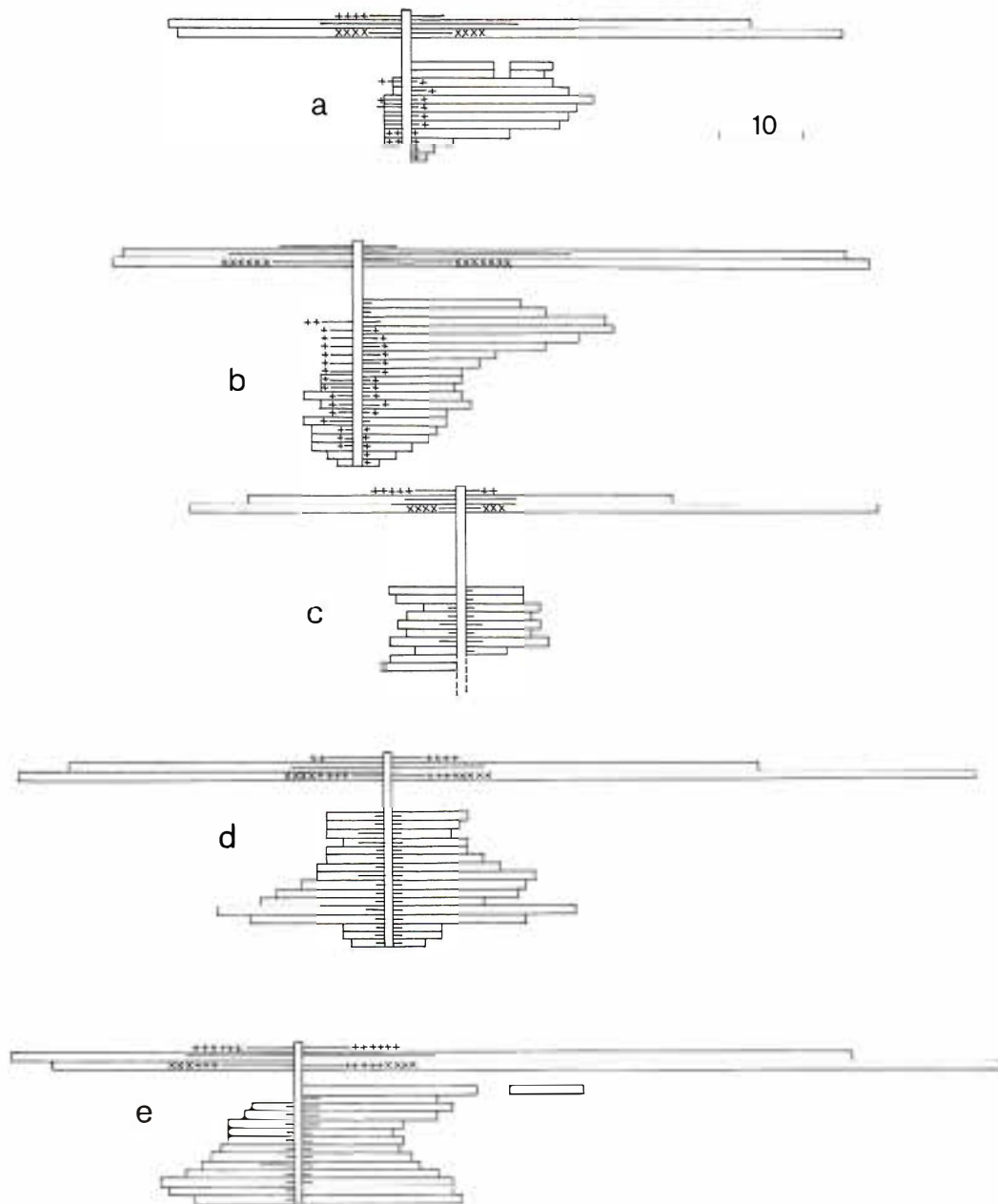
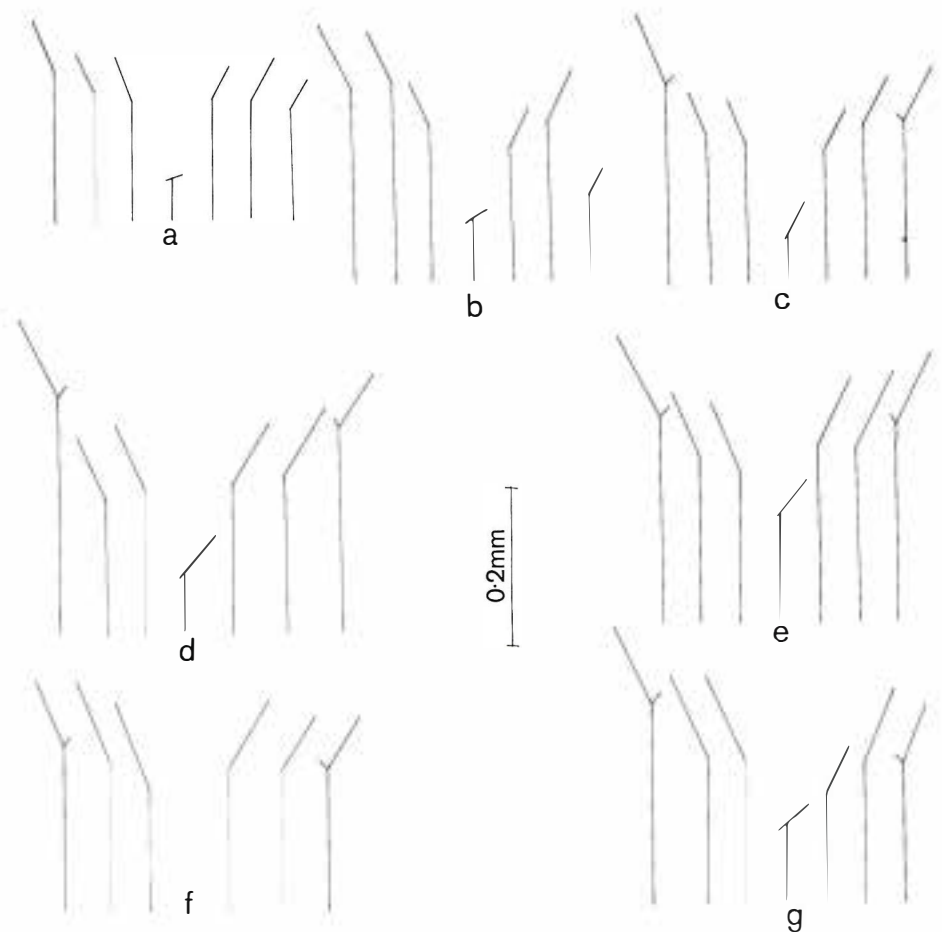


Figure 20 Distribution of setae and uncini in **a** *Romanchella perrieri*; **b** *Romanchella solea*; **c** *Pileolaria tegwyni*; **d** *Pileolaria (Duplicaria) pocillator*; **e** *Pileolaria (Duplicaria) koehleri*. (See Fig. 6 for explanation of histograms.)

Figure 21 Relative sizes of setal shafts and blades in **a** *Romanchella perrieri*; **b** *Romanchella solea*; **c** *Pileolaria tegwyni*; **d** *Pileolaria (Duplicaria) pocillator*; **e** *Pileolaria (Simplicaria) pseudo-militaris*; **f** *Pileolaria (Simplicaria) ovata*; **g** *Pileolaria (Duplicaria) koehleri*. (See Fig. 2 for explanation of stick diagrams.)



REMARKS: The characteristic tube, operculum, and setae render identification comparatively easy. It is the type-species for *Romanchella*, and it exhibits a method of egg retention which is typical of the genus.

Caullery & Mesnil (1897) recognised three varieties of this species and, from material collected around New Zealand, it seems that their observations reflect the variety of tube and opercular structure exhibited by the species. The description above applies to the typical growth form observed at the Poor Knights Islands. Specimens collected further south had larger tubes, and in many cases dense calcification had obliterated the intricate pattern of longitudinal ridges and indentations or perforations. The operculum may have few plates or

it may develop into a truncated cone consisting of many plates. The continual growth and delamination of opercular plates such as occurs in *R. perrieri* presumably discourages settlement of epibiota.

OTHER RECORDS: Patagonia (Caullery & Mesnil 1897); Strait of Magellan (Ehlers 1900, 1901); Port Charcot (Gravier 1907); Cape Adare (Ehlers 1912); South Georgia (Augener 1932); Tristan da Cunha (Harris 1969); East Falkland Islands (Harris 1969); Auckland Islands (present survey).

“*Romanchella perrieri*” recorded from Kerguelen Islands was in fact regularly coiled *Helicosiphon* (Knight-Jones, Knight-Jones & Bregazzi 1973).

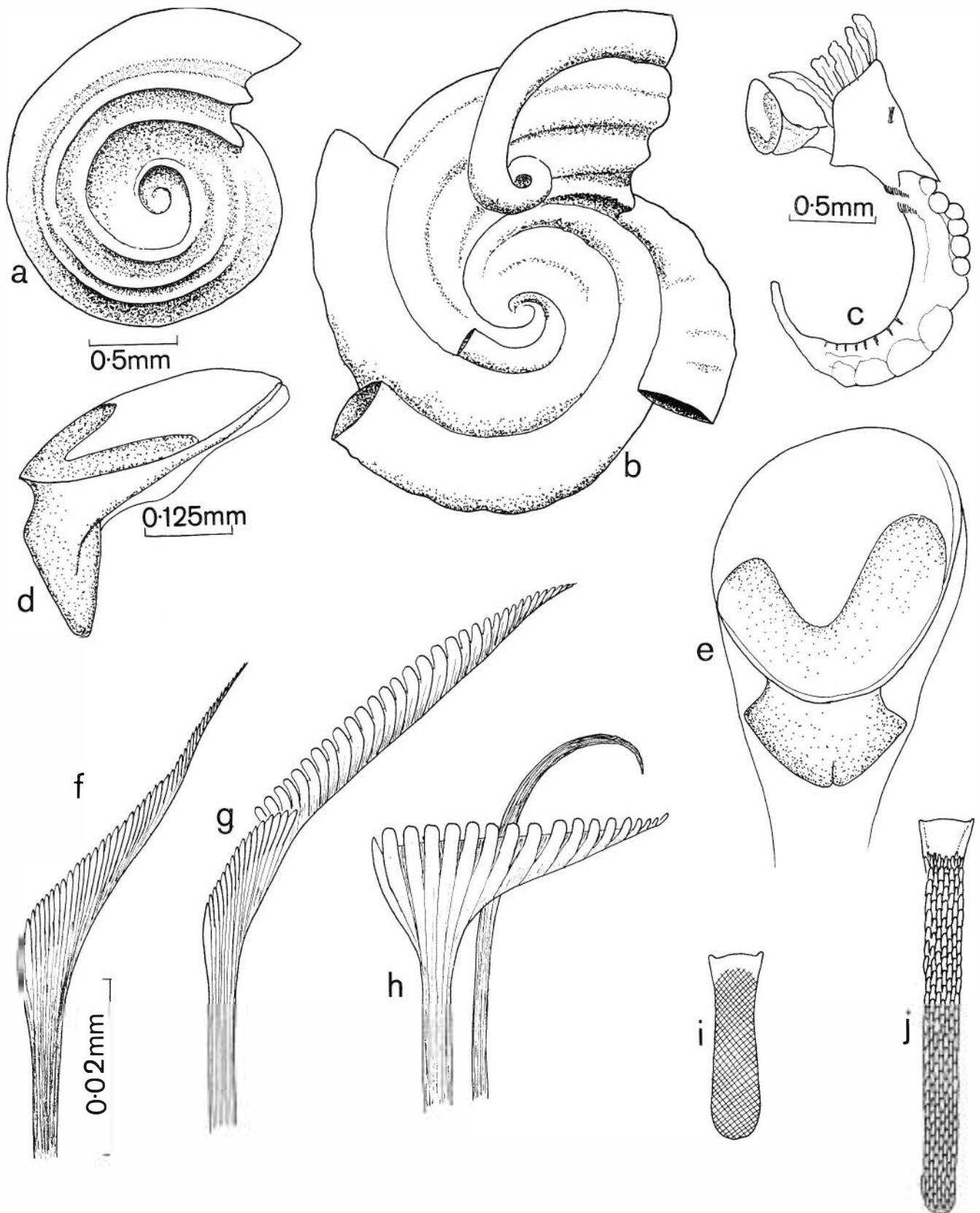


Figure 22 *Romanchella solea* a tube; b tube partially obscured by tubes of another species (i.e. *Paralaeospira levinseni*); c worm (dorsal view); d operculum (side view); e operculum (dorsal and from above); f collar seta; g sickle seta from third thoracic fascicles; h abdominal setae; i abdominal uncinus; j thoracic uncinus.

Romanchella solea new species

Figures 20b, 21b, 22

HOLOTYPE: British Museum (Natural History) Reg. No. ZB. 1971.258.

PARATYPES: British Museum (Natural History) Reg. No. ZB. 1971.259.

MATERIAL EXAMINED: About 150 specimens.

LOCATION: Landing Bay, Poor Knights Islands.

HABITAT: On fronds of a small brown kelp, *Ecklonia radiata* Agardh, 2–40 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, porcellanous, 3 or sometimes 4 longitudinal ridges, usually prolonged into teeth above mouth (Fig. 22a). Outer longitudinal ridge often less pronounced than those inside it. Sides oblique, or more or less vertical. Tube thick, heavily calcified. Coil diameter 1.5–2.0 mm. Usually tube structure obscured by tubes of another species (*Paralaeospira levinseni*) for which this tube appears to be a favourite settlement substrate. Several smooth, loosely coiled tubes of *P. levinseni* frequently smother larger tubes of *R. solea*, creating a circular saw effect (Fig. 22b).

Operculum with flat or slightly concave plate, incomplete calcification gives horseshoe shape (Figs 22d, e). Talon heavily calcified, bifid at extremity.

Thorax. 7 radioles with short terminal filaments (about $1\frac{1}{2}$ times as long as distal pinnules). Collar folds fused dorsally; collar extends anteriorly, surrounding basal section of branchiae. 2 tori and 3 fascicles of setae on each side of thorax. Collar setae (Fig. 22f) with simple finely striated blades, not cross-striated. Smooth, curved, capillary setae, associated with collar setae. 2nd and 3rd fascicles with simple setae similar to collar setae, sickle setae (Fig. 22g) present in 3rd fascicles. Distal portions of blades of these long compared with short proximal sections. Uncini (Fig. 22j) vary greatly in length, creating strongly tapered tori; with broad anterior pegs, deeply scalloped creating appearance of 2 distinct “horns” when viewed under light microscope. 5–7 longitudinal rows of narrow teeth.

Asetigerous region about 4 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 21 segments. Uncini arranged very asymmetrically, few present on convex side (Fig. 20b). Setae (Fig. 22h) of 2 types, strongly geniculate with short blades bearing blunt teeth, and curved capillary setae. Uncini (Fig. 22i) with broad anterior pegs, about 10 longitudinal rows of fine teeth.

Incubation. Embryo mass containing about 20 eggs attached by short, delicate, transparent funnel to thorax at about level of 1st tori. Embryos held in a string which spirals around abdomen, in preserved animals string appeared to be lodged in a groove.

Body colours of live specimen. Radioles tinged with orange (Pl. 6, A5*); stomach, ochre brown (Pl. 8, C8); anterior of abdomen, reddish (Pl. 8, A8); posterior of abdomen, colourless. Eggs in string, brown (Pl. 9, C8).

REMARKS: This is closely related to *Romanchella quadricostalis* Knight-Jones (1973) from South Australia, but differs from that species in several ways. The tube is considerably larger than that of the Australian species. The opercula differ, as that of the Australian species has a more evenly calcified plate and lacks the triangular talon which is a feature of the species described above. Thoracic uncini of the Australian species do not have such deeply scalloped anterior pegs, and therefore, do not appear to have two “horns”. Also, they have more longitudinal rows of teeth than are present in the species described here. The horseshoe-shaped calcification of the opercular plate is a characteristic feature of this species, and it has been named with this in mind.

Genus *Pileolaria* Claparède, 1868 (emended; Knight-Jones 1973)

Sinistral coiling; only 2 pairs of thoracic tori; incubation in operculum; each collar seta with fin, separated from blade which is usually coarsely serrated and cross-striated; sickle setae present or absent; thoracic uncini very slender, with 1–3 rows of teeth and blunt anterior peg; abdominal setae obliquely geniculate (with tapering blades), usually about $\frac{1}{2}$ size of collar setae; abdominal uncini fairly symmetrical in bilateral distribution; largest abdominal tori lie in posterior half of setigerous region; larvae with single, white, mid-dorsal attachment glands.

TYPE-SPECIES: *Pileolaria (Pileolaria) militaris* Claparède, 1868

Subgenus *Pileolaria* Claparède, 1868

Without multiple opercular plates, sickle setae present.

TYPE-SPECIES: *Pileolaria (Pileolaria) militaris* Claparède, 1868

*In Methuen Colour Book (Kornerup & Wanscher 1967)

Pileolaria (Pileolaria) tegwyni new species

Figures, 20c, 21c, 23

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.260a.

MATERIAL EXAMINED: 5 specimens, 2 mounted in polyvinyl lactophenol.

LOCATION: Landing Bay, Poor Knights Islands.

HABITAT: On bryozoan *Hipellozoon novaezelandiae* at about 40 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, smooth or with irregular transverse growth striae (Fig. 23a). Often coiled helically, round in cross-section. Coil diameter 1.5 mm.

Operculum with rounded calcified dome, extends as apron over most of dorsal side (Fig. 23b), but reduced on ventral side which is thus open (Fig. 23d).

Thorax. 5 radioles. Collar folds not fused dorsally. 2 tori on each side. Collar setae (Fig. 23e) have proximal fin and distal blade with large blunt serrations and distinct cross-striations. Capillary setae associated with these. 2nd and 3rd fascicles with simple finely striated setae, sickle setae (Fig. 23f) present in 3rd fascicles. Uncini (Fig. 23h) with bifid anterior pegs, single rows of teeth along most of length.

Asetigerous region about 9 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 13 segments. Setae (Fig. 23g) geniculate with long, straight, fairly narrow blades, with distinct protuberance at heel. Uncini (Fig. 23h) with broad anterior pegs, about 8 longitudinal rows of fine teeth.

Incubation in opercular brood chamber.

Body colours of live specimen. Radioles and collar, red (Pl. 9, B7*); stomach, red (Pl. 10, A8); abdomen, light pink (Pl. 5, A4); larvae, orange (Pl. 6, A7), with single white attachment glands.

REMARKS: A species from the Palmer Archipelago in the South Atlantic, described by Harris (1969) and identified by him as "*S. moerchi*" Levinsen, 1883, agrees closely with the species described here. A close comparison of material studied by Harris and that

*In Methuen Colour Book (Kornerup & Wanscher 1967)

described above revealed no significant differences in tubes, opercula, or setation. Type specimens of *Pileolaria moerchi* (Levinsen) were examined and showed several differences from *P. moerchi* sensu Harris. The tube of *P. moerchi* (Levinsen) is approximately 4.0 mm in diameter whereas *P. tegwyni* has a much smaller tube with a maximum diameter of approximately 1.0 mm. The operculum in type material of *P. moerchi* has a slight distal concavity flanked by a small protuberance, while that of *P. tegwyni* is evenly rounded, lacking any protuberances. Although both species possess sickle setae (an observation in doubt until recent examination of type specimens of *P. moerchi*) there are some differences in details of setation. There are many more thoracic setae and uncini in *P. moerchi* than in *P. tegwyni*. The asetigerous region of the larger species, *P. moerchi*, is only twice the distance between first and second abdominal tori whereas it is four or five times the distance in *P. tegwyni*.

"*Laeospira*" *rosepigmentata* Uchida, 1971 is closely related to these forms, but should be easily distinguished from *P. tegwyni* by the bilobed shape of its brood chamber.

Another species which shows several close similarities with *P. tegwyni* is *P. daijonesi* Knight-Jones, 1972. Several differences in tube structure and setation separate these two. The tube of *P. daijonesi* is evolute and bears fine irregular growth lines whereas that of *P. tegwyni* is typically more tightly coiled and lacks such a fine pattern of growth striations. Collar setae of the Kenyan species have narrow blades and do not have such coarse teeth as the characteristically prominent teeth of *P. tegwyni*. There are more uncini in thoracic tori of the latter species (approximately twice as many as in equivalent tori of *P. daijonesi*). Sickle setae of *P. daijonesi* have blades with short proximal portions and much longer distal portions whereas those of *P. tegwyni* have blades more or less equally divided between finely serrated proximal portions and bluntly toothed distal sections. Abdominal setae of the latter species are more strongly geniculate and with broader blades than those of *P. daijonesi*.

OTHER RECORDS: Antarctica, Palmer Archipelago (Harris 1969); Acapulco, Mexico (pers. obser.); NE Australia (pers. obser.). It appears that this may be a widely distributed *Pileolaria* species which has been mistakenly identified on a number of occasions as *P. moerchi*.

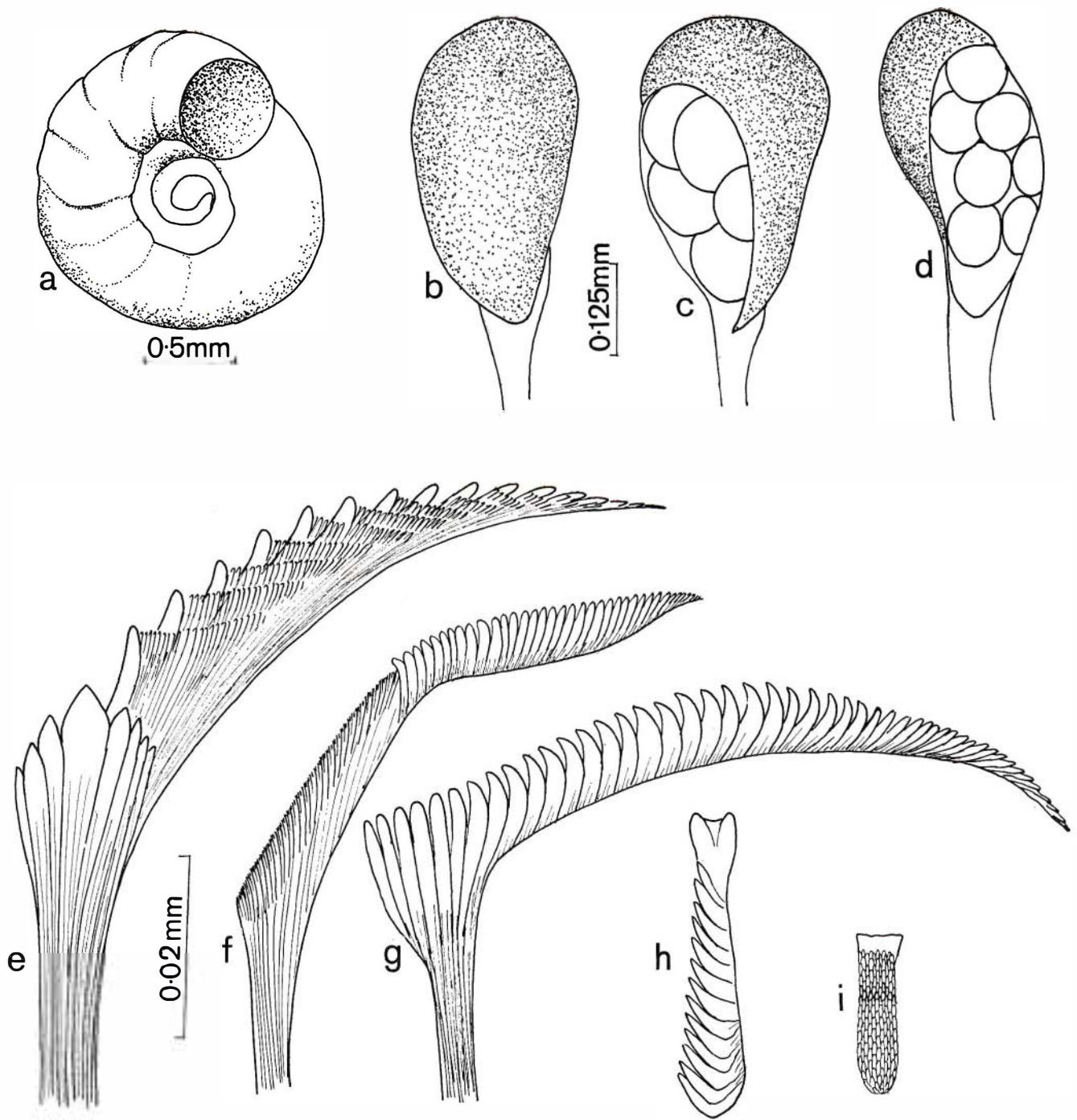


Figure 23 *Pileolaria tegwyni* a tube; b operculum (dorsal view); c operculum (ventro-lateral view); d operculum (ventro-lateral view); e collar seta; f sickle seta from third thoracic fascicle; g abdominal seta; h thoracic uncinus; i abdominal uncinus.

Subgenus **Simplicaria** Knight-Jones, 1973

Like *Pileolaria* sensu stricto, but without sickle setae in 3rd thoracic fascicles.

TYPE-SPECIES: *Pileolaria* (*Simplicaria*) *pseudomilitaris* (Thiriot-Quévieux, 1965).

Pileolaria* (*Simplicaria*) *pseudomilitaris (Thiriot-Quévieux, 1965)

Figures 21e, 24, 25a

Spirorbis pseudomilitaris Thiriot-Quévieux, 1965

Spirorbis berkeleyanus Rioja, 1942 sensu Harris (1968)

Spirorbis regalis Bailey in Bailey & Harris, 1968

Pileolaria (*Simplicaria*) *pseudomilitaris*: Vine, Bailey-Brock & Straughan, 1972

MATERIAL EXAMINED: 6 specimens.

LOCATION: Goat Island Bay, towards the middle of the bay.

HABITAT: On stones in pools at HWN.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, smooth, round cross-section. All preserved tubes decalcified before drawings made.

Operculum with slightly bulging convex plate, delicate transparent rim bearing spines around one side of plate (Fig. 24a). Calcified plate extends over upper walls of chamber on one side, but remainder of walls transparent, developing embryos appear to have more or less uninterrupted contact with surrounding water.

Thorax. 7 radioles with terminal filaments about 3 times as long as distal pinnules; collar folds not fused on dorsal side; 2 tori and 3 fascicles on each side; collar setae (Fig. 24b) have proximal fin and distal blade with

distinct cross-striations. Capillary setae associated with collar setae. 2nd and 3rd fascicles with simple narrow-bladed setae (Fig. 24c), no sickle setae in 3rd fascicles. Uncini (Fig. 24f) with broad anterior peg 2 or 3 longitudinal rows of teeth.

Asetigerous region short, about 3 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 20 segments. Setae (Fig. 24d) tend to have long shafts, geniculate, with tapering blades bearing blunt teeth. Uncini (Fig. 24e) with broad anterior peg, about 7 longitudinal rows of teeth. Distribution of setae in Fig. 25.

Incubation in opercular brood chamber.

Body colours of live specimen. Radioles, colourless; collar, red (Pl. 9, A8*); stomach, brown (Pl. 6, B8); abdomen, colourless; eggs in operculum, dark brown (Pl. 6, D6); larvae with single white attachment gland.

REMARKS: This description agrees closely with that of Thiriot-Quévieux (1965) who described specimens from the Mediterranean. It has been designated the type-species for the subgenus *Simplicaria* Knight-Jones, 1973 which is characterised by absence of sickle setae from the third fascicle. It is a cosmopolitan species; recent records have extended its known distribution to South Australia (Knight-Jones 1973), NE Australia (pers. obser.), and Hawaii (Vine *et al.* 1972).

The feature of the developing embryos appearing to have more or less uninterrupted contact with the surrounding water may be because this species is often found quite high in the intertidal region and in pools where the oxygen tension may be low.

OTHER RECORDS: Mediterranean (Thiriot-Quévieux 1965; Zibrowius 1968, as *S. berkeleyanus* Rioja sensu Harris, 1968); Aegean (Bailey 1969a); Galapagos Islands (Bailey & Harris 1968); West Indies (Bailey 1970); South Australia (Knight-Jones 1973); NE Australia (pers. obser.); Hawaii (Vine *et al.* 1972).

*In Methuen Colour Book (Kornerup & Wanscher 1967)

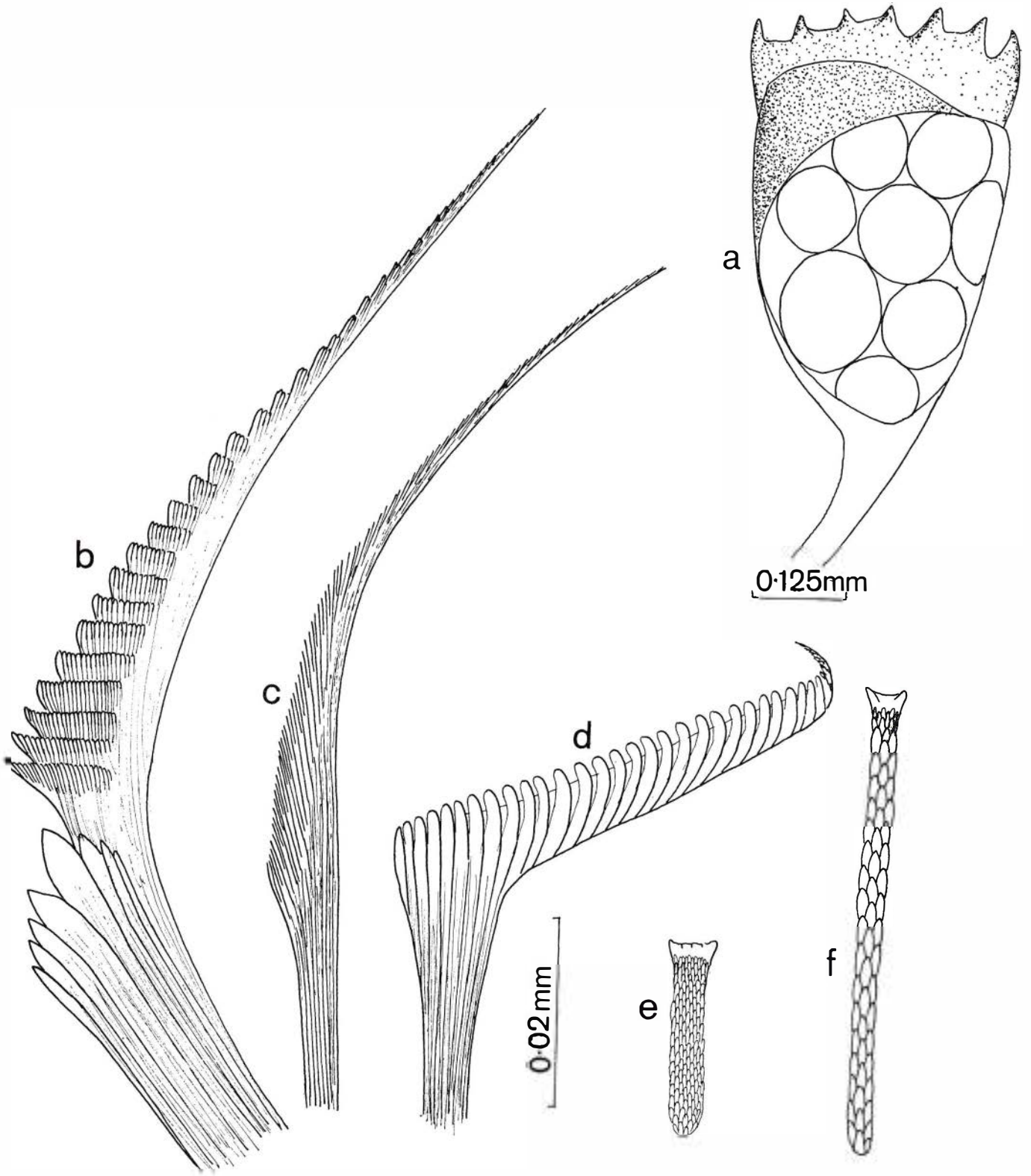


Figure 24 *Pileolaria (Simplicaria) pseudomilitaris* a operculum; b collar seta; c simple seta from second thoracic fascicle; d abdominal seta; e abdominal uncinus; f thoracic uncinus.

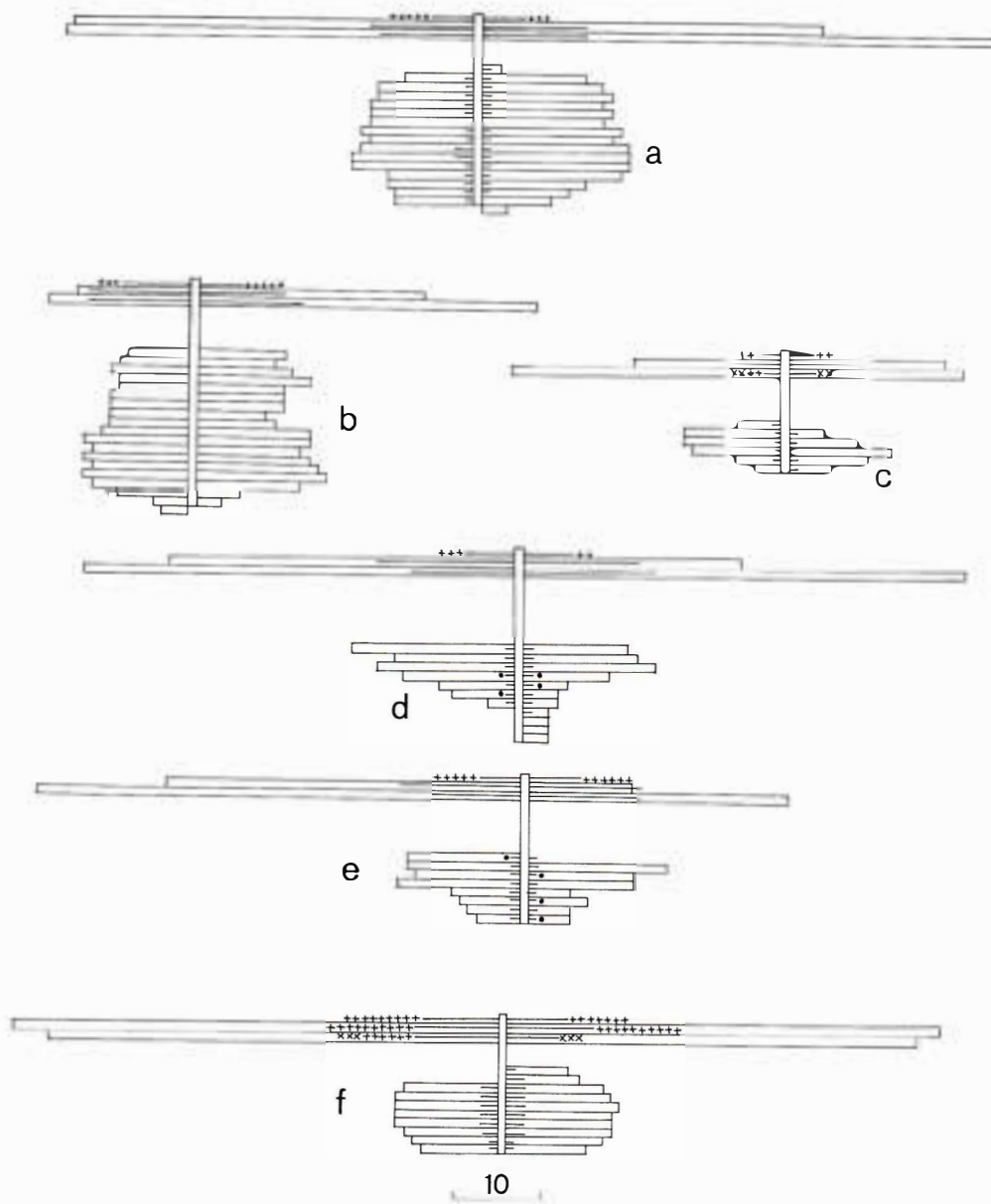


Figure 25 Distribution of setae and uncini in **a** *Pileolaria (Simplicaria) pseudomilitaris*; **b** *Pileolaria (Simplicaria) ovata*; **c** *Janua (Janua) pagenstecheri*; **d** *Janua (Dexiospira) steueri*; **e** *Janua (Dexiospira) pseudocorrugata*; **f** Sp. A. (See Fig. 6 for explanation of histograms; • = secondary setae with rudimentary shafts.)

***Pileolaria (Simplicaria) ovata* new species**

Figures 21f, 25b, 26

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.263a.

PARATYPES: British Museum (Natural History) Reg. No. ZB.1971.264a.

MATERIAL EXAMINED: 22 specimens.

LOCATION: Goat Island Channel.

HABITAT: On stones and brachiopod species, 5 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, fragments easily when removed from substrate, difficult to obtain undamaged tubes. Usually, in slicing tube from substrate, spiral opened underneath, and worms often released from their tubes. Tube with 2 rather indistinct longitudinal ridges and irregular pattern of transverse thickenings. Sides of tube not sharply angled from top but curve down to wide base of attachment (Fig. 26a). 2 or 3 whorls. Coil diameter 2.0 mm.

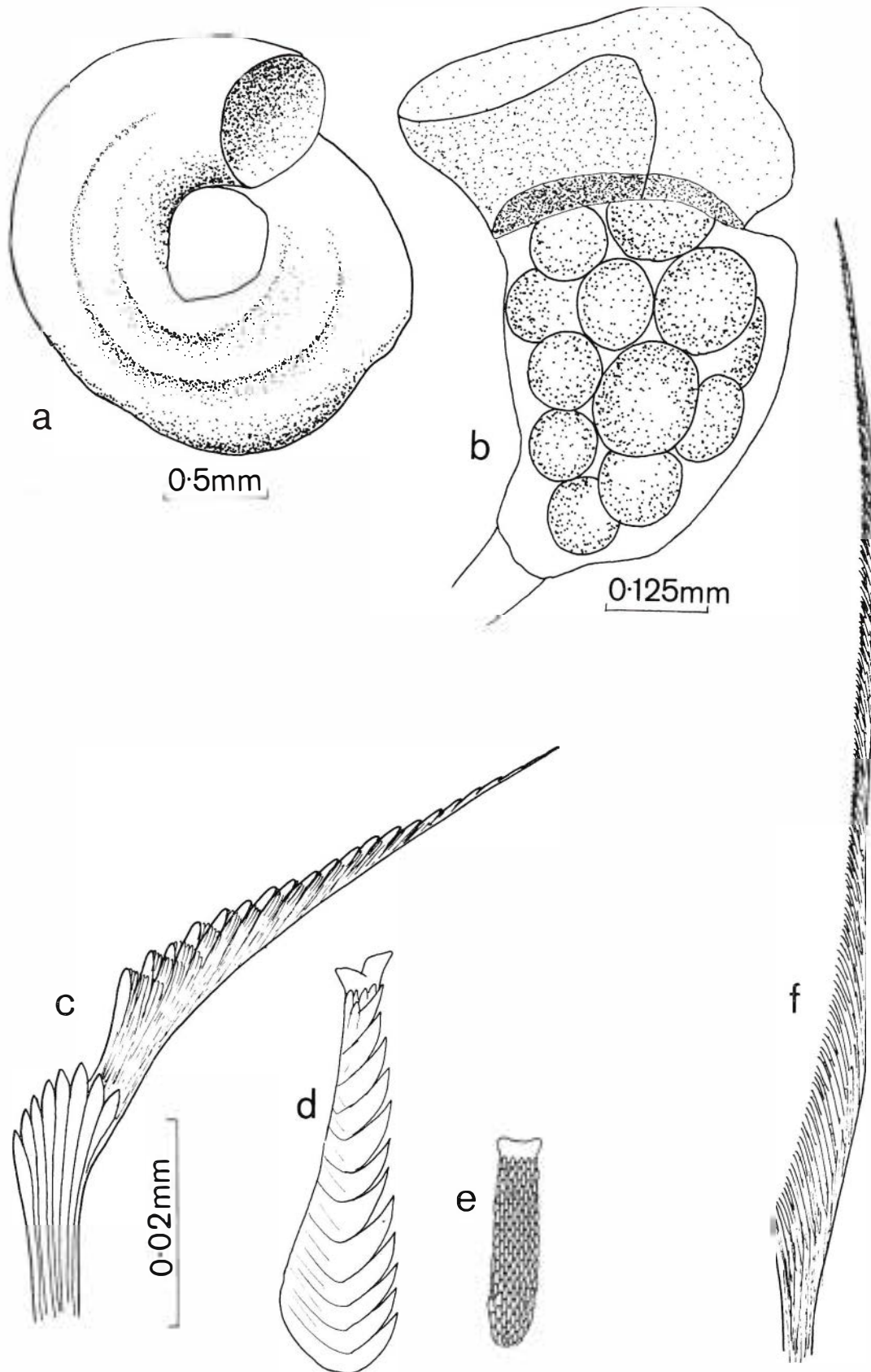


Figure 26 *Pileolaria (Simplicaria) ovata* a tube; b operculum (side view); c collar seta; d thoracic uncinus; e abdominal uncinus; f simple seta from third thoracic fascicle.

Operculum forms brood chamber. Distal plate elongate, oval, thin, lightly calcified with narrow opaque band around periphery (Fig. 26b). Arising from edge of plate is a wide flared, transparent brim, not completely continuous. On one side of operculum, calcified rim extends to cover upper portion of side walls of chamber, but rest of walls transparent.

Thorax. Collar folds not fused dorsally; 2 tori and 3 fascicles on each side; collar setae (Fig. 26c) have proximal fin and blade with narrow teeth and indistinct cross-striations. Capillary setae associated with these. 2nd and 3rd fascicles have setae with simple narrow blades (Fig. 26f), no sickle setae in 3rd fascicles. Uncini (Fig. 26d) with broad, indented anterior peg and single longitudinal row of teeth.

Asetigerous region about 5 times as long as distance between 1st and 2nd abdominal tori on concave side.

Abdomen most unusual in that no abdominal setae observed although 5 clear polyvinyl lactophenol preparations examined. Uncini distributed more or less evenly between concave and convex sides, with broad anterior peg and 5–7 longitudinal rows of fine teeth (Fig. 26c). About 20 abdominal segments, longest tori towards posterior end.

Incubation in opercular brood chamber.

Body colours in live specimen. Radioles, colourless; collar, orange (Pl. 7, A8*); stomach, brown (Pl. 8, C8); abdomen, tinged with orange. Alongside stomach, a long cream coloured gland. Embryos in early stage of development dark brown (Pl. 9, E8). Larvae with single white attachment gland.

REMARKS: Knight-Jones (1972b) designated the subgenus *Simplicaria* to include those *Pileolaria* species which lacked sickle setae. The species described above is clearly a member of this subgenus. The operculum is characteristic and unlike that of any other *Pileolaria* species. The name “*ovata*” refers to the laterally compressed operculum which is oval in cross-section.

Subgenus *Duplicaria* Vine, 1972a

Like *Pileolaria*, except that adult operculum develops from juvenile form without sharp dimorphism and may have 2 or more opercular plates stacked one above the other; embryos brooded below them in a chamber with lightly calcified, rather delicate walls; collar setae not distinctly cross-striated; thoracic uncini have 1 or 2 longitudinal rows of teeth; anterior abdominal torus on concave side may be split into 2 unequal portions.

TYPE-SPECIES: *Pileolaria (Duplicaria) koehlerii* (Caullery & Mesnil, 1897.)

*In Methuen Colour Book (Kornerup & Wanscher 1967)

Pileolaria (Duplicaria) koehlerii (Caullery & Mesnil, 1897)

Figures 20e, 21g, 27

Spirorbis koehlerii Caullery & Mesnil, 1897

Spirorbis (Pileolaria) polyoperculatus Straughan, 1969

Pileolaria (Duplicaria) koehlerii: Vine, Bailey-Brock & Straughan, 1972

MATERIAL EXAMINED: 7 specimens, 2 mounted in polyvinyl lactophenol.

LOCATION: Southern Cave, Poor Knights Is.

HABITAT: On stones in cave at approximately 12 m.

DESCRIPTION OF SPECIES

Tube. Sinistral; non-porcellanous; 3 irregular longitudinal ridges and transverse thickenings (Fig. 27a). Sides of tube more or less vertical; 1 or 2 whorls visible and coiling often somewhat helical. Coil diameter about 1.5 mm.

Operculum forms a brood chamber underneath 2 or 3 interlocking opercular plates (Fig. 27b). Plate immediately covering chamber with long talon, whereas 2 more distal plates have short talons with lateral wings providing support for plates. Walls of chamber thinly calcified, easily fragmented during dissection. When developing embryos occupy more space in chamber, calcified cup tends to hinge back, leaving a gap between its rim and opercular plates. Larvae escape via this gap.

Thorax. Collar folds not fused dorsally. 2 tori and 3 fascicles on each side. Collar setae (Fig. 27c) large, with proximal fin and blades with finely serrated edges. Capillary setae associated with these. 2nd and 3rd fascicles with simple setae (Fig. 27d), sickle setae (Fig. 27e) present in 3rd fascicle. Uncini (Fig. 27g) with broad anterior peg and 1 or 2 longitudinal rows of teeth along most of their length.

Asetigerous region, about twice distance between 1st and 2nd abdominal tori.

Abdomen, about 15 segments. Setae (Fig. 27f) geniculate with blunt teeth. Uncini with somewhat bifid anterior peg and 10 or more longitudinal rows of fine teeth. Those from 1st torus on concave side differ from other uncini by being longer and having fewer longitudinal rows of teeth (Fig. 27h). 1st torus on concave side divided into 2 unequal portions (Fig. 20e).

Incubation in opercular brood chamber.

REMARKS: This is the type-species for the subgenus *Duplicaria*. It is easily recognised by its characteristic operculum, and recent research has extended its known distribution to include the Red Sea and the Pacific (see below).

OTHER RECORDS: Mediterranean (Caullery & Mesnil 1897; Zibrowius 1968); Aegean (Bailey 1969a); West Indies (Bailey 1970); Red Sea (Vine 1972a); Australia (pers. obser.); Hawaii (Vine *et al.* 1972).

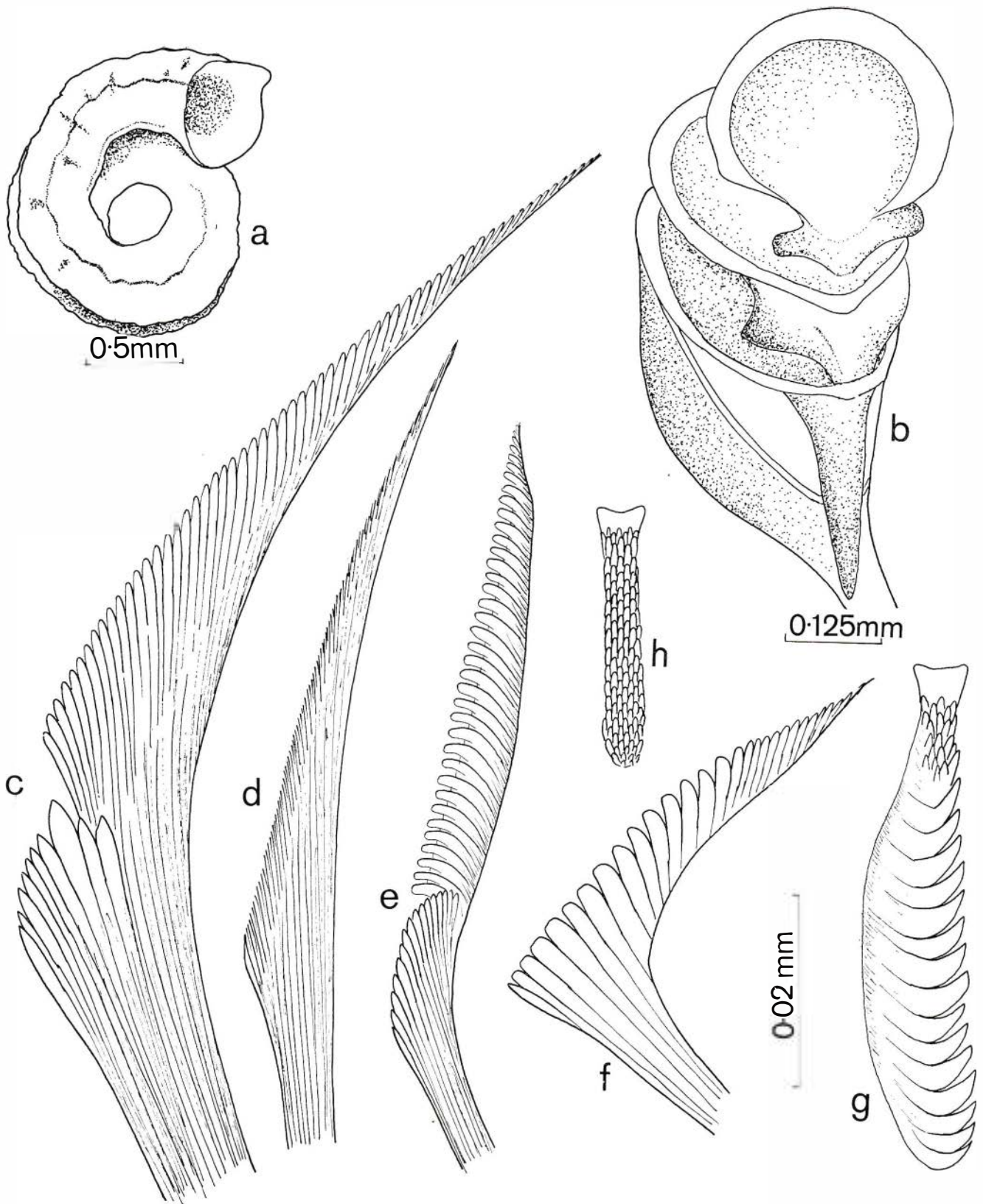


Figure 27 *Pileolaria (Duplicaria) koehleri* a tube; b operculum; c collar seta; d simple seta from second thoracic fascicle; e sickle seta from third fascicle; f abdominal seta; g thoracic uncinus; h abdominal uncinus.

***Pileolaria (Duplicaria) pocillator* new species**

Figures 20d, 21d, 28

HOLOTYPE: British Museum (Natural History) Reg. No. ZB.1971.261a.

PARATYPES: British Museum (Natural History) Reg. No. ZB.1971.262.

MATERIAL EXAMINED: More than 100 specimens.

LOCATION: Whangateau Harbour.

HABITAT: On dead "Pipi" shells, *Paphies (Paphies) australis* (Gmelin), from shell bank in middle of harbour.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, with 3 broad and usually well-worn longitudinal ridges prolonged into teeth above aperture of tube (Fig. 28a). Older tubes may have irregular transverse thickenings. Terminal section usually partly overlies previous whorl. Coil diameter 2.0 mm.

Operculum formed by deep calcified cup in which embryos are brooded. Juvenile operculum (Fig. 28d) with slight talon, not present in adult. Embryos developing in cup often protrude above level of top of cup, held in place by membranous transparent covering. In earlier stages of development of embryos, transparent covering stretches flat across cup; as embryos increase in size they push up covering, thus stretching it. Around distal region of cup, usually a narrow, less densely calcified band through which one can see eggs or embryos, whereas rest of cup is opaque.

Thorax. 7 radioles with long terminal filaments, about 4 or 5 times length of distal pinnules. Collar folds not fused dorsally. Collar setae (Fig. 28e) have broad proximal fins and distinctly cross-striated blades. Several smooth, flexible capillary setae associated with these. 2nd and 3rd fascicles with long finely striated simple blades (Fig. 28f), sickle setae (Fig. 28g) also present in 3rd fascicles. Uncini (Fig. 28j) with somewhat bifid anterior pegs and single rows of teeth for most of their length.

Asetigerous region about 4 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 15 segments. Setae (Fig. 28h) geniculate with fairly long tapering blades and prominent bulge at heel. Uncini arranged more or less equally between concave and convex sides, with broad anterior pegs (Fig. 28i) and about 10 longitudinal rows of teeth.

Incubation in opercular cup.

Body colours of live specimen. Radioles, colourless at tip but orange (Pl. 8, A7*) at base; collar, orange (Pl. 8, A7); oesophagus and stomach, green (Pl. 26, D8); thorax, orange (Pl. 8, A8); abdomen, orange (Pl. 8, A6); embryos in early stage of development, brown (Pl. 8, D5); Embryos with single white attachment gland.

REMARKS: The cup in which the embryos are brooded occupies a position like that of the secondary plate in a species of *Janua*, but it resembles still more closely the incubatory cups figured by Bailey (1969a) for *Pileolaria koehleri* and *P. endoumensis* Zibrowlus. These species retain previously formed opercular plates as protective covers over their embryos, but are otherwise very like *P. pocillator*, which may therefore be regarded as a representative of the group *Duplicaria*, but unusual in not having opercular plates duplicated distally.

Pileolaria dalestraughani Vine, 1972b from Hawaii has a similar cup-shaped operculum. It differs however from *P. pocillator* in the following features: the tube of *P. dalestraughani* is smaller and has four delicate longitudinal ridges while *P. pocillator* has three more robust ridges. The cup-shaped operculum of the former is more lightly calcified and has a V-shaped indentation on the ventral side of the rim in addition to a minute talon. The species described above does not have these features except that some small opercular cups may bear a minute talon (Fig. 25d). A close comparison of holotypes shows that although collar and abdominal setae are similar, sickle setae are markedly different, those from *P. pocillator* having blades with long proximal portions, about the same length as the distal portions, whereas those from *P. dalestraughani* have blades with short proximal portions and longer distal sections. Thoracic uncini from *P. pocillator* are about twice as long as those from *P. dalestraughani* and there are considerably more uncini in each thoracic torus. *P. pocillator* has an extended thoracic cloak which has not been observed in *P. dalestraughani*.

Pileolaria langerhansi Caullery & Mesnil, 1897 from Panama appears to be similar to *P. (D.) pocillator*. Unfortunately the original description is inadequate and type material not available for comparison. From the original description *P. langerhansi* could be the same as *P. (D.) dalestraughani* recently described from Hawaii or *P. (D.) pocillator* presently recorded. In view of these facts and the considerable distance separating the New Zealand and Panama species, *P. (D.) pocillator* is here regarded as a species separate from *P. langerhansi* but later studies may link them.

*In Methuen Colour Book (Kornerup & Wanscher 1967)

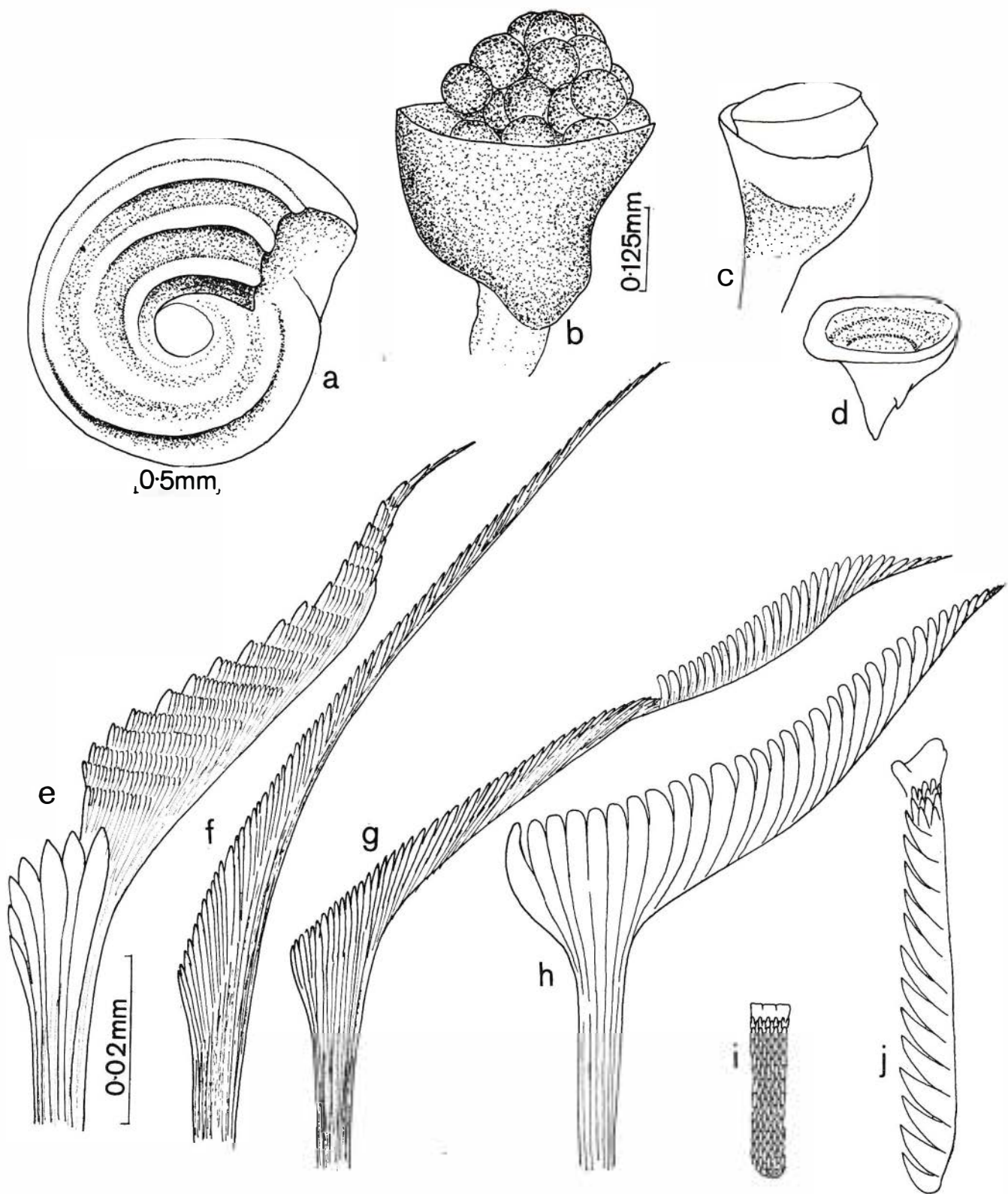


Figure 28 *Pileolaria (Duplicaria) pocillator* a tube; b operculum of adult containing eggs; c juvenile operculum; d plate from juvenile operculum; e collar seta; f simple seta from second thoracic fascicle; g sickle seta from third thoracic fascicle; h abdominal seta; i abdominal uncinus; j thoracic uncinus.

Genus *Amplaria* Knight-Jones, 1973

Sinistral coiling; 4 thoracic tori and 4 fascicles of setae on concave side, 3 tori and 5 fascicles on convex; incubation in operculum; fin and blade collar setae without cross-striations; sickle setae present in 3rd and 4th fascicles; thoracic uncini slender, with blunt anterior peg; abdominal setae geniculate, with prominent indentation at "heel", less than $\frac{1}{4}$ size of collar setae, with short tapering blades; abdominal uncini somewhat asymmetrical in bilateral distribution, with largest tori about halfway along setigerous region of abdomen.

TYPE-SPECIES: *Amplaria spiculosa* Knight-Jones, 1973.

Amplaria spiculosa Knight-Jones, 1973

Figures 29, 30

MATERIAL EXAMINED: 2 specimens.

LOCATION: Southern Cave, Poor Knights Is.

HABITAT: On undersides of stones in middle of cave at about 10 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, chalky white, non-porcellanous; sides more or less vertical and perpendicular to flat top (Fig. 29a); slight longitudinal indentations on top and irregular transverse thickenings but no regular pattern. Outer edge of tube on top with irregular rim projecting outwards. Terminal portion ascends. 1 whorl; coil diameter 2.5–3.0 mm.

Operculum forms brood chamber. Distal plate bears prominent, somewhat recurved, spine and transparent brim. Talon rests in groove in basal plate. Chamber walls lightly calcified. Embryos brooded between distal and basal plates. Latter also with spine, protrudes into embryo mass apparently helping to hold them in chamber when walls dehisce and distal plate pushed up by developing embryos. Basal plate also with short talon, observed more easily when operculum cleared in clove oil.

Thorax. Collar folds not fused dorsally. Parapodial rudiments equivalent to $4\frac{1}{2}$ thoracic segments. On concave side, 4 tori and 4 fascicles of setae, convex side 3 tori and 5 fascicles. Collar setae (Fig. 29f) have broad shafts, proximal fin, and blade; blade finely serrated but not cross-striated. Capillary setae associated with them. 2nd, 3rd, 4th, and 5th fascicles have simple setae (Fig. 29g), and 3rd, 4th, and 5th also have sickle setae (Fig. 29h). Uncini (Fig. 29k) have broad anterior peg and single longitudinal row of teeth for most of their length.

Asetigerous region very short, approximately same length as distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 17 segments. Setae (Fig. 29i) geniculate, with prominent heel and apparently a fan of small teeth at junction of blade with shaft. Uncini (Fig. 29j) with broad anterior peg and about 7 longitudinal rows of fine teeth. Distribution and sizes of setae given in Fig. 30.

Incubation in opercular brood chamber.

REMARKS: This species is unusual in the large number of thoracic segments. Another genus, *Anomalorbis* Vine, 1972a, from the Red Sea has a similar number of parapodial rudiments in the thorax but differs from this species in direction of coiling, and in details of setae and uncini. The collar setae, for instance, are simple, suggesting affinities with *Janua*, whereas *Amplaria* is fairly close to *Pileolaria*. The present record of this recently discovered species is a notable extension of its distribution, for it was otherwise known from a single specimen collected on the shore of Kangaroo Island.

OTHER RECORDS: South Australia (Knight-Jones 1973).

Genus *Janua* Saint-Joseph, 1894 (emended; Knight-Jones 1972)

Mostly with dextral coiling; only 2 pairs of thoracic tori; incubation in opercular brood chamber, below which a secondary plate (rudiment of next opercular plate) formed soon after spawning; collar setae without toothed fin; abdominal setae with elongate blades as big as or bigger than those of collar setae, often accompanied by secondary setae, with rudimentary shafts; thoracic uncini with anterior pegs narrow and more or less pointed in surface view; largest abdominal tori lie in anterior half of setigerous region; larvae have paired white attachment glands in thoracic region.

TYPE-SPECIES: *Janua (Janua) pagenstecheri* (Quatrefages, 1865).

Subgenus *Janua* Saint-Joseph, 1894

Dextral coiling; sickle setae present in 3rd thoracic fascicles; thoracic collar not fused dorsally.

TYPE-SPECIES: *Janua (Janua) pagenstecheri* (Quatrefages, 1865).

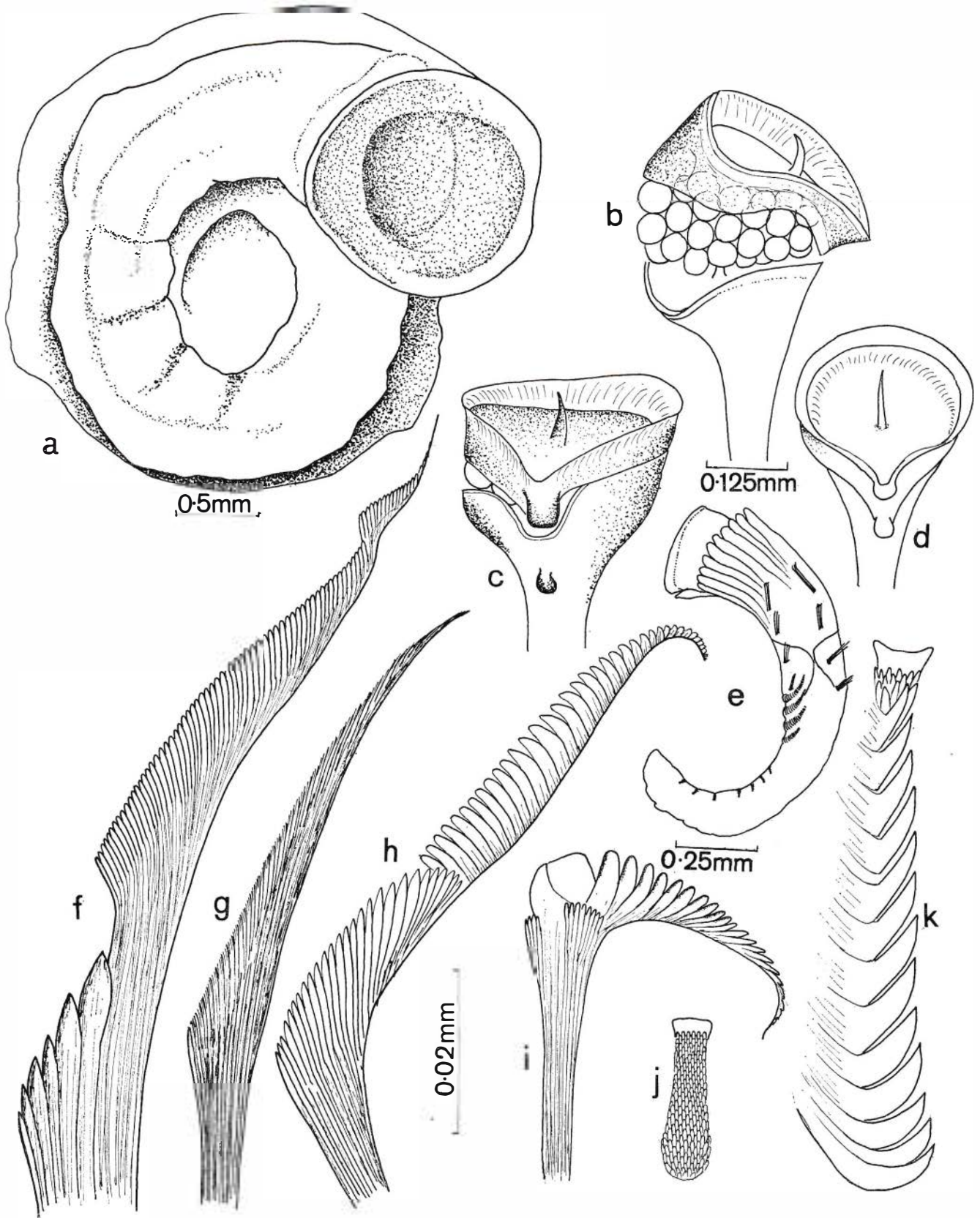


Figure 29 *Amplaria spiculosa* a tube; b adult operculum with eggs (ventrolateral view); c adult operculum (dorsal view); d more juvenile operculum (dorsal and from above); e worm (dorsal view); f collar seta; g simple seta from second thoracic fascicle; h sickle seta from third thoracic fascicle; i abdominal seta; j abdominal uncinus; k thoracic uncinus.



Figure 30 *Amplaria spiculosa* a (above) Distribution of seta and uncini; b (right) relative sizes of setal shafts and blades. (See Figs. 2 and 6 for explanations of stick diagrams and histograms, respectively.)

Janua (Janua) pagenstecheri (Quatrefages, 1865)

Figures 25c, 31, 32a

Spirorbis pagenstecheri Quatrefages, 1865

Spirorbis pusilloides Bush, 1904

Spirorbis (Dexiospira) pagenstecheri: Zibrowius 1968

Spirorbis epichysis Bailey, 1970

Janua (Janua) pagenstecheri: Knight-Jones, Knight-Jones & Llewellyn (in press)

MATERIAL EXAMINED: 11 specimens.

LOCATION: Landing Bay, Poor Knights Islands.

HABITAT: On stones at about 45 m depth.

DESCRIPTION OF SPECIES

Tube. Dextral, non-porcellanous, with 3 well-defined longitudinal ridges and faint transverse ridges (Fig. 31a). Sides oblique; 2 or 3 whorls visible from above. Coil diameter 1.2 mm.

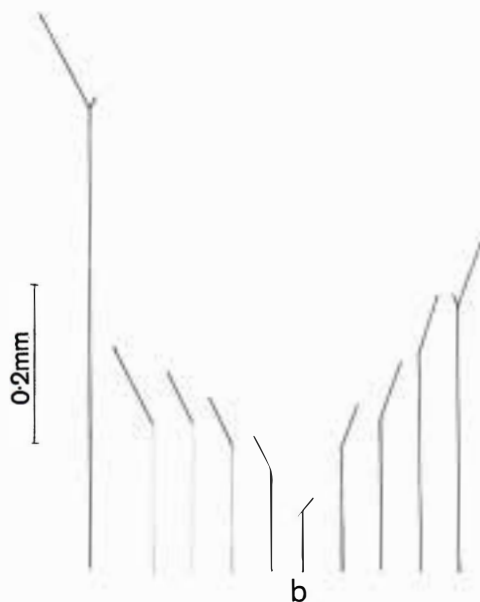
Operculum. Plate somewhat thickened and convex. In juveniles, finger-shaped talon present; may be absent in subsequent brood chambers. Eggs brooded in cup-shaped transparent-walled chamber.

Thorax. Radioles rather short; collar folds not fused dorsally; 2 tori and 3 fascicles on each side. Collar setae (Fig. 31d) few, with simple blades, not cross-striated, without any sign of rudimentary fin. Some capillary setae, associated with collar setae. 2nd and 3rd fascicles with simple setae (Fig. 31f), sickle (Fig. 31g) also present in 3rd fascicles. Uncini (Fig. 31h) with narrow anterior peg, 4 or 5 longitudinal rows of teeth.

Asetigerous region long, about 5 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 7 segments. Setae (Fig. 31i) geniculate with long narrow blades (Fig. 32). Uncini (Fig. 31e) appear to have broad indented anterior peg and many longitudinal rows of fine teeth.

Incubation. In opercular brood cup.



Body colours of live specimen. Collar, thorax, and anterior of abdomen tinged with pale pink (Pl. 5, A4*^c).

REMARKS: Some authors have described a rudimentary fin at the base of the collar setae of *J. (J.) pagenstecheri*, while other authors have not seen a fin. Its appearance may perhaps depend on how the setae are orientated and to what extent they are squashed. Its known distribution includes Australia (Knight-Jones 1973) and Hawaii (Vine *et al.* 1972).

OTHER RECORDS: Reviewed in some detail by Zibrowius (1968). It is widely distributed in the Mediterranean and Atlantic. In addition to the records listed by Zibrowius it has been found off Chios in the Aegean (Bailey 1969a) and *Spirorbis epichysis* Bailey, 1970 from the West Indies appears to be con-specific. Recent Pacific records are from the Galapagos Islands (Bailey & Harris 1968), South Australia (Knight-Jones 1973) and Hawaii (Vine *et al.* 1972).

Other records from the Pacific are: near Vancouver as *S. pusilloides* (Pixell 1912 – see Zibrowius, 1968, for discussion); Mexico (Rioja 1941, 1942); Tuamotu atolls (Fauvel 1919, 1947). In the Indian Ocean it is known from Ceylon (de Silva 1961).

**In* Methuen Colour Book (Kornerup & Wanscher 1967)

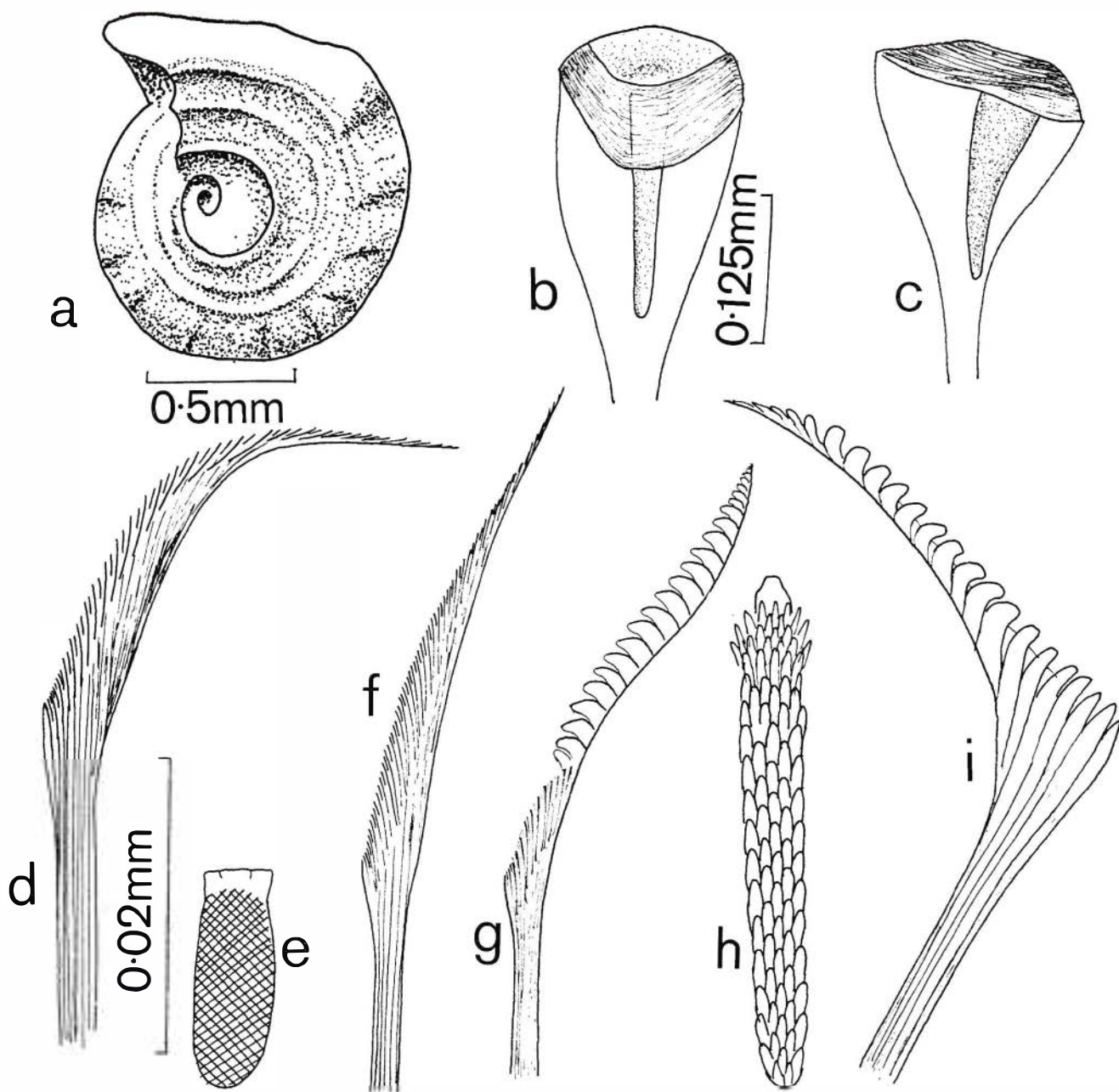


Figure 31 *Janua (Janua) pagenstecheri* a tube; b operculum (dorsal view); c operculum (lateral view); d collar seta from convex side; e abdominal uncinus; f simple seta from second thoracic fascicle; g sickle seta from third thoracic fascicle; h abdominal uncinus; i abdominal seta.

Subgenus *Dexiospira* Caullery & Mesnil, 1897

Neodexiospira Pillai, 1970

Like *Janua*, with coiling usually dextral, but with sickle setae absent and margins of collar usually fused to form tunnel over mid-dorsal thoracic groove.

TYPE-SPECIES: *Janua (Dexiospira) pseudocorrugata* (Bush, 1904), new name for *Spirorbis corrugatus* of Caullery & Mesnil, 1897 and most recent authors, not of Montagu 1803, not of Langerhans 1880 (see Knight-Jones 1972).

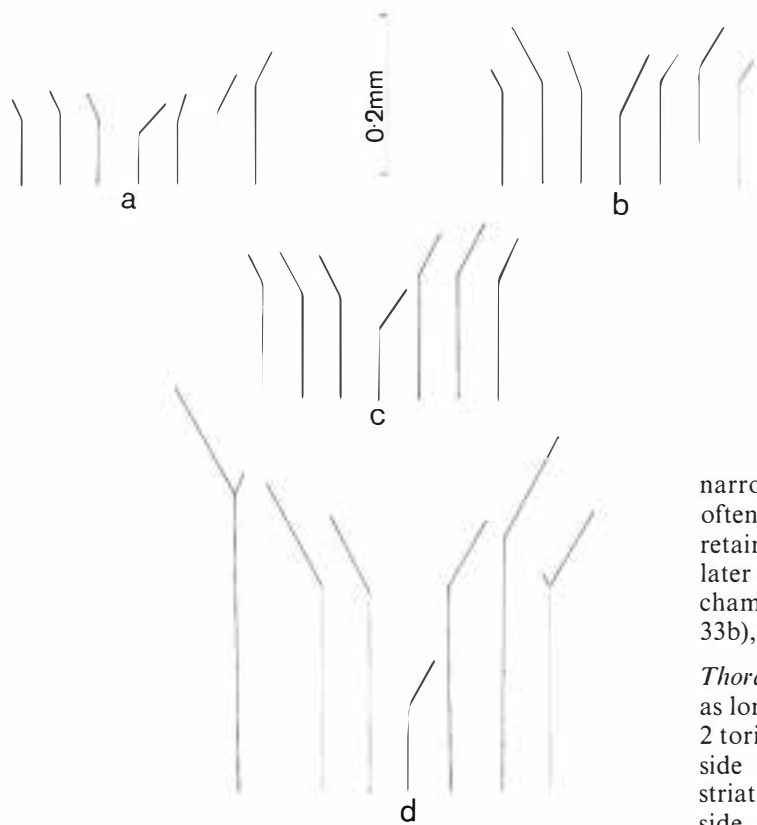


Figure 32 Relative sizes of setal shafts and blades in **a** *Janua* (*Janua*) *pagenstecheri*; **b** *Janua* (*Dexiospira*) *pseudocorrugata*; **c** *Janua* (*Dexiospira*) *steueri*; **d** Sp. A. (See Fig. 2 for explanation of stick diagrams.)

***Janua* (*Dexiospira*) *pseudocorrugata* (Bush, 1904)**

Figures 25e, 32b, 33

Spirorbis corrugatus of Caullery & Mesnil, 1897

Janua (*Dexiospira*) *pseudocorrugata*: Knight-Jones, Knight-Jones & Llewellyn (in press)

MATERIAL EXAMINED: More than 100 specimens.

LOCATION: Aquarium of Marine Laboratory at Goat Island Bay, on littoral stones in Whangateau Harbour, and Christchurch region.

HABITAT: On glass and plastic walls of aquarium and in sheltered intertidal areas on stones.

DESCRIPTION OF SPECIES

Tube. Dextral, non-porcellanous, 3 longitudinal ridges with shallow indentations between ridges and on outer edge of tube (Fig. 33a). Sides almost vertical, sharply angled from top of tube; mouth round in cross-section, usually overlies previous whorl; 2 whorls visible; coil diameter 1.5–2.0 mm.

Operculum forms cylindrical brood chamber with lightly calcified transparent walls. Plate more or less flat with

narrow peripheral collar (Fig. 33c). 2nd brood chamber often forms underneath distal chamber, both may be retained at same time. Embryos in distal chamber at a later stage of development than those in proximal chamber. Only primary operculum develops talon (Fig. 33b), tends to be wedge-shaped, not densely calcified.

Thorax. 7 radioles with terminal filaments 4 or 5 times as long as distal pinnules. Collar folds not fused dorsally. 2 tori and 3 fascicles on each side; collar setae on convex side (Fig. 33d) with blades, coarsely serrated, cross-striations visible only in edge view; those on concave side with simple blades, not cross-striated. Capillary setae associated with collar setae. 2nd and 3rd fascicles with simple setae (Fig. 33e), no sickle setae in 3rd fascicles. Uncini (Fig. 33h) with narrow anterior peg, about 5 longitudinal rows of teeth.

Asetigerous region long, about 6 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 8 segments. Setae (Fig. 33g) somewhat geniculate, with long narrow blades. Uncini (Fig. 33f) with anterior peg, about 10 longitudinal rows of fine teeth.

Incubation in opercular brood chamber.

Body colours of live specimen. Radioles, colourless; collar, tinged with orange (Pl. 7, A7*); oesophagus and stomach, brown (Pl. 7, F7); larvae brown (Pl. 7, D3) with 2 white attachment glands.

REMARKS: Knight-Jones (1973) reviewed the taxonomic history of *J. (D.) pseudocorrugata* and supported Bush's action in renaming *Spirorbis corrugatus* sensu Caullery & Mesnil, 1897 as *S. pseudocorrugata*. Zibrowius (1968) studied this species and considered *S. treadwelli* Pillai, 1965, *S. foraminosus* Moore & Bush, 1904, *S. heideri* Sterzinger, 1909 and *S. steueri* Sterzinger, 1909 as synonymous. Studies of Spirorbinae from the Red Sea (Vine 1972a) tend to support the suggestion that *S. steueri* and *S. heideri* may not be separate species, but Phyllis Knight-Jones (pers. comm.) regards them as

*In Methuen Colour Book (Kornerup & Wanscher 1967)



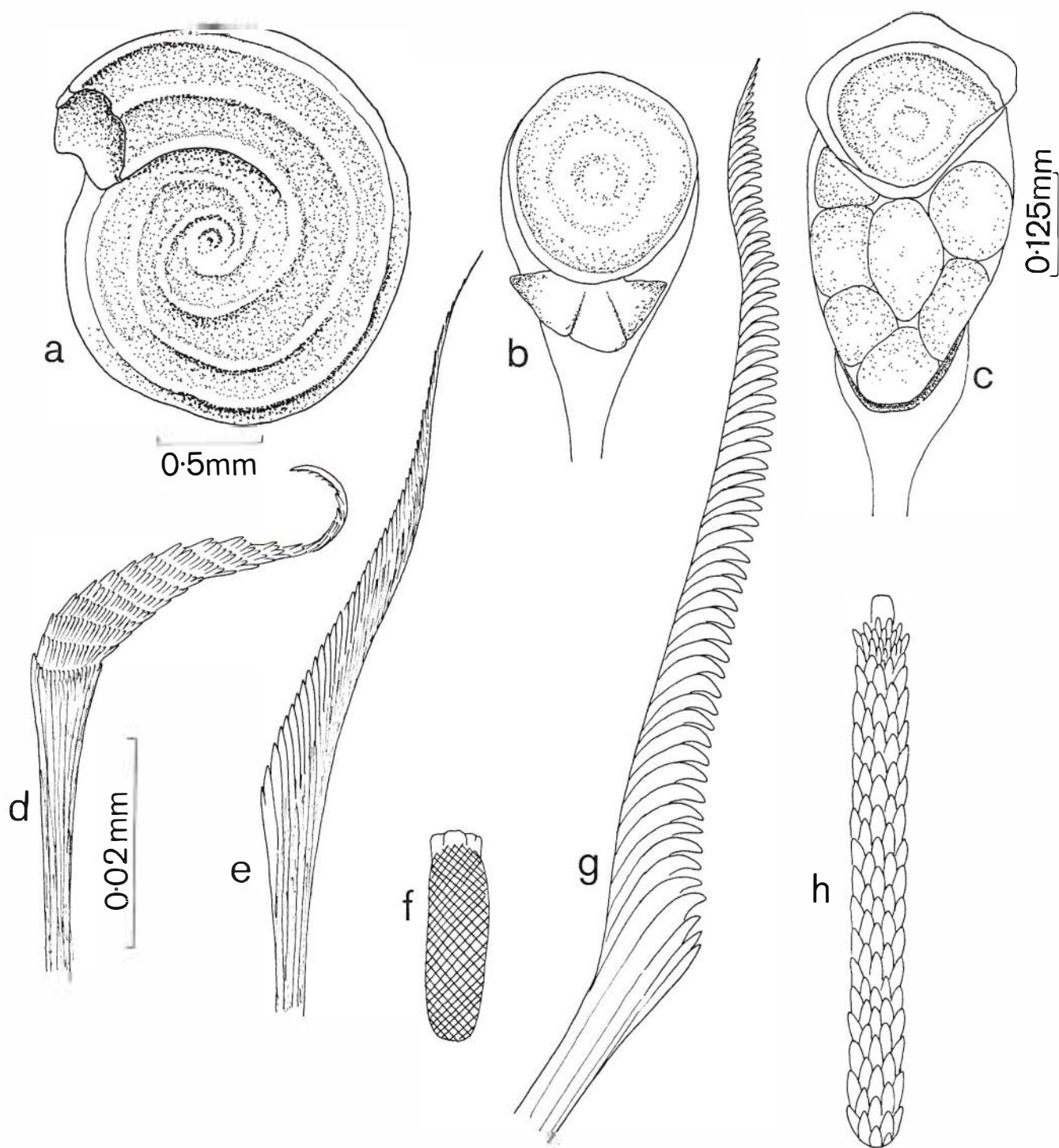


Figure 33 *Janua (Dexiospira) pseudocorrugata* a tube; b juvenile operculum; c adult operculum with eggs; d collar seta from convex side; e simple seta from second thoracic fascicle; f abdominal uncinus; g abdominal seta; h thoracic uncinus.

separate, and the latter as a junior homonym of *S. foraminosus*. They both appear to be different from *J. (D.) pseudocorrugata*. Their tubes have a more intricate pattern, the walls of their brood chambers are more heavily calcified, and their abdominal setae are shorter

and broader than those of *J. (D.) pseudocorrugata*. Although there is some variability in the shape of the talon of *J. (D.) pseudocorrugata*, it is always different from that of *J. (D.) steueri* which has a bifid, more densely calcified central section and usually lightly calcified

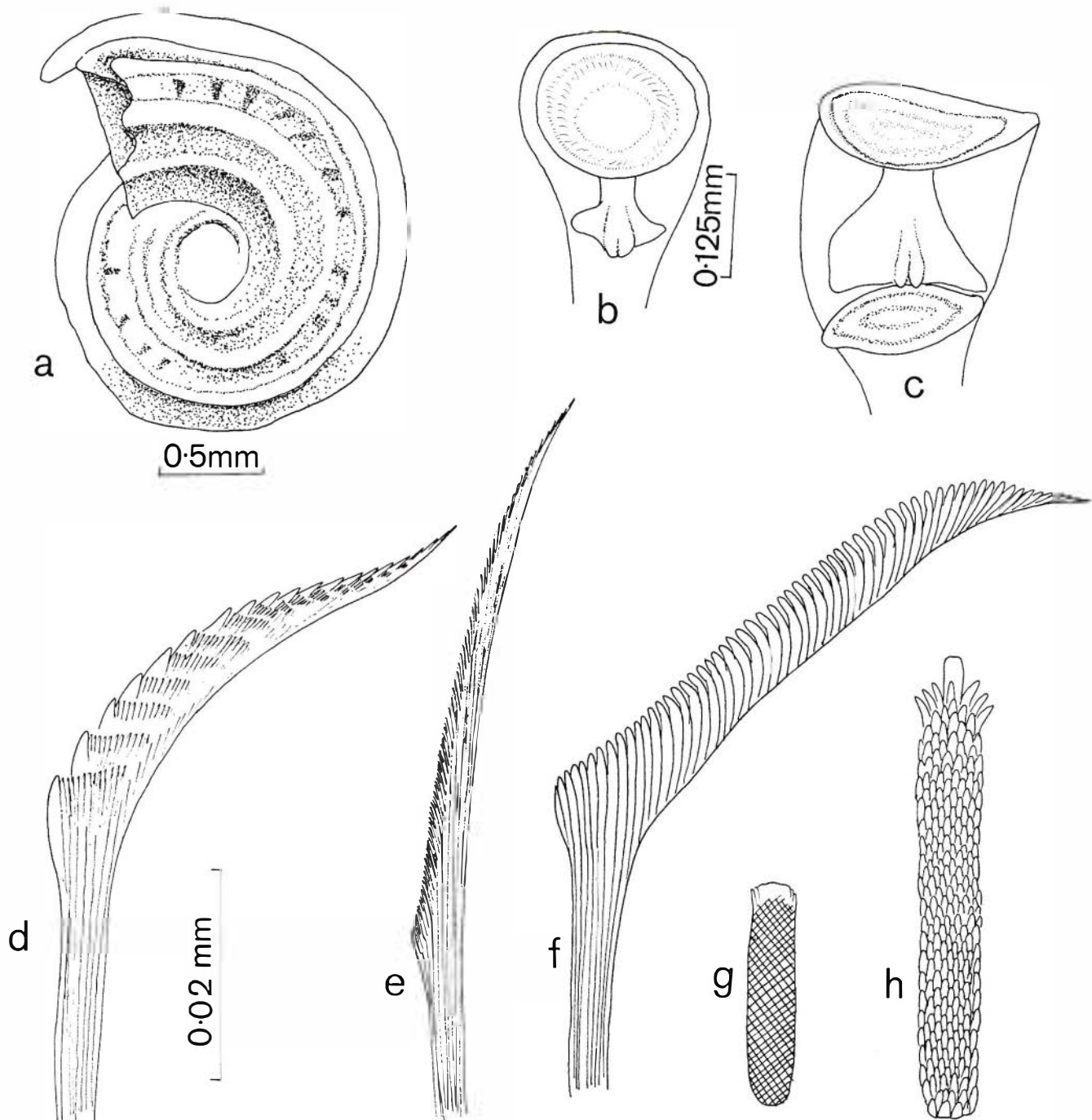


Figure 34 *Janua (Dexiospira) steuri* a tube; b juvenile operculum; c adult operculum; d collar seta from convex size; e simple seta from second thoracic fascicle; f abdominal seta; g abdominal uncinus; h thoracic uncinus.

lateral wings. Pillai (1965) did not compare *S. treadwelli* with either *J. (D.) pseudocorrugata* or *J. (D.) steuri*, and it seems likely to be synonymous with the latter species. Mrs Phyllis Knight-Jones has studied type material of *S. foraminosus* and *S. brasiliensis* Gruke (senior homonym for *S. bellulus* Moore & Bush, 1904) and compared them with the above material from Leigh

aquarium and with *J. (D.) pseudocorrugata* from the type locality. She regards *J. (D.) foraminosa* as a distinct species and the Leigh material as indistinguishable from *J. (D.) brasiliensis*. The latter is very close to *J. (D.) pseudocorrugata* but differs in that the talon is usually fan-shaped and rarely or never bifid, whilst the collar setae cross-striations are so faint that they appear only

when the “blade” is seen in edge view (as in Fig. 33d). It is uncertain, however, whether *J. (D.) brasiliensis*, which is known from Japan, New Zealand, and Cape Town (Phyllis Knight-Jones, pers. comm.), deserves the status of a distinct species, or whether it is merely a variety of *J. (D.) pseudocorrugata*.

This description of material from New Zealand agrees closely with that of Zibrowius (1968).

OTHER RECORDS: Reviewed in detail by Zibrowius (1968), under the name *Spirorbis corrugatus*. As noted above, he considered several species synonymous with *J. (D.) pseudocorrugata* but this view is not adopted here. The distribution listed below refers only to records of *J. (D.) pseudocorrugata*.

English Channel (Caullery & Mesnil 1897); Roscoff (L’Hardy & Quiévreux 1964); NW Spain (Rioja 1923); Morocco (Fauvel 1936); Madeira (Langerhans 1880); Azores (Fauvel 1909, 1914); Sargasso Sea (Fauvel 1909, 1914); Mexico (Rioja 1959); Mediterranean (Caullery & Mesnil 1897; Sterzinger 1909, 1910; Fauvel 1911; Bellan 1959; Zibrowius 1968; Bailey 1969a); West Indies (Bailey 1970); South Australia (Knight-Jones 1973); Hawaii (Vine *et al.* 1972).

Janua (Dexiospira) steueri (Sterzinger, 1909)

Figures 25d, 32c, 34

Spirorbis steueri Sterzinger, 1909

Spirorbis treadwelli Pillai, 1965

Janua (Dexiospira) steueri: Knight-Jones, Knight-Jones & Llewellyn (in press)

MATERIAL EXAMINED: 27 specimens.

LOCATION: Kaikoura, South Island.

HABITAT: On red algae, LWS.

DESCRIPTION OF SPECIES

Tube. Dextral, non-porcellanous, with 3 distinct longitudinal ridges on top of tube and 1 on side (Fig. 34a). Transverse indentations between ridges. 1 or 2 whorls visible from above; coil diameter 2.0 mm.

Operculum. Opercular plate more or less flat. Juvenile operculum has bifid talon with lateral wings (Fig. 34b). Brood chamber walls more heavily calcified and opaque than *J. (D.) pseudocorrugata* or *J. (D.) bellula*. Primary chamber retains talon (Fig. 34c), whereas later opercula do not have a talon.

Thorax. Collar folds fused dorsally. 2 tori and 3 fascicles of setae on each side. Collar setae on convex side (Fig. 34d) have simple blades with coarse serrations and cross-striations, those from concave side with smoother edges and lack cross-striations. Capillary setae associated with collar setae. 2nd and 3rd fascicles with

simple setae (Fig. 34e), no sickle setae in 3rd fascicles. Uncini (Fig. 34h) with narrow anterior peg flanked on each side by about 3 teeth, about 10 longitudinal rows of teeth.

Asetigerous region, about 8 times distance between 1st and 2nd abdominal tori on concave side.

Abdomen, about 7 segments. Setae (Fig. 34f) geniculate with long, rather narrow, blades; uncini (Fig. 34g) have blunt anterior pegs and many longitudinal rows of fine teeth.

Incubation in opercular brood chamber.

REMARKS: Resembles *J. (D.) formosa* (Bush) which extends to South Australia (Knight-Jones 1973), but can be distinguished by the remarkably broad blades of its abdominal setae (Knight-Jones 1972). For comparisons with other species (see above) *J. (D.) steueri* has been found by the present author in the Red Sea and elsewhere in the Pacific (see below). The specimens studied from New Zealand agree closely with specimens from these other areas and with the original description by Sterzinger (1909). In the Red Sea this species coils both dextrally and sinistrally (Sterzinger 1909; Vine 1972a), whereas only dextral specimens have been found in New Zealand.

OTHER RECORDS: Red Sea (Sterzinger 1909; Vine 1972a); Kenya (Knight-Jones 1972, as *S. treadwelli*); Philippines (Pillai 1965); Heron Island (Straughan 1967); South Australia (Knight-Jones 1973); NE Australia (pers. obser.); Hawaii (Vine *et al.* 1972). In addition to these records from the Indo-Pacific, Bailey (1970) recorded *J. (D.) steueri* from the Caribbean.

Sp. A.

Figures 25f, 32d, 35

MATERIAL EXAMINED: Single specimen mounted in polyvinyl lactophenol, operculum preserved in clove oil.

LOCATION: Cape Hallett, Ross Sea, 72° 17.7' S, 170° 13.1' E, NZOI Stn E186, 20 January 1965.

HABITAT: On carapace of spiny crab at about 50 m.

DESCRIPTION OF SPECIES

Tube. Sinistral, non-porcellanous, with flat, smooth top and vertical sides (Fig. 35a); some slight growth ridges; terminal section ascends, 2 whorls visible from above; coil diameter 3.0 mm.

Operculum with shallow concave plate and a peg-shaped talon (Fig. 35b).

Thorax. Collar folds not fused. 2 tori on each side. Most of thorax stained with brown granules, these

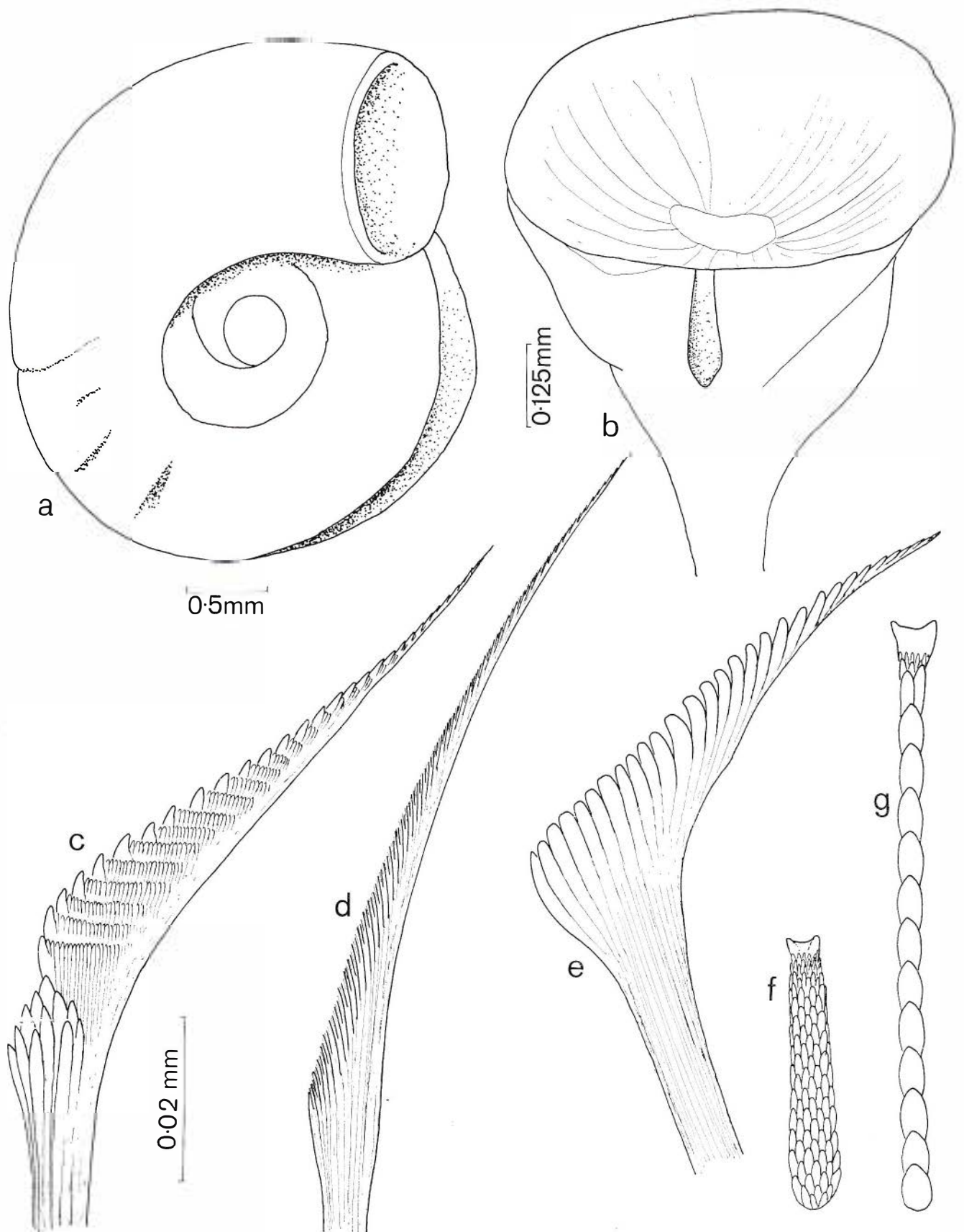


Figure 35 Sp. A. a tube; b operculum; c collar seta; d simple seta from second thoracic fascicle; e abdominal seta; f abdominal uncinus; g thoracic uncinus.

obscure some setae and uncini. Collar setae (Fig. 35c) with proximal fin consisting of many closely packed small teeth, and a distal blade with coarse rounded serrations and distinct cross-striations. Smooth capillary setae present in all thoracic fascicles. 2nd and 3rd fascicles have setae with simple finely striated blades (Fig. 35d); some sickle setae present in 3rd fascicles, but on single slide available these obscured and are not illustrated. Uncini (Fig. 35g) have broad, somewhat bifid, anterior peg and single row of teeth.

Asetigerous region about 3 times as long as distance between 1st and 2nd abdominal tori on concave side.

Abdomen. Only a part of abdomen intact; consisted of 12 segments; uncini distributed fairly symmetrically between concave and convex sides (Fig. 25f). Setae geniculate (Fig. 35e) with distinct heel and blunt teeth, and uncini (Fig. 35f) with broad anterior peg and about 8 longitudinal rows of fine teeth.

Incubation not known.

REMARKS: The distribution of uncini in the abdomen suggests that this is not a species which incubates an embryo string held along the convex side of the body in the tube. The tube-incubating genus *Spirorbis* does, however, have a symmetrical distribution of uncini between concave and convex sides of the abdomen. In species belonging to this genus the embryo string is attached posteriorly to the tube and held in the tube mostly behind the abdomen. There is little about the tube, operculum, setation, or distribution of uncini of this species which clearly aligns it with the genera *Spirorbis* or *Pileolaria*, but the thoracic uncini are like those found in many *Pileolaria* species, being slim with a single row of teeth and a gouged anterior peg. Although the present description is not adequate since complete opercular stages and method of incubation are not known, it is probably a member of the genus *Pileolaria*.

Distribution and Ecology of Species in New Zealand

Ecological observations

The general distribution of species is given in Table 2. Tables 3, 4, and 5 summarise regional distribution and some aspects of the ecology of Spirorbinae collected at the Poor Knights Islands and off mainland New Zealand.

POOR KNIGHTS ISLANDS: (summer sea surface temperature approximately 21°C) (Table 3)

The transect was located at Landing Bay and large collections of substrata were made at five depths, down to 50 metres. In addition, some collections were made inside Southern Cave. Species found in the cave and not on the transect are indicated in parentheses in Table 3. An approximate estimate of relative abundance of species at each depth was made. Comparisons can be made between species in the same generalised habitat (i.e., at the same depth station) and more tentatively between different depth stations.

GOAT ISLAND BAY: (summer sea surface temperature approximately 20°C) (Table 4)

Three sites are represented in Table 4. In the first column, representing the littoral zone in Goat Island Bay, shore levels where each species was most abundant are indicated in parentheses. A qualitative estimate of relative abundance of species in the same generalised habitat was made. The paucity of species encountered at

20 m off Goat Island may be explained by the fact that this was in a region of turbidity below the main zone of algal growth.

WHANGATEAU HARBOUR: (summer sea surface temperature approximately 20°C) (Table 5)

Collections were made around Ti Point wharf, along the channel on the north side of the harbour, and on a shell bank in the middle of the harbour. Some differences were observed in the assemblage of Spirorbinae at each locality.

KAIKOURA BAY: (summer sea surface temperature approximately 15°C).

A small collection was made on the shore in front of the Edward Percival Marine Laboratory at Kaikoura. On stones at LWS, *Protolaeospira lebruni* and *Pileolaria pocillator* were collected. *Metalaospira clansmani* and *Janua steueri* were found attached to algae in the littoral zone, and *Romanchella solea* was found on algae washed up onto the shore. No estimates were made of relative abundance.

CHRISTCHURCH REGION: (summer sea surface temperature approximately 17°C)

Two areas were sampled: McCormick's Bay Culvert, in several centimetres of water under a road bridge where

Table 2 Distribution of species in the New Zealand region. – = absent, + = present.

Species	Poor Knights Islands	Goat Island Bay, Goat Island and Little Barrier Island	Whangateau Harbour	Kaikoura	Christchurch	Stn F905 (35°25'S, 175°48.5'E)	Auckland Islands (Stn D62) 50°31.3'S, 166°09'E)	Cape Hallett (Stn E186) 72°17.7'S, 170°13.1'E)
<i>Spirorbis bidentatus</i>	+	–	–	–	–	–	–	–
<i>Metalaeospira armiger</i>	–	–	–	–	–	–	–	+
<i>Metalaeospira clansmani</i>	+	+	–	–	–	–	–	–
<i>Paralaeospira levinseni</i>	–	+	+	+	+	–	–	–
<i>Paralaeospira monacanthus</i>	–	–	–	–	–	–	–	+
<i>Paralaeospira parallela</i>	–	–	–	–	–	–	+	–
<i>Protolaeospira ambilateralis</i>	–	–	–	–	–	+	–	–
<i>Protolaeospira augeneri</i>	+	–	–	–	–	–	–	–
<i>Protolaeospira capensis</i>	–	+	–	–	–	–	–	–
<i>Protolaeospira gracei</i>	+	–	–	–	–	–	–	–
<i>Protolaeospira lebruni</i>	+	+	+	+	+	–	+	–
<i>Protolaeospira translucens</i>	–	–	–	–	–	+	–	–
<i>Romanchella perrieri</i>	+	–	–	–	–	–	+	–
<i>Romanchella solea</i>	+	+	+	+	–	–	–	–
<i>Pileolaria tegwyni</i>	+	–	–	–	–	–	–	–
<i>Pileolaria (Duplicaria) koehleri</i>	+	–	–	–	–	–	–	–
<i>Pileolaria (Duplicaria) pocillator</i>	–	+	+	+	+	–	–	–
<i>Pileolaria (Simplicaria) pseudomilitaris</i>	–	+	–	–	–	–	–	–
<i>Pileolaria (Simplicaria) ovata</i>	+	+	–	–	–	–	–	–
<i>Amplaria spiculosa</i>	+	–	–	–	–	–	–	–
<i>Janua (Janua) pagenstecheri</i>	+	–	–	–	–	–	–	–
<i>Janua (Dexiospira) pseudocorrugata</i>	–	+	–	–	+	–	–	–
<i>Janua (Dexiospira) steueri</i>	–	–	–	+	–	–	–	–
Sp. A.	–	–	–	–	–	–	–	+

Table 3 Transect at Landing Bay, Poor Knights Islands, showing species abundance and distribution of species according to depth.

– = not collected
 + = uncommon (less than 10 specimens collected)
 ++ = common (10–30 specimens collected)
 +++ = abundant (more than 30 specimens collected)

Species	Depth (m)				
	10	20	30	40	50
<i>Spirorbis bidentatus</i>	–	–	–	–	+
<i>Metalaeospira clansmani</i>	+++	+++	+++	–	–
<i>Paralaeospira levinseni</i>	+++	+++	+++	–	–
<i>Protolaeospira augeneri</i>	+	+	+	++	+
<i>Protolaeospira gracei</i>	–	+	+	+	++
<i>Romanchella perrieri</i>	+++	++	+	+	+
<i>Romanchella solea</i>	+++	+++	+++	+	–
<i>Pileolaria tegwyni</i>	–	–	–	+	+
<i>Pileolaria pocillator</i>	–	++	–	–	–
<i>Pileolaria ovata</i>	++	++	+	–	–
<i>Pileolaria koehleri</i>	(cave) +	–	–	–	–
<i>Amplaria spiculosa</i>	(cave) +	–	–	–	–
<i>Janua pagenstecheri</i>	–	–	–	+	+

Table 4 Species abundance at 3 localities, Goat Island. - = absent, + = uncommon, ++ = common, +++ = abundant; HWN = high water neap, LWN = low water neap, LWS = low water spring.

Species	Locality		
	Littoral zone in Goat Island Bay	1-2 m depth Goat Island Channel	20 m depth off Goat Island
<i>Metalaeospira clansmani</i>	-	+	-
<i>Paralaeospira levinseni</i>	(LWN) +++	+++	-
<i>Protolaeospira augeneri</i>	(LWS) +	-	-
<i>Protolaeospira gracei</i>	-	+	-
<i>Protolaeospira lebruni</i>	(LWS) ++	+++	+++
<i>Romanchella solea</i>	-	+	-
<i>Pileolaria pocillator</i>	-	++	++
<i>Pileolaria pseudomilitaris</i>	(HWN) ++	-	-
<i>Pileolaria ovata</i>	(LWN) +	+	-
<i>Janua pseudocorrugata</i>	(aquarium) ++	-	-

Table 5 Species abundance at 3 localities, Whangateau Harbour. - = absent, + = uncommon, ++ = common, +++ = abundant; LWS = low water spring.

Species	Locality		
	On valves of <i>Amphidesma australe</i> on shell bank LWS	On stones at Ti Point LWS	On <i>Carpophyllum flexuosum</i> in channel 1-5 m
<i>Paralaeospira levinseni</i>	++	+	-
<i>Protolaeospira lebruni</i>	+++	+	-
<i>Romanchella solea</i>	-	-	+
<i>Pileolaria pocillator</i>	+++	+	-
<i>Janua pseudocorrugata</i>	-	++	-

there was quite rapid water movement at times but which was a well sheltered locality; and at 10 metres depth in Taylor's Mistake. In the first locality *Janua (D.) pseudocorrugata* was the dominant species but it was not found in the murky waters of Taylor's Mistake. *Paralaeospira levinseni*, *Protolaeospira lebruni*, and *Pileolaria pocillator* were found at both localities.

Distribution according to substrate

Three species, *Romanchella solea*, *Metalaeospira clansmani*, and *Janua (D.) steueri* were found only on algae, and *Romanchella perrieri* was present only on a species of green *Bugula* sp. The depth and horizontal distribution of these species were limited by the distribution of their preferred substrata. Thus at the Poor Knights Islands, where dense growth of *Ecklonia radiata* and other algae occurred down to about 30 m, the depth range of the associated species of Spirorbinae was also great. At Goat Island Bay, on the other hand, where the water was much less transparent and the algal zone extended to about 15 m, the depth range of associated species was similarly limited. The green *Bugula* sp. on

which *R. perrieri* settled was found only at the Poor Knights Islands, and this may explain the apparent absence of this species from mainland localities. In other parts of the world *R. perrieri*, like *J. (D.) steueri*, has been recorded mostly from algal substrata.

Pileolaria pseudomilitaris and *Janua (D.) pseudocorrugata* were found only in the littoral zone where, providing conditions were sufficiently sheltered, they could be the dominant species. *Paralaeospira levinseni* was also found mostly in the littoral zone or in shallow water. *Pileolaria koehleri* and *Amplaria spiculosa* were in shallow water, which agrees with the depth distributions of these species in Hawaii and South Australia respectively. Most other species occurred over a wide depth range. However, *Janua (J.) pagenstecheri*, which is one of the commonest species on British shores, seems to be rare in New Zealand, and was found only at considerable depths at the Poor Knights Islands. Similarly, *Spirorbis bidentatus* and *Pileolaria tegwyni* have been recorded elsewhere in shallow water, but were found only beneath 30 m at the Poor Knights Islands.

Distribution in relation to sea temperatures

Table 6 indicates that two main elements can be detected in the New Zealand Spirorbinae: an assemblage of species widely distributed throughout warmer seas and an assemblage known mainly from cold water areas. Most collections have been made within the Aupourian province (Finlay 1927) and some are from the Cookian. Warm West Wind Drift currents tend to carry subtropical or even tropical species to the northeast coast of New Zealand, and cold circumpolar currents carry Antarctic species around the southern oceans.

The probable significance of sea temperature in relation to distribution of Spirorbinae may be illustrated by two examples.

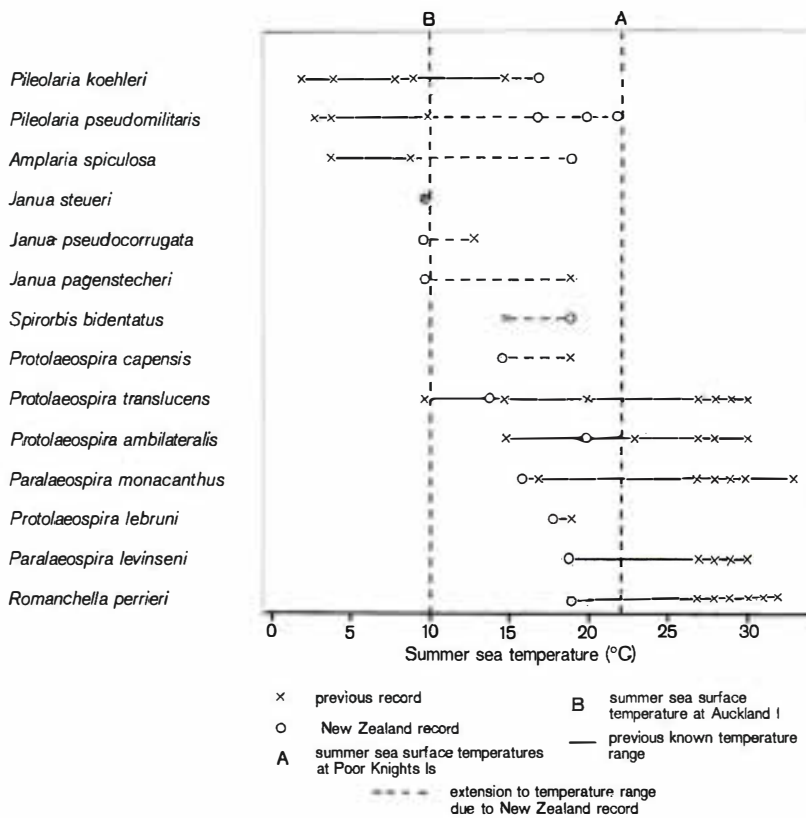


Table 6 Spirorbinae presently recorded from New Zealand plotted according to summer sea temperatures in regions from which each species has been recorded. Where species have been collected from depths exceeding 10 m, an estimate of the sea temperature at the appropriate depth has been made (data from Sverdrup *et al.* 1942).

Protolaeospira lebruni is a cold water species which has not previously been recorded within the temperature covered by the present collection from mainland New Zealand (Table 6). Although it was an abundant species at Goat Island Bay and all regions south (e.g., Whangateau Harbour, Kaikoura, and Christchurch), it was not recorded from the Poor Knights Islands where surface sea temperatures in summer are usually about 1°C higher than sea temperatures at Goat Island Bay. Recently a number of species regarded as tropical or subtropical have been recorded at the Poor Knights Islands (Morton & Miller 1968). The summer sea surface temperature at Goat Island Bay, with a maximum of about 21°C in February, is close to the maximum range suitable for settlement and survival of *P. lebruni*. It is likely that a summer sea surface maximum of 21°C marks the northern limits of distribution of this species elsewhere in shallow depths of southern oceans.

Pileolaria (Duplicaria) koehlerii on the other hand is a widely distributed warm water species which has not previously been described from regions with summer sea surface temperatures as low as those around New Zealand (Table 6). A few specimens were found at the Poor Knights Islands, but it was not recorded from any of the collecting sites on mainland New Zealand. The distribution of this species appears to be limited by a minimum sea surface temperature of 13°C. The temperature recorded at Goat Island Bay in July

1967 was 13.2°C, and was probably slightly higher at the Poor Knights Islands. In the Northern Hemisphere it is present in the Mediterranean (sea surface winter minimum temperature approximately 13°C), whereas it has not been recorded from the Atlantic coasts of Spain, France, or Britain which have somewhat lower sea surface minimum temperatures. A winter low of 13°C appears to mark the north and south distribution of this opercular-incubating species. In most regions winter minima of 13°C correspond with summer maxima of about 20°C, which is close to the upper limit for *P. lebruni*.

This temperature range (i.e., summer maximum of 20–21°C and winter minimum of about 13°C) marks the limits of distribution of many Spirorbinae. It has already been noted by several authors that opercular-incubating species are mostly found in warm seas, whereas tube incubators are mostly found in colder seas (Bailey 1970; Vine 1972a). The critical division between these two groups of species appears to occur along this sea surface isotherm range, so that cold water species in Northern and Southern Hemispheres are isolated from each other by a wide barrier of warm water. Species which can settle at great depths may bridge this barrier via cold deep waters, and thus some cold water species and genera may exhibit bipolar distribution. This appears to have occurred with the genus *Protolaeospira*, whose members appear particularly well adapted for transport on deep water crustacean exoskeletons, and to a much

lesser degree with the predominantly Northern Hemisphere genus *Spirorbis* and the mainly Southern Hemisphere genus *Paralaeospira*.

Most of the cold water species whose distribution is known demonstrate a circumpolar distribution, with records from Cape Horn, Falkland Islands, Kerguelen Islands, Macquarie Island, and the Antarctic mainland. Although several *Protolaeospira* species show a more north-south distribution than do the other cold water species, the only littoral *Protolaeospira* species recorded here, *P. lebruni*, has not been recorded north of 35°S. Warm water species on the other hand are widely distributed between about 40°S and 45°N.

New Zealand Spirorbinae thus show close affinities with the southern oceans, and also with many regions in tropical, subtropical, and warm temperate zones in both hemispheres. Based on comparisons of sea

surface temperatures, the Poor Knights Islands can be approximately compared with Sydney or Perth, Australia, mid-California, or the Mediterranean coast of South France. Goat Island Bay and most of North Island, New Zealand, is more like South Australia, South-west Africa, much of the west coast of USA, or north-west Spain (to the English Channel). The southern region of South Island is more like Patagonia, Vancouver Island, or Great Britain. These temperature comparisons are closely reflected by distribution of Spirorbinae.

The pattern of distribution of New Zealand Spirorbinae described above reflects the distribution patterns of other groups of flora and fauna in New Zealand waters. However, details of distribution and relative abundances of the different New Zealand Spirorbinae species are still incomplete.

Zoogeographical Distribution

A wide variety of habitats off the coasts of New Zealand was investigated, from the extremely sheltered conditions at McCormick's Bay Culvert or Whangateau Harbour to relatively exposed shores at Kaikoura, and from the Poor Knights Islands off the north-east coast to Auckland Island and Cape Hallett in the Antarctic. Twenty-four species of Spirorbinae are recorded in this paper; most regional surveys elsewhere record about 13 species. Fifteen species were recorded from South Australia (Knight-Jones 1973), 13 from Hawaii (Vine *et al.* 1972), 13 from Sri Lanka (de Silva 1961, 1965; Pillai 1970), and 13 from Britain (Gee 1961). The present study of New Zealand Spirorbinae has covered a greater depth range (down to 161 m) than have most other surveys, however, and collections kindly made available by the N.Z. Oceanographic Institute account for six species which were not found elsewhere. Even deducting these six, the 18 species recorded is unusually large. One explanation is perhaps the temperature range between the Poor Knights Islands (summer sea surface temperature 21°C) and Kaikoura (summer sea surface temperature 15°C). Although this range is only moderate, it appears to span the critical transition between warmer sea temperatures favouring opercular-incubating species and colder waters favouring tube-incubating species.

An attempt was made to collect all the species occurring around the Poor Knights Islands and in the Goat Island Bay and Whangateau region, whereas the more cursory collections made at Kaikoura and Christchurch were inadequate and did not cover sufficient sublittoral habitats. The collections made by the N.Z. Oceanographic Institute at Auckland Island and Cape Hallett were not concentrated on Spirorbinae. These southerly localities have not been closely studied, but there are several previous records of Spirorbinae from the region (e.g., *P. monacanthus* and *P. augeneri* at Auckland Island, Augener 1922).

Present knowledge concerning distribution of Spirorbinae seems to indicate that there were few species of *Spirorbis* sensu stricto in the Southern Hemisphere. It appears that this genus evolved in the Northern Hemisphere, and that the warm equatorial waters have proved a barrier to the transport of the tube-incubating species. It is a general rule that opercular incubators are favoured in warm regions (Bailey 1970; Vine 1972a). The single record of *Spirorbis bidentatus* from the Poor Knights Islands is, therefore, interesting and it is perhaps significant that this species was found only in the deepest collection (i.e., 50 m). It might be thought that this, and perhaps other *Spirorbis* species, have spread across warm equatorial seas in colder depths and that they may be found in relatively shallow waters in higher latitudes. Nevertheless, in the Galapagos Islands, which lie on the Equator but are cooled by the Humboldt Current, *S. bidentatus* is an intertidal species.

The genus *Metalaospira* is represented by two different species, *M. clansmani* and *M. armiger*. The former appears to be closely related to a species from South Australia (Knight-Jones 1973), and the latter has no known close relatives. There have not yet been sufficient studies of sublittoral Spirorbinae from the Pacific to establish whether species such as *M. armiger* also occur nearer the tropics but in deeper waters. At present *Metalaospira* is centred in, and may be restricted to, the Southern Hemisphere.

The genus *Paralaeospira* is represented by three species. This too is mainly a Southern Hemisphere genus, with only *P. malardi* Caullery & Mesnil north of the Equator. *P. levinseni* frequently occurs in shallow sheltered conditions and tends to settle on tubes of *Romanchella solea*. It is common around New Zealand and appears to be widespread throughout colder waters in the Southern Hemisphere. *P. monacanthus* and *P. parallela* are rarer on mainland coasts of New Zealand. *P. monacanthus* has

been known since 1922 when it was described from Auckland Island, the same locality recorded in this study.

The genus *Protolaeospira* is represented by six species. All except *P. lebruni* are sublittoral and mainly deep-water species. Several appear to favour settlement on crustacean carapaces and it may be, as Pixell (1912) tentatively suggested, that the thoracic attachment stalk is an advantage for tube-incubating species settling in conditions where there is rapid water movement (Pixell was referring to conditions in rapids where 7–9 knot currents ran and where *P. ambilateralis* was found.) Perhaps species settling on carapaces of spiny lobsters, which swim jerkily in retreat, would experience problems in retention of embryos, if it were not for the attachment stalk characteristic of the genus. An added advantage of this method of incubation was suggested by observations on live *P. lebruni*. When water in a petri dish was heated by a microscope light, some worms extended their bodies further outside the mouths of their tubes, so that their embryos were exposed to the surrounding water. An exactly similar stalk is seen in the antarctic genus *Helicospira*, and in view of the generally cold water distribution of *Protolaeospira* species, it is doubtful whether aeration of embryos has been a significant factor in the evolution of thoracic attachment stalk incubation. Nevertheless the genus seems to be better represented in warm seas than is any other tube-incubating genus of Spirorbinae.

The genus *Romanchella*, represented by *R. perrieri* and *R. solea*, has a method of embryo retention somewhat similar to that employed by *Protolaeospira* species, but in live specimens the embryo attachment stalk appeared to be more delicate than in specimens of *P. lebruni* or *P. gracei*. In *R. perrieri* the stalk often remained after embryos hatched, but in *R. solea* this was observed on only a few specimens. Embryos were attached tenaciously to the thorax but not so strongly as in *Protolaeospira* species. This method of embryo retention, although possibly less efficient than that in *Protolaeospira*, may have been an advantage to larger species settling on algal fronds or filamentous bryozoans which are constantly swept back and forth by waves and swell (even at 30 m deep at the Poor Knights Islands).

Neither of these *Romanchella* species occurred in the most exposed localities, even though *Carpophyllum* algae may have been present.

Members of the genus *Pileolaria*, represented by four species, are widely distributed throughout all seas from the Arctic to the Antarctic, although they are less well represented in the coldest regions. They are well adapted to withstand temperature extremes and varying degrees of exposure. *P. pseudomilitaris*, for example, was found in pools high on the rocky shore at Goat Island Bay where few other Spirorbinae species had settled. *P. pocillator* was the dominant species in sheltered and rather sandy conditions inside Whangateau Harbour. Specimens which had been covered by sand and mud proved, on examination, to be still alive. *P. pseudomilitaris* and *P. koehleri*, together with the *Janua* species recorded here, show the most world-wide distribution of any of the New Zealand Spirorbinae.

Amplaria spiculosa is the only species in the genus *Amplaria*. In New Zealand it was collected from the Poor Knights Islands where it had settled on stones a short distance inside the entrance to Southern Cave, at about 10 metres. The holotype was collected in the intertidal zone at Kingscote, South Australia (Knight-Jones 1973).

Three New Zealand Spirorbinae belong to the genus *Janua*. They are widely distributed, but only *J. (J.) pagenstecheri* is known from the Arctic. This species was found at the Poor Knights Islands only below 30 metres, whereas it is a littoral and shallow water species around Europe and in other localities. Bailey & Harris (1968) found few in the littoral zone around the Galapagos Islands and suggested that it may be more sublittoral in tropical conditions. It remains to be seen whether it occurs in the littoral zone in some localities on mainland New Zealand. Zibrowius (1968) commented on the ability of *J. (D.) pseudocorrugata* to survive in conditions of low oxygenation, and this observation is supported by its habitats in New Zealand, as it settles only in the most sheltered localities. *J. (D.) steueri* on the other hand tolerates less sheltered conditions and was found settling on algae at the relatively exposed Kaikoura Bay.

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