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## Australian Aplacophoran Molluscs: I. Chaetodermomorpha from Bass Strait and the Continental Slope off South-eastern Australia

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**ABSTRACT.** Four new species of Chaetodermatidae (*Chaetoderma usitatum*, *Falcidens chistos*, *F. lipuros* and *F. macrafrondis*) and a new genus and species of Prochaetodermatidae (*Rhabdoderma australe*) are the first Chaetodermomorpha described from off Australia; all are from the shelf in Bass Strait or from the continental slope off southeastern Australia. Two species are numerous: *F. chistos* occurs at densities sometimes up to 180 m<sup>2</sup> from 22 to 120 m in 20 of the 23 shelf samples that contain Chaetodermomorpha, and the prochaetodermatid *R. australe* is common from deeper water, 1,120 to 2,510 m. Several additional species only recently received or with a single specimen are noted but not described; three belong to *Prochaetoderma*, *Limifossor*, or *Scutopus*, thereby extending the recorded ranges of these genera to the western Pacific. Of the 16 species of Chaetodermomorpha collected, four are shelf species occurring at depths of less than 200 m (*F. chistos*, *F. lipuros*, one Prochaetodermatidae, one undetermined), six are upper slope species extending to 1,000 m (three species of *Falcidens*, *Chaetoderma* sp., *Scutopus* sp., *Limifossor* sp.) and six extend below 1,000 m (*C. usitatum*, *F. macrafrondis*, *R. australe*, *Falcidens* sp., *Chaetoderma* sp., *Prochaetoderma* sp.). These depth distributions are similar to other Pacific Chaetodermomorpha genera except for *Chaetoderma*, a genus usually common on the shelf but missing from Bass Strait.

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Aplacophoran molluscs belonging to the footless, burrowing group comprising the subclass Chaetodermomorpha (= Caudofoveata) have not been reported before from off Australia. Five species in two families and three genera are described here from recent collections made on the slope off southeastern Australia and the shelf in Bass Strait.

### Materials

A total of 231 specimens in 27 samples were examined: 23 samples were taken between 22 and 130 m in Bass Strait,

three samples from the continental slope off south-east Victoria between 1,120 and 2,510 m, and one sample from 1,200 m off Wollongong, New South Wales (Table 1). Twenty five of the Bass Strait stations are part of the Museum of Victoria Bass Strait Survey (RV *Hai-Kung*, FV *Sarda*, RV *Tangaroa*); one sample from the Bass Strait (Esso-Gipps Stn 20) and one sample from off Wollongong (FRV *Kapala*) comprise part of the collection of the Australian Museum (AMC149631 and AMC149638, respectively). In addition, 937 specimens from 17 stations taken by the Museum of Victoria between 363 and 1,850 m on the slope off Point Hicks (RV *Franklin*) have been

recently received and cursorily examined; a few data from these stations are included here (slope stations 25 and 27, Table 1; Discussion).

### Methods

Descriptions of Chaetodermomorpha are based on external morphology, including measurements of body divisions, shape of oral shield, and attitude of spicules on the body wall; morphology of spicules; and morphology of entire, isolated radulae (see Scheltema, 1976, 1985, for more complete accounts of descriptive and statistical methods). Measurements of specimens were made with dividers on lines drawn lengthwise and crosswise on microscope images using a camera lucida attached to a dissecting microscope. The oral shield index is calculated by  $[(\text{length} \times \text{width}) \div \text{greatest trunk diameter} \times 100]$ .

Spicules were removed by teasing after placing the specimen in a drop of glycerine in a depression slide; drawings were made using a camera lucida. Thickness was

determined by using cross-polarised light, and lines were drawn between selected colour bands, or isochromes (Scheltema, 1985). Figure 1A shows morphological characters of a spicule.

Radulae were isolated by dissecting out the buccal mass and removing the tissue with sodium hypochlorite in a depression slide; after thorough rinsing, a drop of glycerine was added. Small radulae were removed in a drop of glycerine to a flat slide and examined under a coverslip.

Permanent slides were made of spicules from the holotype and of spicules and radulae from paratypes. Spicules were teased directly onto a slide and air-dried before mounting in a standard histologic mountant. Radulae were retrieved from the glycerine preparation, washed in distilled water in a depression slide, and run through a dehydration series before mounting.

Scanning electron microscope photographs were taken of holotype spicules using a JEOL JSM-840 microscope (Fig. 2).

Types and paratypes are deposited in either the Museum of Victoria, Melbourne (MV) or the Australian Museum,

Table 1. Specimens examined. C.u. = *Chaetoderma usitarum*; F.C. = *Falcidens chiastos*; F.l. = *Falcidens lipuros*; F.m. = *Falcidens macrafrondis*; R.a. = *Rhabdoderma australe*; P. sp. = *Prochaetoderma* sp.; Sp.undet. = Species undetermined.

Cruise <sup>1</sup> and Stn	Gear <sup>2</sup>	Date	Depth m	Lat. S	Long. E	Sediment <sup>3</sup>	C.u.	F.c.	F.l.	F.m.	R.a.	P. sp	Sp.undet.
Sa80-113	S-M	3/11/80	66	40°23.9'	145°32'	msh		1					
HK-139	T	7/2/81	55	40°43.8'	148°32.7'	s							1
T-155	ES	12/11/81	70	38°56.0'	145°16.6'	m		12					
T-155	S-M	12/11/81	70	38°55.5'	145°17.0'	m		9					
T-156	ES	13/11/81	74	39°45.9'	145°33.5'	m		13					
T-156	S-M	13/11/81	74	39°45.9'	145°33.3'	m		18					
T-157	ES	13/11/81	75	40°10.9'	145°44.3'	m		7					
T-157	S-M	13/11/81	75	40°10.9'	145°44.3'	m		1					
T-158	ES	13/11/81	82	39°48.6'	146°18.8'	m		38					
*T-159	ES	13/11/81	80	*39°46.0'	*146°18.0'	m		*64					
T-159	S-M	13/11/81	80	39°43.5'	146°18.8'	m		7					
T-163	ES	14/11/81	56	43°43.9'	148°32.5'	ms		1					
T-163	S-M	14/11/81	56	43°43.9'	148°32.5'	ms							1
T-165	ES	14/11/81	60	40°13.8'	148°39.6'	ms		1					
T-165	S-M	14/11/81	60	40°14.4'	148°30.0'	ms		1					
T-166	S-M	14/11/81	22	40°06.8'	148°24.4'	sh		1					
T-169	ES	15/11/81	120	39°02.4'	148°30.6'	sm		4	1				
*T-170	S-M	15/11/81	130	*38°57.8'	*148°26.5'	ms			*2				
T-179	ES	18/11/81	55	39°03.2'	146°39.5'	ms		1					
T-180	ES	18/11/81	65	39°12.9'	146°27.3'	ms		1					
T-181	ES	19/11/81	79	38°39.8'	144°18.2'	fs		3					
T-181	S-M	19/11/81	79	38°39.8'	144°18.2'	fs		10					
T-Q631	P	15/11/81	1120	38°35.1'	148°36.8'	sm					1	1	1
T-Q634	P	16/11/81	2510	38°42.3'	148°48.0'	m					1		
T-Q635	P	16/11/81	1730	38°55.6'	148°46.4'	scl					6		
E-G 20	n.d.	5/69	95	39°00.0'	148°24.8'	s		6					
*K76-23-02	n.d.	13/12/76	1200	*34°27-26'	*151°27'	n.d.	*6			*2	*9		
F-Slope 25	ES	22/7/86	1850	38°25.9'	148°58.6'	m	1				5		
F-Slope 27	ES	22/7/86	1500	38°26.0'	149°00.0'	cl	6				47	4	
<b>Totals</b>							13	199	3	2	69	5	3

<sup>1</sup> Sa80 = F.V. *Sarda*, Nov. 1980; HK = RV *Hai-Kung*, Feb. 1981; T = RV *Tangaroa*, Nov. 1981; E-G = *Esso-Gipps*, May 1969; K76 = FRV *Kapala*, Dec. 1976; F = RV *Franklin*, July 1986.

<sup>2</sup> S-M = Smith-MacIntyre grab, 0.1 m<sup>2</sup>; ES = epibenthic sled; P = pipe dredge; T = trawl.

<sup>3</sup> cl = clay; fs = fine sand; m = mud; ms = muddy sand; msh = muddy shell sand; s = sand; scl = silty clay; sh = shell; sm = sandy mud.

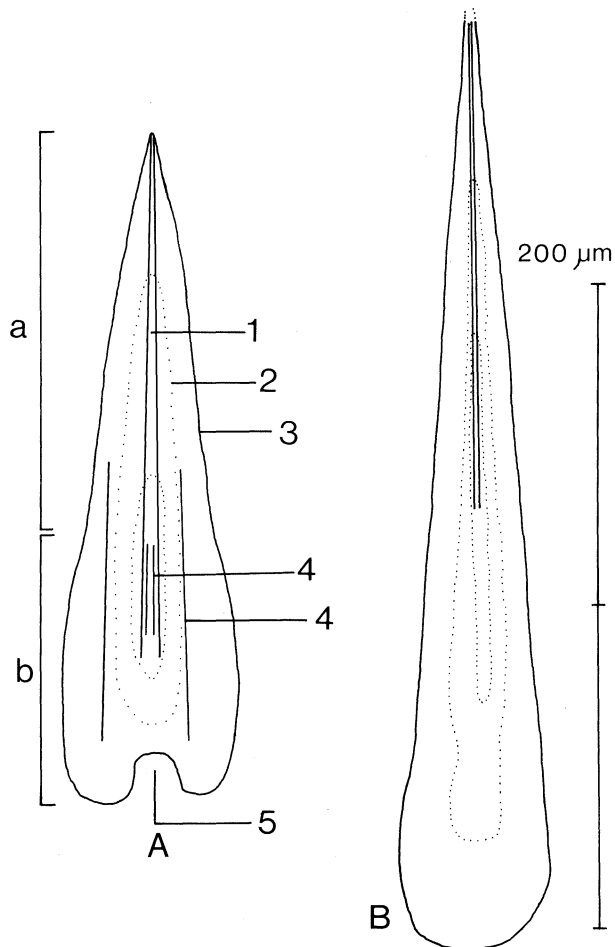
\* Type locality

Sydney (AM).

## Systematics

**Chaetodermomorpha** Pelseneer, 1905Chaetodermomorpha Pelseneer, 1905  
Caudofoveata Boettger, 1956

**Diagnosis.** Aplacophora lacking ventral furrow and foot; with oral shield as extension of pharyngeal cuticle (Scheltema, 1981, 1988) and with paired gills in cloaca (mantle cavity); often with distinct narrow constriction anteriorly; stomach and digestive gland differentiated from each other (Scheltema, 1981); radula distichous with bipartite or fused (unipartite) radular membrane (Scheltema, 1981,



**Fig.1.** A: Generalised spicule, distal end at top, showing morphology: 1, medial keel; 2, isochrome (line between two color bands) as seen under cross-polarised light; 3, side edge; 4, ridges; 5, basal notch; a, blade; b, base; the waist lies between a and b. Spicule length is the distance between most proximal and most distal points; width of blade and of base is the greatest distance between their side edges. B: Spicule of *Prochaetoderma* sp. from Stn Q631 (see Table 1); greatest thickness 9 µm.

1988), or radula specialised into a cone with a pair of denticles (Scheltema, 1972); spicules solid and more or less leaf-shaped; with distinct or indistinct dorsoterminal sensory organ (Haszprunar, 1987).

**Chaetodermatidae** Marion, 1885

**Diagnosis.** Chaetodermomorpha having a cone-shaped radula with a pair of denticles; arrangement of internal organs and musculature reflected externally by 4 body divisions: neck, anterior trunk, posterior trunk, and posterium, which vary among species in length relative to total body length; anterior constriction between neck and anterior trunk usually obvious (Figs 3, 10).

**Chaetoderma** Lovén, 1844*Chaetoderma* Lovén, 1844.

*Crystallophrisson* Möbius, 1875.-Ivanov, 1981. (See Heppell, 1963; Bulletin of Zoological Nomenclature, 1966, Opn 764; Salvini-Plawen, 1984.)

**Type species.** *Chaetoderma nitidulum* Lovén, 1844, by monotypy.

**Diagnosis.** With characters of the family. Radula with paired denticles lying outside dome-shaped membrane which covers the buccal mass and with paired lateral projections extending from radula cone to dome-shaped membrane opposite base of denticles (Fig. 5).

**Distribution.** World ocean except Antarctic, especially near coasts.

**Chaetoderma usitatum** n.sp.

Figs 2A, 2B, 3, 4, 5; Table 1

**Type material.** HOLOTYPE: off Wollongong, NSW, 34°27'-26'S, 151°27'E, 1,200 m. AM C156232 (wet specimen, spicule slide. Second spicule slide MV F54194). PARATYPES 1, 2: type locality. AM C156233 (1), C156234 (2).

**Diagnosis.** Large, up to nearly 3 cm in length, posterior trunk half or less total length, up to about 2 mm in diameter, longer and wider than anterior trunk; spicules up to 400 µm long, greater than 100 µm thick in all body regions, thickest medially with broad keel, flared base, distinct waist, and narrow blade, those of neck and anterior trunk bent outwards and held perpendicular to body wall with sediment densely packed between them, those of posterior trunk flat lying; radula large, up to 550 µm in total length and two fifths neck diameter, lateral projections short, 40-60 µm, dome-shaped membrane extending one third distance along

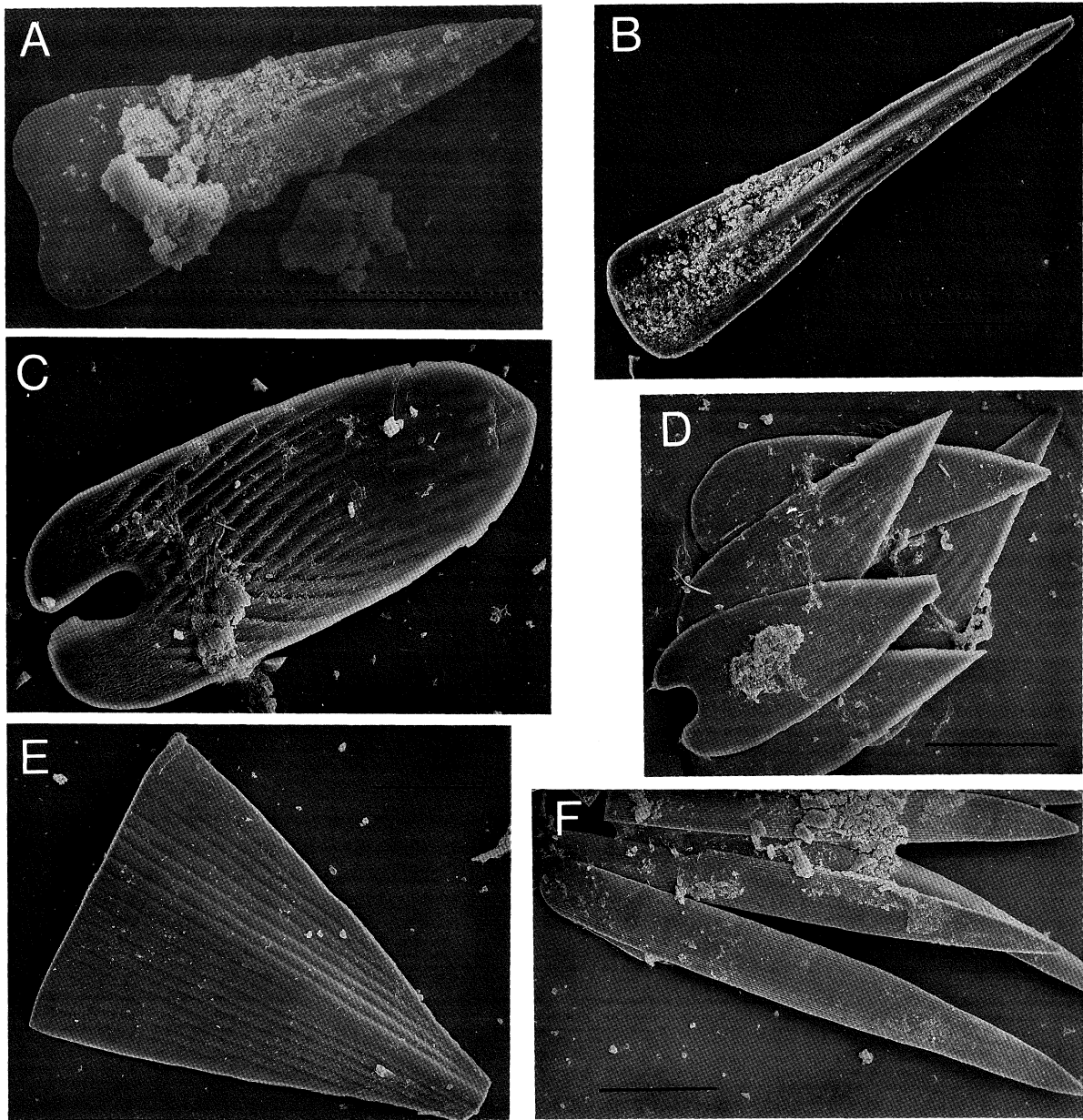
cone, cone nearly square in cross-section, 150 by 190  $\mu\text{m}$ , denticles about 50  $\mu\text{m}$ .

**Etymology.** From *usitatum*, meaning usual.

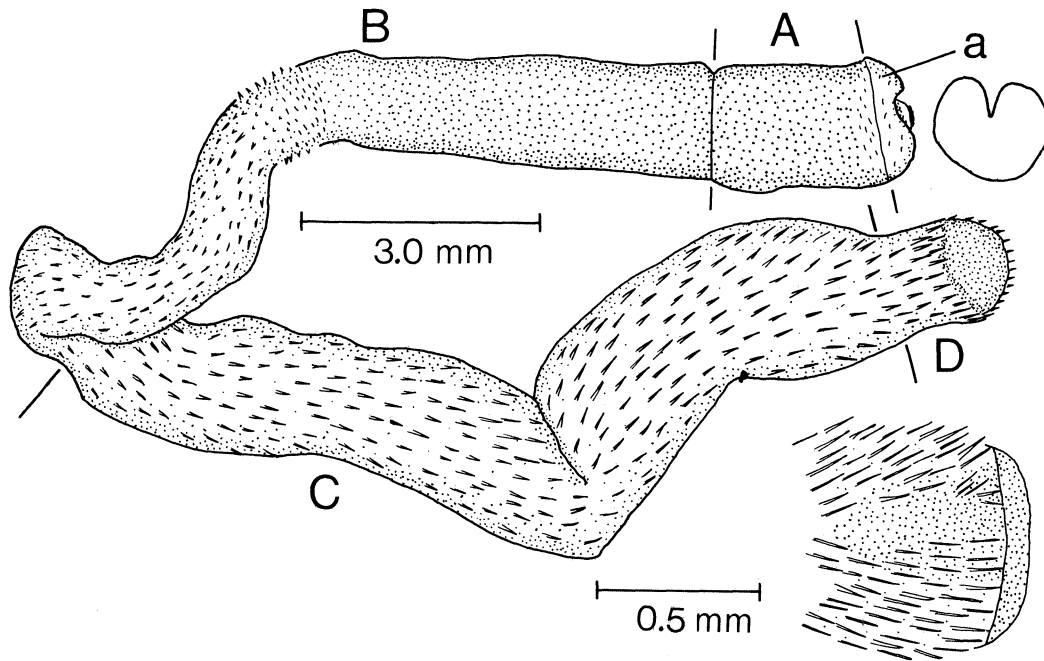
**Description.** *External morphology.* *Chaetoderma usitatum* is largest Chaetodermomorpha in samples from off south-east Australia ranging up to nearly 3 cm in length (Fig. 3); smallest specimen in collection measures 7.1 mm. Body conforms to a shape common for genus

*Chaetoderma*. Neck is short, one tenth body length; anterior trunk shorter than posterior trunk, which is one half or less body length; posterium less than one tenth body length. Anterior trunk widest at usually distinct anterior constriction. Neck and anterior trunk about same diameter, up to 1.5 mm; diameter of posterior trunk nearly one and one half times that of greatest anterior trunk diameter and measures up to 1.9 mm.

Spicules of neck and anterior trunk held perpendicular to body wall and are scarcely visible because of sediment



**Fig.2.** Spicules from holotypes of: A: *Chaetoderma usitatum* n.sp., body region 'e' (see Fig.4); B: *C. usitatum*, region 'g'; C: *Falcidens chistos* n. sp., region 'e' (see Fig. 7); D: *Falcidens lipuros* n.sp., between regions 'd' and 'e' (see Fig. 11); E: *Falcidens macrafrondis* n.sp., distal half of large trunk spicule (see Figs 13A, 14); F: *Rhabdoderma australe* n.sp., body region c' (see Fig. 16), showing fine longitudinal striations. Scale bars = 50  $\mu\text{m}$ .



**Fig.3.** *Chaetoderma usitatum* n.sp., holotype, with oral shield and posterior/cloaca shown enlarged. Coarse stippling indicates sediment packed between the spicules; sediment perhaps covers the dorsoterminal sensory organ of the posteriorium, which is drawn in dorsal view. Body divisions are a, antero; A, neck; B, anterior trunk; C, posterior trunk; D, posteriorium.

packed between them from distal tips to cuticle. Spicules of posterior trunk flat lying and easily dislodged, leaving body translucent where they are missing.

Anterium and oral shield usually exposed; oral shield of moderate size for genus and has short dorsal cleft.

Cloaca flattened on posterior end and packed with sediment; spicules of cloaca not noticeably longer than those of posteriorium and do not form discrete ring. Dorsoterminal sensory organ not evident, probably hidden by sediment.

*Holotype*: total length 26.3 mm; antero 0.3 mm long; neck 2.1 mm long by 1.4 mm in diameter; anterior trunk, which is stretched beyond natural condition, is 11.5 mm long by 1.3 mm in diameter; posterior trunk 11.2 by 1.9 mm; posteriorium 1.2 by 0.7 mm; oral shield is 0.35 mm in width by 0.30 mm in height; index 5.53.

*Spicules*. Spicules from all body regions thickest medially, greater than 10  $\mu\text{m}$ , with usually broad, flared base, distinct waist, relatively narrow blade with distinct, broad keel (Figs 2A and B, 4). Lengths increase from about 100  $\mu\text{m}$  on neck (region 'b') to about 400  $\mu\text{m}$  on posterior part of posterior trunk (region 'h'). Spicules from neck and anterior part of anterior trunk (regions 'b'-'d') are bent outward at a 20-30° angle; those from posterior part of anterior trunk are less bent (region 'e'); and those from posterior trunk (regions 'f'-'h') are nearly flat, slightly bent toward body. Thickest part of spicule shifts from base in spicules from antero, neck and most anterior trunk (regions 'a', 'b', 'c') to waist in spicules from trunk regions 'e'-'h' and back to proximal end on spicules from posteriorium (region 'i'). Base and blade are of about equal length on bent spicules from neck and anterior trunk ('b'-'e'); blade

becomes relatively longer on nearly flat spicules of posterior trunk ('f'-'h'). Base widths of bent trunk spicules ('c', 'd') more than 2 to 3 times blade width and bases flared, i.e., widest part proximal. In spicules of neck ('b'), midtrunk ('e') and posterior trunk ('f'-'h'), base width 2 times blade width or less. Two types of spicules predominate in mid- and posterior trunk regions ('e'-'h'): in one, edges of base flared; in other, edges of base nearly parallel. Blades of latter type narrower than those of former. Third type of spicule found scattered throughout trunk: short, with edges of base and blade very convex and blade wide relative to base.

Besides keel, ornamentation restricted to ridge parallel to each edge from below waist to midblade; a few short ridges are present on keel of some spicules from mid- and posterior trunk ('e'-'h').

Spicules of posteriorium ('i') long (more than 300  $\mu\text{m}$ ), narrow (less than 50  $\mu\text{m}$ ), without waist, bluntly pointed; some short, thin, sharply keeled, asymmetric spicules with one edge more curved than other, tapered proximally, also present.

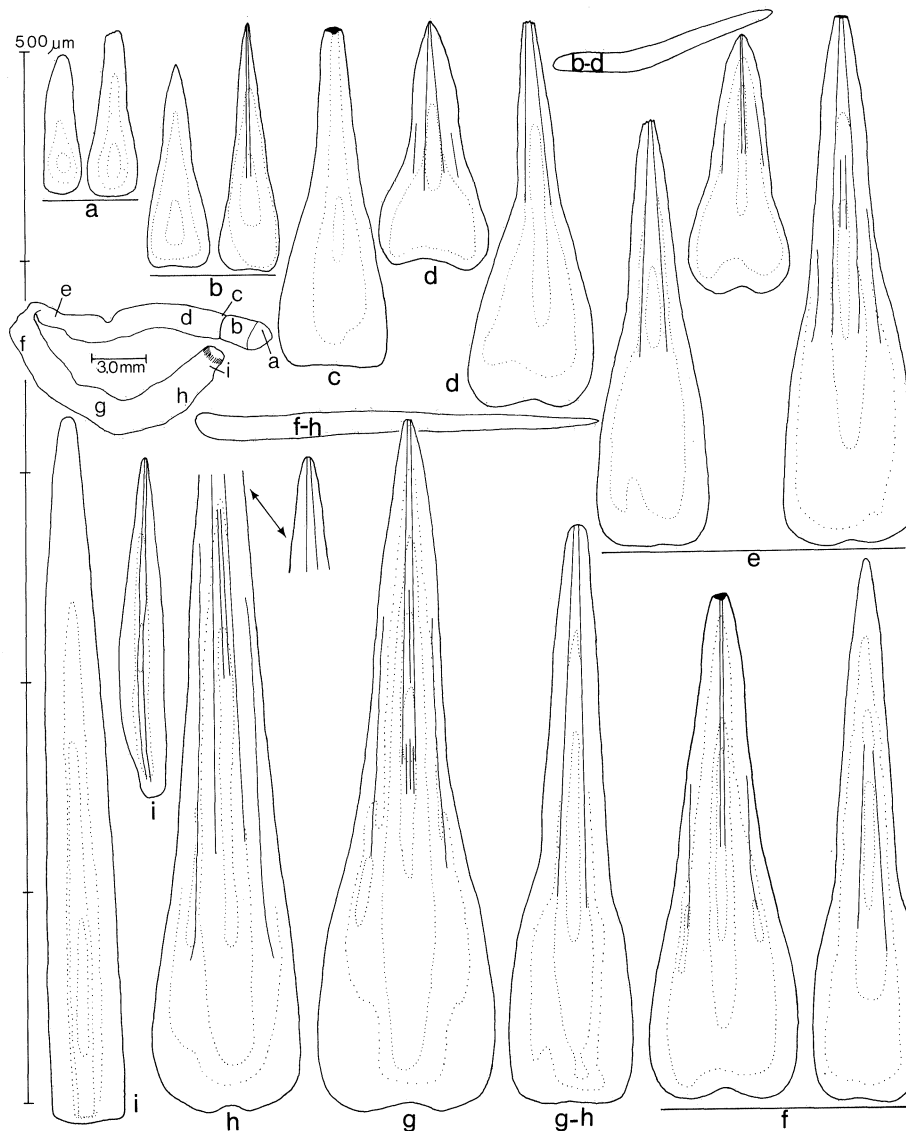
*Radula*. Two radulae were examined (Fig. 5). Radula large, 500 and 550  $\mu\text{m}$  in total length, nearly two fifths neck diameter. Cone of one radula is 470  $\mu\text{m}$  long and nearly square in cross-section, 150  $\mu\text{m}$  wide on anterior and posterior sides and 190  $\mu\text{m}$  laterally (see description of radula under *Falcidens chiastos* below for orientation). Lateral projections very short, 40 to about 60  $\mu\text{m}$ . Dome-shaped membrane (200 and 275  $\mu\text{m}$ ) extends about one third of distance along cone. Denticles, seen clearly in only one radula, are 52  $\mu\text{m}$ .

**Distribution.** The species is known from 13 specimens taken between 1,200 and 1,850 m off Point Hicks, Victoria, and off Wollongong, New South Wales (Table 1).

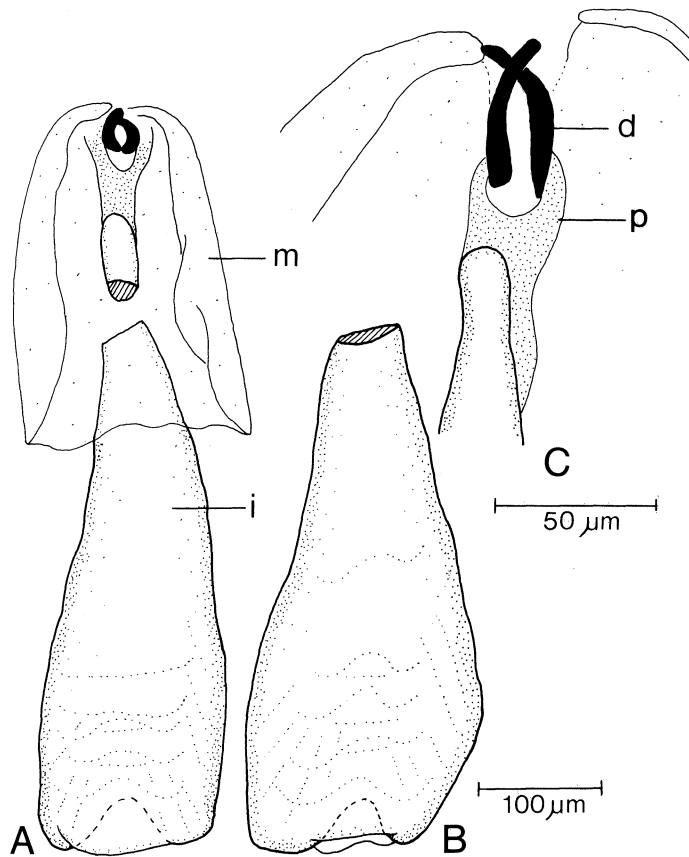
**Closely related species.** *Chaetoderma californicum* Heath, 1911 is a north-eastern Pacific species taken from between 1100 and 1200 m off San Diego, California (holotype, known only from slides) and from 800 m (1 specimen) and 1600 m (2 specimens) off the coast of Oregon. (The holotype slides and Oregon specimens have been examined but a redescription of the species has not yet been published.). *Chaetoderma californicum* is similar to *C. usitatum* in general body shape and size, in morphology of the posterior trunk spicules, and in size of the radula. However, the anterior trunk spicules of *C. usitatum* have a longer and narrower blade than those of *C. californicum*,

the neck is shorter relative to total body length, and the oral shield is smaller. In *C. californicum* the ratio of posterior to anterior trunk width (2 times) is greater than in *C. usitatum* (1.5 times) and the length of the lateral projection of the radula is up to 2 times greater.

*Chaetoderma sibogae* (Stork, 1941) [= *C. indicum* (Stork)] from 959 and 1,886 m in the Java Sea is similar in body shape, and the posterior part of the anterior trunk is similarly distorted by stretching, but the species is too poorly described for a more precise comparison. *Chaetoderma akkesiensis* Okuda, 1943 from 54 m off Japan is likewise similar in shape, but the illustrated spicules are dissimilar, as are those of *Chaetoderma militare* Selenka, 1885 from the Philippines (genus of the latter is uncertain, and the species is poorly described).



**Fig. 4.** Spicules of *Chaetoderma usitatum* n.sp., paratype no. 1 (illustrated at middle left), from the anterior ('a'), neck ('b'), anterior trunk ('c'-'e'), posterior trunk ('f'-'h'), and posterior ('i'). Side views are labelled 'b'-'d' and 'f'-'h'; distal end is to the right, outer surface is above. Greatest thickness is greater than 10 μm for all body regions, but most from the anterior ('a') are 10 μm or less.



**Fig.5.** Radula of *Chaetoderma usitatum* n.sp. A, B: paratype no. 1, cone broken; A, posterior view; B, lateral view; C: paratype no. 2 showing detail of lateral projections. d, denticle; i, cone-shaped piece; m, dome-shaped membrane which covers buccal mass; p, lateral projection.

***Falcidens*** Salvini-Plawen, 1969

*Falcidens* Salvini-Plawen, 1969.

*Chaetoderma*.-Ivanov, 1981 (non Lovén, 1844). (See Salvini-Plawen, 1984).

**Type species.** *Falcidens crossotus* Salvini-Plawen, 1984, by original designation.

**Diagnosis.** With characters of the family. Radula with paired sickle-like teeth attached to the cone-shaped piece (Figs 9, 12, 13).

**Distribution.** World ocean except Antarctic, especially near coasts.

***Falcidens chistos* n.sp.**

Figs 2C, 6, 7, 8, 9; Table 1

**Type material.** HOLOTYPE: Bass Strait, 39°46.0'S, 146°18.0'E, 80 m (RV *Tangaroa*, Stn 159 epibenthic sled, 13 Nov. 1981). MV F54192 (wet specimen, spicule slide. Second spicule slide AM). ILLUSTRATED PARATYPES: Nos 1, 2, 4: type locality. MV F54190

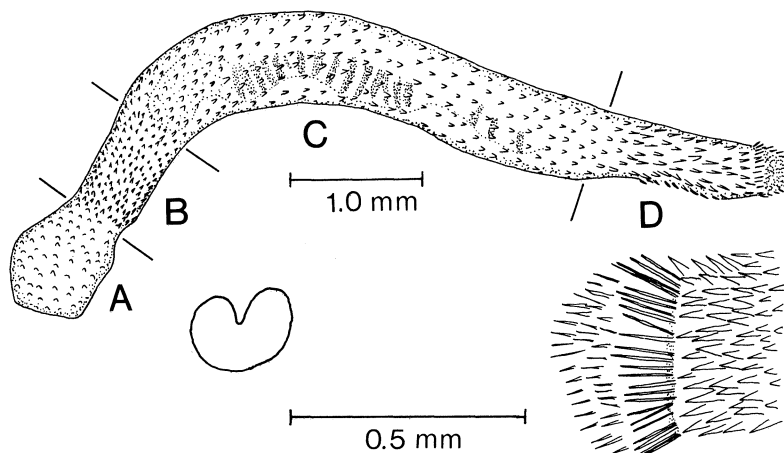
(no.1), F54189 (no. 2) and F54191 (no.4). No. 3: Bass Strait, 39°00'S, 148°24'50"E, 95 m (Esso-Gipps Stn 20, May 1969). AM C156227.

**Diagnosis.** Translucent and shiny, slender, up to 12 mm long by 0.8 mm diameter, anterior trunk short, narrower than posterior trunk which is about half total body length, anterior constriction not pronounced, posterium less than one quarter body length; spicules mostly flat lying but somewhat erect on anterior trunk and posterium, without distinct waist, ornamented by crossed diagonal ridges, with 25 µm notch or rounded basally, about 50 µm in width, ranging up to 150 µm in length, thickness 8 µm or less; radula length up to 220 µm, cone-shaped piece narrow anteriorly, 10-20 µm, and broad laterally, 60 µm or more, sickle teeth 35 µm, distal ends set widely apart, lateral membranes long, extending one half length of cone.

**Etymology.** From *chistos*, arranged diagonally.

**Description.** *External morphology.* Slender, translucent species up to 12 mm in length (Fig. 6). About 50 percent of body length occupied by posterior trunk containing digestive gland and gonad (range, 38-60 percent, N = 49,





**Fig. 6.** *Falcidens chiastos* n.sp., holotype, entire specimen and cloaca in lateral view, and oral shield of paratype no. 4. Spicules of cloacal region are heavily encrusted, not indicated here. Body divisions are A, neck; B, anterior trunk; C, posterior trunk; and D, posteriorium.

Stn 159 ES); anterior trunk and posteriorium short relative to total length, averaging 14 and 23 percent, respectively (ranges, 9-23 percent and 16-30 percent, respectively). Neck about same length as anterior trunk, but of greater diameter (mean diameters 0.6 and 0.4 mm, respectively); constriction between them not pronounced. Long posterior trunk somewhat broader than anterior trunk, averaging 0.6 mm. Narrowest region is the posteriorium (0.3 mm average).

Spicules on neck and posterior trunk flat lying; internal organs visible, especially dark-coloured stomach and folds of digestive gland. Anterior trunk and posteriorium opaque, spicules somewhat erect in preserved specimens. Cloaca ringed by short circle of spicules and bears a brush of usually heavily encrusted needles. Dorsoterminal sensory organ not evident.

Oral shield only slightly wider than high and cleft dorsally; withdrawn in most specimens. Dimensions in paratype no. 4 are 0.16 mm in height by 0.21 mm in width; index is 4.20.

**Holotype:** total length 6.6 mm; neck 0.9 long by 0.7 mm in diameter; anterior trunk 0.8 by 0.5 mm; posterior trunk 3.6 by 0.7 mm; posteriorium 1.3 by 0.3 mm.

**Spicules.** Crossed diagonal ridges ornamenting spicules at indistinct waist give species its name (Figs 2C, 7). Most spicules about 50  $\mu\text{m}$  in width, symmetrical and curved slightly toward body; thickest, 6-8  $\mu\text{m}$ , where diagonal ridges cross. Spicules of neck ('b') ovate or widest distally and less than 75  $\mu\text{m}$  in length; those from anterior and posterior trunk ('c'-'f') and posteriorium ('g') 100-150  $\mu\text{m}$ , at least twice as long as wide. Spicules from neck and trunk rounded distally or rounded with a broad point; those from posteriorium have a broad point. Proximally, spicules either notched deeply (notch about 25  $\mu\text{m}$  long) or unnotched; neither type predominates. Unnotched spicules either

rounded or straight basally. Notch openings vary in width of gap from nearly closed (less than 2  $\mu\text{m}$ ) to more than notch width (greater than 10  $\mu\text{m}$ ) (Fig. 8). Spicules from region near cloaca ('h') vary from broad and short (50 by 10  $\mu\text{m}$ ) with short, sharp distal point to narrow and long (35  $\mu\text{m}$  or less by 125-175  $\mu\text{m}$ ) with a long distal point. Needle-like spicules of 150  $\mu\text{m}$  also occur at cloaca.

**Radula.** Three radulae examined, ranging in total length from 185-220  $\mu\text{m}$ , one quarter to more than one third neck diameter (Fig. 9). Radula in preserved specimens of *Falcidens* oriented with sickle teeth dorsal; largest, and growing, end of cone ventral; and triangular plate faces anteriorly. (Triangular plate probably not attached to sickle teeth as described by Scheltema [1972], but may instead be a guide against which ride the sickle teeth, which are attached to the cone [cf. Fig. 9C and F]). Cone-shaped piece ('i') very narrow anteriorly and posteriorly (12-24  $\mu\text{m}$ ) and 3-5 times broader laterally, 60  $\mu\text{m}$  or more at greatest width; cone length in figured paratypes 165 and 185  $\mu\text{m}$ . Sickle teeth ('h') are about 35  $\mu\text{m}$  from base to tip and gape broadly at tips. Entire triangular plate ('c') tanned (i.e., yellowed); has ridges along outer edges (Fig. 9E). Apophyses of triangular plate consist of a bar-shaped piece ('b') and two denticles ('a'). Pair of thin lateral membranes ('y') that lie outside buccal mass about 105  $\mu\text{m}$  long and extend almost half length of cone.

**Distribution.** *Falcidens chiastos* is the most numerous Chaetodermomorpha species in the Australian samples (Table 1). A total of 199 specimens were examined, all from Bass Strait between 22 and 120 m; sediments ranged from fine muds to fine sands and shell. Densities at some stations were high: 180  $\text{m}^2$  at Stn 156 S-M, 100  $\text{m}^2$  at 181 S-M, and 70  $\text{m}^2$  at 151 S-M.

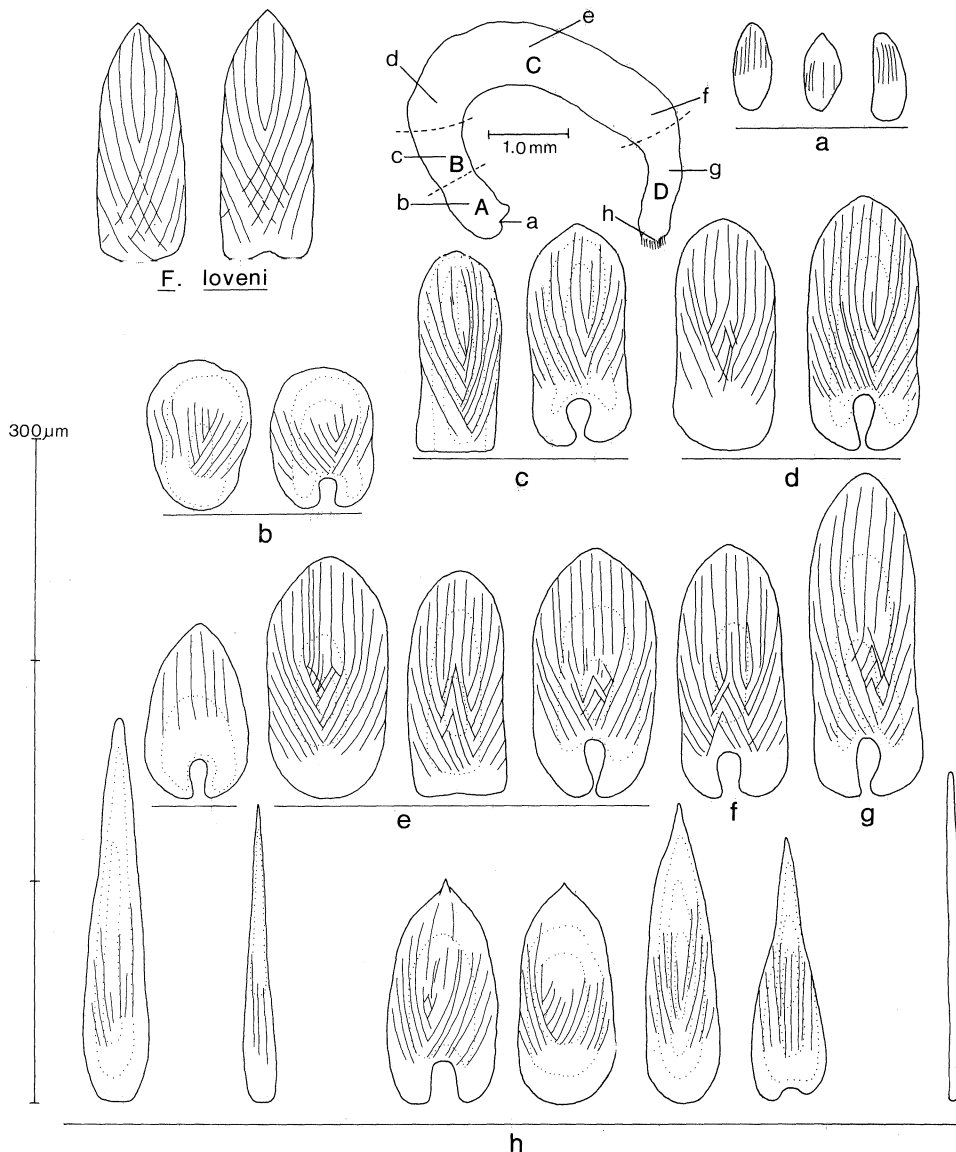
**Closely related species.** *Facidens loveni* (Nierstrasz, 1902), described from two complete specimens and a

fragment dredged on the *Siboga* expedition from 1,310 m in the Java Sea (8°0.3'S, 116°59'E, Stn 35), has spicules with similar diagonally crossed ridges (Fig. 7) and a similar body shape. *Falcidens chiastos* differs from *F. loveni* as illustrated by Nierstrasz, however, in having a significantly shorter posterium relative to total length ( $p$  less than 0.01 in one population, Stn 159 ES; see Scheltema, 1985, for statistical importance of relative posterium length between species). The spicules of *F. chiastos* are broader relative to their length and more deeply notched than those illustrated for *F. loveni*. The sickle teeth of the radula differ in the two species (Fig. 9); in *F. chiastos*, they have a shorter proximal

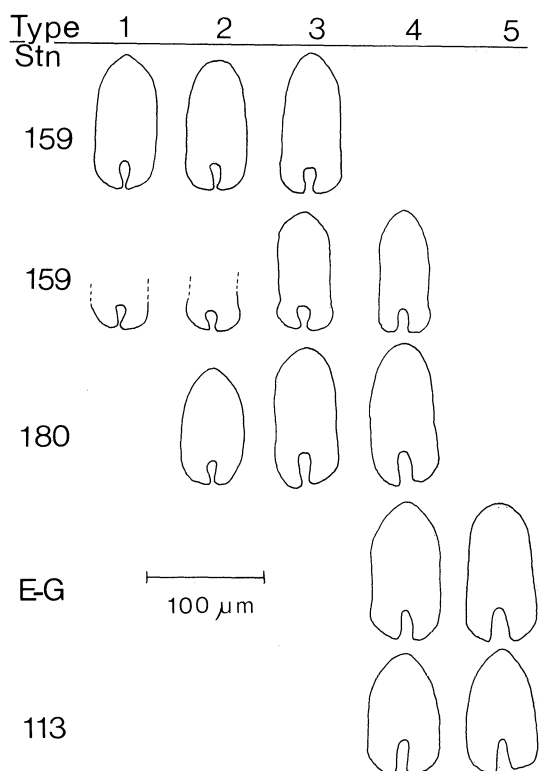
base and a wider gap between the distal ends than in the illustration for *F. loveni*.

A *Falcidens* species similar to *F. chiastos* occurs between 400 and 600 m on the slope off south-eastern Victoria. A preliminary examination shows it to have longer and narrower spicules with the diagonal ridges incomplete or lacking and with a shallower basal notch.

Two other unnamed species of *Falcidens* with similar notched spicules ornamented by crossed diagonal ridges occurs in the western Atlantic off south-eastern United States and north-eastern South America.



**Fig.7.** Spicules of *Falcidens loveni* Nierstrasz and *F. chiastos* n.sp. Spicules of *F. loveni* at upper left are redrawn from Nierstrasz (1902, Fig.183) (scale unknown). 'a'-'h', spicules of *F. chiastos* from paratype no. 1 figured at top: 'a', from oral region; 'b', from neck; 'c', from anterior trunk; 'd', 'e', 'f', from anterior, midpart, and posterior part of posterior trunk; 'g', from posterium; 'h', from around cloaca. Greatest thicknesses for body regions are: 'a', less than 3 µm; 'b', 6.5 µm; 'c'-'f', 8 µm; 'g', 7.5 µm; 'h', 7 µm.



**Fig. 8.** *Falcidens chiastos* spicules, variation in notch width at proximal end of spicule. Spicules in each horizontal row are from the midposterior trunk of a single specimen from the location indicated by station number or letter (see Table 1). Vertical rows show type of spicule notch: 1, nearly closed proximally, opening less than 2  $\mu\text{m}$ ; 2, somewhat open, opening 2 to less than 5  $\mu\text{m}$ ; 3, width of opening broad but less than greatest notch width, 5-7  $\mu\text{m}$ ; 4, notch of even width, sides of notch nearly parallel, opening 8-10  $\mu\text{m}$ ; 5, notch widest at opening, greater than 10  $\mu\text{m}$ .

***Falcidens lipuros* n.sp.**

Figs 2D, 10, 11, 12; Table 1

**Type material.** HOLOTYPE: Bass Strait, 38°57.8'S, 148°26.5'E, 130 m (RV *Tangaroa*, Stn 170 Smith-McIntyre grab, 15 Nov 1981). MV F54188 (wet specimen, spicule slide. Second spicule slide AM). ILLUSTRATED PARATYPE: No. 1: type locality. MV F54187.

**Diagnosis.** Short, thick body up to 6.7 mm long, broadest at anterior trunk (up to 1.0 mm in diameter), tapered posteriorly, posterium short and not tail like, posterior trunk more than half total body length, anterior constriction narrow but distinct; trunk spicules flat lying, elongate, up to 200  $\mu\text{m}$  long and 50  $\mu\text{m}$  wide, less than 8  $\mu\text{m}$  thick, notched or rounded basally, many with broad ridges at waist not parallel to edges or medial axis, waist usually distinct, blade pointed distally; radula 200  $\mu\text{m}$  long, cone narrow anteriorly, 15  $\mu\text{m}$ , and broad laterally, 60  $\mu\text{m}$ ,

sickle teeth 48  $\mu\text{m}$  with points nearly meeting, lateral membranes short, extending less than one quarter length of cone.

**Etymology.** From *lipuros*, without a tail.

**Description.** *External morphology.* Short, anteriorly broad species without distinct tail, or posterium (Fig. 10). Greatest length of 3 known specimens 6.7 mm. Anterior trunk short, only one sixth total length, and broadest part of body, up to 1.0 mm in diameter. Neck short, one tenth body length, 0.1-0.2 mm narrower than anterior trunk; very narrow but distinct constriction appears as fine line between them. Posterior trunk more than half total length; tapers gradually to posterium, narrowing to 0.1 or 0.2 mm less in diameter than anterior trunk. Short posterium, one sixth total length, is relatively broad, 0.4-0.5 mm in diameter. Anterior and posterior ends of body flat when contracted. Dorsoterminal sensory organ evident. Oral shield of paratype no. 1 twice as wide laterally as high (0.27 by 0.14 mm), with deep dorsal cleft extending more than halfway ventrally; index is 4.72.

Spicules flat lying and distinctly pointed; increase in length posteriorly. Posterior trunk translucent, dark digestive gland apparent. Cloaca encircled by a ring of spicules shorter than those of posterium; spicules of contracted posterior wall converge like spokes of a wheel into center.

*Holotype:* total length, 6.8 mm; neck 0.8 long by 0.8 mm diameter; anterior trunk 0.9 mm by 1.0 mm; posterior trunk 4.2 by 0.9-0.8 mm posteriorly; posterium 0.9 by 0.5 mm.

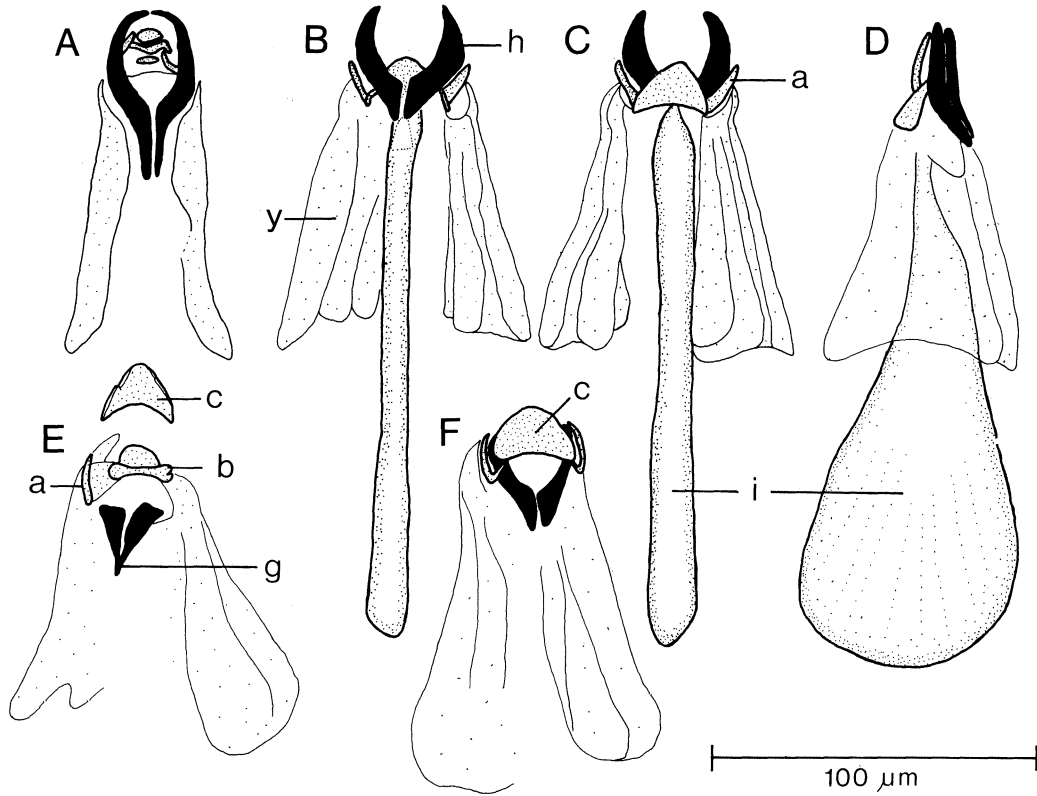
*Spicules.* Spicules of *F. lipuros* symmetrical, flat and either notched or rounded basally (Figs 2D, 11). Side edges of both base and blade convex; waist usually distinct (but indistinct in Fig. 2D); many, but not all, spicules have distinct, wide, longitudinal grooves and ridges at waist not parallel to sides or to medial axis. Thickest part of spicules is medial and extends from base to just beyond waist; greatest thickness (up to 8  $\mu\text{m}$ ) same in neck and trunk spicules. Blade broad relative to base. Distal tips thin and often broken off.

Spicules from oral region ('a') thin (up to 4  $\mu\text{m}$ ), elongate (up to 60  $\mu\text{m}$  long by 20  $\mu\text{m}$  wide), often somewhat pointed, without ridges. Spicules of neck ('b') and anterior trunk ('c') have broad blade with distinctly convex edges, end in a nipple-like point distally. Blades and bases about equal in length; total lengths and base widths range up to 100 by 42  $\mu\text{m}$  on the neck and up to 120 by 50  $\mu\text{m}$  on anterior trunk.

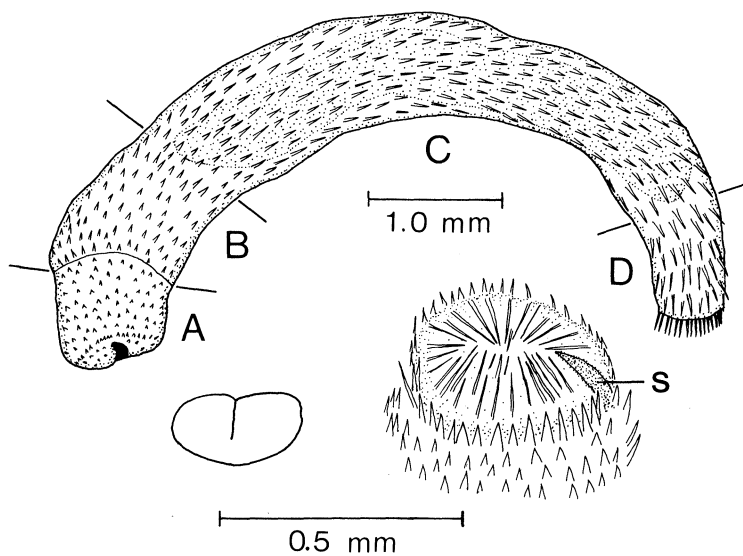
Blades in spicules of posterior trunk ('d', 'e') longer than bases, have only slightly convex edges, ending in a point not set off from rest of blade. Spicule lengths and base widths range up to 180 by 50  $\mu\text{m}$  anteriorly and up to 200 by 55  $\mu\text{m}$  posteriorly.

Spicules of posterium ('f') have elongate, narrow blades and range up to 350  $\mu\text{m}$  in length, 50  $\mu\text{m}$  in width, and 10  $\mu\text{m}$  in thickness; interspersed are spicules like those of trunk.

Scattered on neck and trunk are few thin (4-5  $\mu\text{m}$ ), short,



**Fig.9.** Radula of *Falcidens loveni* (Nierstrasz) (A) and *F. chiastos* n.sp. (B-F). A: redrawn from Nierstrasz (1902, fig.191); B-D: paratype no. 1, posterior (B), anterior (C), and lateral (D) views; E: paratype no. 2; F: paratype no. 3. In E, the triangular plate 'c' has broken away from its apophyses 'a' and 'b' and shows ridged edges; the sickle teeth 'h' are broken off, but the proximal spring connection 'g' remains. In F the triangular plate 'c' is more distal relative to the sickle teeth than in the radula drawn in B and C, probably indicating preservation at different times of radula movement. a, b, apophyses of triangular plate; c, triangular plate; g, spring-like connection of sickle teeth; h, sickle teeth; i, cone-shaped piece; y, lateral membranes that lie outside buccal mass. Scale applies to B-F; unknown for A.



**Fig.10.** *Falcidens lipuros* n.sp., holotype, entire specimen and posterolateral view of cloaca, and oral shield of paratype no. 1. Body divisions are A, neck; B, anterior trunk; C, posterior trunk; and D, posterior. The dorsoterminal sensory organ ('s') is evident.

subtriangular spicules posteriorly ('e') having a long, narrow, thickened blade.

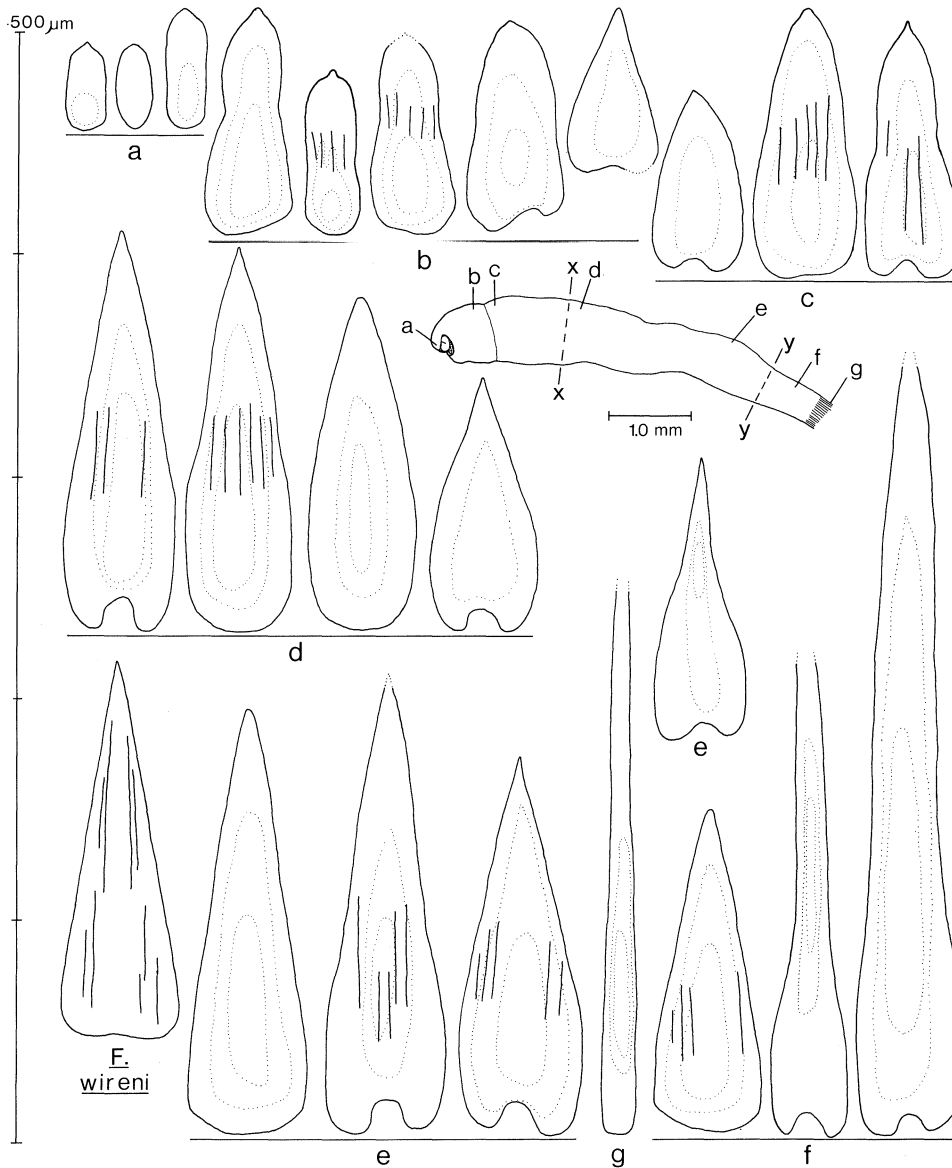
Spines surrounding cloaca are less than 300 µm long and 8 µm thick, shorter and thinner than longest posterior spicules; base flattened and narrow, 15 µm in width.

**Radula.** One radula examined (Fig. 12); total length 200 µm, nearly one third neck diameter. Cone-shaped piece 155 µm long and anteriorly and posteriorly very narrow (15 µm), one quarter lateral width (60 µm). (See description above of *F. chiastos* radula and Fig. 9 for radula morphology.) Sickle teeth 48 µm from base to tip; tips curve towards each other nearly to touch. Tanned portion of triangular plate shaped like inverted base of

heart and bears on each side a broad, tanned apophysis extending only slightly onto sickle tooth. Connections to second pair of denticles lying alongside sickle teeth were not seen. Lateral membranes short, about 70 µm in length, extend less than one quarter length of cone.

**Distribution.** Three specimens were taken from two stations at 120 and 130 m with mixed mud and sand in Bass Strait (Table 1).

**Closely related species.** *Falcidens lipuros* and *F. chiastos* may at first be confused when they are found in the same sample, but the greater anterior trunk width and longer posterior spicules in *F. lipuros* quickly distinguish them



**Fig.11.** Spicules of *Falcidens lipuros* n.sp. and *F. wireni* (Nierstrasz) (redrawn from Nierstrasz, 1902, fig.205, scale unknown). 'a'-'g', spicules from paratype no. 1 figured at upper right: 'a', from oral region; 'b', from neck; 'c', from anterior trunk; 'd', 'e', from anterior and posterior part of posterior trunk; 'f', from posterior; 'g' from around cloaca. Line x-x, division between anterior and posterior trunk; y-y, division between posterior trunk and postorium. Greatest thicknesses for body regions are: 'a', 4 µm; 'b'-'e', 7.5-8 µm; 'f', 10 µm; 'g', 8 µm.

under a dissecting microscope. Under a compound microscope, the spicules are distinctive.

*Falcidens wireni* is a species 11 mm long described by Nierstrasz (1902) from 1,570 m in the Banda Sea at 4°24.3'S, 129°49.3'E; from Nierstrasz's drawings (fig. 204) and description it is similar to *F. lipuros* in being wider anteriorly (more than 1 mm) than posteriorly (1 mm), in lacking a tail-like posterium, and in having a flat, blunt anterior end. The illustrated spicule of *F. wireni* (fig. 205A; redrawn here, Fig. 11) is somewhat like those of *F. lipuros* in general proportions of length to width and in having longitudinal ridges; however, the sides are straight rather than convex and the ridges are not restricted to the region of the waist. The radula drawings are inadequate for comparison.

A species of *Falcidens* similar to *F. lipuros* occurs on the slope off south-east Victoria between 363 and 800 m. cursory examination shows it to have spicules that are shorter and keeled with fine parallel ridges extending far distally on the blade.

***Falcidens macrafrondis* n.sp.**

Figs 2E, 13, 14; Table 1

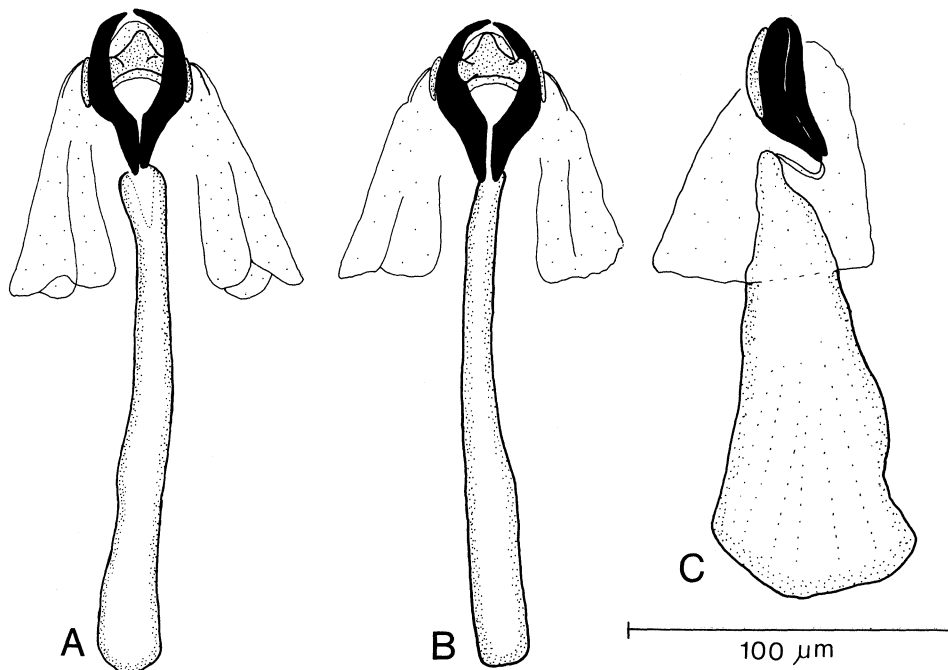
**Type material.** HOLOTYPE: off Wollongong, NSW, 34°27-26'S, 151°27'E, 1200 m. AM C156228 (wet specimen, spicule slide. Second spicule slide MV F54193). PARATYPE: type locality. AM C156229.

**Diagnosis.** Small for genus, less than 4.5 mm long by 0.5 greatest diameter, posterium probably elongate and narrow; trunk spicules triangular, very large and thick for body size, more than 300  $\mu\text{m}$  in length and 150  $\mu\text{m}$  in base width, 10  $\mu\text{m}$  or more thick, distally pointed, blade with numerous sharp longitudinal ridges and broad keel, waist not distinct; radula cone short (60  $\mu\text{m}$ ) relative to tooth length (45  $\mu\text{m}$ ), total length (100  $\mu\text{m}$ ) about one fifth neck diameter.

**Etymology.** From *macra*, large and *frons*, leaf.

**Description.** *External morphology.* Two specimens collected have been distorted by stretching and length of body divisions cannot be determined (Fig. 13). Total stretched length about 4.5 mm; width of neck, which is not stretched, about 0.5 mm. Posterium presumably elongate, body-wall musculature weak. Probably no anterior constriction between neck and anterior trunk. Paratype female, as determined in glycerine-squashed preparation, with largest egg 32 by 45  $\mu\text{m}$ , size possibly indicates immature specimen of average adult body length (see Scheltema, 1987). Spicules remarkably large for body size, even in oral area; spicules project from neck and withdrawn mouth, but presumably flat lying on trunk, although most trunk spicules lost from specimens. Ring of long spicules surrounds relatively large, rounded cloaca (0.4 long by 0.3 mm wide); tips of spicules broken off in holotype. Shape of oral shield not known; dorsoterminal sensory organ not evident.

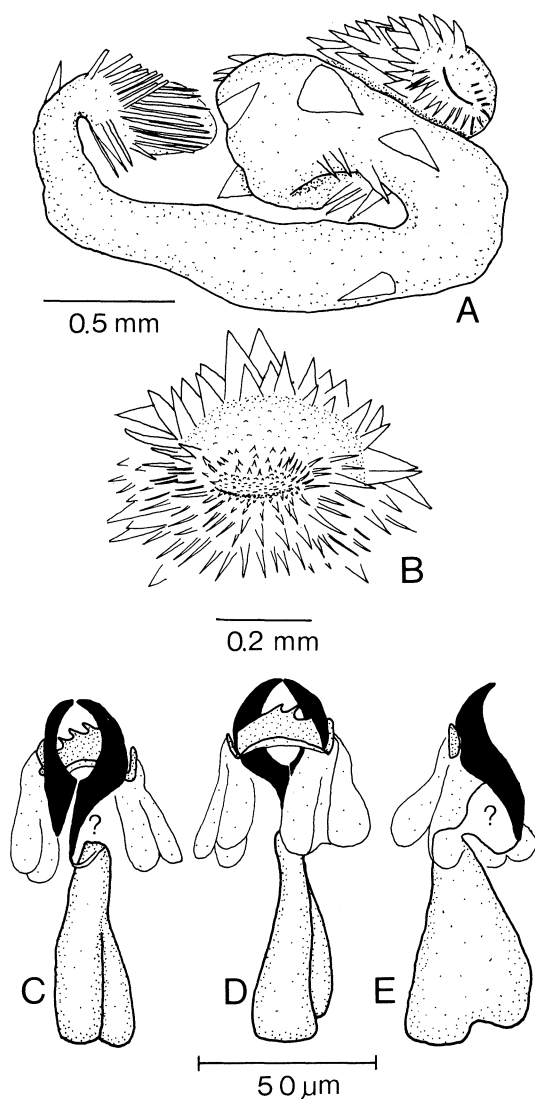
*Spicules.* Spicules flat and range in size from about 200 to 350  $\mu\text{m}$  in length (Fig. 14) with broad base 70 to 150  $\mu\text{m}$



**Fig.12.** Radula of *Falcidens lipuros* n.sp., paratype no. 1. A, B, C: posterior, anterior, and lateral views, respectively (cf. Fig. 9). Lateral view somewhat tilted and foreshortened.

wide; those that ring cloaca 30  $\mu\text{m}$  in width. Spicules from most anterior end large, especially those ventral to mouth (120  $\mu\text{m}$  long). Blades have broad keel and numerous fine, sharp, longitudinal ridges that run fan like, converging distally (Fig. 2E). Waist not distinct. Spicules are thickest at keel, 10  $\mu\text{m}$  or more; entire spicule flat and thick, 7  $\mu\text{m}$  over its greater area in spicules 200  $\mu\text{m}$  long, and 9 to 10  $\mu\text{m}$  in spicules 350  $\mu\text{m}$  long. Distal end sharply pointed; edges often becoming concave in outline near tip. Proximal end of base straight or somewhat indented.

**Radula.** Radula small, 100  $\mu\text{m}$  in total length (Fig. 13) and about one fifth neck diameter. Cone only 60  $\mu\text{m}$  long, hardly longer than sickle teeth, which are 45  $\mu\text{m}$  long; such a short cone may indicate early growth in immature specimen. Anterior cone width 15  $\mu\text{m}$ ; lateral width, 38  $\mu\text{m}$ , about 2.5



**Fig. 13.** *Falcidens macrafrondis* n.sp., holotype (A,B) and radula of paratype (C-E). Spicules illustrated on the trunk of the holotype (A) are the only ones remaining in this view; spicules ringing the cloaca are broken. C, D, E: posterior, anterior, and lateral views, respectively (cf. Fig. 9).

times greater. Triangular plate approaches bar shape; has 3 distinct little denticles that bend towards sickle teeth. Apophyses consist of pair of denticles. Lateral membranes short, about 35  $\mu\text{m}$ , extend down only one tenth length of cone.

**Distribution.** Only two specimens from 1200 m off Wollongong, New South Wales, are known (Table 1).

**Closely related species.** There are no known species close to *F. macrafrondis* with its large spicule size relative to body size.

### *Falcidens* spp.

A single specimen of a species with a long posterium was collected from Bass Strait at 1,120 m (Stn Q631, Table 1).

### Prochaetodermatidae Salvini-Plawen, 1969

**Diagnosis.** Chaetodermomorpha with large, cuticular jaws and small, distichous radula with 8-13 rows of paired teeth on unipartite radular membrane; each tooth with medial serrated membranous brush and lateral wing (Fig. 17D), radular membrane with tooth-like projections that extend along each tooth (Fig. 17B). Oral shield divided, often bordered by large spicules; posterium usually tail like; trunk not divided (Fig. 15); dorsoterminal sensory organ present but not evident (Haszprunar, 1987). Genera differentiated on basis of nonoverlapping character states of spicules shared by several species, some still undescribed (Scheltema, 1985).

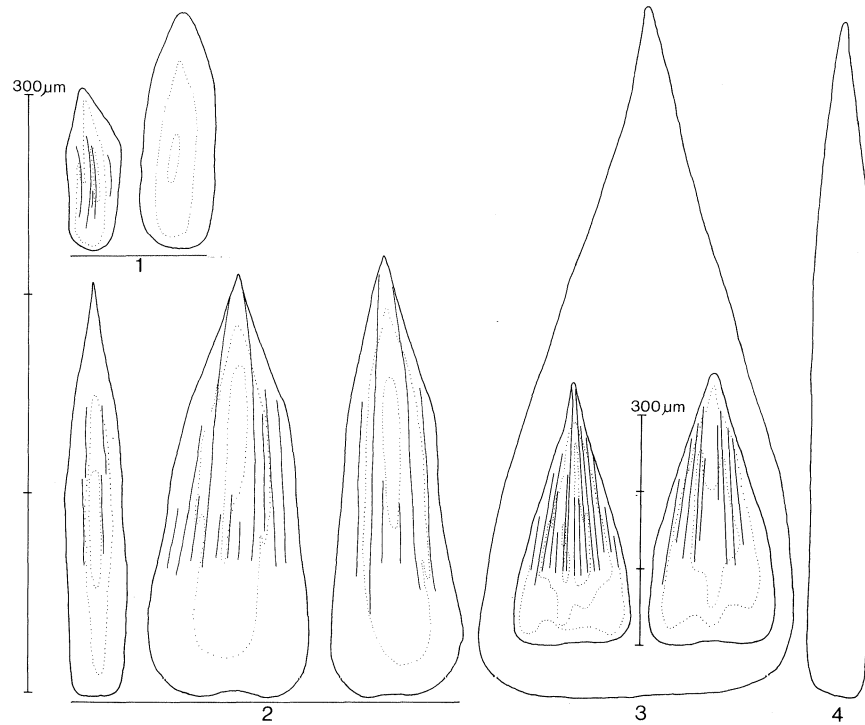
### *Rhabdoderma* n.gen.

**Type species.** *Rhabdoderma australe* n.sp.

**Diagnosis.** With characters of the family. Spicules rod like, symmetrical or somewhat asymmetrical, long, thick, pointed, flattened, lacking obvious ornamentation; base longer than blade on trunk spicules (Figs 2F, 16). Spicules of trunk bound to body and arranged obliquely; they diverge on each side of ventral midline, spiral up dorsally and posteriorly, and meet at angle along dorsal midline (Fig. 15). Differentiated from *Chevroderma* Scheltema, 1985 by lack of longitudinal groove and chevron-shaped cross grooves on spicules.

**Distribution** (based largely on undescribed species). Off south-eastern Australia; north-eastern Pacific; western Atlantic from south of Cape Hatteras to the Argentine Basin; eastern Atlantic from West European Basin to Namibia Basin.

**Etymology.** From *rhabdos*, a rod.



**Fig.14.** Spicules of *Falcidens macrafrondis*, paratype: 1, probably from anteriormost end; 2 and 3, trunk spicules, but spicule on left perhaps from posterium; 4, one of the spicules ringing the cloaca, drawn from glycerine-squashed preparation. In 3, large spicule in outline is at the same magnification as spicules labeled 2; spicules within the outline are the same size as the outline but drawn at less magnification. Greatest thicknesses are: 1, 9  $\mu\text{m}$ ; 2, 3, greater than 10  $\mu\text{m}$ ; 4, not determined.

### *Rhabdoderma australe* n.sp.

Figs 2F, 15, 16, 17; Table 1

**Type material.** HOLOTYPE: off Wollongong, NSW, 34°27'-26'S, 151°27'E, 1,200 m. AM C156230 (wet specimen, spicule slide. Second spicule slide, MV F54196). DESCRIBED PARATYPES: No. 1: type locality. AM C156231. No. 2: Bass Strait, 38°55.6'S, 148°46.4'E, 1,730 m (RV *Tangaroa*, Stn Q635, pipe dredge, 16 Nov. 1981). MV F54195.

**Diagnosis.** Large and broad prochaetodermatid, largest specimens more than 5 mm long by 1 mm in trunk diameter; posterium about one third total length; trunk translucent, spicules up to 400  $\mu\text{m}$  long, narrow (less than 50  $\mu\text{m}$ ), and thick (10  $\mu\text{m}$  or more), crossing at acute angle mid-dorsally, ornamented with fine striations, blade short relative to base, waist indistinct or lacking, base usually tapered; cloaca conical, spicules not in distinct ring; oral shield spicules not obviously larger than surrounding spicules; teeth of radula and jaws large, 175 and 825  $\mu\text{m}$  long, respectively, central plate D-shaped, 45 x 18  $\mu\text{m}$ .

**Description.** *External morphology.* *Rhabdoderma australe* is large for a prochaetodermatid both in length (up to 5.2 mm) and in trunk diameter (up to 1.1 mm) (Fig. 15). Posterium one third to two fifths body length and about one half body width. Trunk translucent; spicules closely bound to body and meet at a pronounced angle mid-dorsally.

Spicules of anterior end large and stand out somewhat from body; on opaque posterium spicules extend away from body. Oral shield spicules not obviously larger than surrounding spicules; oral shield does not cover entire oral area of anterium in some specimens. Cloaca conical and not surrounded by discrete ring of spicules; spicules of cloaca brush like.

*Holotype:* total length 4.8 mm; trunk 2.9 by 1.1 mm; posterium 1.9 by 0.5 mm; index of posterium length to trunk length 0.66. Oral shield (left half of pair) 0.13 by 0.20 mm, index 2.36.

*Spicules.* Spicules long, thick, curved slightly toward body (Fig. 16); numerous faint striations run lengthwise (Fig. 2F). Base longer than blade except in a few spicules from anterior end ('a') and in those from posterium ('d'). Sides of base gently convex; in some spicules convexity greater on one side than the other and spicules slightly asymmetrical (cf. genus *Chevroderma* Scheltema, 1985). Proximal end of base rounded and either tapered or untapered, or straight and either untapered or flared. Short blade has rounded point distally; side edges either continue curve of base or set off by slight indentation at waist. Spicules thickest medially; isochromes symmetrical.

At anterior end (region 'a') spicules long (up to 160  $\mu\text{m}$ ), thick (7-10  $\mu\text{m}$ ), and up to 40  $\mu\text{m}$  wide; distal ends of blade bluntly rounded and waist usually distinct.

Most spicules from lateral and dorsal trunk (regions 'b<sub>1</sub>' and 'c<sub>1</sub>') are 300 to nearly 400  $\mu\text{m}$  long, 35-45  $\mu\text{m}$  wide, and 9 to more than 10  $\mu\text{m}$  thick, but spicules from ventral



body surface ('b<sub>2</sub>' and 'c<sub>2</sub>') are smaller, less than 200 µm long, 25-30 µm wide, and 5 to 8 µm thick, with usually sharper distal points. Scattered amongst most usual spicules are other types: (1) short (length 160 µm), thin (7 µm), blade narrow and sharply pointed with distinct waist; (2) long (up to 350 µm), thick (greater than 10 µm), with edges of sides parallel and 9-µm isochromes running parallel to each other to straight proximal end of base, waist not distinct; (3) similar to type (2) except shorter (80-160 µm long) and with flared base; (4) short (225 µm in length) and broad (45 µm width) with a broad blade. Some specimens have many type 2 spicules, and some have few.

Spicules of posterium (region 'd') long and narrow, from 350 µm up to 425 µm long and 30 µm or less in width. Blades longer and thicker (up to 10 µm) than base which is scarcely or not at all tapered.

Spicules from cloaca (region 'e') narrow, curved rods 10 µm thick and somewhat more pointed distally than proximally; same length (up to 425 µm) as those from posterium.

*Radula*. Radula and jaws in *F. australe* large; teeth in 12-13 rows, first 3 pairs worn. In a specimen with trunk measuring 3.0 by 1.1 mm (paratype no. 1), teeth 175 µm long with broad lateral wing (Fig. 17). Jaws 825 µm long by 390 µm wide. Membranous lateral tooth-like extensions of radular membrane large and obvious, reaching half way up sides of teeth with small basal projection. Central plates

D-shaped, thin and indistinct, of average length (45-50 µm) for family, but wide, up to 18 µm. In much smaller specimen (trunk 1.6 by 0.6 mm), teeth 130 µm long, jaws 560 by 280 µm, central plates 40 by 18 µm.

**Distribution.** A total of 69 specimens were taken from the slope between 1,120 and 2,510 m off Wollongong, New South Wales, and Point Hicks, Victoria (Table 1).

### *Prochaetoderma* Thiele, 1902

**Type species.** *Chaetoderma raduliferum* Kowalevsky, 1901 by monotypy.

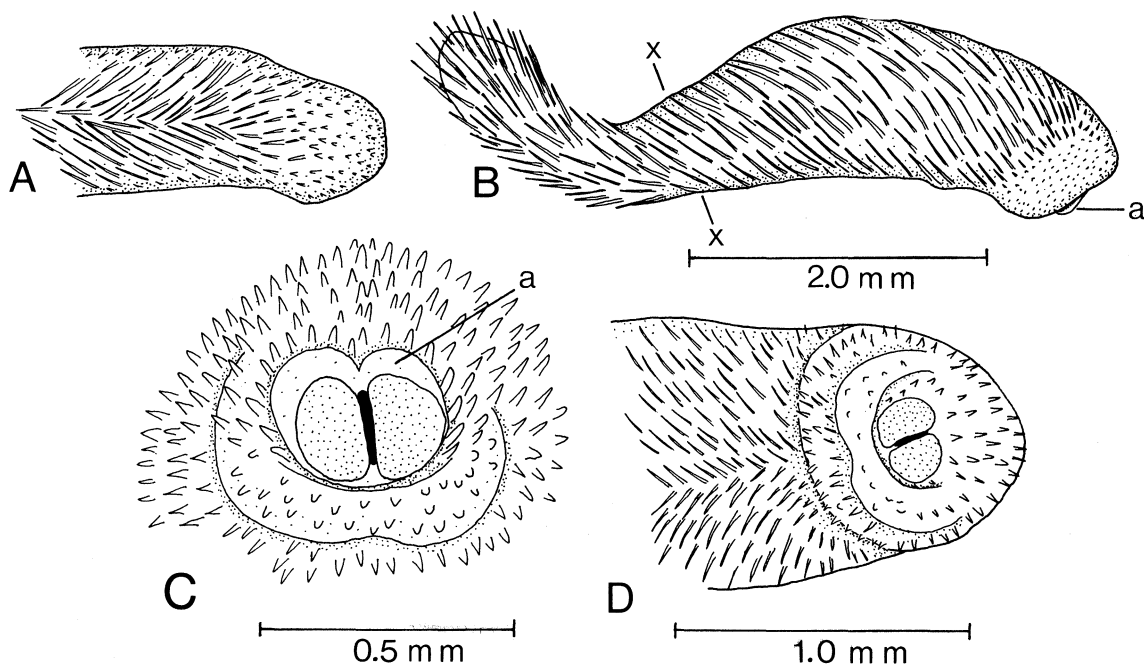
**Diagnosis.** With characters of the family. Spicules flat; base shorter than blade, blade triangular with median keel and sharp distal point; waist present (Fig. 1B).

**Distribution.** Eastern and western Atlantic Ocean; Mediterranean; off south-eastern Australia.

### *Prochaetoderma* sp.

Fig. 1B

A single small specimen 1.9 mm long with a very short posterium (0.19 x trunk length) was taken from 1,120 m in



**Fig. 15.** *Rhabdoderma australe* n.sp., holotype. A: anterodorsal view; B: lateral view; C: anterior view, oral shield and anteriorium; D: anteroventral view. a, anteriorium; x-x, division between trunk and posterium. A and B at same scale.

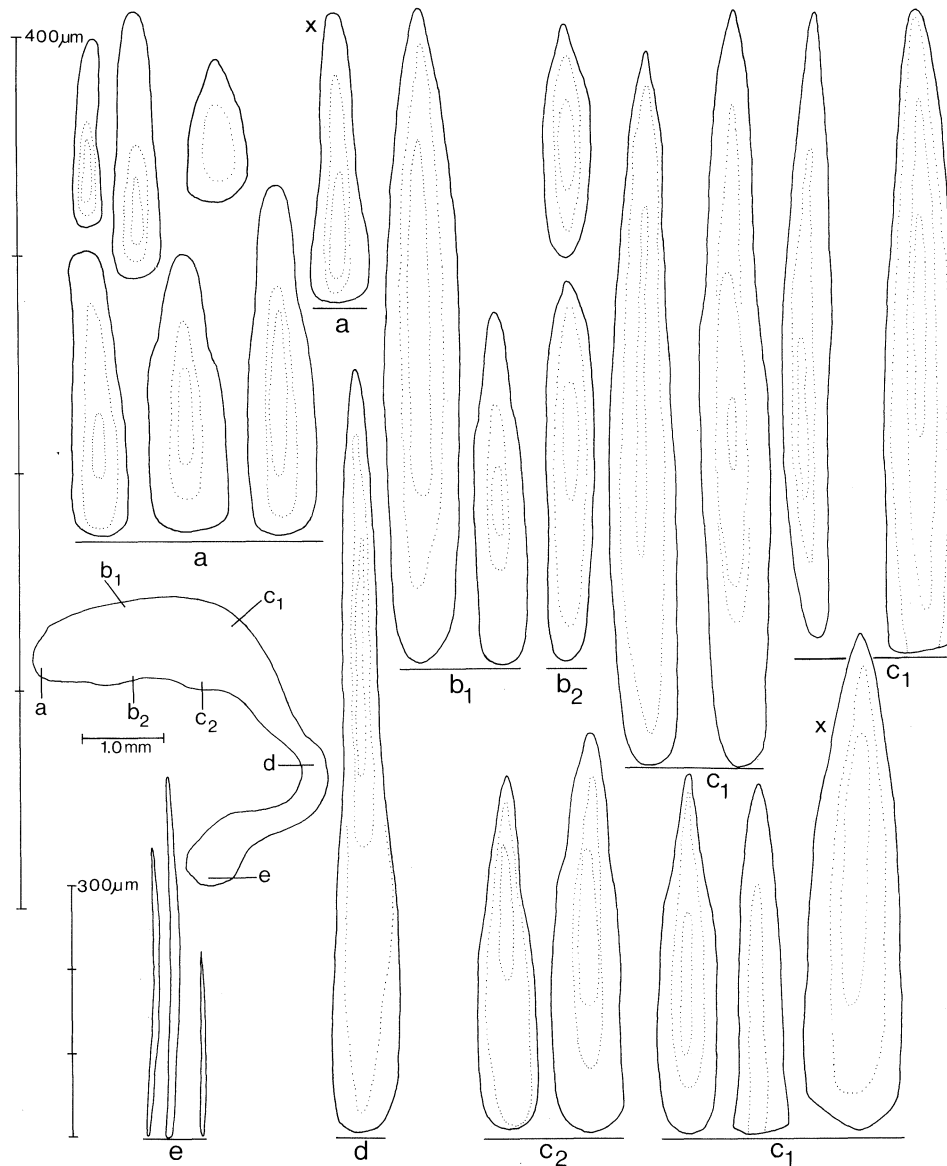
the same sample as a specimen of *R. australe* (Stn Q631, Table 1). The spicules are long for the size of the specimen, up to 300  $\mu\text{m}$ , a condition often seen in juveniles, whose spicules usually appear to be too large for them. However, eggs measured through the integument are nearly 100  $\mu\text{m}$  long, a size which indicates adult body length but not full maturity (see Scheltema, 1987).

The genus has not been recorded before from the Pacific. (*Prochaetoderma californicum* Schwabl belongs to the genus *Spathoderma*; determination based on re-examination of syntypes, not yet published.) A full

description and species designation awaits additional specimens. [New material from Slope Stn 27 provides 4 specimens (Table 1).]

#### Undetermined Prochaetodermatidae

A single specimen of a prochaetodermatid species lacking spicules was taken from 55 m in Bass Strait at R.V. *Hai-kung* Stn 139 (Table 1). It is not the same as either of the above species.



**Fig. 16.** Spicules of *Rhabdoderma australe* n.sp. Spicules are from body regions 'a'-'e' of paratype no. 1 as indicated in figure, except for two marked x, which are from other specimens. Thickest spicules from each body region are 10  $\mu\text{m}$  or more thick, except for ventral spicules  $b_2$  and  $c_2$ , which are up to 7 and 8  $\mu\text{m}$  thick, respectively. Ornamentation of fine lengthwise striations (see Fig. 2F) is not shown. The posterior of paratype no. 1 is unnaturally stretched.

**Undetermined Chaetodermomorpha**

A single specimen of a small (2.5 mm), transparent chaetodermatid with thin spicules thinly dispersed and deeply imbedded in the cuticle was taken from 56 m at Stn T-163 S-M (Table 1).

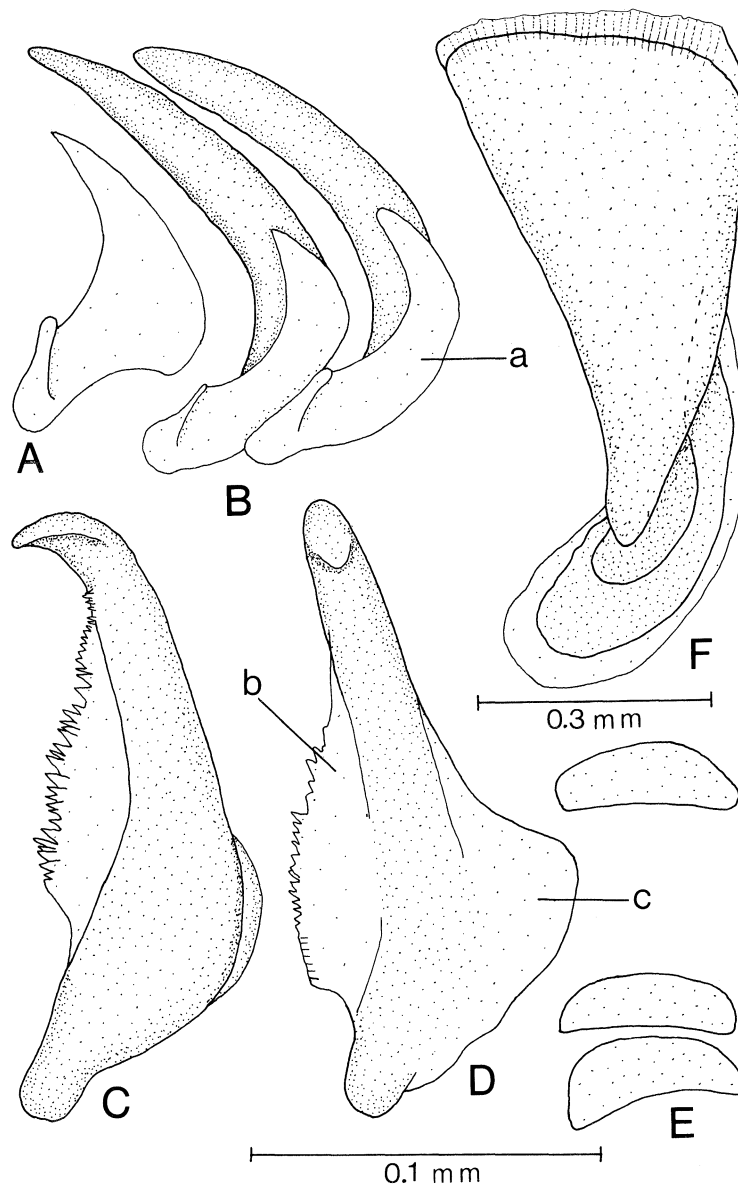
**Undetermined slope species**

Besides the species listed in Table 1, the following new

slope species have been recently received and await description: three species of *Falcidens*, two species of *Chaetoderma*, one species of *Scutopus*, and one species of *Limifossor*. The recorded ranges of *Scutopus* and *Limifossor* are thus extended to the western Pacific.

**Discussion**

The aplacophoran fauna of the Pacific is not well known.



**Fig.17.** Radula and jaw of *Rhabdoderma australe* n.sp., paratype no. 1. A: lateral tooth-like extension of radular membrane; B: third and fourth teeth from proximal end of radular sac, lateral view, anterior to right; lateral tooth-like extensions ('a') in natural position; C, D: two views of individual teeth showing medial denticulate membrane, or brush ('b'), and lateral wing ('c') (bent over in view C); E: central plates; F: left jaw, lateral view from inside; mouth opens at right.

Most of the species of Pacific Chaetodermomorpha that have previously been described were collected by four surveys: the *Siboga* Expedition (Nierstrasz, 1902; Stork, 1941), the U.S. Fish Commission vessel *Albatross* (Heath, 1911), the Pacific Expedition of the Allan Hancock Foundation, University of Southern California (Schwabl, 1963), and the USSR Academy of Sciences in the Sea of Japan (Ivanov, 1984). The great *Challenger* Expedition collected only one aplacophoran in the Pacific (Selenka, 1885). Several additional descriptions not part of surveys or expedition reports have also been published (Okuda, 1943; Salvini-Plawen, 1972; Osorio & Tarifeño, 1976; Scheltema, 1985). The total number of Chaetodermomorpha species so far described is small, about 36 (Table 2). Some of this number are suspected to be synonyms; species names known to be synonyms from examination of new material and re-examination of types are reflected in the table numbers.

The 16 new species collected off south-east Australia increase the number of Pacific Chaetodermomorpha by a half. The vertical distributions of these species by genus are similar to those of previously described species, with the exception of the genus *Chaetoderma* (Table 2). *Chaetoderma* is not represented at all in the south-east

Australian shelf collections, and only by one species on the upper slope, whereas in the rest of the Pacific, species of *Chaetoderma* occur mostly at depths less than 1,000 m. Furthermore, in the family Chaetodermatidae, the genus *Falcidens* off south-east Australia, unlike the rest of the Pacific, has more species than the genus *Chaetoderma*. This preponderance of *Falcidens* species perhaps reflects speciation in that region.

Two species of Chaetodermomorpha off south-east Australia are common. *Falcidens chiastos* occurs at densities up to 180 m<sup>2</sup> in 20 of the 46 shelf samples that contain Aplacophora. The slope prochaetodermatid species *Rhabdoderma australe* also appears to be abundant at depths below 1,000 m, although quantitative data are lacking (Table 1). Some members of the Prochaetodermatidae are known to be among the most numerically abundant animals in the deep-sea fauna, including a Pacific species in the closely related genus *Chevroderma* (Scheltema, 1985).

The genus *Psilodens* Salvini-Plawen, 1977 (= *Scutopus partem*) does not occur in the shelf or slope samples, although it is in collections from both the east Pacific and Indian Ocean (the latter is unpublished). An uncommon but widespread genus, it probably will eventually be found

Table 2. Distribution of Chaetodermomorpha in the Pacific by depth.

Genus	Depth m <sup>1</sup>	Previously Described <sup>2</sup> No. Species	New spp. off South-east Australia No. Species	Total Species
<i>Scutopus</i>	<200	0	0	0
	200-1,000	1	1	2
	>1,000	0	0	0
<i>Psilodens</i>	<200	0	0	0
	200-1,000	0	0	0
	>1,000	1	0	1
<i>Limifossor</i>	<200	0	0	0
	200-1,000	2	1	3
	>1,000	0	0	0
<i>Falcidens</i>	<200	1	2	3
	200-1,000	1	3	4
	>1,000	3	2	5
<i>Chaetoderma</i>	<200	4	0	4
	200-1,000	18	1	19
	>1,000	3	2	5
Prochaeto- dermatidae (genera combined)	<200	0	1	1
	200-1,000	1	0	1
	>1,000	1	2	3
TOTAL		36	15 <sup>3</sup>	51

<sup>1</sup> <200 m - shelf species; 200-1,000 m - upper slope species, including those that also extend onto the shelf; >1,000 m - lower slope or abyssal species, including those that also extend onto the upper slope or, in a few cases, also onto the shelf. <sup>2</sup> Numbers reflect known, but unpublished, synonyms. Data from Heath (1911), Ivanov (1984), Nierstrasz (1902), Okuda (1943), Osorio & Tarifeño (1976), Salvini-Plawen (1972), Scheltema (1985), Schwabl (1963), Selenka (1885), and Stork (1941). <sup>3</sup> A single specimen of a shelf species of undetermined affinity is not included (Stn 163 S-M, Table 1).

off the Australian coast.

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