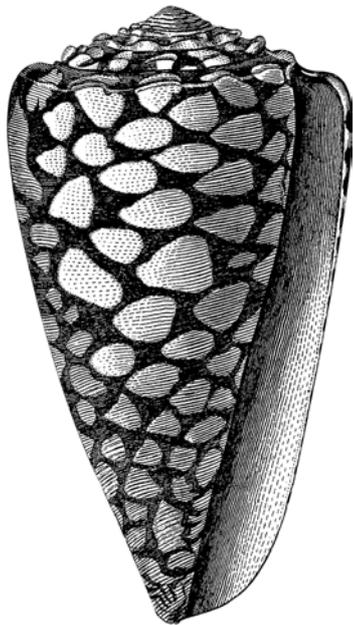


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## Prochaetodermatidae of the Indian Ocean collected during Soviet VITYAZ cruises 1959–1964 (Mollusca : Aplacophora)

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### Abstract

Four new aplacophoran mollusc species of Prochaetodermatidae (*Prochaetoderma arabicum* n. sp., *Chevroderma lusae* n. sp., *Chev. javanicum* n. sp., and *Chev. vityazi* n. sp.) and three new records (*Chev. turnerae* Scheltema, *Chev. paradoxum* Ivanov & Scheltema, *Claviderma laticarinatum* Ivanov & Scheltema) are added here to those described earlier for the western Indian Ocean and Arabian Sea and Atlantic Ocean. One of the species, the abyssal *Chev. turnerae*, is cosmopolitan throughout the Atlantic Ocean and is here reported from the eastern and western Indian Ocean. *Prochaetoderma arabicum* n. sp. is the only species in the genus *Prochaetoderma* that has been collected in the Indian Ocean/Arabian Sea. Two eastern Indian Ocean species, both with a curiously long narrow posterium, are superficially similar; one, *Chev. javanicum*, occurs at hadal depths in the Java Trench and the other, *Chev. vityazi*, was collected from the lower continental slope. So far, no prochaetodermatid species has been collected from the Indian Ocean at depths less than 1000 m.

*Additional keywords:* biogeography, deep sea, depth distribution, radula, spicules.

### Introduction

Aplacophoran molluscs are a common, and sometimes abundant, part of the shelf, bathyal, abyssal and hadal oceanic benthic macrofauna from depths of <200 to >9000 m. Although they occur in most dredge and quantitative samples taken at these depths, they remain relatively unknown. General accounts of the two taxa comprising the Aplacophora, the Neomeniomorpha or Solenogastres and Chaetodermomorpha or Caudofoveata may be found in Salvini-Plawen (1985), Scheltema (1998) and Scheltema *et al.* (1994).

The Prochaetodermatidae is a family of mostly deep-sea Chaetodermomorpha that is distributed globally. It is comprised so far of five genera and 25 species. Their importance to the deep-sea benthos is belied by the low number of species because, in many localities, they are a dominant part of the benthos in numerical abundance (Grassle and Maciolek 1992; Scheltema 1997). They are small animals, usually <5 mm, and are covered with glistening aragonite spicules (C. C. Wu in Acknowledgments of Scheltema 1985) that identify them as belonging to the Aplacophora. So far, species of Prochaetodermatidae have been described from the north-west, south-west, north central, and north-east to south-east Atlantic, the Mediterranean Sea, the north, north central and north-west Pacific, the Indian Ocean and off south-eastern Australia at depths ranging between 100 and >9000 m (Kowalevsky 1901; Schwabl 1963; Salvini-Plawen 1972, 1992, 1999; Scheltema 1985, 1989; Belyaev 1989; Ivanov 1995, 1996; Scheltema and Ivanov 2000, 2001; Ivanov and Scheltema 2001a, 2001b). Some species and all genera have broad geographic ranges (Scheltema 1985; Scheltema and Ivanov 2000, 2001; Ivanov and Scheltema 2001a, 2001b).

The descriptions of prochaetodermatid species are continued here for Soviet collections made in the Indian Ocean from 1959 to 1964, adding further species to those already

described from the western Indian Ocean and Arabian Sea (Ivanov and Scheltema 2001a). It is our plan eventually to study existing collections from all oceans. We expect that hypotheses about the biogeography of the deep-sea fauna will finally result from the distributions of prochaetodermatid species as they become known.

### Materials and methods

Fifty prochaetodermatid specimens collected in the Indian Ocean and Java Trench during cruises of the Soviet research vessel VITYAZ from 1959 to 1964 were examined (Table 1). These specimens are in addition to the 12 VITYAZ specimens reported earlier by Ivanov and Scheltema (2001a; see Table 1). Methods for studying prochaetodermatids and the taxonomic characters used here are given in full in Scheltema and Ivanov (2000) and Ivanov and Scheltema (2001a). The characters are based on external appearance, including measurements of the anterium, trunk, shank and knob, and the ratio of posterium length (shank + knob) to trunk length (Fig. 58), on the morphology of spicules from anterior to posterior, including the base, blade, longitudinal axis and isochromes (lines of equal colour when viewed under crossed polarised light indicated by dotted lines; e.g. Fig. 6) and on the morphology of isolated radulae and jaws. Greatest dimensions are given for all measurements. In cases in which descriptions of new species rely only on the holotype, or on the holotype and a single or few paratypes, radula dissections were not made.

All material is deposited in the Zoological Museum of the University of Moscow (ZMUM).

**Table 1. Prochaetodermatidae material examined from VITYAZ cruises in the eastern and western Indian Ocean 1959–1964 (see also Ivanov and Scheltema 2001a: table 1)**

Stn	Gear	Depth <sup>A</sup> m	Date d.m.y	Latitude	Longitude	Species <sup>B</sup>													
						<i>jav</i>	<i>vit</i>	<i>lus</i>	<i>par</i>	<i>tur</i>	<i>ar</i>	<i>lat</i>	<i>ga</i>						
4530	TR <sup>C</sup>	6935	01.11.59	10°17'S	110°20'E	22													
4535	TR	6820	04.11.59	10°08'S	107°55'E	15													
4666	GR <sup>C</sup>	3888	05.03.60	06°53'S	53°36'E							1							
4697 <sup>D</sup>	GR	4144	22.03.60	03°48'S	53°00'E							1							
4699	GR	3272	25.03.60	03°30'S	55°46'E							1							
4725 <sup>D</sup>	GR	3070	15.04.60	13°36'N	54°28'E												1		
4795 <sup>D</sup>	GR	2833	29.10.60	11°07'N	52°13'E												2		
4799 <sup>D</sup>	GR	4458	01.11.60	08°21'N	56°17'E							1							
4800 <sup>D</sup>	GR	3470	01.11.60	09°33'N	57°02'E							1							
4804 <sup>D</sup>	GR	3717	04.11.60	17°18'N	58°58'E												4		
4806	GR	1730	05.11.60	21°09'N	59°39'E											2			
4852	GR	3840	25.11.60	15°07'N	65°57'E							1		1					
4854	GR	3160	26.11.60	19°13'N	65°56'E							1							
4858	GR	3530	28.11.60	23°12'N	64°12'E									1?					
4933 <sup>D</sup>	GR	2030	31.01.61	18°57'N	87°00'E												3 <sup>E</sup>		
4939	GR	3620	04.02.61	08°54'N	87°02'E							1							
4963	GR	2520	01.03.61	16°09'N	92°37'E									1					
5292	GR	3850	30.10.62	05°05'N	91°45'E									1					
5307	GR	2875	29.10.64	14°51.7'N	88°09.9'E							1							
Totals												37	1	3	4	5	2	3	7

<sup>A</sup>Minimum depth.

<sup>B</sup>*jav*, *Chevroderma javanicum*; *vit*, *Chevroderma vityazi*; *lus*, *Chevroderma lusae*; *par*, *Chevroderma paradoxum*; *tur*, *Chevroderma turnerae*; *ar*, *Prochaetoderma arabicum*; *lat*, *Claviderma laticarinatum*; *ga*, *Claviderma gagei*.

<sup>C</sup>TR, trawl; GR, unspecified grab.

<sup>D</sup>Reported in Ivanov and Scheltema 2001a.

<sup>E</sup>Including one new record.

**Key to genera of Indian Ocean/Arabian Sea Prochaetodermatidae  
based on trunk spicules and number of oral shield spicules**

1. Medial groove and chevron-shaped growth lines and base (Figs 29–35, 48–56), two rows of oral shield spicules ..... *Chevroderma*  
Without medial groove, growth lines straight or curved, one or more rows of oral shield spicules . . . . . 2
2. Spicules adpressed. . . . . 3  
Blade of spicule bent outwards from body . . . . . 4
3. Spicules flat, longitudinal axis straight (Figs 6–10, 15–19), two rows of oral shield spicules . . . . .  
..... *Prochaetoderma*  
Base and blade of spicules curved towards body, longitudinal axis curved,  $\geq 3$  rows of oral shield spicules  
..... *Claviderma*
4. Plane of spicule base flat, spicule blade width one- to two-thirds base width, three rows of oral shield  
spicules . . . . . *Spathoderma*  
Base of spicule transversely curved, very broad, blade narrow, one-fifth or less base width, one to two  
rows of oral shield spicules . . . . . *Niteomica*

**Taxonomy**

Family **PROCHAETODERMATIDAE** Salvini-Plawen, 1972

Prochaetodermatidae Salvini-Plawen, 1969: 57 (without diagnosis).

Prochaetodermatidae Salvini-Plawen, 1972: 37.

*Diagnosis*

Aplacophorans with a divided oral shield (Fig. 2) and jaws (Figs 46, 47; *in situ* Fig. 65, arrowhead), with posterium usually narrow and tail-like (Figs 65–68).

Genus ***Prochaetoderma*** Thiele, 1902

*Prochaetoderma* Thiele, 1902: 275. Salvini-Plawen, 1972: 37; Ivanov, 1981: 25; Scheltema, 1985: 498;

Salvini-Plawen, 1992: 323; Salvini-Plawen, 1999: 79; Scheltema & Ivanov, 2000: 327.

Type species: *Chaetoderma radulifera* Kowalevsky, 1901, by monotypy.

*Diagnosis*

Spicules adpressed, parallel on trunk and posterium to longitudinal body axis or only on posterium. Planes of spicule base and blade flat or blade slightly curved towards body; base and blade not obviously offset or at an angle to each other or rotated relative to each other; longitudinal axis straight, isochromes symmetrical or nearly so; waist shallow, sometimes indistinct. Blade with short or long medial keel, edges convex, blade width approximately same as base width at waist. Oral shield spicules in two rows.

*Distribution*

Northern and southern Atlantic, Mediterranean Sea, Arabian Sea, western Pacific, from shelf to bathyal depths (includes unpublished data).

***Prochaetoderma arabicum*** n. sp.

(Figs 1–19, 65, 69)

*Material examined*

*Holotype.* North-western Arabian Sea, 21°09'N, 59°39'E, 1730 m, VITYAZ stn 4806, 5 Nov. 1960, ZMUM no. Le1-96.

*Paratype.* One individual, type locality, ZMUM no. Le1-97.

*Diagnosis*

Small, translucent, silky, broad trunk narrowing abruptly to narrow shank, posterium shorter than trunk (unnaturally stretched during processing in paratype); spicules symmetrical, short, thin, edges of base and blade convex, basally rounded, distally keeled with sharp point, base long, blade broad; fringing spicules longer than knob.

*Description*

*Appearance* (Figs 1–3, 11–14, 65). Small, translucent, silky sheen; trunk broad, indented approximately one-third distance from anterior; clear demarcation between trunk and shank; fringing spicules extending beyond knob; oral shield spicules not prominent.

*Body measurements*. Holotype: length 2.2 mm, anterium length 0.1 mm, trunk length 1.3 mm, greatest diameter posterior, 0.4 mm, shank length and width 0.5×0.1 mm, knob length 0.3 mm, length posterium/trunk 0.62; oral shield 0.1×1.5 mm.

*Spicules* (Figs 4–10, 15–19). Most <100 µm long, thin, symmetrical, edges of both base and blade convex, proximally rounded, blade broad with sharp distal keel and point, thickest at and below waist, longitudinal axis straight; spicules from beside oral shield broadly sinuous, 43 µm long, 18 µm wide, 3.5 µm thick; from anterium, many pyramidal, not sharply keeled, edges straight to convex, 40×18×1–3 µm, some with distinct waist and base narrower than blade; from anterior trunk, to 100 µm long, base 56 µm long, 45 µm wide, longer and broader than blade, 45×18 µm, 4 µm thick; from shank, narrower, shorter and thinner than trunk spicules, 74 µm long × 3.5 µm thick, base 22×14 µm, shorter than blade, 52×9 µm, with a few broad (~38 µm), thin (<3 µm), nearly pyramidal spicules; knob spicules to approximately 65 µm long, with tapered base; fringing spicules to 145×12 µm.

*Radula*. Not examined; jaws appearing narrow under transmitted light in undissected animals (Fig. 65, arrowhead).

*Distribution* (Fig. 69)

Lower slope, western Arabian Sea.

*Remarks*

We consider that the elongate and extremely narrow posterium of the paratype (Fig. 11) is not natural, but a result of stretching during collecting and sieving. This species is the only member of the genus *Prochaetoderma* so far found in the Indian Ocean/Arabian Sea. It is distinguished from the Mediterranean and Atlantic species *P. raduliferum*, *P. boucheti* and *P. yongei* by a narrower posterium, by spicules with broader blades with more convex sides and less distal taper and by narrow shank spicules and from *P. atlanticum*, in which spicules are curved.

*Etymology*

Named for type locality.

Genus *Chevroderma* Scheltema, 1985

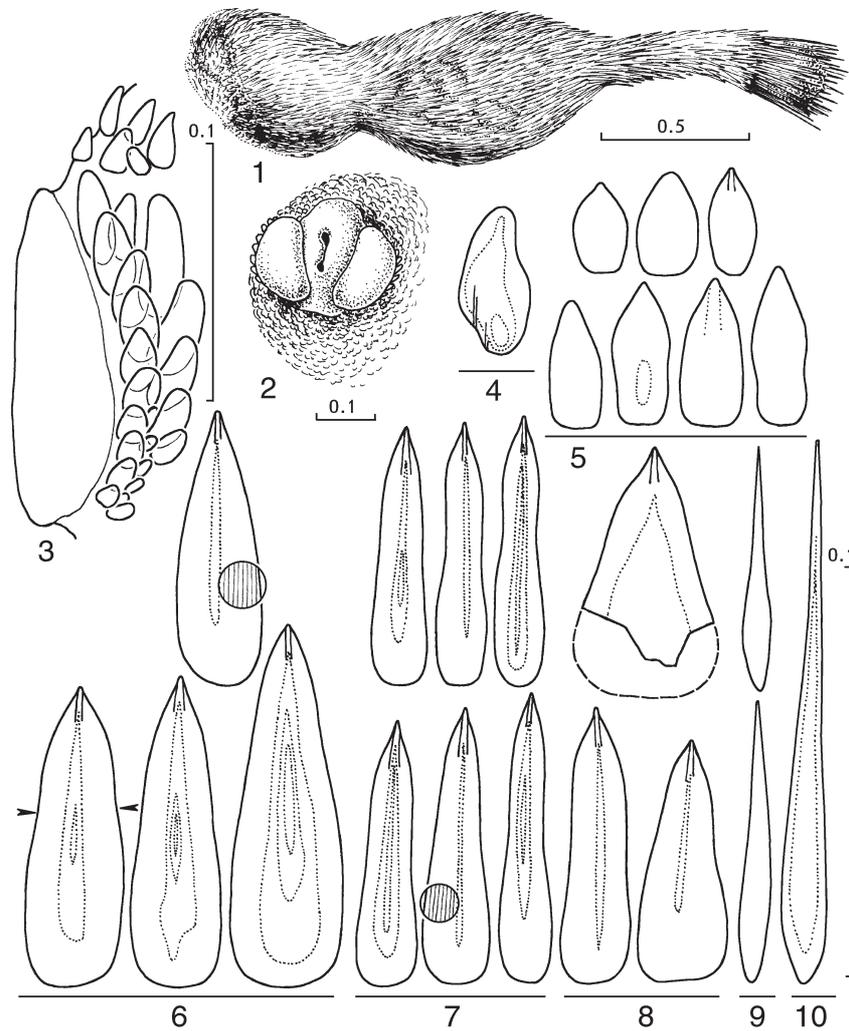
*Chevroderma* Scheltema, 1985: 512. Ivanov, 1996: 3; Scheltema & Ivanov, 2000: 344; Ivanov & Scheltema, 2001a: 14.

*Prochaetoderma* (*Chevroderma*) Salvini-Plawen, 1992: 323.

Type species: *Chevroderma turnerae* Scheltema, 1985: 512–516, by original designation.

*Diagnosis*

Spicules with usually distinct, but sometimes faint, medial groove that extends either entire length of spicule or only part way. Growth lines and base of spicules chevron-shaped. Plane

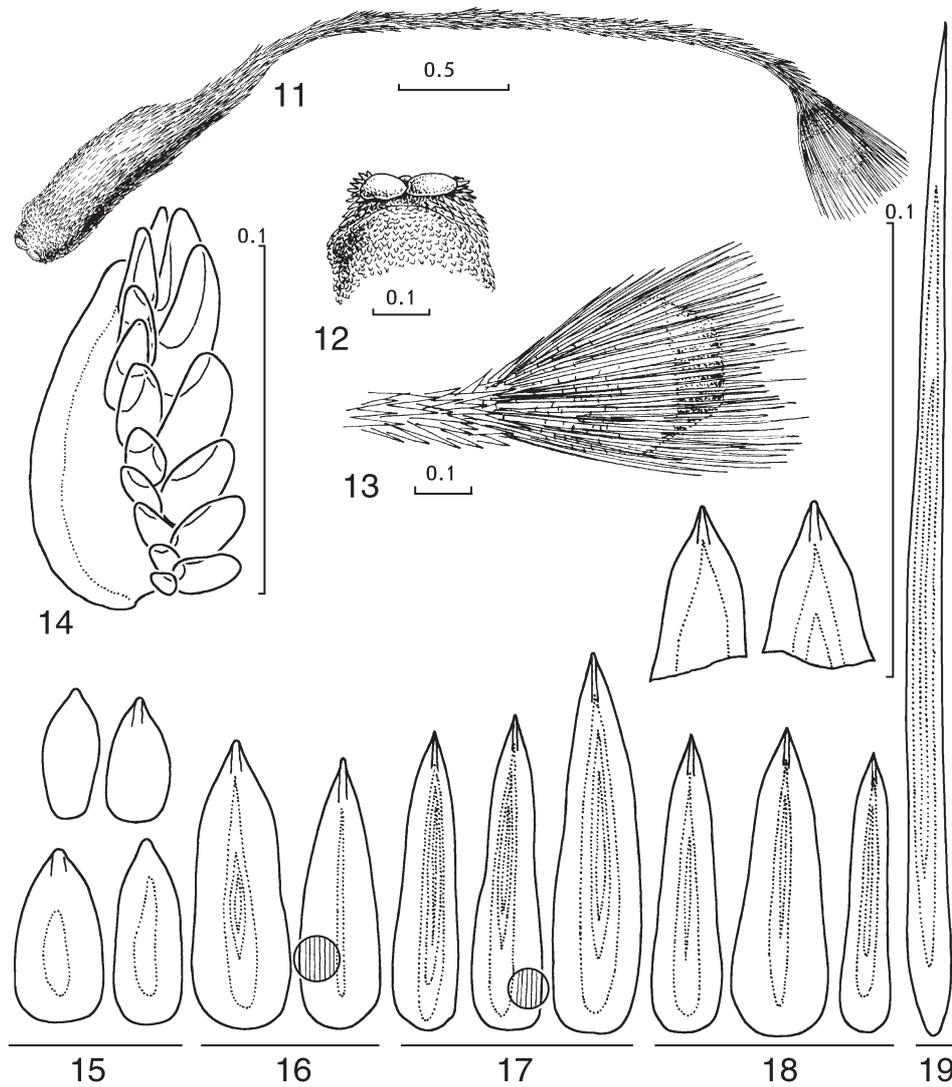


**Figs 1–10.** *Prochaetoderma arabicum* n. sp. holotype. 1, entire; 2, oral shield; 3, oral shield spicules *in situ*; 4–10, spicules of: 4, oral shield; 5, anterior; 6, dorsal trunk (arrowheads indicate waist); 7, anterior shank; 8, posterior shank; 9, knob; and 10, fringe.

of spicule blade bent outwards from plane of base. Longitudinal axis straight to abruptly curved at waist. Waist usually distinct, blade narrower than base at waist, edges of blade nearly straight and tapered. Isochromes on each side of groove asymmetrical. Two rows of oral shield spicules.

#### *Distribution*

Species of *Chevroderma* have been found in most of the world's oceans: eastern and western north and south Atlantic, eastern and western Indian Ocean, eastern and western north and south Pacific and central north Pacific (Scheltema and Ivanov 2000, unpublished data). The shallowest depth recorded is 1427 m; the deepest, for *Chev. hadalis* Ivanov, is 8390 m in the



**Figs 11–19.** *Prochaetoderma arabicum* n. sp. paratype, posterior unnaturally stretched. *11*, entire; *12*, oral shield with barely discernible oral shield spicules; *13*, knob with long fringing spicules; *14*, oral shield spicules *in situ*; *15–19*, spicules of: *15*, anterior; *16*, trunk; *17*, anterior shank; *18*, posterior shank; and *19*, fringe.

Kurile-Kamchatka Trench and for an undescribed species also in the Pacific at >9000 m. All but one species, *Chev. scalpellum* Scheltema, are found at abyssal to hadal depths.

***Chevroderma turnerae* Scheltema, 1985**

(Fig. 69)

*Chevroderma turnerae* Scheltema, 1985: 512–516. Scheltema and Ivanov, 2000: 345–348.

**Material examined**

Five individuals, one from each of five VITYAZ stations: 4666, 4699, 4852, 4858 (questionable identification) and 4963 (Table 1). ZMUM nos. Le1-106 through 110.

*Diagnosis*

Large, opaque, up to 5.5 mm in length and 0.8 mm in diameter, length posterium/trunk ranging from 0.32 to 1.36; oral shield large, oral shield spicules prominent; trunk spicules converging at prominent angle mid-dorsally, to 300  $\mu\text{m}$  long, base long, blade short and bluntly pointed, thickest proximal to waist; radula and jaws large, teeth to 140  $\mu\text{m}$ , jaws to 700  $\mu\text{m}$ .

*Distribution* (Fig. 69)

*Chevroderma turnerae* was first described from the north-western Atlantic, the Argentine Basin, equatorial Atlantic and the entire eastern Atlantic. The five specimens recorded here extend the range into the western Indian Ocean and Bay of Bengal. Morphologically, they fall within the same range of differences that occur in Atlantic populations. The species is a lower slope and abyssal form.

***Chevroderma lusae* n. sp.**

(Figs 20–35, 66, 69)

*Material examined*

*Holotype.* Bay of Bengal, 08°54'N, 87°02'E, 3620 m, VITYAZ stn 4939, 4 Feb. 1961, ZMUM no. Le1-98.

*Paratype.* One individual, eastern Arabian Sea, 15°07'N, 65°57'E, 3840 m, VITYAZ stn 4852, 25 Nov. 1960, ZMUM no. Le1-99.

*Other material examined.* One individual, eastern Arabian Sea, 19°13'N, 65°56'E, 3160 m, VITYAZ stn 4854, 26 Nov. 1960, ZMUM no. Le1-100.

*Diagnosis*

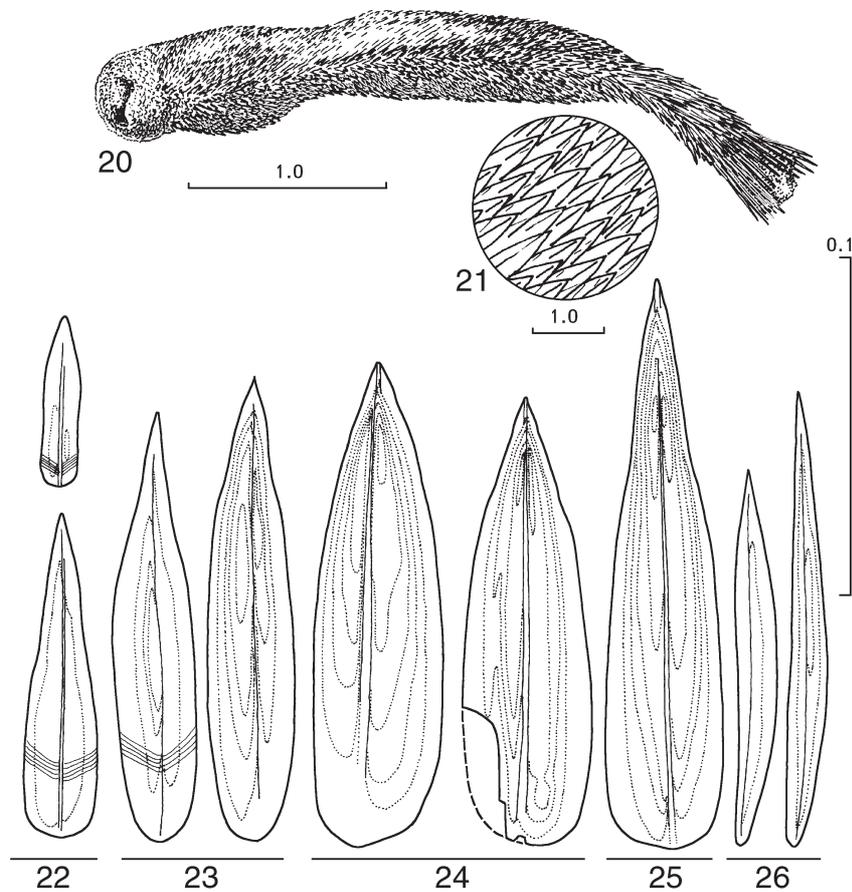
To nearly 4 mm, silky sheen, greatest diameter anterior, posterium one-third or less total length, trunk and shank spicules with indistinct or no waist, distally sharply pointed or nipple like, knob spicules tapered basally and distally.

*Description*

*Appearance* (Figs 20, 21, 27, 28, 66). Opaque to translucent, depending on degree of contraction, silky sheen; trunk indented between pharyngeal region and posterior part; posterium short, prominently set off from trunk; knob truncated, slanting; fringing spicules extending somewhat beyond knob; approximately nine oral shield spicules, not prominent.

*Body measurements.* Holotype largest individual, length 3.7 mm, anterium length 0.2 mm, trunk length and greatest width 2.4×0.5 mm, shank length and width 0.7×0.2 mm, knob 0.35 mm, length posterium/trunk 0.46; oral shield dimensions not determined.

*Spicules* (Figs 22–26, 29–35). Base broad with edges convexly curved, spicules on trunk and shank usually without waist, sharply pointed or nipple-like distally, thickest distally; spicules from beside oral shield symmetrical to curved, widest and thickest basally, to 63  $\mu\text{m}$  long, 27  $\mu\text{m}$  wide, 6  $\mu\text{m}$  thick; from anterium, symmetrical or curved, thin, blade same width or broader than base, with medial groove, 47×13×1  $\mu\text{m}$ ; from ventral trunk, waist apparent, 94×34×4  $\mu\text{m}$ , thickest on base, blade pyramidal on anterior ventral trunk, approximately one-third length of base; from ventral midtrunk, base longer and narrower; from dorsal midtrunk, 135–150×32×5  $\mu\text{m}$ , thickened asymmetrically on either side of medial groove; from shank, like dorsal trunk spicules but thickened symmetrically on either



**Figs 20–26.** *Chevroderma lusae* n. sp. holotype. 20, entire; 21, enlargement of spicule coat; 22–26, spicules from: 22, anterior; 23, midventral trunk; 24, shank; 25, posteriormost shank; and 26, knob.

side of groove,  $117 \times 36 \times 5 \mu\text{m}$ ; from knob, straight or curved, with medial groove, tapered distally and basally, distally pointed, tapered and rounded basally, thickest medially,  $144 \times 14 \times 5 \mu\text{m}$ ; from fringe, thickest and widest basally, tapered basally, with medial groove,  $232 \times 17 \times 6 \mu\text{m}$ .

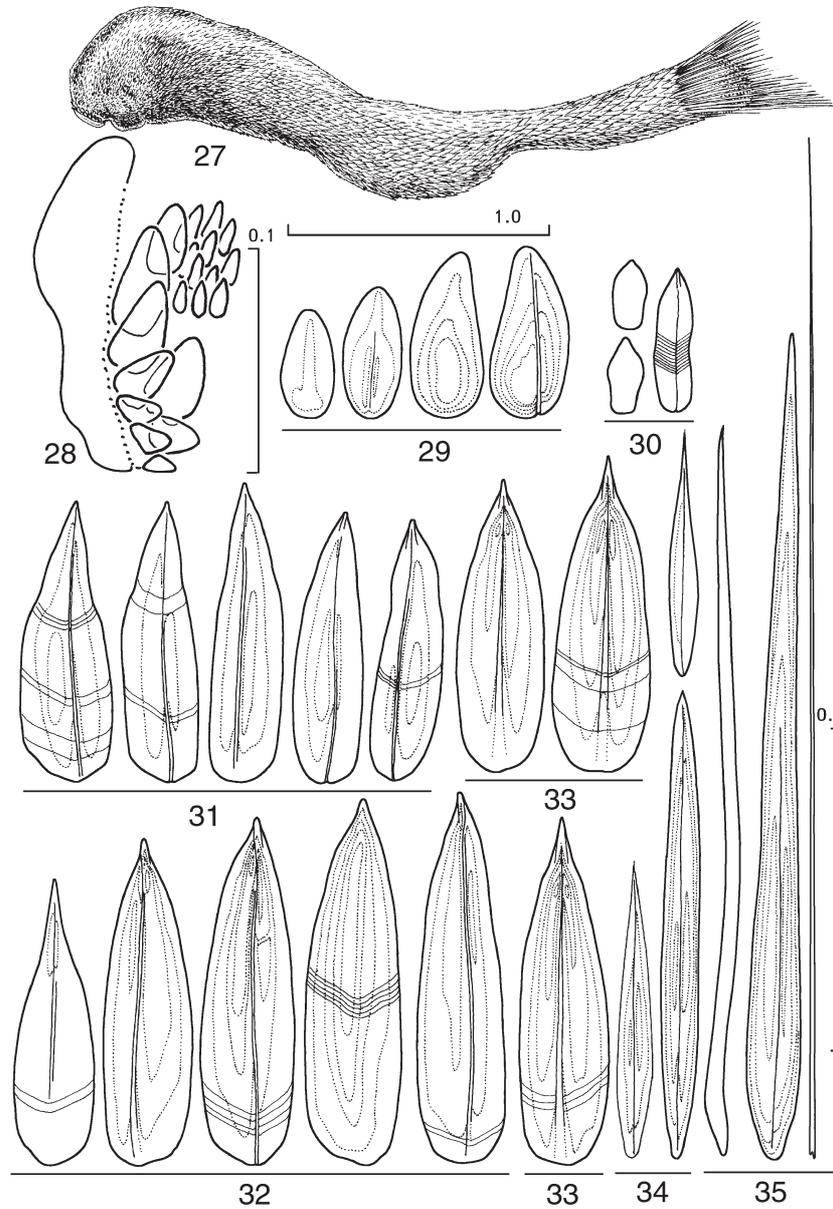
*Radula.* Not examined.

*Distribution* (Fig. 69)

Abyssal; Bay of Bengal and eastern Arabian Sea.

*Remarks*

The very short blade and indistinct waist of dorsal trunk spicules differentiates *Chevroderma lusae* from all but one described *Chevroderma* species, which have a long, tapered trunk blade and a distinct waist. In *Chev. javanicum* (below), the waist is also indistinct, but the trunk spicules are nearly twice the length and one-half to two-thirds the



**Figs 27–35.** *Chevroderma lusae* n. sp. paratype. 27, entire; 28, oral shield spicules *in situ*; 29–35, spicules from: 29, beside oral shield; 30, anterium; 31, anteroventral trunk; 32, dorsal midtrunk; 33, shank; 34, knob; and 35, fringe.

width. The individual from VITYAZ 4854, eastern Arabian Sea, is excluded from the type series because the sparseness of material makes it uncertain whether spicule differences (pronounced waist and longer blade of trunk spicules) indicate population or species differences.

*Etymology*

Named in honor of Valentina Lus, who gave careful attention to the Soviet Aplacophora collection when it was at the Shirshov Institute of Oceanology.

*Chevroderma paradoxum* Ivanov & Scheltema, 2001

(Fig. 69)

*Chevroderma paradoxum* Ivanov & Scheltema, 2001a: 14.

*Material examined*

One individual, Southern Bay of Bengal, 05°05'N, 91°45'E, 3850 m, VITYAZ stn 5292, 30 Oct. 1962, ZMUM no.Le1-101.

*Diagnosis*

Length <3 mm, greatest diameter anterior, 0.5 mm, compact, trunk tapering to shank usually without distinct demarcation, terminal end of knob truncated, slanted, oral shield small, height to 0.16 mm, oral shield spicules few, six in inner row, three in outer row.

*Spicules.* From anterium, symmetrical to asymmetrically curved; from trunk, with distinct waist, groove indistinct to slight, colour of isochromes on each side of groove indicating one side of spicule markedly thinner than the other, base longer than blade, thickest below waist, to 255 µm long; shank spicules similar to trunk spicules, to 325 µm long, base shorter than blade in more posterior spicules; knob spicules grooved, straight, tapered proximally and distally, to 176 µm long, or curved and bent proximally. Jaws to 424 µm long, 141 µm wide; radula teeth to 91 µm long, serrated membrane short with few, broad serrations.

*Distribution* (Fig. 69)

Abyssal, off Somalia and La Réunion and in the southern Bay of Bengal between 3240 and 4458 m.

*Remarks*

The compact body with usually no demarcation between trunk and shank distinguishes *Chev. paradoxum* from all other described species. The body shape in conjunction with the usually poorly defined groove on the spicules, small oral shield, few oral shield spicules and short radula tooth membrane with few serrations identify this species.

The distribution of *Chev. paradoxum* is herein extended to the eastern Indian Ocean. The spicules of the individual from this region are more distinctly grooved medially than of those previously described from the western Indian Ocean (Ivanov and Scheltema 2001a), but we regard the individuals as conspecific because the size and shape of the animals and the sizes and shapes of their spicules are the same, as are the number of oral shield spicules. We consider the distinctness of the groove in the Bay of Bengal individual, the only difference we could see, to be a population and not a species difference.

*Chevroderma javanicum* n. sp.

(Figs 36–57, 67, 69)

*Material examined*

*Holotype.* Java Trench, 10°17'S, 110°20'E, 6935–7060 m, VITYAZ stn 4530, 1 Nov. 1959, ZMUM no. Le1-102.

*Paratypes.* Twenty-one individuals, type locality, ZMUM no. Le1-103; 15 individuals, Java Trench, 10°08'S, 107°55'E, 6820–6850 m, VITYAZ stn 4535, 4 Nov. 1959, ZMUM no. Le1-104.

*Diagnosis*

Body long, narrow, appearance slick, dorsal midline well defined, ventral midline broad and flattened, anterior part of trunk narrower than more posterior part; spicules long and narrow, blade extremely short, waist ill-defined; radula tooth membrane scarcely serrated.

*Description*

*Appearance* (Figs 36–38, 40–42, 67). Elongate, slender, spicules closely adpressed, glistening; dorsal and ventral midlines distinctly defined dorsally by sharp angle where left and right lateral spicules meet, ventrally by broad, flattened region covered by small spicules; midlines continuing distinctly onto anterior shank; shank long, very narrow, varying widely in length from one-third to more than one-half body length; trunk narrower anteriorly than posteriorly, then tapering to shank; knob cone shaped, fringing spicules extending beyond knob; anterium protruded, sometimes bulbous; oral shield small, oral shield spicules not prominent;

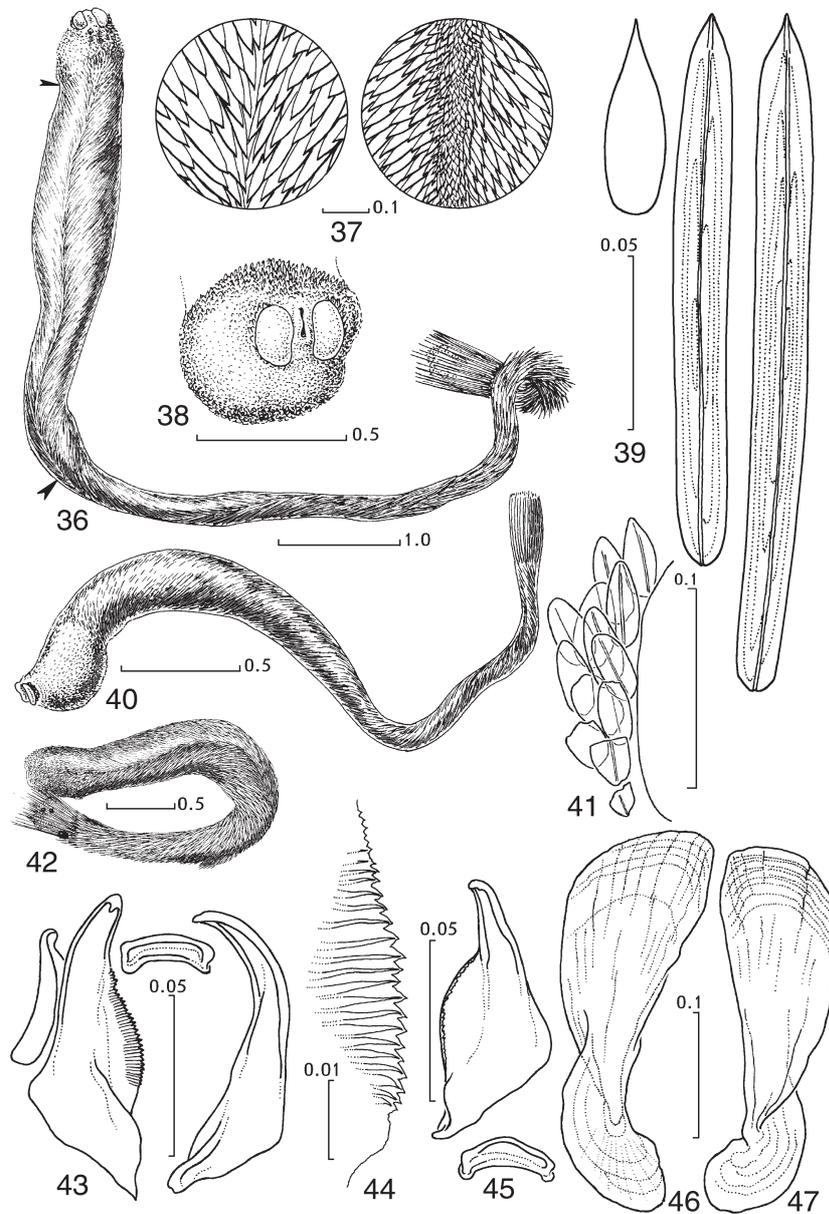
*Body measurements.* Holotype largest individual, length approximately 9.5 mm, anterium length 0.6 mm, trunk length 3.3 mm, diameter 0.5 mm anteriorly, 0.7 mm posteriorly, shank length and width approximately 5.0×0.2 mm, knob length 0.6 mm, length posterium/trunk approximately 2.0; oral shield height greatest dimension, 0.2 mm. Smallest individual 3.9 mm long, anterium 0.3 mm long, trunk 2.0×0.3 mm anteriorly, 0.5 mm posteriorly, shank 1.3×0.2 mm, knob 0.3 mm long, length posterium/trunk 1.0;

*Spicules* (Figs 39, 48–57). Removed for study only with difficulty; long, narrow, sides parallel, longitudinal axis straight to curved in frontal view, base curved towards body, thickest medially; waist indistinct, blade very short, 1/10 to 1/25 total spicule length; distally sharply pointed with a short keel and bent outwards from body; medial groove distinct, running length of spicule, chevron-shaped growth lines distinct only on anterior spicules, but many spicules basally chevron shaped; oral shield spicules subquadrate to pointed ovate, medially grooved, 45×22×4 µm; spicules just anterior to oral shield spicules ovate, 25×11×1 µm; from anterium to knob, major differences among most spicules in size, not shape, with trunk spicules diminishing in length from dorsal to ventral; anterium, 45×14×2 µm; anterior dorsal trunk, 260×22×7.5 µm; anterior ventral trunk, 130×17×6 µm; posterior dorsal trunk, 290×17×8 µm; posterior ventral trunk, 116×17×5 µm; shank, 270×14×9 µm; knob spicules tapered basally and distally with a sharp distal point, 226×17×8 µm; fringing spicules curved, 464×17×>10 µm.

*Radula* (Figs 43–47; two examined). Eight rows of teeth; jaws to 360 µm long, 87 µm wide in one specimen, but relatively broad, 128 µm, in the other; teeth to 100 µm; serrated membrane medial, 50 µm, scarcely serrated, some with ridges perpendicular to long axis of tooth; central plate short, deeply curved, 34×11 µm.

*Distribution* (Fig. 69)

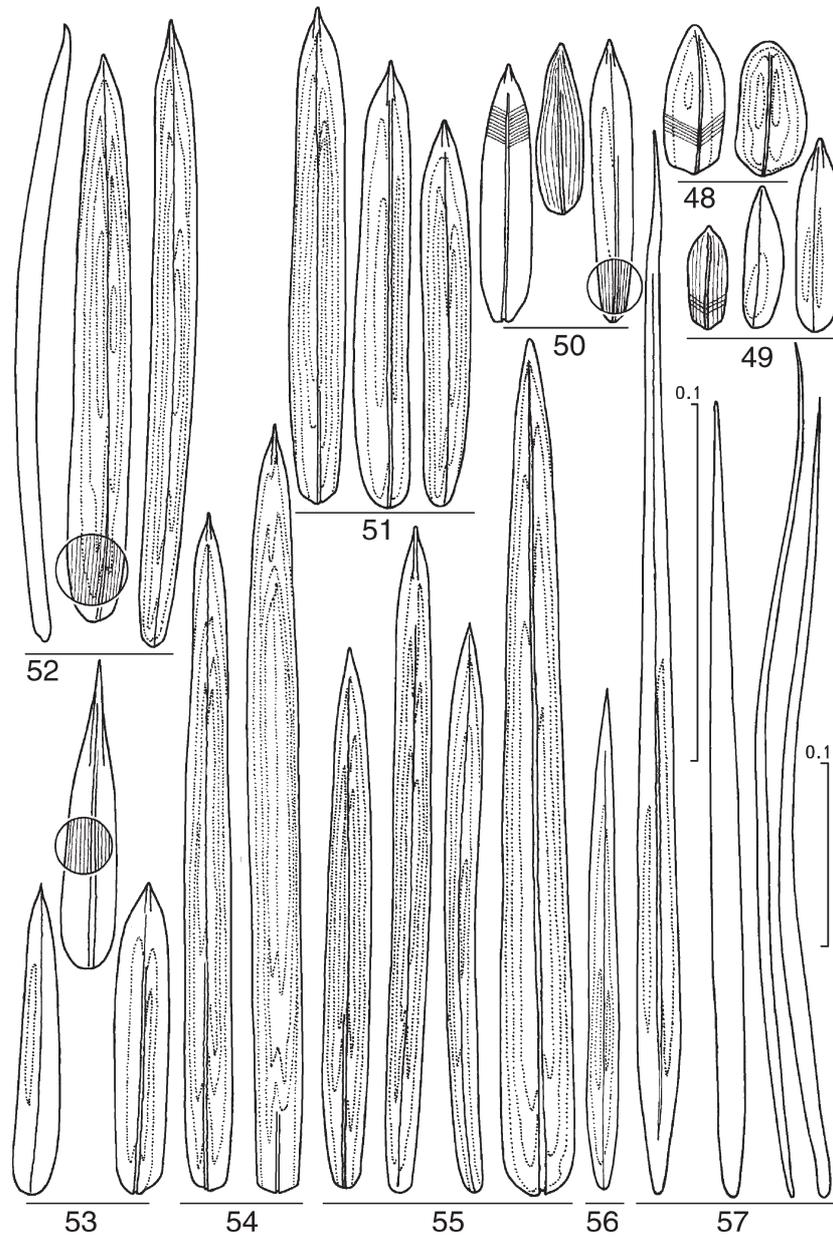
Hadal; Java Trench.



**Figs 36–47.** *Chevroderma javanicum* n. sp. 36–39, holotype; 36, entire, trunk delimited by arrowheads; 37, dorsal (left) and ventral arrangement of midline spicules; 38, oral shield; 39, spicules from ventral midline (left) and lateral trunk; 40, 41, paratype, VITYAZ stn 4535, entire and oral shield spicules *in situ*; 42, smallest individual, type locality, VITYAZ stn 4530; 43–47, radula teeth, central plates and jaws of: 43, 44, 46, an individual from type locality; 45, 47, paratype figured in 40.

#### Remarks

The long, slender body and narrow spicules with a short blade of *Chevroderma javanicum* are distinguishing characters. *Chevroderma javanicum* is morphologically close to



**Figs 48–57.** *Chevroderma javanicum* n. sp. spicules from paratype (Fig. 40): 48, beside oral shield; 49, anterior; 50, anterior ventral trunk; 51, lateral anterior trunk; 52, dorsal ventral trunk (note very short, outward bent blade of left spicule); 53, posterior ventral trunk; 54, dorsal posterior trunk; 55, shank; 56, knob; 57, fringe.

*Chev. vityazi*, but can best be distinguished from it by the spicules, which, in *Chev. javanicum*, are longer, thicker and thickest medially and have an extremely short blade, giving the animals a smooth, glistening appearance.

*Etymology*

Named for the type locality.

*Chevroderma vityazi* n. sp.

(Figs 58–64, 68, 69)

*Material examined*

*Holotype.* Bay of Bengal, 14°51.7'N, 88°09.9'E, 2875 m, VITYAZ stn 5307, 29 Oct. 1964, ZMUM no. Le1-105.

*Diagnosis*

Somewhat shaggy, with narrow, long shank, oral shield spicules not prominent, trunk width probably even throughout, shank twice as wide near trunk as further posteriorly, knob cone-shaped.

*Description*

*Appearance* (Figs 58, 59, 68). Holotype only individual; spicule coat somewhat shaggy owing to outwardly bent spicule blades (Fig. 61, right spicule), spicules converging mid-dorsally and diverging midventrally; posterium narrow, long; trunk width probably same throughout length, although slightly broken specimen appears widest posteriorly; shank somewhat wider near trunk; posterium nearly twice trunk length; knob cone-shaped, fringing spicules extending beyond knob; oral shield small, higher than wide, oral shield spicules not prominent.

*Body measurements.* Holotype total length 3.5 mm, anterium approximately 0.2 mm, trunk 1.2 mm long, 0.3 mm in diameter, shank 1.8×0.1 mm, knob length 0.3 mm, length posterium/trunk 1.7; oral shield not measured.

*Spicules* (Figs 60–64). Long, narrow, widest at midpoint or just below midpoint, base tapered proximally, blade short, sharply tapered to point, waist distinct, thickest on base just below waist; spicules from between anterium and trunk to 74×16×1–2 µm thick; trunk spicules to 170×22×4 µm, blade to 34 µm long; shank spicules shorter and thinner than trunk spicules, to 150×20×4 µm and with slightly longer blade, to 38 µm; knob spicules tapered proximally and distally, relatively broad medially, to 117×9×3.5 µm, waist usually distinct, blade long, to 52 µm; fringe spicules with broad, short base, to 273×13×6 µm, blade length to 157 µm.

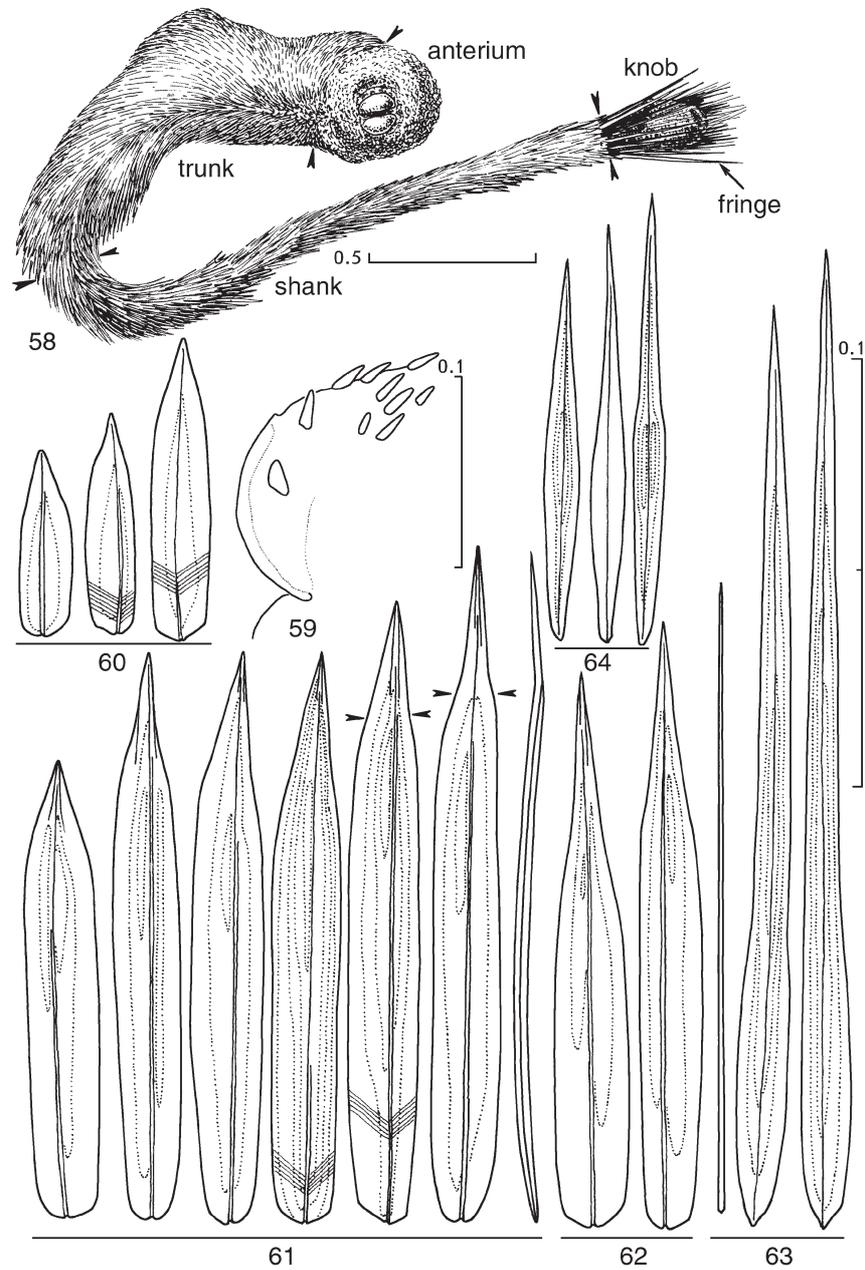
*Radula.* Not examined.

*Distribution* (Fig. 69)

Lower slope; Bay of Bengal.

*Remarks*

*Chevroderma vityazi* is similar to *Chev. javanicum*, but shorter spicules with a distinct waist, a slightly rough spicule coat and ventral midline that is not broad distinguish *Chev. vityazi* from *Chev. javanicum*.



**Figs 58–64.** *Chevroderma vityazi* n. sp. holotype. 58, entire, with body regions indicated; 59, a few spicules remaining *in situ* beside the oral shield; 60–64, spicules from: 60, between anterium and anterior trunk; 61, mid-dorsal and lateral trunk (arrowheads indicate waist); 62, shank; 63, fringe; and 64, knob.

#### *Etymology*

Named for the research vessel VITYAZ.

Genus *Claviderma* Scheltema & Ivanov, 2000

*Rhabdoderma* Scheltema, 1989: 56.

*Claviderma* Scheltema & Ivanov, 2000: 351. Ivanov & Scheltema, 2001a: 18.

Type species: *Rhabdoderma australe* Scheltema, 1989: 56 (original designation).

*Diagnosis*

Plane of spicule base and blade form single curve toward body, spicules closely adpressed, without keel. Longitudinal axis of spicules straight to slightly curved, waist distinct to indistinct, blade nearly as broad as base at waist, lateral edges slightly to markedly convex. Isochromes mostly symmetrical. Oral shield spicules in three or more rows.

*Distribution*

Known from western Atlantic south of 35°N to the Argentine Basin, eastern Atlantic from the Bay of Biscay to Cape Basin, Indian Ocean and south-western Pacific at depths between 1000 and 3800 m, except one species at depths between 93 and 143 m in the Bay of Biscay (Salvini-Plawen 1999; Scheltema and Ivanov 2000, 2001).

*Claviderma laticarinatum* Ivanov & Scheltema, 2001

(Fig. 69)

*Claviderma laticarinatum* Ivanov & Scheltema, 2001: 18.

*Material examined*

One individual, northern Bay of Bengal, 18°57'N, 87°00'E, 2030 m, VITYAZ stn 4933, 31 Jan. 1961. ZMUM no. Le1-111.

*Diagnosis*

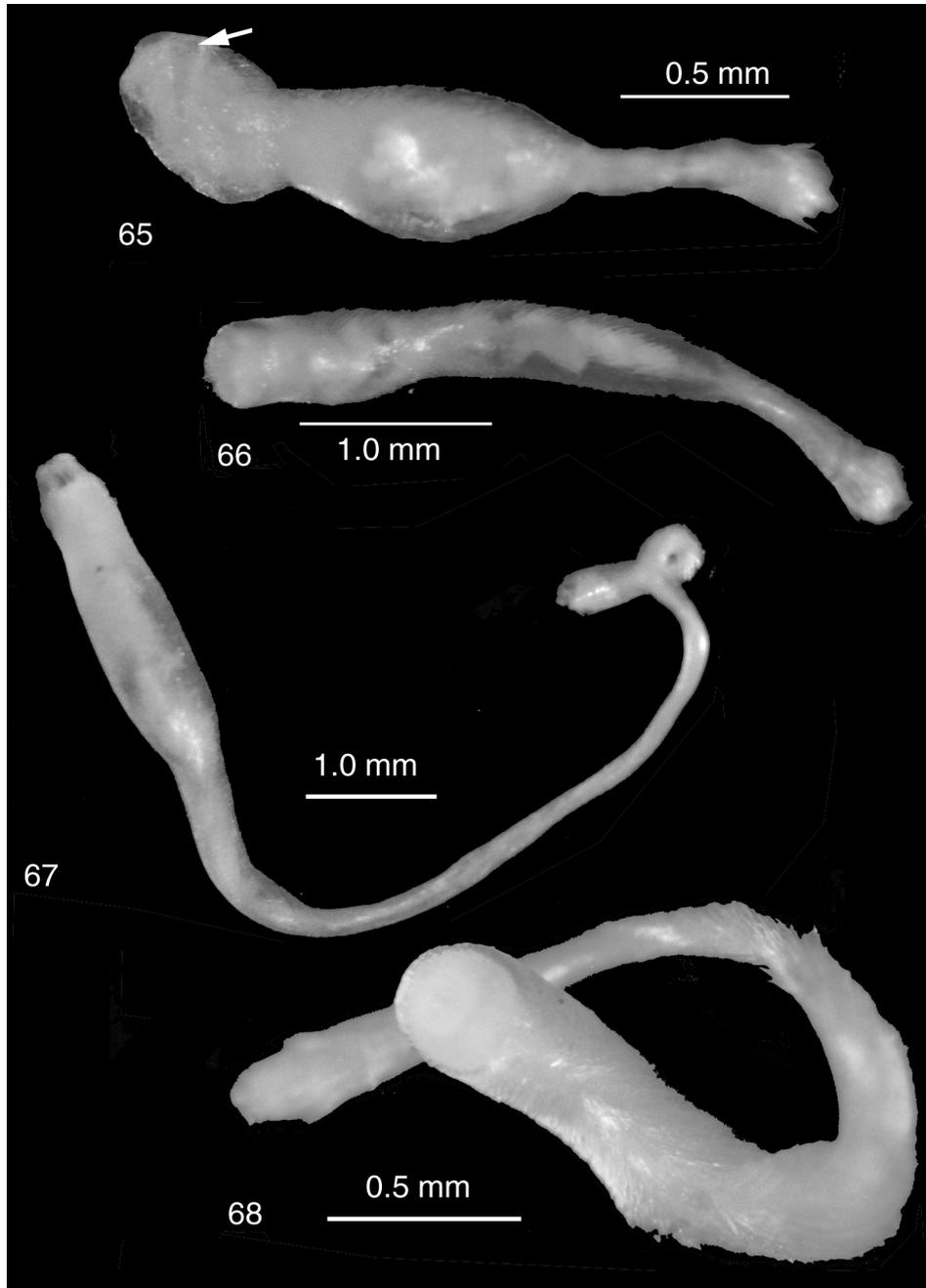
Elongate, semitranslucent, to nearly 5 mm in length, greatest diameter anterior, posterium 0.3 mm or greater, length posterium/trunk 0.68 or greater, spicules conspicuously long, shank spicules overlapping fringe spicules. Oral shield and oral shield spicules prominent on protruded anterior. Defining spicules long, slender, curved, with a broad thickening abfrontally appearing as a broad keel in transmitted light; trunk and shank spicules to 239 and 264 µm, respectively. Radula jaws to 660 µm long, 265 µm wide, teeth to 118 µm long, medial membrane with deep serrations.

*Distribution* (Fig. 69)

North-east of La Réunion Island at 3240 m (type locality) and northern Bay of Bengal (VITYAZ stn 4933; Table 1). The map published in Ivanov and Scheltema (2001a: fig. 18b) unfortunately places VITYAZ station 4933 off the west coast of India, although the coordinates are given correctly in the text and table. Two individuals (paratypes) were recorded from VITYAZ stn 4933 in that publication; the individual recorded here brings the total number to three at stn 4933. Our original description of individuals from La Réunion and the two paratypes from the Bay of Bengal were reported in Ivanov and Scheltema (2001a).

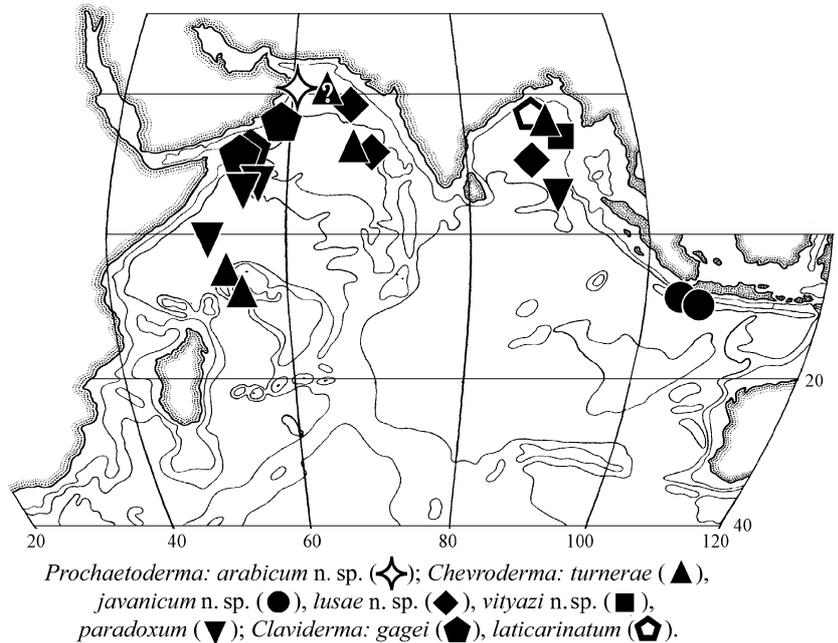
**Discussion**

All species of Prochaetodermatidae known from the Indian Ocean and Arabian Sea have been collected at depths below 1000 m (Table 2; Ivanov and Scheltema 2001a, table 1),



**Figs 65–68.** Holotypes of: 65, *Prochaetoderma arabicum* n. sp., jaws (arrow) seen through cuticle; 66, *Chevroderma lusae* n. sp.; 67, *Chevroderma javanicum* n. sp.; and 68, *Chevroderma vityazi* n. sp.

although a few Chaetodermidae (undescribed) have been found on the upper slope off La Réunion. It is uncertain whether the depth distributions reflect the actual situation or sampling effort.



**Fig. 69.** Map of species collected by the Soviet research vessel VITYAZ reported herein (Table 1).

The genus *Prochaetoderma* is represented by only two individuals of a single species, *P. arabicum*, in the Indian Ocean, yet one *Prochaetoderma* species, *P. yongei* Scheltema, is amphi-Atlantic and numerically dominant at some localities in the west Atlantic (Grassle

**Table 2.** Depth records for all known Indian Ocean/Arabian Sea prochaetodermatoid species

Species <sup>A</sup> and author	Sublittoral shelf		Bathyal		Abyssal	Hadal
	0–200 m	200–1000 m	Upper slope	Lower slope	3000–6000 m	>6000 m
<i>S. subulatum</i> Ivanov & Scheltema <sup>B</sup>				+		
<i>S. longisquamosum</i> (Salv.-Pl.) <sup>C</sup>				+		
<i>P. arabicum</i> n. sp.				+		
<i>Chev. vityazi</i> n. sp.				+		
<i>Cl. laticarinatum</i> Ivanov & Scheltema <sup>B</sup>					+	+
<i>Chev. turnerae</i> Scheltema <sup>BD</sup>				+	+	
<i>Cl. gagei</i> Ivanov & Scheltema <sup>B</sup>				+	+	
<i>N. liliae</i> Ivanov & Scheltema <sup>B</sup>				+	+	
<i>Chev. paradoxum</i> Ivanov & Scheltema <sup>B</sup>						+
<i>Chev. lusae</i> n. sp.					+	
<i>Chev. javanicum</i> n. sp.						+

<sup>A</sup>*Chev.*, *Chevroderma*; *Cl.*, *Claviderma*; *N.*, *Niteomica*; *P.*, *Prochaetoderma*; *S.*, *Spathoderma*.

<sup>B</sup>Ivanov and Scheltema, 2001a.

<sup>C</sup>Salvini-Plawen, 1986.

<sup>D</sup>Scheltema, 1985; Scheltema & Ivanov, 2000.

and Maciolek 1992). Species of other genera of Prochaetodermatidae are numerical dominants in the Aleutian Trench (*Chevroderma whitlatchi*; Scheltema 1985), eastern Pacific off California (*Spathoderma* sp.; Scheltema 1997) and western Atlantic (*Spathoderma clenchi*; Scheltema 1985; Grassle and Maciolek 1992). It has not been possible to determine densities of most populations of species in the Indian Ocean/Arabian Sea because samples have not been collected with quantitative gear. The only exception is for *Claviderma gagei* Ivanov & Scheltema, 2001, which were collected by 0.25 m<sup>2</sup> box cores in the west Arabian Sea, where densities were 28 m<sup>-2</sup> at 3000 m.

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We appreciate the help of Aleksandr Sysoev on numerous occasions during the time the authors were working together in Woods Hole, when he served as our liaison with the Zoological Museum in Moscow. The research was performed under a grant from the National Science Foundation to A. H. S. in the PEET program (Partnerships for Enhancing Expertise in Taxonomy), DEB-9521930. This is contribution no. 10644 of the Woods Hole Oceanographic Institution.

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