INTRODUCTION

The Sipuncula (Peanut worms) comprises sedentary, softbodied and unsegmented coelomates inhabiting either in the coralline, rocky, sandy and muddy habitats of marine and estuarine environments, or inside a protective shelter of a discarded molluscan shell, foraminiferan test or polychaete tube.

Though the study of sipunculans dates back to 1555, the first mention of Indian sipunculan available is in Gray's work (1828). Subsequently, Shipley (1903) provided a short account of Lakshadweep sipunculans followed by a few scattered contributions by others. In this context the present work is undertaken to make a comprehensive systematic study of the sipunculans from the Indian coast and waters. It is based on extensive surveys in different intertidal belts inclusive of both the mainland and insular areas and its sublittoral waters. It deals with habits,habitats and geographical distribution along with systematic account of the species and discussion. The historical review, material and methods, morphology and terminology and keys to identification of the species concerned have also been included in the paper. Over and above, at least six species have been compared with the types brought on loan from different museums. The study of sipunculans comprising 37 species is based on the material surveyed by the author and his colleagues under his leadership. As many as sixteen species constitute new locality records in parts or wholly for the area surveyed, eighteen are common with the earlier known fauna and the rest, reviewed from the literature. Further, the nomenclature of four species described by Johnson (1964, 1971) has been changed on the basis of literature review, since the type specimens could not be located, and one species described by Haldar (1978) is relegated to a known form previously unrepresented here. Apart from all these, some other species like *Physcosoma ruppellii*, *Phascolosoma dissors* and *Phascolopsis gouldii* are excluded from this work, since the former has been treated by Cutler (1983) under *incertae sedis* while the identification of the latter two are doubtful (Cutler, personal communication)

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HISTORICAL REVIEW

The pioneering work on the Indian Sipuncula dates back to Shipley (1903) though the group attracted the attention of the taxonomists from other parts of the globe since the later half of the sixteenth century. This was subsequently followed by a rather scattered series of taxonomic contributions made

by Gravely (1927), Prashad (1936), Johnson (1964, 1969, 1971), Haldar (1975, 1976, 1977, 1978, 1985a, b, in press), Cutler (1977) and, Cutler and Cutler (1979). So far 23 species in 8 genera distributed over 4 families from the coastal mainland and islands of India, are known. It is interesting to note that the name of the present day phylum Sipuncula of Stephen (1964) had to undergo a series of changes made from time to time by the workers like Delle Chiaje (1823), De Blainville (1827), Quatrefages (1847), Sedgwick (1898) and Hyman (1959). The member of this phylum is referred to as 'sipunculan', earlier common names being sipunculoid and sipunculid.

CLASSIFICATION

The present-day phylum Sipuncula passed through a series of nomenclatural changes. The classification was sheerly artifical, when Quatrefages (1847) regarded the group as Gephyrea with an assemblage of the echiurans, priapulans and true sipunculans. Sedgwick (1898) for the first time seggregated the true sipunculans from the aforesaid heterogenous group and gave them the status of phylum Sipunculoidea. Later, Pickford (1947) changed the name of the phylum to Sipunculida. Hence onwards, further reshuffling of nomenclature of the group at the phylum level was brought about by Fisher (1952) and Hyman (1959), until Stephen (1964) introduced Sipuncula as a most familiar name of to-day. With this, substantial changes have been noticed as regards to the earlier names of the phylum-equivalent groups like Gephyrea, Sipunculoidea and Sipunculida in the taxonomical hierarchy.

Keferstein (1865a) treated Sipunculidae as order which he divided into two families, viz., Sipunculacea and Priapulacea. Baird (1868) treated Gephyrea as subclass and divided it into two orders, viz., Gephyrea inermia and Gephyrea armata, of which former included the priapulans and also sipunculans. This order was further subdivided into four families, viz., Sipunculidae, Aspidosiphonidae, Loxosiphonidae and Priapulidae, of which the last name is now raised to the status of distinct phylum. Pickford (1947) classified Sipunculida into four anonymous groups and Akesson (1958), into three such groups on the basis of different sets of characters. Afterwards, Stephen and Edmonds (1972), in their monumental monographic work, classified the phylum Sipuncula into four families, viz., Sipunculidae, Golfingiidae, Aspidosiphonidae and Phascolosomatidae, including a total of seventeen genera. Cutler and Gibbs (1985) attempted to analyse the group on the basis of natural phylogeny and subsequently, Gibbs and Cutler (1987) exhaustively dealt with the classificaion of the phylum in the light of the basic work of Stephen and Edmonds (1972). The major contributions made in their (Cutler and Gibbs, 1985; Gibbs and Cutler, 1987) revisionary works include higher classification of taxa. As a result, they divided the phylum Sipuncula into two classes (Sipunculidea and Phascolosomatidea), four orders (Sipunculiformes, Golfingiiformes, Phascolosomatiformes and Aspidosiphoniformes) and six families. Of the six families, three, viz., Sipunculidae, Phascolosomatidae and Aspidosiphonidae, are retained after Stephen and Edmonds (1972), while the other three, viz., Golfingiidae, Phascolionidae and Themistidae, are segregated from the Golfingiidae earlier treated as a composite family by Stephen and Edmonds. Their works also include seventeen genera, but with certain modifications. The genera *Nephasoma* (= *Golfingia*, in part) and *Apionsoma* (= *Fisherana*, and *Golfingia*, in part) have been rearranged while Stephen and Edmonds' subgenera *Thysanocardia* (= *Golfingia*, in part) and *Antillesoma* (= *Phascolosoma*, in part) have been upgraded to genric level. Also, *Centrosiphon* and *Paraspidosiphon* have been relegated as congeners of *Golfingia*, and *Aspidosiphon* (in part) respectively. The author follows their classification under the systematic account.

MATERIAL AND METHODS

Quite a number of surveys have been made since 1969 at different localities of the vast Indian coast. The material comprising 1640 specimens are mostly collected from Gujarat, Maharashtra, Tamil Nadu, Lakshadweep, Krusadai and islands of the Andamans and Nicobars as well as some earlier unexplored areas such as West Bengal, Andhra Pradesh, Orissa, Kerala and other islands of the Gulf of Manaar. Emphasis has also been made to collect these animals from diversified habitats viz., muddy and sandy beds, sand and rock-pools, coral and rock substrata, calcareous rock platforms, crevices, fissures, under stones and coral boulders, and also among sea-weeds.

As the sipunculans inhabit wide ranges of substrata the method of their collection varies according to their habitats. For the sand and mud dwelling forms, the most suitable ways is to dig out the worm with a hand-shovel at low tide, but sometimes special technique is adopted for *Sipunculus indicus* as mentioned in the text. It is much more difficult to collect those intertidal forms which inhabit coral or rock, since these require meticulous technique for breaking hard substrata with a sharp blow of hammer along the fissure, gallery or tube inhabited by the worm. Afterwards, specimen, if any, is to be removed with the help of forceps. Where it is difficult to dislodge the specimens from the small piece of coral or rock in good condition, it is worthwhile to place the entire piece along with the worm in a very weak solution of formalin prepared from the sea water. The worm then partially or completely dislodges itself from its refuge after sometime. It is easier to collect specimens which take shelter in rock crevices or under stones from other habitats.

After collection, narcotisation is to be made by sprinkling some quantity of menthol crystals or adding a few drops of 70% alcohol in the water containing specimens at frequent intervals. They are to be left in the relaxing medium one hour or more depending on size to allow the introverts to protrude. Initial fixation should be with 4% formaldehyde and permanent preservation with 70% alcohol.

MORPHOLOGY AND TERMINOLOGY

Sipunculans have two principal parts : introvert and trunk. The introvert (Fig.1,i) is usually shorter (in some species, quite long) and slender than trunk, retractile in nature, generally lies along same axis of the trunk but sometimes it is displaced ventrally. It is provided with terminal mouth usually surrounded by tentacles (Fig.8,t) which are variable in the degree of development and complexity. Tentacular region follows a zone which may bear chitinous, posteriorly directed hooks (Fig.11,12) either scattered or arranged in regular rings. The level of usually paired nephridiopores (Fig.2, np) and anus (Fig.2,a) or either of them, whichever is anterior, demarcate (s) the introvert-trunk junction.

The shape of the trunk (Fig.2,tr) may vary from almost globular to cylindrical, and sometimes retains spiral appearance for those inhabiting gastropod shells. Its anterior end is generally simple but in few groups it is armed with varying shapes of calcareous cap (Fig.2, as) and posterior end is blunt or pointed (Fig.1,tr) or acorn-like or provided with cap (Fig.2, cs). Trunk bears papillae (Fig.1,p) of various shapes and sizes being more dense at both ends than at the middle or localised regionally and sometimes modified as holdfast or totally absent.

The longitudinal (Fig.4, lm) and circular muscles (Fig.4,cm) of the bodywall are frequently arranged in smooth, uniform layers but sometimes these are gathered into bundles. Retractors (Fig. 1, dr, vr), main muscles of the coelom, varying from 1-4 in number cross it as free longitudinal bands, being fixed anteriorly behind the oral disc and posteriorly, at different levels of the trunkwall and control the introvert.

The major portion of coelom is occupied by digestive tract having a straight oesophagus (Fig. 1, 0), double helix (coiled) intestine (Fig. 1, int) and rectum (Fig.1,r) with or without caecum. The anus is usually placed at the anterior end of trunk. In the coelom usually three types of gut muscles are found namely, spindle muscle, wing muscles and fixing muscles. Spindle muscle (Fig.13,s) is single, slender and thread-like and it originates from the body wall near anus or from rectal wall. It extends down the centre of intestinal coil and terminates posteriorly either in the intestinal coil or at the posterior end of the trunk. Wing muscles (Fig. 13, wm) are paired thin sheets and anchor the distal part of rectum to the body wall. Fixing muscle (s) (Fig.13 f_1, f_2) are fine strands of varying numbers and anchor intestinal coils or oesophagus to the body wall.

Contractile vessel (sometimes called polian vessel or compensatory sac) is a closed tubular structure connecting tentacular cavities, runs along the oesophagus and sometimes carries numerous villi or tubules (Fig. 101).

Nephridia (Fig.1,n) is single or usually two. It is simple tubular or sac-like structure of variable length and serves as excretory sacs and gonoducts. These either hang freely in the coelom or are attached partially or wholly by more extensive mesentry. Nephridiopores (Fig.4,np) are discernible externally and lie on the ventral side at the anterior end of trunk. Gonads (fig. 1,g) the transitory structures in the form of conspicuous fringe, develop at the base of the retractor, usually at its ventral pair, when present. Sipunculans are dioecious and lack any sexual dimorphism. The gametes are retained in the coelom until mature, then they are released through nephridiopores and the fertilisation is external. After metamorphosis of free swimming trochophore larvae, the juveniles settle onto a suitable substratum and probably remain there throughout their lives.

Abbreviations used in the text and figures

a	:	Anus	no	:	Nuchal organ
ac	:	Accessory caeca	np	:	Nephridiopore
act	:	Accessory tooth	o	:	Oesophagus
as	:	Anal shield	p	:	papilla
at	:	Apical tooth	r	:	Rectum
cc_1	:	Cephalic collar	rg	:	Racemose gland
cc_2	:	Cervical collar	R.I.M.S.	:	Royal Indian Marine Survey Ship
cm	:	Circular muscle			
C.M.F.R.I	:	Central Marine Fisheries Research Institute	rm	:	Retractor muscle
			s	:	Spindle muscle
cp	:	Coelomic papilla	s_1, s_2	:	Lateral branch of spindle muscle
cs	:	Caudal shield			
cv	:	Contractile vessel	st	:	Central streak
d	:	Dissepiments		:	
dr	:	Dorsal retractor	t	:	Tentacle
f, f_1-f_4	:	Fixing muscle	ta	:	Triangular area
g	:	Gonad	tb	:	Transverse bar
Coll	:	Collector	tf	:	Tentacular fold
h	:	Hook	tp	:	Triangular papilla
i	:	Introvert			
int	:	Intestine	tr	:	Trunk
Kb	:	Keferstein bodies	v	:	Contractile vessel villi
lm	:	Longitudinal muscle	vr	:	Ventral retractor
m	:	Mouth	w	:	Wart
n	:	Nephridium	wm	:	Wing muscle

SYSTEMATIC ACCOUNT

CLASSIFIED LIST OF SIPUNCULA OF THE INDIAN COAST

Phylum **Sipuncula** Stephen, 1964

A] Class **SIPUNCULIDEA** Gibbs and Cutler, 1987

A. Order **SIPUNCULIFORMES** Cutler and Gibbs, 1985

I. Family **SIPUNCULIDAE** Baird, 1968

i) Genus **Sipunculus** Linnaeus, 1766

Subgenus **Sipunculus** Linnaeus, 1766

1. *S.* *(S.)* *norvegicus* Danielssen,1869

* 2. *S.* *(S.)* *nudus* Linnaeus, 1766

3. *S.* *(S.)* *robustus* Keferstein, 1865

4. *S.* *(S.)* sp.

Subgenus **Austrosiphon** Fisher, 1954

5. *S.* *(A.)* *indicus* Peters, 1850

ii) Genus **Siphonosoma** Spengel, 1912

6. *S.* *australe* (Keferstein, 1865)

7. *S.* *cumanense* (Keferstein, 1867)

*** 8. *S.* *rotumanum* (Shipley, 1898)

9. *S.* *vastum* (Selenka and Bulow, 1883)

B. Order **GOLFINGIIFORMES** Gibbs and Cutler, 1987

II. Family **GOLFINGIIDAE** Stephen and Edmonds, 1972

iii) Genus **Nephasoma** Pergament, , 1946

\+ 10. *N.* *filiforme* (Sluiter, 1902)

* 11. *N.* *pellucidum* (Keferstein, 1865)

* 12. *N.* *rutilofuscum* (Fischer, 1916)

III. Family **THEMISTIDAE** Cutler and Gibbs, 1985

iv) Genus **Themiste** Gray, 1828

Subgenus **Themiste** Gray, 1828

*** 13. *T* *(T.) hennahi* Gray, 1828

Subgenus **Lagenopsis** Edmonds, 1980

14. *T* *(L.) lageniformis* Baird, 1868

B] Class **PHASCOLOSOMATIDEA** Gibbs and Cutler, 1987

C. Order **PHASCOLOSOMATIFORMES** Gibbs and Cutler, 1987

IV) Family **Phascolosomatidae** Stephen and Edmonds, 1972

v) Genus **Antillesoma** Stephen and Edmonds, 1972

* 15. *A.* *antillarum* (Grube and Oersted, 1858)

vi) Genus **Phascolosoma** Leuckart, 1828

Subgenus **Phascolosoma** Leuckart, 1828

* 16. *P.* *(P.)* *agassizii* Keferstein, 1866

* 17. *P.* *(P.)* *albolineatum* Baird, 1868

* 18. *P.* *(P.)* *arcuatum* (Gray, 1828)

** 19. *P.* *(P.)* *granulatum* Leuckart, 1828

** 20. *P.* *(P.)* *japonicum* Grube, 1877
* 21. *P.* *(P.)* *nigrescens* Keferstein, 1865
* 22. *P.* *(P.)* *pacificum* Keferstein, 1866
* 23. *P.* *(P.)* *perlucens* Baird, 1868
24. *P.* *(P.)* *scolops* (Selenka and de Man, 1883)
** 25. *P.* *(P.)* *stephensoni* (Stephen, 1942)

vii) Genus **Apionsoma** Sluiter, 1902
* 26. *A. trichocephala* Sluiter 1902
** 27. *A. misakiana* (Ikeda)
28. *Apionsoma* sp.

D. Order **ASPIDOSIPHONIFORMES** Cutler and Gibbs, 1985

V. Family **ASPIDOSIPHONIDAE** Baird, 1968

viii) Genus **Aspidosiphon** Diesing, 1851

Subgenus **Aspidosiphon** Diesing, 1851
29. *A.* *(A.)* *elegans* (Chamisso and Eysenhardt, 1821)
+ 30. *A.* *(A.)* *exhaustus* Sluiter, 1912
** 31. *A.* *(A.)* *gracilis* Baird, 1868
+ 32. *A.* *(A.)* *tortus* Selenka and Bulow, 1883

Subgenus **Paraspidosiphon** Stephen, 1964
33. *A.* *(P.)* *klunzingeri* Selenka and de Man, 1883
*** 34. *A.* *(P.)* *pachydermatus* Wesenberg-Lund, 1937
* 35. *A.* *(P.)* *steenstrupii steenstrupii* Diesing, 1859
35a. *A.* *(P.)* *steenstrupii ambonensis* Augener, 1903

ix) Genus **Cloeosiphon** Grube, 1868
* 36. *C.* *aspergillus* (Quatrefages, 1865)

x) Genus **Lithacrosiphon** Shipley, 1902
37. *L.* *cristatus* (Sluiter) *lakshadweepensis* Haldar

* new locality records;
** new to the Indian coast;
*** new to the Indian Ocean;
\+ reviewed from literature.

Class **SIPUNCULIDEA** Cutler and Gibbs

Sipunculida Cutler and Gibbs, 1985, *Syst. Zool.* ,**34** (2) : 167.
Sipunculidea Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 47

Diagnosis : Tentacles enclosing centrally placed mouth on the oral disc; introvert hooks, if present, simple, sharply pointed and usually scattered in their distribution; spindle muscle not attached posteriorly except in *Siphonosoma* and *Siphonomecus*.

Key to orders of **SIPUNCULIDEA** known from the Indian coast

Longitudinal muscle layer of the body wall always separated into bands ... Sipunculiformes Cutler and Gibbs

Longitudinal muscle layer of the body wall continuous, not separated into bands ... Golfingiiformes Gibbs and Cutler

Order **SIPUNCULIFORMES** Cutler and Gibbs

Sipunculiformes Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 167.
Sipunculiformes : Gibbs and Cuttler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 47

Diagnosis : Longitudinal muscle layer of the body wall always separated into bands; coelomic extensions - canals or sacs - present in the epidermis except in *Phascolopsis*.

Family **SIPUNCULIDAE** Stephen and Edmonds

Sipunculidae Baird, 1868, *Proc. zool. Soc. Lond.* **1868** : 77 (in part).
Sipunculidae Sedgwick, 1898, *A student's text book of Zoology*, **1**. Swan Sonnenschein, London : 539 (in part).
Sipunculidae Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura*. Trustees of the British Museum (Natural History), London : 19-20
Sipunculidae : Gibbs and Cutter, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 48

Diagnosis : Tentacles may form clusters or be arranged in meridonial rows; retractor muscles two pair but only one pair in *Siphonomecus*.

Type genus : *Sipunculus* Linnaeus, 1766
Distribution : Cosmopolitan.

Remarks : Amongst a total of five genera of this family known from the world two genera have so far been recorded from the Indian coast. The remaining three genera namely, *Siphonomecus*, *Phascolopsis* and *Xenosiphon* are monotypic. Among these the first one is only known from the type locality *i.e.*, Key West, Florida and the second one is endemic to the east coast of the United States, north of Florida while the third one as defined by Cutler and Cutler (1985) is reported from California and Florida to Ecuador, West Caroline Islands and Burma.

Key to genera of **Sipunculidae** known from the Indian coast

Introvert papillae irregularly arranged, flattened, subtriangular and posteriorly directed; spindle muscle not attached posteriorly	...	*Sipunculus* Linnaeus
Introvert papillae regularly arranged in rings, conical, cylindrical or round in shape; spindle muscle attached posteriorly	...	*Siphonosoma* Spengel

Genus **Sipunculus** Linnaeus

Sipunculus Linnaeus, 1766, *Systema Naturae,* 12th edition : 1078.
Sipunculus : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 49.

Diagnosis : Usually large in size; introvert shorter than and sharply differentiated from trunk, without hooks but covered with irregularly arranged triangular papillae; mouth surrounded by tentacles, sometimes modified with the development of an intertentacular membrane; trunk long, cylindrical, generally thick walled; epidermal coelomic canals- extensions of coelom - present between muscle bands as parallel longitudinal canals; longitudinal and circular muscle layers divided into distinct bands; retractor muscles two pair; alimentary canal with post-oesophageal loop held in position by numerous connective tissue strands; contractile vessels two in number and both without villi; spindle muscle not attached posteriorly; nephridia paired.

Type species : *Sipunculus nudus* Linnaeus, 1766.
Distribution : Cosmopolitan.

Remarks : Cutler and Cutler (1985) redefined the genera *Sipunculus* and *Xenosiphon* based on the evaluation of historically used characters and divided the genus *Sipunculus* into two subgenera namely, *Sipunculus* and *Contraporus*. Gibbs and Cutler (1987) replaced *Contraporus* by *Austrosiphon* of Fisher (1954).

Key to subgenera of **Sipunculus** known from the Indian coast

Nephridiopore anterior to anus; spindle muscle arising from body wall anterior to anus	...	*Sipunculus* Linnaeus
Nephridiopore posterior to anus; spindle muscle arising from rectum	...	*Austrosiphon* Fisher

Subgenus **Sipunculus** Linnaeus

Sipunculus Linnaeus, 1766, *Systema Naturae*, 12th edition : 1078.
Sipunculus (Sipunculus) : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 49.

Diagnosis : Nephridiopore anterior to anus; spindle muscle arising from body wall anterior to anus.

Type species : *Sipunculus nudus* Linnaeus, 1766.
Distribution : Cosmopolitan.

Remarks: According to Cutler and Cutler (1985) this subgenus is represented by eight species of which four including presently recorded an anonymous species are known from this coast.

Key to species of subgenus **Sipunculus** known from the Indian coast

1.	Longitudinal muscle bands 23 or more	...	2
	Longitudinal muscle bands 21 or 22	...	*S. (S.) norvegicus* Danielssen
2.	Longitudinal muscle bands split in glans region	...	*S. (S.) nudus* Linnaeus
	Longitudinal muscle bands non-split in glans region	...	3
3.	Longitudinal muscle bands 24-31	...	*S. (S.) robustus* Keferstein
	Longitudinal muscle bands 32-39	...	*Sipunculus (Sipunculus)* sp.

Sipunculus (Sipunculus) norvegicus Danielssen
(Figs. 14, 15, 54)

Sipunculus norvegicus Danielssen, 1869, *Ford. skand. Naturf. Christiana Mote*, **10** : 541-542.
Sipunculus priapuloides Koren and Danielssen, 1877, *In* : Sars, M., *Fauna Littoralis Norwegiae*, Christiania, **3** : 126-128
Phallosoma norvegicus Levinsen, 1884, *Vidensk. Meddr dansk naturh. Foren*, **11** : 268.
Sipunculus nitidus Sluiter, 1900, *Result. Camp. Scient. Prince Albert I*, **15** : 14-16, Pl. 1, Figs. 4-5,pl. 3, figs.10-11
Sipunculus aequabilis Sluiter, 1902, *Siboga Exped.*, **25** : 7.
Sipunculus infrons Sluiter, 1902, *Siboga Exped.*, **25** : 10, pl. 1, fig. 4.
Sipunculus priapuloides var. *americana* Gerould, 1913, *Proc. U.S. natn. Mus.*, **44** : 429-432.
Sipunculus norvegicus : Cutler and Cutler, 1985, *Zool. J. Linn. Soc.*, **85** : 239-240.

Type locality: Hardanger fjord, West coast of Norway. *Location of type* : Zoological Museum, University of Bergen, Norway.

Material examined: 3 exs., sta. 177, 13°47'49" N, 73°7' E, 1164 m, Lakshadweep Sea, 5 .v. 1894, Coll. Marine Survey of India; 2 exs., Sta. 273, 12°47' N, 73°44'45" E, 1591-1505 m, Lakshadweep Sea,

27. xii. 1900, Coll. Marine Survey of India; 3 exs., Sta. 325, Bay of Bengal, 18°18' N, 93°25' E, 1541 m, 22.xii. 1903, Coll. Marine Survey of India; 2 exs., Bay of Bengal (no other data available).

Description: Trunk 34-78 mm long and 23-36 mm wide at about mid-trunk region, more or less cylindrical, thin -skinned and dirty whitish to yellowish gray in colour; surface devoid of papillae and quadratic areas but usually with longitudinal furrows; glans region usually conical and sharply demarcated from rest of trunk by annular ridge and usually interrupted ventrally by a furrow. Introvert partially or mostly retracted in all the specimens, 18-29 mm long, about one-third to half as long as trunk and covered with subtriangular papillae. Tentacular membrane divided into 8-10 lappets.

Longitudinal muscle layer divided into 21 or 22 non-anastomosing usually distinct bands which correspond to longitudinal furrows externally; most of these bands split into two in the vicinity of glans region. Circular muscle layer similarly divided into bands, both longitudinal and circular muscle bands fusing to form continuous layer in glans region. Retractor muscles two pair, separated from each other, arising at the same level from anterior third to fifth of trunk; ventrals originating from longitudinal muscle band (s) 3 or 3-4 (in part of both the muscles) and dorsals from 8-9 or 9. Intestine damaged in most of the specimens having 12-14 coils; rectum moderately long and with an oval caecum nearly at its middle and a pair of racemose glands; intestinal coils and anal part of rectum attached to body wall by thin strands of fibres and wing muscles respectively. Spindle muscle originating 2-3 mm ahead of anus, passing over the rectum having attachment with rectal caecum and finally entering into intestinal coils. Contractile vessel paired and without villi. Nephridia, in most of the specimens highly contracted, about one-sixth of trunk length in the largest one but not extending up to retractor base; tubular thin-walled grayish white in colour and completely free; opening anterior to anus about 11.5-18% of trunk length between muscle bands 4-5. Brain flattened and with inconspicuous lobes but without brain processes.

Remarks: This species may be easily differentiated from other members of this subgenus known from this coast by the presence of lesser number of longitudinal muscle bands (21 or 22) and absence of brain processes.

As no additional specimen is available with the author, the description of this species is based on the material already dealt by Prashad (1936). Prashad's (1936) brief description of *S. aequabilis* based on three dissected specimens out of eleven provides no additional information to Sluiter's (1902) original description The author is able to locate Prashad's ten specimens and notes the variations particularly in the number of longitidinal muscle bands (21 or 22) and their tendency of splitting into two in the vicinity of the glans region, inconsistency of annular ridge (at least in two specimens from Station 273) and ventral interruption of annular ridge where present, and non-attached nephridia. Further, one specimen from Station 177 possesses two additional caecal-like structures having filamentous outgrowths from their tips.

Majority of the literature indicates that the number of longitudinal muscle bands is constant either 21 or 22, rarely 23 but Cutler (1973, 1977a), and Cutler and Cutler (1985) show the range from 20 to 24 (commonly 21-22). The ventral retractors are attached to longitudinal muscle bands 3 and 4 (rarely just 3 or 2 and 3) while dorsal retractors to 8 and 9 (rarely just 8 or 9) but Murina (1964c) states that dorsals are attached to 3 and ventrals to 8 or 8 and 9 longitudinal muscle bands. But this can not

be, reverse is true. Moreover, Theel (1905) placed no weight on the "annular prominence" at the glans region.

In the revisionary work on the genus *Sipunculus*, Cutler and Cutler (1985) synonymized Sluiter's *S. aequabilis* with *S. norvegicus* Danielssen on the basis of the number of longitudinal muscle bands, attachment of dorsal and ventral retractors with the former and the shape of the brain. After perusal of original description and re-examination of Prashad's *S. aequabilis* the author agrees with Cutler and Cutler's (1985) view.

Previous Indian Records : Lakshadweep Sea and Bay of Bengal (Prashad, 1936).

Distribution : This is a deeper, cool-water species and usually found between 200-3000 m. It is apparently absent from eastern Pacific, south Atlantic and Antarctic waters.

In India : Lakshadweep Sea; Bay of Bengal.

Elsewhere :

(a) *Indian Ocean* : Suez Canal (Robinson, 1927), Gulf of Aden and East Africa (in Cutler and Cutler, 1979a); Madagascar (Cutler and Cutler, 1979a); Strait of Malacca (Cutler, 1977a; Cutler and Cutler, 1979a); Sumatra (Cutler and Cutler, 1979a); Great Australian Bight (in Murina, 1978).

(b) *Pacific Ocean* : East China Sea (Murina, 1976); Philippines (Fisher in Stephen and Edmonds, 1972); Makassar Strait (Cutler, 1977a); Flores Sea (Sluiter, 1902); Hawaii (Fisher in Stephen and Edmonds, 1972; Cutler and Cutler, 1979a); Loyalty Islands (Shipley, 1899a); Tasman Sea (Cutler, 1977a); Southern Pacific (Murina, 1978).

(c) *Atlantic Ocean* : East Greenland (Wesenberg-Lund, 1937a); Iceland (Wesenberg-Lund, 1937b); western North Atlantic (Gerould, 1913; Cutler, 1973; Rowe, in Cutler and Cutler, 1985); North Sea (Stephen, 1934); South-West Ireland (Southern, 1913b); Gulf of Gascogne (Cutler and Cutler, 1980c); Off Las Pilones (Roule, 1907); Mediterranean Sea (Murina, 1964c); Off Azores and Cape Verde Islands (Sluiter, 1900); Senegal (Stephen, 1960a); Bay of Guinea (Cutler, 1977a); Off French Guinea (Wesenberg-Lund, 1959a); West Africa (Roule, 1898).

Sipunculus (Sipunculus) nudus Linnaeus
(Figs. 16, 55-57)

Sipunculus nuds Linnaeus, 1766, *Systema Naturae*, 12th ed. : 1078.
Syrinx tesselatus Rafinesque, 1814, Precis des decouvertes et travaux zoologiques, Palerme : 32.
Sipunculus nudus var. *tesselatus* Costa, 1853, *Fauna del Regno di Napoli.* Echinodermi apodi., **9** (11) : 17-20, pl.2.
Sipunculus tesselatus Keferstein and Ehlers, 1861, *Nachr. Ges. wiss. Gottingen*, **1860** : 38, pl.7, fig.1.
Sipunculus eximioclathratus Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 81-82
Sipunculus titubans Selenka and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 100-101.
Spinuculus titubans var. *diptychus* Fischer, 1895, *Abh. Geb. naturrw., Hambrug*, **13** : 7, fig. 3.
Sipunculus norvegicus vemae Stephen, 1966, *Ann. Mag. nat. Hist.*, (13) **9** : 147.

Sipunculus delphinus Murina, 1967a, *Zool. Zh.*, **46** : 1336-1337, figs. 4(3) and 5.
Sipunculus (Sipunculus) nudus : Cutler and Cutler, 1985, *Zool. J. Linn, soc.*, **85** : 236-237, fig.5.

Type locality : Not known. *Location of type* : Not known

Material Examined: 3 exs., Digha, West Bengal, 15.ix. 1964, Coll. A.K.Datta; 3 exs., Pamban, Tamil Nadu, "bottom trawl net", 8-10 m, 23.xii.1974, Coll. Gopnath Menon; 1 ex., east of Camorta jetty, Nicobars, 30.i.1976, Coll. D.R.K.Sastry; 6 exs., Marine jetty, Port Blair, South Andamans, "washed up on beach after storm", ?.xii. 1976, Coll. A.K.Dattagupta; 3 exs., Chidyatapu, South Andamans, "from mangrove bed", 25.v.1978, Coll. B.P.Haldar.

Description: Trunk 60-115 mm long and 13-37 mm wide, pink, pinkish-white or grayish-white in colour with irridescent cuticle; thick-skinned and opaque in large specimens while thin-skinned and translucent in small ones; almost cylindrical with usually bulbous posterior end; surface showing numerous quadratic (rectangular or square) areas. Introvert, retracted in all the specimens excepting one, 20-40 mm long, much narrower than trunk and bearing numerous, subtriangular, posteriorly directed scale-like papillae. Tentacular membrane divided into 4-5 lappets, the dosrsally placed two are longer than ventrally placed ones.

Longitudinal muscle layer divided into 24-32 non-anastomosing prominent muscle bands; circular muscle layer also divided into numerous bands; longitudinal muscle bands usually splitting into two while circular muscle layer continuous in the glans region. Retractor muscles two pair, equally strong and arising from anterior third to fourth of trunk, more or less at the same level; ventral spanning 2 to 6 muscle bands while dorsal 3 to 6 muscle bands and base of dorsal and ventral of the same side in some specimens connected by thin membranous sheet. Oesophagus attached to retractor muscles anteriorly by mesenteries and with characteristic "post-oesophageal" loop; intestinal coils 20-24 in number, extending up to posterior end of trunk; rectum comparatively short and 70% of the examined specimens bearing rectal caecum - an extraordinarily long, white, narrow tube - arising from beginning of rectum and extending posteriorly along ascending part of intestine, not attaching to it anywhere by mesenteries and ending blindly at midtrunk level; anal opening lying in between the space made by bifurcation of 13th muscle band. Racemose glands single pair attached to mesenteries connecting rectum and body wall near the base of dorsal retractors. Spindle muscle arising 5-7 mm ahead of anus from 14th muscle band, running posteriorly and closely adhering to rectal caecum and terminating on the last 4th to 6th intestinal coil. "Post-oesophageal loop" and intestinal coils attached by thin strands of fibres. Contractile vessel simple and paired, thin-walled and convoluted, running along dorsal and ventral side of oesophagus up to base of retractor muscles. Nephridia one-fifth to one-tenth of trunk length, yellowish-white, brown to dark tan in colour; their anterior two-fifths to one-tenth attached to body wall and opening anterior to anus by one-eighth to one-sixteenth of trunk length and posterior to anterior end of trunk by one-seventh to one-eighth of trunk length. Brain with a number of short digitate processes along its anterio-dorsal margin. Eggs spherical, double coated and measuring 0.14-0.17 mm in diameter.

Remarks : The species may be recognised from its nearest ally, viz., *S. robustus* by the partial attachment of nephridia and anterio-dorsal digitate processes of the brain.

The different shape of the quadratic areas (rectangular or square) over the turnk surface as observed by Prashad (1936), as well as in present specimens, is due to different stages of contraction or relaxation of circular muscle bands. In majority of specimens, glans region is smooth while in a few glans region* show longitudinal ridges. This probably happened during the process of narcotisation or preservation. Anal opening is a transverse slit lying in the same level of trunk but placed on a raised area in two specimens from South Andamans. In the aforesaid specimens, oval bodies (2 and 4 in number) measuring 0.06-0.08 mm long are observed to attach to the muscle bands on either side of the nerve cord in the glans region. Rectal caecum is small reported by previous workers including Prashad (1936) and author (1975, 1976) but the said structure is extraordinarily long in the material examined as well as in the specimens referred to by Sato (1930). Perusal of literature indicates that the number of longitudinal muscle bands ranges from 24 to 34. In the present material some of the specimens from the Andamans and the Nicobars there are 24-28, 25-27 and 26 (*versus* 31-34 or 33 by Prashad, 1936 and by the author in 1975, 1976). The present specimens are also satisfying Cutler and Cutler's (1985) view of "positive correlation between the total number of LMBs** and ventral margin of dorsal retractors".

Previous Indian Records : Lakshadweep Sea and Arabian Sea (Haldar, 1975); Andamans (Prashad, 1936; Haldar, 1975, 1976); Nicobars (Prashad, 1936; Haldar, 1976; Cutler, 1977b).

Distribution : This species is a cosmopolitan inhabitant of shallow, temperate, tropical and subtropical water from 56° N to 30° S latitude. Vertical distribution of this species sometimes extends from littoral to sublittoral, 55-60 m (Stephen, 1966; Cutler, 1977b), bathyal 710 m (Selenka, 1885) and even abyssal, penetrating to a depth of 2298-2308 m (Selenka, 1885; Haldar, 1975).

In India : Lakshadweep Sea; Arabian Sea; Tamil Nadu; West Bengal; Andamans; Nicobars.

Elsewhere :

(a) *Indian Ocean*: Red Sea (Herubel, 1904b; Wesenberg-Lund, 1957b; Murina, 1971c), Off Mombasa (Cutler, 1977b); Zanzibar (Stephen and Robertson, 1952); Madagascar (Fischer, 1895; Cutler and Cutler, 1979a, 1985); Malacca (Selenka and de Man, 1883); South Australia (Fisher, 1914b; Murina, 1972).

(b) *Pacific Ocean* : Siam (Fischer, 1923b), Indo-China (Leroy, 1942); China (Chen and Yeh, 1958; South China Sea (Murina, 1964b); Fukien (Chin, 1947); East Indies (in Fisher, 1952); Philippines (Selenka and de Man, 1883; Ikeda, 1904; Cutler, 1977b); Formosa and Korea (Sato, 1939); Japan (Ikeda, 1904; Sato, 1930, 1934a, 1934b, 1937a; Cutler, Cutler and Nishikawa, 1984); West Caroline Islands (Sato, 1935); New Britain (Shipley, 1899a); Queensland (Cutler, 1977b, Cutler and Cutler, 1985); Kermadec Island (Benham, 1912); Christmas Island (Shipley, 1899b); French Polynesia (Cutler and Cutler, 1985a); Panama (Keferstein, 1867); Costa Rica (Selenka and Bulow, 1883; Cutler and Cutler, 1985a); Guatemala (Fisher, 1895).

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* Glans region = Acorn-like structure at posterior end of trunk set off by an annular fold of skin.
** LMBs = Longitudinal muscle bands

(c) *Atlantic Ocean* : North Carolina (Gerould, 1913; Cutler, 1973); Florida (Selenka and de Man, 1883; Gerould, 1913; Cutler, 1973; Cutler and Cutler, 1985a); Bermuda (Verrill, 1904); West Indies (Selenka and de Man, 1883; Augener, 1903; Gerould, 1913; ten Broeke, 1925); Off Cuba (Murina, 1967a); Havana (Fischer, 1895); Brazil (in Fisher, 1952; Ditadi, 1982); Plymouth, Ireland (Southern, 1913b; Wesenberg-Lund, 1954a); off North Ireland (Selenka, 1885); North Sea (Selenka and de Man, 1883); British Islands (Gibbs, 1977a); English Channel (in Gerould, 1913); France : Finistere (Edmonds, 1962); Arcachon (Cuenot, 1922), Cannes (Wesenberg-Lund, 1933); Spain (Ochran, 1980; Saiz Salinus, 1980); Mediterranean Sea (Selenka and de Man, 1883; Fischer, 1913); Istrien (Fischer, 1913); Ibiza (Fischer, 1922a); Sardinia (Marcialis, 1892); Sicily (Keferstein, 1865a; Augener, 1903), Neapel (Keferstein, 1865a; Augener, 1903); Adriatic Sea (in Fisher, 1952; Zavodnik and Murina, 1976); Israel (Stephen, 1958); Azores (Cutler and Cutler, 1985a); Off North Morocco (Selenka, 1885); Senegal (Stephen, 1960a) Ivory Coast (Cutler and Cutler, 1985a); Accra (Fischer, 1895); Bay of Guinea (Cutler and Cutler, 1895a); Vema Sea Mount (Stephen, 1966).

Sipunculus (Sipunculus) robustus Keferstein
(Figs. 17, 58, 59)

Sipunculus robustus Keferstein, 1865a, *Z. wiss. Zool.*, **15** : 421.
Sipunculus angasii Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 76.
Sipunculus (Sipunculus) robustus : Cutler and Cutler, 1985, *Zool. J. Linn.Soc.*, **85** : 237-238.

Type locality : Uwea, Wallis Island. *Location of type* : Zoological Museum, University of Hamburg.

Material examined : 4 exs., Marine jetty, Port Blair, South Andamans, "washed up on beach after storm", ?.xii.1976, Coll. A.K. Dattagupta; 2 exs., Car Nicobar, Nicobars, 3.x.1977, Coll. K. Pitambaram, (Government College, Port Blair, Andamans).

Description : Trunk 145-255 mm long and 48-80 mm wide; pink in colour with somewhat loosely attached irridescent cuticle; thick-skinned and opaque; cylindrical, glans region round with longitudinal furrows and ridges; surface cut up into quadratic areas. Introvert, in most of the specimens less than half retracted inside, 49-59 mm long; covered with numerous subtriangular backwardly pointed and irregularly arranged scale-like papillae. Tentacular margin leaf-like arising from tentacular fold.

Longitudinal muscle layer divided into 29-31 non-anastomosing prominent muscle bands. Circular muscle layer also grouped into numerous bands. Longitudinal muscle bands non-splitting and circular muscle layer banded in nature in the glans region. Retractor muscles two pair, equally strong and arising at the same level from anterior one-fourth to one-fifth of trunk; ventral pair from muscle bands 1-5 (3-4) while dorsal pair from muscle bands 9-13 (10-12) and both the pair remaining free up to brain. "Post-oesophageal" loop present; intestine with 18-20 loosely wound coils, almost extending up to posterior end of trunk; rectum one-fifth to one-fourth as long as trunk and with small more or less round caecum at its beginning. Racemose glands present. Spindle muscle arising 4-5.5 mm ahead of anus from fifteenth muscle band and terminating in the twelfth intestinal coil. "Post-oesophageal loop", intestinal coils and rectum attached by thin strands of fibres.Contractile vessel paired, well developed,

brown in colour and highly convoluted. Nephridia 54-68 mm long; extending beyond retractor base, tubular, thin-walled, light-brown to brown in colour and completely free; opening between muscle band 4 and 5 or 5 and 6 anterior to anus by one-eighth to one-sixth of trunk length. Brain with a number of dorso-laterally long, slender digitate processes.

Remarks : This species is very closely related to *S. nudus* and may be distinguished from the latter by the number of longitudinal muscle bands 29-31 which are non-splitting in nature in the glans region, completely free nephridia and long, slender droso-lateral digitate processes.

A number of workers including Stephen and Edmonds (1972) and Edmonds (1980) stated the presence of rectal caecum which has been observed in the present material but Wesenberg-Lund (1954a) and Murina (1964a) did not mention the same in their specimens. Contractile vessels are paired according to many workers except Keferstein (1865a), and Selenka, de Man and Bulow (1883). In one of the present material ventral contractile vessel is narrower than the dorsal one. Further, Wesenberg-Lund (1954a) and Edmonds (1955) observed villi on the contractile vessels. The fact that the anus is bounded anteriorly by two muscles and posteriorly by one muscle as reported in the literature is not observed in the examined specimens. In the Chinese specimen Murina (1964b) noted the attachment of nephridia by one-fifth to one-sixth of their length.

Stephen and Edmonds (1972) stated, "*S. nudus* Linnaeus and *S. robustus* Keferstein are very closely related species". Cutler and Cutler (1985) remarked, "It is very possible that over the years this name has been applied to *S. nudus* population and vice versa ....." The fact that number of longitudinal muscle bands (within *S. nudus* range) and unattached nephridia (usually 10-40%, rarely 0-50% attached in *S. nudus*, vide Cutler and Cutler , 1985) resulted such confusion. The other supplemented criteria, e.g., non-splitting nature of longitudinal muscle bands in the glans region as well as long, slender dorso-lateral digitate processes are to be taken into consideration for identifying this species.

Previous Indian Records : Dwaraka, Gujarat (Haldar, 1975), Madras, Tamil Nadu (Prashad, 1936; Rajulu, 1975a); Nicobars (Prashad, 1936); Andamans (Prashad, 1936; Haldar, 1975, 1976).

Distribution : This is usually a shallow, warm water form and widely distributed in the tropical seas of the Indo-West Pacific region and also occurring in the Caribbean Sea. Hence, it appears to be circumtropical.

In India : Gujarat; Tamil Nadu; Andamans and Nicobars.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Stephen, 1965 ; Murina, 1971c) ; Zanzibar (Stephen and Robertson, 1952); Madagascar (Cutler, 1965); False Bay, South Africa (Stephen and Cutler, 1969); Off south-east of South Africa (Cutler, 1977a); Gulf of Oman and Maldives (Stephen, 1941); Mergui (Selenka, 1887; Prashad, 1936); Malacca Strait (Cutler, 1977a); Singapore (Lanchester, 1905a); Western Australia and South Australia (Edmonds, 1980).

(b) *Pacific Ocean* : Billiton (Sluiter, 1886); Nusa-laut (Sluiter, 1902); Amboina (Selenka

and de Man, 1883; Augener, 1903); Banda Neira (Wesenberg-Lund, 1954a); Timor and Lyly Island (Selenka, de Man and Bullow, 1883); South China Sea (Murina, 1964b); China (Leroy, 1942); Hongkong (Prashad, 1936); Palao (Selenka, de Man and Bullow, 1883; Sato, 1935); Yap (Sato, 1935); New Britain (Shipley, 1899a); Solomon Islands (Leroy, 1936); Marshall Islands (in Edmonds, 1980); Wallis Island (Keferstein, 1865a; Baird, 1868); Marquesas (Fischer, 1922a); Pelew Islands (Fischer, 1895);Queensland (Monro, 1931; Edmonds, 1955, 1980; Gibbs, 1978); New South Wales (Augener, 1903); Victoria (Edmonds, 1980); Tasmania (Murina, 1978; Edmonds, 1980).

(c) *Atlantic Ocean* : Barbados (Selenka, de Man and Bullow, 1883); Antilles (Augener, 1906 in Murina, 1964b); Curacao (ten Broeke, 1925).

Sipunculus (Sipunculus) sp.
(Figs. 20, 60, 61)

Sipunculus inclusus : Haldar, 1977, *Newsl. zool. Surv. India,* 3 (3) : 120-123.

Material examined : 1 ex., Viper Island, South Andamans, "sand under coral stone", 1.i.1950, Coll. H.C. Ray; 1 ex., Panchabati, Rangat, Middle Andamans, 23.x.1972, Coll. S. Chakrapany; 1 ex., Peel Island near Havelock Island, South Andamans, 7. iv.1974, Coll. G.C. Rao; 1 ex., Corbyn's Cove, Port Blair, South Andamans, 8.iv.1982, Coll. M.K. Devroy.

Description : Trunk 80-88 mm long and 29-41 mm wide at posterior part of trunk; thick-skinned and gray to light pink in colour; cylindrical, rounded posteriorly and without papillae but surface dividing into numerous rectangular areas excepting glans region which is smooth. Introvert 18-31 mm long, about one-fourth to two-fifths of trunk length; almost half of it retracted inside, concolorous with trunk and provided with large number of subtriangular, scale-like papillae. Tentacular crown 5 mm long and divided into 5-6 lappets.

Longitudinal muscle layer grouped into separate, distinct and rarely anastomosing bands : 32-34 anteriorly, 34-36 in mid-trunk region, 38-39 posteriorly and in glans region. Circular muscle layer also dividing into separate bands. Both the muscle layers showing distinct banded nature even in glans region where longitudinal muscle bands non-splitted. Retractor muscles two pair and equally strong, arising from anterior fourth to fifth of trunk; ventrals from muscle bands 1-6 or 1-7, rarely 1-3 and dorsals from muscle bands 10-14 (10-15, 11-16); both pair remaining separate up to brain. Oesophagus moderately long, its anterior part attached to retractor muscles by mesenteries and with characteristic 'post-oesophageal loop' extending beyond mid-trunk level; intestinal coils 19-24 in number; rectum one-fifth to one-sixth of trunk length and with small round or oblong rectal caecum in its middle; anus lying between muscle bands 15 and 16 or 16 and 17, 'post-oesophageal loop', intestinal coils and rectum held in position by fine threads of connective tissue. Spindle muscle originating 1-3.5 mm anterior to anus from 16th or 17th muscle band and extending posteriorly up to 7th or 8th ascending coil from rectum. Racemose glands present. Nephridia one-fourth to one-fifth of trunk length, light brown to brown in colour, thick-walled and attached to body wall by one-sixth to two-fifths of their length; opening anterior to anus by one-eleventh to one-sixteenth of trunk length between muscle bands 4 and 5. Brain conspicuous with anteriodorsal digitate processes. Eggs spherical, double coated and measuring 0.14-0.20 mm in diameter.

Remarks : The anonymous species may be easily differentiated from *S. nudus* and *S. phalloides* by the higher and lower range of number of longitudinal muscle bands (32-39 *versus* 24-34 and 32-39 *versus* 35-41 respectively).

S. phalloides Pallans differs from the examined specimens by the absence of spindle muscle, rectal caecum and racemose glands (as reported by Keferstein, 1865a). Lack of spindle muscle in *S. galapagensis* Fisher and *S. multisulcatus* Fisher is supposed to be a conspicuous diagnostic feature to separate them from the specimens examined. Cutler and Cutler (1985) synonymised the latter two species with the former on the belief that they all had a weakly developed spindle muscle which was easily damaged and difficult to see. But in all the examined specimens spindle muscle is, so to say, well developed and can be seen on opening the body cavity. Further, Cutler and Cutler's (1985) analysis of *S. phalloides* reveals that the number of longitudinal muscle bands is 35-41, not 37-38 (Stephen and Edmonds, 1972).

The examined specimens differ from Sluiter's *S. inclusus* by the presence of racemose glands and partially attached nephridia. Though rectal caecum as stated by Sluiter (1902) and racemose glands were not observed in the type specimen of *S. inclusus* by Stephen and Edmonds (1972) but they assumed their presence at the time of first dissection.

Going through the description, Dr. E.B. Cutler hesitated to call these worms *S. inclusus* as they "do not have racemose glands" and remarked that they are closely related to *S. nudus* with "slightly larger number of muscle bands in the posterior end" However, the author feels that the anonymous species may be given subspecific status of *S. nudus* due to presence of spindle muscle, rectal caecum and racemose glands, attachment of nephridia (16-40%) and correlation between the total number of longitudinal muscle bands and ventral margin of dorsal retractors.

Previous Indian Records : Andamans (Haldar, 1977).

Distribution : This form was previously collected from coral sand of the reef area.

In India : Andamans.

Subgenus **Austrosiphon** Fisher

Xenosiphon (Austrosiphon) Fisher, 1954, *Ann. Mag. nat. Hist.*, (12) **7** (76) : 314.
Xenosiphon (Xenopsis) Johnson, 1969, *J. Bombay nat. Hist. Soc.*, **66** (1) : 44.
Sipunculus (Contraporus) Cutler and Cutler, 1985a, *Zool. J. Linn. Soc.*, **85** : 241.
Sipunculus (Austrosiphon) : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 49.

Diagnosis : Nephridia posterior to anus; spindle muscle arising from anterior ventral surface of rectum.

Type species : *Sipunculus mundanus* Selenka and Bulow, 1883.

Distribution : Indian and Pacific Oceans.

Remarks : Fisher (1954) created the subgenus *Austrosiphon* under the genus *Xenosiphon* to accommodate *Sipunculus mundanus*. Later Cutler and Cutler (1985a) erected a new subgenus *Contraporus* under the genus *Sipunculus* for *Sipunculus mundanus* and *S. indicus* in their revisionary work on the genera *Sipunculus* and *Xenosiphon*. They brought back the former species under *Sipunculus* again giving much weight on the characteristic features like parallel longitudinal coelomic canals and post-oesophageal loop which Fisher (1954) ignored. Very recently Gibbs and Cutler (1987) replaced *Contraporus* by *Austrosiphon* as it is senior available name. The subgenus is represented by two species of which one is known from this coast.

5. **Sipunculus (Austrosiphon) indicus** Peters
(Figs. 18, 19, 62, 63)

Sipunculus indicus Peters, 1850, *Arch. anat. physiol.*, **1850** : 382-383.
Sipunculus porrectus Selenka, 1887, *J. Linn. Soc.* (Zool.), **21** (130) : 221-222.
Sipunculus discrepans Sluiter, 1898, *Zool. Jb. Syst.*, **11** : 445-450.
Xenosiphon indicus Johnson, 1969, *J. Bombay nat. Hist. Soc.*, **66** (1) : 44-46, figs. 1-6
Sipunculus (Austrosiphon) indicus : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 49.

Type locality : Mozambique. *Location of type* : Zoological Museum, Humboldt University, East Berlin.

Material examined : 2 exs., Peel Island, South Andamans, 14.v.1978, "purchased from B. Biswas, a shell collector"; 7 exs., Minicoy, Lakshadweep, " sandy lagoon bed, about 0.3 m under water during lowtide", 13.xii.1979, Coll. Mahmmad Koya; 5 exs., Bangaram, Lakshadweep, "sandy lagoon bed, about 0.25 m under water during low tide", 7.iv.1984, Coll. B.P. Haldar with the help of Samsul Koya, a fisherman; 10 exs., Minicoy, Lakshadweep, " sandy bed in lagoon near lighthouse, under water during low tide", 18.ii.1986, "purchased from a fisherman"

Description : Trunk 240-450 mm long and 12.5-27 mm wide at anterior part of trunk, more or less uniformly cylindrical; glans region externally smooth with slight swelling and rounded tip in some but in others appearing as sharply truncated end; pink or pinkish-white in living state; thick-skinned, devoid of papillae and surface dividing into numerous square or rectangular areas. Introvert, mostly retracted inside, 10-26 mm long in fully expanded ones; covered with subtriangular, posteriorly directed scale-like papillae while a small region just behind the tentacular crown is smooth and devoid of any papillae. Tentacular membrane divided into six lappets and with large number of digitiform tentacles.

Longitudinal muscle layer being divided into distinct, rarely anastomosing bands: 36-38 at anal level, 42-44 in mid-trunk region and 39-42 at posterior end and in glans region of trunk. Circular muscle layer also divided into large number of separate bands but these bands fusing to form continuous layer in the glans region. Retractor muscles two pair, more or less equally strong, arising almost at the same level from anterior sixth to eighth of trunk length; ventrals originating from longitudinal muscle bands

2-4 or 3-5 and dorsals from 10-14 (11-14 or 12-14). Oesophagus very long attached anteriorly to retractor muscles by mesenteries and with characteristic "post-oesophageal loop"; intenstinal coils numerous extending up to posterior tip of trunk; rectum very long and with a tuberous rectal caecum nearly at the middle but closer to last intestinal coil; anal part of rectum attached to body wall by broad wing muscles; anal aperture transverse lying anterior end of trunk (2-3% of trunk-length); post-oesophageal loop, intestinal coil and rectum attached to body wall by thin strands of fibres. Spindle muscle arising from ventral wall of rectum more or less at the level of base of dorsal retractor muscles and running into intestinal coil. Contractile vessel paired and without villi, running nearly to post-oesophaegal loop. Nephridia long, about one-fourth to one-sixth of trunk-length, thin whitish tubular structure and more or less completely attached to body wall; opening posterior to anus about 1.5-3% of trunk-length between muscle bands 4-5 (5-6 or 6-7). Brain simple and without tufted organ. Eggs spherical, double coated and measuring 0.068-0.102 mm in diameter.

Remarks : The species may be easily recognised by its enormously large size and the absence of protractor muscle which separates it from other species of this subgenus and the position of nephridiopore (*i.e.*, posterior to anus) distinguishes it from other members of the subgenus *Sipunculus.*

In some of the specimens with fully expanded introvert, internal organs *i.e.*, retractor muscles are either detatched from introvert or from base, intestinal coils and nephridia are damaged.

This species, locally known as "Vemboloo", reported by Shipley (1903a) is used as bait to catch lagoon fishes. The presence of this worm in the lagoon bed is traced by locating two apertures (diameter bigger than lead pencil) in close approximation, one of them is straight and the other one is oblique and both of them are meeting together shortly down below. The collecting procedure is same as described by Shipley (1903a), Stephen and Robertson (1952) and Cutler (1965).

Johnson (1969) while describing *Xenosiphon (Xenopsis) indicus* from Minicoy, Lakshadweep, neither mentioned anywhere about the occurrence of other sipunculan species of the area as reported by Shipley (1903a) nor compared with any species of *Sipunculus* of Minicoy probably due to alleged presence of "ventral" protractor muscles. His fig.5 clearly shows that protractor muscles drawn from the specimen with fully withdrawn introvert, most probably these muscles are fully damaged in the other with well expanded introvert as already mentioned. Edmonds (1980) first pointed out that *S.indicus* of Western Australia reported by him resembles *Xenosiphon indicus* Johnson but without protractor muscles which in *Xenosiphon* are very small and dorsal but not ventral as stated by Johnson. Moreover, his description is similar in all respect to *S.indicus* excepting for the aforesaid character. Study of the three sets of collection (two from the type locality) from the Lakshadweep and one set from the Andamans leads the author to agree fully with Cutler and Cutler (1985) in reducing *Xenosiphon indicus* Johnson to the junior synonym of *Sipunculus indicus* Peters and turning subgenus *Xenopsis* of *Xenosiphon* null and void.

The length of introvert in relation to length of trunk as reported in the literature, if converted into percentage, is 10.6% (Selenka and de Man, 1883), 7% (Sluiter, 1886) 3.6-4.5% (Johnson, 1969), 5.5% (Edmonds, 1971) and 5-12% (Cutler and Cutler, 1985). The introvert is 7-10% of trunklength in the specimens studied. Similarly, number of longitudinal muscle bands show variation : 39-42 (Selenka

and de Man, 1883), 38-40 and 37 (Sato, 1935; 1939), 32-37 (Murina, 1964b), 40-45 (Johnson, 1969), 38-42 and 37-42 (Edmonds, 1971; 1980) and 37-43 (Cutler and Cutler, 1985). In this respect 36-44 longitudinal muscle bands lie within the range. One specimen from Bangaram, Lakshadweep, shows still lower range 32-35 as in Murina (1964b).

Absence of rectal caecum was noted by Sato (1939) and Murina (1964b) while its presence was reported by Sluiter (1886), Sato (1935), Johnson (1969), Stephen and Edmonds (1972), Edmonds (1980), and Cutler and Cutler (1985). Others either did not mention anything about caecum or stated internal organs damaged. Rectal caecum can not be easily seen especially in damaged specimens (Cutler and Cutler, 1985a). Numerous small villi on contractile vessel, as stated by Stephen and Edmonds (1972) in a specimen from Andaman Island, have not been presently observed.

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a; Johnson, 1969); Andamans (Stephen and Edmonds, 1972).

Distribution : This is an Indo-west Pacific shallow water species preferring clean coralline sandy bed from mid-tide to low-water level.

In India : Lakshadweep; Andamans.

Elsewhere :

(a) *Indian Ocean* : Pemba Island (Lanchester, 1905b); Zanzibar (Fischer, 1892; Stephen and Robertson, 1952) ; Mozambique (Peters, 1850; Keferstein, 1865a; Baird, 1868; Selenka and de Man, 1883; Fischer, 1895; Augener, 1903); South Africa (Sluiter, 1898); Cape Province (Wesenberg-Lund, 1963); Madagascar (Hammarstein, 1915; Cutler, 1965; Cutler and Cutler, 1979a); Mergui Archipelago (Selenka, 1885; Prashad, 1936); Western Australia (Edmonds, 1980).

(b) *Pacific Ocean* : Billiton (Sluiter, 1886, 1891, 1898, 1902; Fischer, 1913, 1914b); South China Sea (Leroy, 1942; Murina, 1964b); Formosa (Sato, 1939); Guam (Edmonds, 1971); West Caroline Islands (Selenka and de Man, 1883; Sato, 1935; Cutler and Cutler, 1985a); Coral Sea (Edmonds, 1980).

Genus **Siphonosoma** Spengel

Siphonosoma Spengel, 1912, *Verh. dt. zool. Ges.*, **22** : 264.
Siphonosoma : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 49-50

Diagnosis : Introvert shorter than trunk having papillae and sometimes also hooks arranged in rings; tentacles usually numerous and arranged around mouth; coelomic canals present in the body wall; circular and longitudinal muscle layers divided into anastomosing bands; retractor muscles two pair; contractile vessel single and with or without villi; spindle muscle attached both anteriorly (sometimes with three roots) and posteriorly; with paired nephridia.

Type species : Phascolosoma australe Keferstein.

Distribution : All oceans, tropical and subtropical.

Remarks : Cutler and Cutler (1982) proposed that this genus does not require any subgeneric division as recognised by Fisher (1950b) and followed by Stephen and Edmonds (1972). They regarded ten valid species instead of twenty-two (Stephen and Edmonds, 1972). Following Cutler and Cutler (1982) it can be inferred that four species including one new record from the Indian ocean are presently known from the Indian coast, of which only one species is widely distributed.

Key to species of the genus **Siphonosoma** known from the Indian coast

1.	Introvert with hooks or scale-like papillae aranged in rows	...	2
	Introvert without hooks or scale-like papillae	...	*S. cumanense* (Keferstein)
2.	Rectum with numerous accessory caeca	...	*S. vastum* (Selenka and Bulow)
	Rectum without accessory caeca	...	3
3.	Introvert with long and pointed hooks	...	*S. australe* (Keferstein)
	Introvert with short and blunt hooks	...	*S. rotumanum* (Shipley)

Siphonosoma australe (Keferstein)
(Figs. 21, 64-70)

Phascolosoma australe Keferstein, 1865b, *Nachr. Ges. Wiss. Gittingen*, No.7 : 197-198
Sipunculus (Phascolosomum) australis: Quatrefages, 1865b, *Historie naturelle des Anneles et d'eau douce.* Paris, **2** : 619.
Sipunculus aeneus Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 81
Phascolosoma australe : Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 81
Spinuculus australis : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) 4 (1) : 90-91, pl. 13, figs. 180-182.
Siphonosoma australis : Spengel, 1912, *Verh. dt. Zool. Ges.* **22** : 263
Siphonosoma australe : Prashad, 1936, *Rec. Indian Mus.*, **38** : 237-238, pl.9, figs. 4-6.
Siphonosoma sp. : Haldar and Rao, 1975, *Ind. J. Zoot.*, **16** (3) : 179-180, pl.1.
Siphonosoma australe : Cutler and Cutler, 1982, *Proc. biol. Soc. Wash.*, **95** (4) : 754, fig. 1C.

Type locality : Sydney, New South Wales, Australia. *Location of type* : Not known.

Material examined : 1 ex., Digha, West Bengal, "sandy mud, at the mouth of Champa River", 15.ii.1964, Coll. A.K.Datta; 1 ex., Rameswaram Island, Gulf of Mannar, Tamil Nadu "muddy sand", 15.ii.1973, Coll. K.V.Rama Rao; 1 ex., Locality data same as above, 1.iii.1974, Coll. B.P.Haldar; 2 exs., Southern Lighter Channel, Visakhapatnam Harbour, Andhra Pradesh, 12.ix.1983, Coll.B.V.S.S.R. Subba Rao (Andhra University, Waltair).

Description : Trunk 140-147 mm long, posteriorly with prominent annular rings, thick, opaque-skinned, brown to dark brown in colour. Introvert, 65-211 mm long, armed with 34-52 rows of hooks large, slightly curved, more or less pointed, dark-brown in colour, 0.25-0.35 mm long and 0.08-0.13 mm wide at base. Tentacles 90-100 in number, long, slender and measuring 0.6-1.3 mm in length.

Papillae whitish, uniformly distributed over the body, smaller in size and circular in surface view in mid-trunk region whereas more prominent and dome-shaped at posterior end; the diameter being 0.37-0.46 mm; whereas at the introvert the diameter of the papillae being 0.04-0.06 mm and in between hook rows papillae circular, mesuring 0.020-0.018 mm in diameter.

Longitudinal muscles in 14-19 bands, anastomosing occasionally. Circular muscles also separated into anastomosing bands. Retractor muscles two pair (dorsal and ventral), originating from different levels, ventral pair stouter, arising from posterior edge of anterior third to fourth of trunk from muscles 1-3, while dorsal pair slender arising from anterior tenth or eleventh of trunk from muscles 4-6, both these muscles of one side uniting anteriorly. Oesophagus being attached to united retractor muscles. Contractile vessel simple, running along dorsal surface of oesophagus up to first intestinal coil. Intestinal tract having 58-67 coils, rectum 40-55 mm long, and usually with a small oblong caecum but without accessory caeca; anal part of rectum held in position by well developed wing muscles; anal aperture in between muscles 7-8 about 5-6 mm behind nephridiopores. Spindle muscle arising anteriorly by three roots and anchoring intestinal coil posteriorly; its first root, 8-10 mm anterior to anus, arising from muscle 8; other two from muscle 7 at the same level of the base of dorsal retractors, these three roots meet near rectal caecum. Fixing muscle single, originating by two roots, 12-15 mm behind base of dorsal retractors and attached to rectum at its beginning, a little below caecum. Nephridia brown, about one-fourth as long as trunk, attached about one-tenth of their length anteriorly and opening on muscle 2 or between 3 and 4. Coelomic papillae in front of nephrostomes and 'Keferstein bodies' (in anterior and posterior part of trunk respectively) present but without any transverse dissepiment.

Remarks : This species may be readily distinguished from other Indian species of this genus by the presence of rather long, dark brown hooks, simple contractile vessel and by the absence of "accessory rectal caeca". Present record shows the extension of range of distribution towards north along the east coast.

Besides the present collection the author recorded this species for the first time from the insular region (Long Island, Middle Andamans) of the Indian subcontinent (Haldar, 1976). He also examined *S.australe* collected and reported by Gravely (1927) from the Gulf of Mannar. The aforesaid material was identified by Prashad who redescribed the same in 1936. After careful examination it was noted that the total length of the specimen differed from the description given by Prashad (1936).

On careful re-examination of introvert hooks, contractile vessel and other internal anatomy of *Siphonosoma* sp. - a giant sipunculan from Rameswaram, Tamil Nadu, reported by Haldar and Rao (1975) together with further collections and comparing with the specimens of *S.australe* from the Krusadai Island (Gravely, 1927) and other places of the Indian coast it is found that the anonymous *Siphonosoma* as stated above belongs to *S.australe*. Further, the alleged "villi" on the contractile vessel are due to folded nature of tubular contractile vessel.

Previous Indian Records : Krusadai Island, Gulf of Mannar (Gravely, 1927; Prashad, 1936); Long Island, Middle Andamans (Haldar, 1976); Visakhapatnam Harbour, Andhra Pradesh (Ganapati and Subba Rao, 1970).

Distribution : This is a warm water but generally shallow water species of the Indian and West Pacific Ocean.

In India : Gulf of Mannar and Rameswaram, Tamil Nadu; Visakhapatnam Harbour, Andhra Pradesh; Digha, West Bengal; Long Island, Middle Andamans.

Elsewhere :

(a) *Indian Ocean* : Zanzibar (Lanchester, 1905b; Stephen and Robertson, 1952), Durban and Koshy Bay (Wesenberg-Lund, 1963); Madagascar (Cutler, 1965; Cutler and Cutler, 1979a); Malay (Lanchester, 1905c).

(b) *Pacific Ocean* : Yap Island, West Caroline Island (Sato, 1935) Formosa (Sato, 1939); Philippines (Selenka and de Man, 1883; Ikeda, 1905) ; Society Island (Augener, 1903); Fiji (Selenka and de Man, 1883; Fischer, 1922a); Samoa (Fischer, 1922b; Fisher, 1950b); New Britain (Fischer, 1926a); Solomon Island (in Edmonds, 1980); Loyalty Island (Shipley, 1902); Sydney, New South Wales (Keferstein, 1865b; Baird, 1868; Augener, 1903); Tasman Sea (Cutler, 1977a); New Zealand (Baird 1868; Edmonds, 1961).

7. **Siphonosoma cumanense** (Keferstein)
(Figs. 22, 71-76)

Lumbricus edulis Pallas, 1774, *Spicilegia Zoologica*, Berolini, (1), **10** : 10-12.
Phascolosoma cumanense Keferstein, 1867, *Z. wiss. zool.*, **17** : 53-55, pl.6, figs. 19-21.
Phascolosoma semirugosum Grube, 1868a, *Verh. zool.-bot. Ges. Wien*, **18** : 641.
Sipunculus deformis Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 80-81, pl.9, fig. 2
Sipunculus cumanensis : Selenka, de Man and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) 4 (1) : 104-107, pl.12 figs. 172-173.
Sipunculus billitonensis Sluiter, 1886, *Natuurk. Tijdschr. Ned. Indie*, **43** : 487-488, pl.3, figs. 1-2.
Sipunculus claviger Sluiter, 1902, *Siboga Exped.*, **25** : 7-8, pl.1, fig. 1-2.
Siphonosoma edule : Spengel, 1912, *Verh. dt. zool. Ges.*, **22** : 263.
Siphonosoma cumanense : Spengel, 1912, *Verh. dt. zool. Ges.*, **22** : 263.
Sipunculus novaepommeraniae Fischer, 1926a, *Mitt. zool. Stlnst. Hamb.*, 42 : 104-106, pl.3, figs. 2-4,6.
Siphonosoma caroliense Fischer, 1928, *Zool. Anz.*, **76** : 138-140.
Siphonosoma hataii Sato, 1935, *Sci. Rep. Tohoku Univ.*, (4) **10** : 305-308, pl.3, fig. 7, text-figs. 3-7.
Siphonsoma formosa Sato, 1939, *Sci. Rep. Tohoku Univ.*,(4)**14** : 375-376, pl.20, fig.7,text-figs.14-17
Siphonosoma marchadi Stephen, 1960a, *Bull. Inst. fr. Afr. Noire*, **22** A (2) : 515-516.
Siphonosoma cumanense : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.* **29** (4/6) : 258-260, pl.1 fig. 1.

Type locality : Cumana, Venezuela. *Location of type* : Not known.

Material examined : 1 ex., Long Island, Middle Andamans, "under stones", 14.i.1962, Coll. K.K.Tiwari; 3 exs., Galathea river entrance, Great Nicobar, 14.iv.1966, Coll. A. Daniel; 7 exs., East of Burmese Temple, Mayabunder, North Andamans, "near the shore in coral sand", 13.x.1972, Coll. B. P. Haldar; 1 ex., Cape Comorin, Tamil Nadu, 7.xii.1973, Coll. K.V. Rama Rao; 2 exs., Nancowry, Nicobars, 24.i.1976, Coll. D.R.K. Sastry; 4 exs., Port Okha, Gujarat, "low water mark, in sand", 9.iv.1977, Coll. B.P. Haldar; 6 exs., Diu, Union Territory, "in sand under stones", 26.i.1978, Coll. B.P. Haldar; 9 exs., Neil Island, South Andamans, "intertidal, pebble beach, sand", 5.v.1978, Coll. B.P. Haldar; 7 exs., Minicoy, Lakshadweep, "coral reef edge; in sand with coral block", 12.xii.1979, Coll. B.P. Haldar ; 12 exs., Kavaratti, Lakshadweep, "from dredged material of lagoon bottom heaped on shore", 30.iii.1984, Coll. B.P. Haldar.

Description : Trunk 70-240 mm in length and 8-18 mm in width, slender and cylindrical, thick-skinned and opaque; brown or pinkish brown in colour. Introvert 20-40 mm long when fully everted, without hooks or spines. Tentacles 22-50 in number, small and digitiform.

Papillae varying considerably in size and appearance; those on introvert base and at posterior end of trunk tall and large 0.15-0.25 mm and 0.08-0.15 mm in height and 0.25-0.40 mm and 0.15-0.30 mm in width respectively; those in the middle region of trunk and anterior region of introvert small, almost flat and circular, 0.02-0.06 mm and 0.06-0.08 mm in height and 0.01-0.03 mm and 0.07-0.09 mm in width respectively. Papillae on the remaining part of body dark, much smaller and flat, each with a minute pore.

Longitudinal muscles seperated into 18-23 (usually 19-21) bands anastomosing only slightly, in some cases anastomosis absent. These muscle bands uniting to form thin, continuous lustrous sheet in the anterior part of introvert. Circular muscle layer gathered into anastomosing bands. Retractor muscle two pair, originating more or less at same level from anterior fourth of trunk, ventrals from 1-3 (2-3, 2-4) and dorsals from 6-7 (6-8, 7-9). The dorsal and ventral of each side uniting in front and the two lateral muscles thus formed remain separated from each other; parts of the united retractors always longer than the remaining separate portions. Anterior part of oesophagus attached by a thin membrane to dorsal edge of united retractors. Intestine long, 21-78 coils extending nearly to posterior end of trunk in most specimens; rectum held in position by broad and well developed wing muscles, rectal caecum prominent, tuberous and placed at anterior part of rectum; anal opening 1-2 mm behind nephridiopores between muscle 10 and 11. Spindle muscle stout, arising anteriorly by three roots - one anterior to anus from muscle 10 and other two from muscle 8 or 9 at the level or in front of bases of dorsal retractors, all these three uniting together at the beginning of rectum, spindle muscle anchoring the intestinal coil posteriorly. Fixing muscles two, originating from muscle 1 on either side of nerve cord a little posterior to bases of ventral retractors and are attached to last coil of intestine. Contractile vessel with numerous short villi extending along oesophagus up to first intestinal coil. Transverse dissepiments numerous, crescent-shaped and occurring only in large specimens on each side of nerve cord between bases of retractors and posterior extremity of trunk. Nephridia long, slender, brown or brownish-yellow or dusty-red; their anterior one-third to one-fifth attached to body wall and extending up to level of retractor bases or behind. Nephridiopores lying between muscles 2 and 3 or 3 and 4. Coelomic papillae about 1 mm tall arranged on the walls of muscles 1-6 just anterior to nephrostomes. Oval bodies, 1-1.5 mm in diameter, either attached to longitudinal muscles or lying in between them. Gonads at the

base of ventral retractors. Eggs relatively few, large, white and opaque in the body cavity of some specimens and measuring 0.57 mm in diameter.

Remarks : This species may be easily differentiated from the other three species known from this coast by the origin of retractor muscles at the same level and by the absence of hooks or scale-like papillae on introvert.

The number, height and distributional pattern of transverse dessepiments vary from specimen to specimen irrespective of sizes. Absence of transverse dissepiments in small specimens correlates the observation of Cutler and Cutler (1979a). All the specimens from the Lakshadweep are reddish brown in colour, with thick and opaque skin but majority with retracted introvert. Some specimens from the Andaman and Nicobar Islands are like those of the Lakshadweep but others are colourless, thin and with more or less translucent skin and some of them strongly contracted like a string of beads.

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a); Port Okha, Gujarat; Aberdeen Bay and Havelock Island, South Andamans; Nancowry Harbour, Nicobars (Haldar, 1975); Tamil Nadu : Mandapam Camp (Haldar, 1975) and Rameswaram (Haldar and Rao, 1975).

Distribution: Widespread in tropical Indian Ocean and West Pacific Ocean and rare in Western Atlantic Ocean. It is usually found in intertidal and shallow water.

In India : Gujarat; Diu; Lakshadweep; Tamil Nadu; North, Middle and South Andamans; Nancowry and Great Nicobars.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Selenka and de Man, 1883; Grube, 1868a; Augener, 1903; Leroy, 1936); Gulf of Aqaba (Stephen, 1952; Wesenberg-Lund, 1957b); Gulf of Aden (Herubel, 1904b); Gulf of Oman (Stephen, 1941); Somali Coast (Murina, 1981b); Zanzibar (Fischer, 1892; Lanchester, 1905b; Stephen and Robertson, 1952); Mozambique (Selenka and de Man, 1883; Wesenberg-Lund, 1963; Cutler and Cutler, 1979a); South Africa (Sluiter, 1898); Madagascar (Herubel, 1908; Hammarstein, 1915; Cutler, 1965; Cutler and Cutler, 1979a) Mauritius (Selenka and de Man, 1883; Wesenberg-Lund, 1959b; Stephen, unpublished, in Cutler and Cutler, 1982); Diego Garcia (Cutler and Cutler, 1979a); Maldive Islands (Shipley, 1903a; Stephen, 1941); Bay of Bengal (in Wesenberg-Lund, 1954a); Malay Archipelago (Sluiter, 1886); west coast of Sumatra and south coast of Java (Fischer, 1922a); Penang and Singapore (Lanchester, 1905a,c); Western Australia (Fischer, 1921; Edmonds, 1955, 1980).

(b) *Pacific Ocean* : Java (Baird, 1868; Sluiter, 1882, 1886, 1891); Billiton (Sluiter, 1891); Damar Island, Sailus Ketjil, Waigeu Island, Sanguisiapo, Lucipara, Sapeh Bay (Sluiter, 1902); Amboina (Sluiter, 1902; Augener, 1903); Thailand (Baird, 1868); Indochina (Leroy, 1942); Philippines (Selenka and de Man, 1883; Augener, 1903; Cutler, 1977a); Formosa (Sato, 1939); Riukiu Island (Ikeda, 1904; Sato, 1939); Guam (Edmonds, 1971); West Caroline Islands (Fischer, 1928; Sato, 1935 and 1939); Japan (Ikeda, 1904; Sato, 1934a, 1937a, 1939; Cutler, Cutler and Nishikawa, 1984); Korea (Sato, 1937b, 1939); New Guinea (Leroy, 1936); Tahiti (Wesenberg-Lund, 1954b); Loyalty Island (Shipley, 1899a); Solomon Island (Shipley, 1899a); Christmas Island (Shipley, 1899b); New Britain

(Shipley, 1899a; Fischer, 1926a); Coral Sea (Cutler, 1977a); Great Barrier Reef (Monro, 1931; Gibbs, 1978b); Queensland (Baird, 1868; Edmonds, 1955, 1980); New South Wales (Edmonds, 1955, 1980).

(c) *Atlantic Ocean* : Florida (Shipley, 1899a; Augener, 1903; Gerould, 1913); Cumana, Venezuela (Keferstein, 1867; Baird, 1868; Selenka and de Man, 1883); St. Berthelemy (Fischer, 1922a); Cuba (Murina, 1967a).

8. **Siphonosoma rotumanum** (Shipley)
(Figs. 81-84)

Sipunculus rotumanus Shipley, 1898, *Proc. zool. Soc. Lond.*, **1898** : 469-470, pl. 37, figs. 1-3.
Siphonosoma eniwetoki Fisher, 1950b, *Ann. Mag. nat. Hist.*, (12) **3** (33) : 805-808, pl.1, figs. 1-5.
Siphonosoma hawaiense Edmonds, 1966b, Pacif. Sci., **20** (3) : 386-388, figs. 1-4.
Siphonosoma rotumanum : Edmonds, 1971 *Micronesica*, **7** (1-2) : 143-144.
Siphonosoma rotumanum : Cutler and Cutler, 1982, *Proc. biol. Soc. Wash.*, **95** (4) : 758-759, fig. 1D.

Type locality : Rotuma. *Location of types* : (a) British Museum (Natural History), London, (b) Zoological Museum, Hamburg.

Material examined : 2 exs., Baruva, Srikakulum, Andhra Pradesh, "from coarse wet sand at the edge of pool in western part of backwater", 1.ii.1939, Coll. B.N. Chopra.

Description : Trunk 35-40 mm in length and 8 mm in width; cylindrical, gray in colour, thin-skinned and almost transparent. Introvert partially retracted and about 30-31 mm in length. Tentacles 15-18 in number, small and filiform. Hooks in 38-41 rows, blunt, grayish white with deep gray border and measuring 0.2-0.3 mm in height and 0.10-0.15 mm in width at base.

Papillae two types—small measuring 0.02-0.03 mm x 0.016-0.020 mm and large measuring 0.18-0.22 mm in diameter; small papillae arranged in rows, closely associated with hooks and large ones placed at introvert base while mixed ones found on the intermediate zone of introvert; small papillae sparsely distributed on the trunk while large ones found on posterior part of trunk.

Longitudinal muscle layer externally visible and grouped into 15-19 infrequently anastomosing bands; these bands weak, flat ribbon-like in anterior half but with prominent ridges in posterior half. Circular muscle layer arranged in anastomosing bands. Retractor muscles two pair and equally strong; long ventrals arising from muscle bands 1-3 or 2-4 from posterior edge of anterior third of trunk while short dorsals arising more anteriorly from muscle bands 3-5; dorsal and ventral of each side fusing anteriorly on the midway. Oesophagus moderately long, thick tube, anterior half attached to fused retractor units; intestinal coil 32-34 in number; rectum short and with a small rectal caecum but without accessory caeca. Spindle muscle attached posteriorly and arising anteriorly by three roots anterior one from muscle band 7 at the same level as nephridiopores and lateral ones from muscle band 5 on either side of nerve cord near the base of dorsal retractor muscles. Fixing muscle single, arising from last intestinal coil and attached to muscle band 1 midway between the base of left dorsal surface of oesophagus extending up to first intestinal coil. Nephridia very short, grayish white, free from body wall and opening slightly in front of anus between muscle band 2 and 3. Without coelomic papillae

and transverse dissepiments but with Keferstein bodies measuring 0.1-0.3 mm in diameter in the anterior region of the body.

Remarks : The species may be easily recognised from the other three congeners known from this coast by the presence of short blunt hooks simple contractile vessel and by the absence of numerous caeca on the rectum.

The specimens agree with the short description of Shipley (1898) except the number of tentacles and also with the supplementary description of Shipley's identified specimens at British Museum by Stephen and Edmonds (1972). Compressed transparent papillae as referred to by Fisher (1950b, Cp of fig.3) and coelomic papillae or tufted bodies by Edmonds (1966b, 1980) are absent in the present specimens. Number of fixing muscle varies as described by Fisher (1950b) and Edmonds (1966b, 1971, 1980) but the re-examined type specimen has only one (Stephen and Edmonds, 1972). Shipley while describing this species mentioned blackish papillae closely and regularly arranged in rows on the proboscis without mentioning spines / hooks in this region. The said structures were established as hooks on re-examining Shipley's specimens by Stephen and Edmonds (1972) and, Cutler and Cutler (1982). As a result of clearance of this confusion *S. hawaiense* Edmonds and *S. eniwetoki* Fisher were turned into junior synonyms of *S. rotumanum* by Edmonds (1971), and Cutler and Cutler (1982) respectively.

Previous Indian Records : None.

Distribution : This species is a tropical intertidal form and especially belongs to the south-western Pacific Ocean. Once only it is reported from sourthern Atlantic Ocean (Chirste and Cutler, 1974). So, the present finding is somewhat significant but not an unusual one.

In India : Andhra Pradesh.

Elsewhere :

(a) *Pacific Ocean* : Queensland (Gibbs, 1978b; Edmonds, 1980); Hawaii (Edmonds, 1966b); Guam (Edmonds, 1971); Rotuma (Shipley, 1898; Edmonds, 1980); Solomon Islands (in Edmonds, 1980); Marshall Islands (Fisher, 1950b).

(b) *Atlantic Ocean* : False Bay, South Africa (Christe and Cutler, 1974).

9. **Siphonosoma vastum** (Selenka and Bulow) (Figs. 77-80)

Sipunculus vastus Selenka and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 103-104, Pl. 12, fig. 171, pl. 13, fig. 179.
Siphonosoma crassum Spengel in Fischer, 1919a, *Zool. Anz.*, **50** : 279
Siphonosoma vastus : Wesenberg-Lund, 1937c, *Bull. Mus. R. Hist. nat. Belg.*, **13** (36) : 2-5; figs. 1-2.
Siphonosoma parvum : Cutler and Cutler, 1982, *Proc. biol. Soc. Wash.*, **95** (4) : 752-753.
Siphonosoma vastum : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 151-152.

Type locality : Jaluit (Marshall Is. Pacific Ocean). *Location of types* : Zoological Museum, Humboldt University, East Berlin.

Material examined: 1 ex., eastern side of jetty, Mayabunder, North Andamans, 13.x.1972, Coll. S. Chakrapany; 1 ex., East Bay, Catchal, Nicobars, "in shallow water under rocks", 28.i.1976, Coll. D.R.K. Sastry; 1 ex., Bay jetty, Rangat, Middle Andamans, "from sandpool" , 4 .iii. 1980, Coll. B.P.Haldar.

Description: Trunk of the largest specimen 85 mm long and 20 mm wide while the smallest one 20.5 mm long and 14 mm wide at posterior end of trunk; cylindrical, whitish to light yellowish brown in colour. Introvert, partially retracted in all, 13-38 mm long. Tentacles numerous, slender and filiform; each 0.5-1.5 mm long. Hooks in 15-50 rows, brownish, blunt and curved; measuring 0.1-0.15 mm in height and 0.16-0.22 mm in width at base.

Papillae between rows of hooks white, round and arranged in rows; at base of introvert dome-shaped and 0.2 mm in height; on the trunk papillae pale white, oval-shaped, measuring 0.4 mm x 0.3 mm and arranged irregularly.

Longitudinal muscle layer gathered into 19-24 anastomosing bands. Circular muscle layer also forming anastomosing bands. Retractor muscles two pair; stouter ventral arising from posterior edge of anterior half of trunk from muscle bands 1-5 or 6 (2-6 or 7) whereas weaker dorsal pair anterior to ventral one arising from muscles 8-9 or 10; both these muscles united anteriorly. Oesophagus attached to united retractor muscles. Contractile vessel with numerous bulbous vesicles running along dorsal surface of oesophagus. Intestinal coils 19-30 in number, connected with one another by fine ligaments. Rectum 7-13 mm long, and with single large, round, custard apple-like caecum, 2-4 mm in diameter at its proximal part; numerous, unbranched, whitish, finger-like projections "accessory caeca" which are 2 to 3 mm long, cover nearly the whole rectum; the uncovered last part of rectum held firmly by well developed wing muscles. Spindle muscle stout, arising anteriorly by three roots from muscle 10 -- one anterior to anus and two other (s_1 and s_2) on either side of nerve cord anterior to dorsal retractor muscles and all these meet together near the caecum and anchored posteriorly. Fixing muscle single, arising from second intestinal coil and attached to muscle 6 in between right dorsal retractor and right lateral root of spindle muscle (s_2); an additional fixing muscle, as found in the specimen from Rangat, Middle Andamans, arising form the rectum behind the caecum and bifurcating for being attached to muscle 1 on either side of nerve cord. Nephridia brown, thin-walled and slender; about a half to one-third the length of trunk; attached to the body wall along a half to two-thirds of their length and opening between muscle 2 and 3 or 3 and 4 at the level of anus; nephrostomes prominent and semilunar. Coelomic papillae present only in the specimen from Rangat. "Keferstein bodies" and transverse dissepiments absent.

Remarks : The species may readily be recognised by the presence of rings of brownish, blunt and curved introvert hooks, numerous "accessory caeca" and large rectal caecum.

In addition to the present collection the author recorded this species for the first time from South Andamans (Haldar, 1975). It may be pointed out here that the species was originally described by

Selenka and Bulow (1883) but Edmonds (1980) mentioned Selenka and de Man as the authors of the species, whereas Cutler and Cutler (1982), and Cutler, Cutler and Nishikawa (1984) mentioned Selenka, de Man and Bulow as the authors of the concerned species. The author reserves his comment in this regard. Furthermore, the latter authors reported the absence of distrinct contractile vessel villi which are observed by Wesenberg-Lund (1937c) and Edmonds (1955, 1980).

Previous Indian records : Minicoy, Lakshadweep (Shipley, 1903a); Macpherson's Strait, Baratong, South Andamans (Haldar, 1975).

Distribution : This is a tropical shallow water form of the Indian and West Pacific Oceans.

In India : North, South and Middle Andamans; Nicobars and Lakshadweep.

Elsewhere :

(a) *Indian Ocean* : Somali coast (Murina, 1981b); Zanzibar and Mozambique (in Murina, 1981b) ; Kenya, Madagascar and Diego Garcia (Cutler and Cutler, 1979a); Mauritius (Selenka and Bulow, 1883); Maldive Islands (Shipley, 1903a); Recif Polo Kalappa, Indonesia (Wesenberg-Lund, 1937c); Western Australia : Shark Bay (Fischer, 1919a, 1926b), Point Cloates (Edmonds, 1980).

(b) *Pacific Ocean* : Japan (Cutler, Cutler and Nishikawa, 1984); Amboina (Augener, 1903); Rotuma and Funafuti (Shipley, 1898); Pigeon Is., New Britain; Lifu, Loyalty Is. and Isles of Pines, New Caledonia (Shipley, 1902); Queensland : Outer Barrier Reef (Edmonds, 1955) and Heron Island (Edmonds, 1980); Marshall Is., Jaluit (Selenka and Bulow, 1883; Fischer, 1928; Cutler and Cutler, 1979a).; Guam (Edmonds, 1971); Solomon Is. (in Edmonds, 1980).

Order **GOLFINGIIFORMES** Cutler and Gibbs

Golfingiaformes Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 167
Golfingiiformes Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 50.

Diagnosis : Longitudinal muscle layer of body wall continuous, not divided into bands.

Key to families of **Golfingiiformes** known from the Indian coast

Tentacles borne on stem-like extensions of oral disc ... Themistidae Cutler and Gibbs

Tentacles not borne on stem-like extensions of oral disc ... Golfingiidae Stephen and Edmonds

Family **GOLFINGIIDAE** Stephen and Edmonds

Sipunculidae Baird, 1868, *Proc. zool. Soc. Lond.* ,**1868** : 77 (in part).
Golfingiidae Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 77.

Golfingiidae : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.* (Zool.), **52** (1) : 50.

Diagnosis : Tentacles surround the mouth but not borne on stem-like extensions; with paired nephridia; contractile vessel usually without villi.

Type genus : *Golfingia* Lankester, 1885.

Distribution : All oceans including Arctic and Antarctic.

Remarks : Stephen and Edmonds (1972) included five genera under this family. Meanwhile, Gibbs, Cutler and Cutler (1983) elevated the subgenus *Thysanocardia* of genus *Golfingia* to the generic rank. Thus, the total number of genera under this family became six. Very recently three have been removed to two other families by Gibbs and Cutler (1987). Therefore, at present, there are three genera known from the world under this family, of which only one, viz., *Nephasoma* has so far been recorded from the Indian coast.

Genus **Nephasoma** Pergament

Nephasoma Pergament, 1946, *Trans. of the Drifting Expedition of the Main Northern Passage on the Ice-breaker Steamship G . Sedov 1939-1940*, **3** : 189.
Golfingia (Phascoloides) Fisher, 1950a, *Ann. Mag. Nat. Hist.*, (12) **3** (30) : 550.
Nephasoma : Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura*. Trustees of the British Museum (Natural History), London : 214.
Golfingia (Nephasoma) Cutler and Murina, 1977, *Zool. J. Linn. Soc.*, **60** (2) : 184.
Golfingia (Nephasoma) : Murina, 1977, *Opredeliteli po faune SSSR, Acad. Nauk SSSR*, Lenningrad, **111** : 180.
Nephasoma : Cutler and Cutler, 1986, *Proc. biol. Soc. Wash*, **99** (4) : 548.

Diagnosis : Introvert almost equal to, or shorter than trunk; hooks, when present, usually scattered; tentacles may be reduced both in size and number and restricted to dorsal region; retractor muscle single pair, often partially fused; contractile vessel simple and without villi; spindle muscle not attached posteriorly; with paired nephridia.

Type species : *Nephasoma marinki* Pergament, 1946.

Distribution : Widely distributed.

Remarks : The genus presently includes all those species which were earlier placed under *Golfingia (Phascoloides)* Fisher (1950a). Both Murina (1977) and, Cutler and Murina (1977) replaced *Phascoloides* Fisher (1950a) by *Nephasoma* Pergament (1946) as Fisher (1950a) included *G. glacialis* in his *Golfingia (Phascoloides)* which was shown to be conspecific with *Nephasoma marinki* by Cutler and Murina (1977). So *Nephasoma* Pergament has priority over *Phascoloides* Fisher.

Though the genus contains 23 species but only three species are so far known from the Indian coast.

Key to species of the genus **Nephasoma** known from the Indian coast.

1.	With hooks on introvert	...	*N. pellucidum* (Keferstein)
	Without hooks on introvert	...	2
2.	Nephridia opening in front of anus	...	*N. rutilofuscum* (Fischer)
	Nephridia opening posterior to anus	...	*N. filiforme* (Sluiter)

10. **Nephasoma filiforme** (Sluiter)

Phascolosoma filiforme Sluiter, 1902, *Siboga Exped.*, **25** : 37-38, Pl. 4, figs. 1-4.
Phascolosoma mucidum Sluiter, 1902, *Siboga Exped.*, **25** : 40
Golfingia (Phascoloides) filiformis : Fisher, 1950a, *Ann. Mag. nat. Hist.* (12) **3** (30) : 551.
Nephasoma filiforme : Cutler and Cutler, 1986, *Proc. biol. Soc. Wash.*, **99** (4) : 560.

Type locality : Banda Sea, 5°46'.7 S, 134°0' E, at 1788 m. *Location of types* : Zoological Museum, University of Amsterdam.

Material examined : None

Description : Trunk 17-40 mm long, skin thin and transparent in mid-trunk region but thick and opaque at anterior and posterior ends of trunk. Introvert 13-30 mm long and without hooks but with numerous filiform tentacles surrounding the mouth. Papillae covering whole body but not similar everywhere; at anterior and posterior ends of trunk these are tuft-like measuring 0.085 mm in height very similar to those found in *Golfingia semperi* and becoming gradually smaller towards introvert. Papillae of the aforesaid type absent in transparent mid-trunk region where these are of different sizes, broad and conical with dark brown base and lighter coloured tip having gland orifice.

Longitudinal muscle layer not separated into bands and specially thin in mid-trunk region. Retractor muscles single pair, not very strong and arising from posterior end of trunk *i.e.*, anterior edge of posterior eighth of trunk length, in mid-trunk region these muscles coming closer to each other, forming a groove in which oesophagus lies. Contractile vessel situated where oesophagus leaving the groove and taking turn upward. Intestine formed by 20 irregular coils and extending up to posterior end of trunk; anus situated at the beginning of introvert. Spindle muscle not attached posteriorly. Nephridia short, more or less vesicular and completely free; opening posterior to anus.

Remarks : No specimen of this species has been examined by the author. The main features of the type material as embodied in Sluiter's (1902) publication is dealt with under description.

Since its first report in 1902 the species has so far not been recorded, as far as the author's knowledge goes, any where else except Pamban, Tamil Nadu. Examining Gravely's collection at the Madras Government Museum, Reddiah (1975) listed *Golfingia filiformis* from Pamban, Tamil Nadu,

along with other three species which were earlier not reported by Gravely (1927). The author visited the said museum in January, 1985 with a view to studying those species as listed by Reddiah (1975) but he failed to locate any one of them.

Hence, it is not possible for the author to make any comment on this species till the re-examination of Gravely's collection as reported by Reddiah (1975).

Previous Indian Records : Pamban, Tamil Nadu (Reddiah, 1975).

Distribution : The species is originally reported from a depth of 1788 m and its occurrence in the intertidal zone (*vide* Reddiah, 1975) is somewhat unusual.

In India : Tamil Nadu.
Elsewhere : Pacific Ocean : Banda Sea (Sluiter, 1902).

11. **Nephasoma pellucidum** (Keferstein) (Figs. 85-90)

Phascolosoma pellucidum Keferstein, 1865a, *Z wiss.Zool.*, **15** : 433, pl. 32, figs. 26-27.
Phascolosoma riisei Keferstein, 1865a, *Z. wiss. Zool.*, **15** : 437, pl. 33, fig. 38.
Phascolosoma verrillii Gerould, 1908, *Science*, **27** (691) : 488-489.
Phascolosoma cinereum Gerould, 1913, *Proc. U.S. natn. Mus.*, **44** (1959) : 396-398, figs. 6-7.
Phascolosoma sluiteri ten Broeke, 1925, *Bijdr. Dierk.* **24** : 84-86 , text-figs. 1-5.
Golfingia (Phascoloides) pellucida : Fisher, 1950a, *Ann. Mag. nat. Hist.* (12) **3** (30) : 551.
Golfingia (Nephasoma) pellucida : Cutler and Murina, 1977, *Zool. J. Linn. Soc.* **60** (2) : 184.
Nephasoma pellucidum : Cutler and Cutler, 1986, *Proc. biol. Soc. Wash,* **99** (4) : 563-564.

Type locality : St. Thomas, Antilles, West Indies. *Location of types* : Zoological Museum, Humboldt University, East Berlin.

Material examined : 2 exs., 43 km south-west of Gopalpur, Ganjam coast, Orissa, dredge, 16.5 m, 23. xii. 1889, Coll. RIMS " Investigator".

Description : Trunk 80 and 86 mm in length, and 19.5 and 18 mm in maximum width at posterior part of trunk; cylindrical with posterior end obtusely pointed ; moderately thick-skinned and steel gray in colour. Introvert, partially retracted in the first and almost fully everted in the second one, 39 and 20 mm in length, cylindrical but gradually wider at base, concolorous with trunk. Tentacles about 60 in number, white, digitiform and appearing to be arranged in three rows, measuring 1.0 -1.5 mm in length. Hooks scattered, occupying a small zone behind tentacular crown; blunt, somewhat shovel-shaped, slightly bent, 0.060-0.075 mm long and about 0.03 mm wide at base.

Papillae more or less concolorous with skin, largest and densely aggregated at posterior end of trunk and at introvert base; in size and abundance papillae gradually decreasing from posterior end of trunk to mid trunk region and from introvert base to distal part of introvert. Largest papillae bluntly conical and measuring on an average 0.125 mm in height and 0.060 mm in width at base. Papillae in mid-trunk region slightly oval in top view, measuring 0.045 mm (approximately) in diameter and in

hooked region of introvert more or less round in top view, measuring on an average 0.035 mm in diameter.

Muscle layers of the body wall continuous. Retractor muscles single pair, broad and strong, arising close to nerve cord from middle to middle-third of trunk and remaining separate up to brain. Oesophagus long, slender tube, major part of which being attached to two-thirds of retractor muscles by mesenteries; intestinal coils about 68 in number, extending up to posterior end of trunk; rectum one-sixth to one -seventh of trunk length and with round rectal caecum at its beginning and wing muscles on the anal part. Spindle muscle strong, arising from rectal wall ahead of rectal caecum, extending up to last intestinal coil but not attached posteriorly. Fixing muscles three in number: f_1 arising from right side of nerve cord anterior to retractor base by one-sixth of trunk length and being attached to last intestinal coil passing through retractor muscles; f_2 and f_3 equally strong as f_1 arising from left ventro-lateral body wall more or less at same level of f_1 but their roots 3.5 mm apart vertically and being attached to last intestinal coil a little behind the attachment of f_1. In the smaller specimen last few intestinal coils lost, so it was not possible to trace the attachment of these muscles. Contractile vessel without villi and extending along oesophagus up to its attachment with retractor muscles. Nephridia short, about one-fourth to one-fifth of trunk length, thin and flabby; their anterior end wider and opening at same level as anus but completely free from trunk; prominent ciliated nephrostome present. Gonads present at base of retractor muscles. Egg double coated, slightly oval and measuring 0.17 mm x 0.15 mm.

Remarks: This species may be easily differentiated from the other two species reported from this coast by the presence of introvert hooks.

Two examined specimens differ from the published account as follows. Tip of hook is not pointed and mid-trunk papilla is not so much oval as shown in Selenka and de Man's (1883) figs. 44 and 46 respectively.

Persusal of literature shows that there exists considerable variation in specimens not only from different localities but also in the same localities and again between smaller and larger ones. Among these variations include presence or absence of hooks, position of attachment of retractor muscles, length of nephridia and position of nephridiopores, presence or absence of rectal caecum and number of fixing muscles.

Keferstein (1865a) reported specimens with and without hooks from St. Thomas. Selenka and de Man (1883) found specimens with hooks from Philippines and without hooks from Singapore. According to Cutler (1973) hooks appear to be more numerous in smaller forms but scattered or entirely absent in large ones. Origin of retractor muscles is reported from middle-third of trunk (Keferstein, 1865a), middle or middle-third of trunk (Selenka and de Man, 1883) or in front of middle of trunk (Gerould, 1913) while Cutler (1973) reported it from 40% to 60% of trunk length. In the present specimens this is from 40% and 48% of trunk length. Length of nephridia is quite variable as reported by different workers. It may be half the trunk length (Selenka and de Man, 1883; Augener, 1903 and Gerould, 1913), about one-third the trunk length (Cutler, Cutler and Nishikawa, 1984) and even short (Keferstein, 1865a). In the present case it is short. Only Keferstein (1865a) and Gerould (1913) reported

that nephridia open well in front or slightly in front of anus but according to Cutler (1973) nephridia open at the same general level of the anus as in the present specimens. Keferstein (1865a), Selenka and de Man (1883) and Gerould (1913) have not mentioned about the rectal caecum. But it is found in the present specimens as already reported by Augener (1903) and Cutler (1973). The number of fixing muscles varies from 3 to 5. The examined specimens possess 3 fixing muscles but all of them are attached to last intestinal coil. This is somewhat unusual.

Previous Indian Records : Cape Comorin, Tamil Nadu (Reddiah, 1975).

Distribution : This is a circumtropical form, extending into subtropical region, usually in shallow and moderate cold water.

In India : Tamil Nadu; Orissa.

Elsewhere :

(a) *Indian Ocean* : Mergui (Selenka, 1887); Singapore (Selenka and de Man, 1883; Lanchester, 1905a; Cutler, 1977b); south of Bali (Cutler, 1977a); Torres Strait (Selenka and de Man, 1883); Western Australia (Fischer, 1919a); Prince Edward (Murina, 1972).

(b) *Pacific Ocean* : Gulf of Siam (Fischer, 1923b; Cutler, 1977b); Japan (Cutler, Cutler and Nishikawa, 1984); Philippines (Selenka and de Man, 1883); Amboina (Augener, 1903); New Zealand (Cutler, 1977a,b); Loyalty Islands (Shipley, 1899a); southern California (Thompson, 1980).

(c) *Atlantic Ocean* : East coast of North America (Gerould, 1908, 1913; Cutler, 1973); Costa Rica (Fischer, 1913; Fisher, 1950a); Cuba (Murina, 1968b); West Indies : Curacao (ten Broeke 1925), Jamaica and Haiti (Fischer, 1913), St. Thomas (Keferstein, 1865a; Baird, 1868; Selenka and de Man, 1883; Augener, 1903; Fisher, 1950a), St. Berthelemy (Fischer, 1922a); east coast of South America (Selenka and de Man, 1883; Fischer, 1913; Leroy, 1936; Fisher, 1950a; Cutler and Cutler, 1979b, 1980a); Cape Town (in Cutler and Cutler, 1986).

12. **Nephasoma rutilofuscum** (Fischer)

Aspidosiphon rutilofuscus Fischer, 1916; *Zool, Anz.*, **48** (1) : 17
Phascolosoma aspidosiphonoides Fischer, 1922b, *Wiss. Ergebn. dt. Tiefsee-Exped. "Valdivia"*, **22** (1) : 11-12, pl.2, figs. 8a-g.
Golfingia (Phascoloides) rutilofusca : Cutler, 1977a, *Galathea Rep.*, **14** : 143-144, fig.7.
Nephasoma rutilofuscum : Cutler and Cutler, 1986, *Proc. biol. Soc. Wash.*, **99** (4) : 564.

Type locality : Off Somalia coast, 2°58' N, 56°5' E, at 1362 m. *Location of types* : Zoological Museum, Houmboldt University, East Berlin.

Material examined : None

Description : Trunk up to 15 mm long, cylindrical, red-brown in general colour with darker

posterior end; pointed posterior shield sharply differentiated by a rim and having 12 very broad anastomosing furrows, not reaching to the tip. Distinct papillae absent but longitudinal rows of lighter coloured, densely aggregated chitinous plates present. Retractor muscles single pair, thin, fused for greater part of their length and arising from posterior end of trunk close to nerve cord. Intestinal coils 28-30 in number; wing muscles holding the rectal part to the trunk wall. Spindle muscle not attached posteriorly. Contractile vessel without villi. Nephridia completely free, short, bladder-like and opening in front of anus.

Remarks : Specimen of this species is neither available in author's collection nor examined by him from other sources.

The description of the species is based on Fischer's (1916) account of the type specimens and his (1922b) subsequent redescription.

Shield-like nature of the posterior end of trunk misled Fischer (1916) in placing the specimens under the genus *Aspidosiphon*. Further, his description is not clear about the nature of termination of spindle muscle. Fischer (1922b) rectified his mistake and renamed the aforesaid specimens as *Phascolosoma aspidosiphonoides* and there he mentiond that spindle muscle is unattached posteriorly. More than six decades later Danish deep-sea Expedition collected a single specimen off Mozambique at a depth of 380 m (Cutler, 1977a). Subsequently, Cutler and Cutler (1979a) reported a large number of specimens from lagoon bed and from shallow waters (25-88 m) off India, Durban and Madagascar and provided supplementary description along with excellent figures. According to them, introvert is 5-6 times the trunk length with about 30 unique, slender and unbranched tentacles arising from paid-like zone along dorsal side of the tip of introvert. This arrangement is unlike any other known sipunculan. Hooks are absent. A pair of retractor muscles originates from the posterior-fifth of trunk and free nephridia open anterior to anus. Gut is loosely coiled and without any fixing muscle. No evidence of spindle muscle is present. Shield-like nature of the posterior end of trunk which Fischer (1922b) figured appears as very coarsely grooved with a definite apex. Regarding this they figured and stated, "A wide range of conditions is found from smooth and rounded to grooved and pointed. The majority are more rounded than pointed"

It may be mentioned here that the type locality of this spices is Off Somalia coast, not Off Zanzibar as stated by Stephen and Edmonds (1972), and Cutler and Cutler (1979a).

Previous Indian Records : Gujarat : Off Okha, 22°32' N, 68°06' E, 58 m and Off Kori Creek, 23°31' N, 66°55' E, 88 m (Cutler and Cutler, 1979a).

Distribution : This is a tropical and subtropical species so far restricted to the Western Indian Ocean and originally described from a depth of 1362 m but subsequently recorded from shallow waters (25-88m) and lagoon bottoms (Cutler and Cutler, 1979a).

In India : Off Gujarat.

Elsewhere : Indian Ocean : Off Zanzibar (Fischer, 1916); Off Mozambique (Cutler, 1977a); Durban (Stephen and Cutler, 1969; Cutler and Cutler, 1979a); Madagascar (Cutler and Cutler, 1979a).

Family **THEMISTIDAE** Cutler and Gibbs

Themistidae Cutler and Gibbs, 1985, *Syst. zool.*, **34** (2) : 167.
Themistidae : Gibs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 53

Diagonsis : Tentacles surrounded the mouth and borne on stem-like extensions ; with paried nephridia; contractile vessel with villi.

Type genus : *Themiste* Gray, 1828.

Distribution : Mostly in tropical and temperate seas.

Remarks : Due to unique tentacular crown i.e., stem-like extensions of the oral disc carrying the peripheral tentacles Cutler and Gibbs (1985) removed the genus *Themiste* from the family Golfingiidae of Stephen and Edmonds (1972) and created this monogeneric family.

Genus **Themiste** Gray

Themiste Gray, 1828, *Spicilegia Zoologica*, **16** : 8, pl.6, figs. 4, 4a.
Dendorstomum Grube and Oersted, 1858, *Vidensk, Meddr dansk naturh. Foren*, **1858** : 118.
Dendorstoma Keferstein, 1865b, *Nachr. Ges. wise. Gottingen*, **1865** : 207-208.
Themiste : Stephen, 1964, *Ann. Mag. nat. Hist.*, (13) **7** (80) : 458.
Themiste : Cutler and Cutler, 1988, Proc. biol. Soc. Wash., 101(4) : 752.

Diagnosis : Introvert less than trunk length; with or without hooks; tentacles basically surrounding mouth but developing along margins of stem-like extensions of oral disc; retractor muscles one pair; spindle muscle not attached posteriorly; contractile vessel with a few to many, long or short villi; with paired nephridia.

Type species : *Themiste hennahi* Gray, 1828.

Distribution : Mostly in tropical and temperate seas.

Remarks : Edmonds (1980) divided the genus into three subgenera, viz., *Themiste* (s.s.) *Lagenopsis* and *Stephensonum* on the basis of the number of retractor muscles and the length of the contractile vessel villi. But Gibbs and Cutler (1987) reduced the third subgenus *Stephensonum* (based on two species) to the status of a junior synonym of *Golfingia* as the type species, *T. stephensoni* (Stephen) has a golfingiid, not themistid, tentacular crown and *T. pinnifolium* (Keferstein) is regarded as a *nomen dubium*.

Subgenus **Themiste** Gray, 1828

Themiste Gray, 1828, *Spicilegia Zoologica*, **16** : 8, pl. 6, figs. 4, 4a.
Themiste (Themiste s.s.) Edmonds, 1980, *Rec. S. Aust. Mus.*, **18** (1) : 33.
Themiste (Themiste) : Cutler and Cutler, 1988, Proc. biol. Soc. Wash., 101(4) : 752.

Diagnosis : Contractile vessel with long and thread-like villi.

Type species : Themiste hennahi Gray, 1828.

Remarks : A total of 11 species have been included under this subgenus from the world, of which only one species is presently known from the Indian coast.

13. **Themiste (Themiste) hennahi** Gray
(Figs. 23, 91)

Themiste hennahi Gray, 1828, *Spicilegia Zoologica*, **16** : 8, pl. 6, figs. 4, 4a.
Dendorstoma peruvianum Collin, 1892. *Arch. Naturgesch*, **58** : 179-180, pl. 2, figs. 7-13.
Dendorstoma zostericolum Chamberlain, 1919, *Pomona Coll. J. Ent.*, **12** : 30.
Dendorstomum peruvianum : Wesenberg-Lund, 1955b, *Acta Unit. Lund.*, (5) **10** (51) : 12-13.
Themiste (Themiste) hennahi : Cutler and Cutler, 1988, *Proc. biol. Soc. Wash.*, **101**(4) : 753-755, figs. 4 A-C, 6,7.

Type locality : Peru. *Location of types* : British Museum (Natural History), London.

Material examined : 3 exs., East of Camorta jetty, Nicobars, "under coral boulders in the sandy mud at low tide", 24.i.1976, Coll. D.R.K. Sastry.

Description : Trunk of the largest specimen 50 mm long and 31 mm wide at the level of base of retractor muscles; barrel-shaped, posterior end almost rounded; dark tan in colour and wrinkled with large number of grooves in contracted specimens. Introvert, partially retracted in all the specimens, approximate ratio of introverrt : trunk : : 1 : 2.3. Tentacules numerous, pale gray and derived from six main profusely branched stems. Collar smooth, whitish to gray in colour. Hooks absent behind the collar on intrevert. Skin thick, smooth and with only small papillae in anal region.

Longitudinal muscle layer of body wall continuous and silky glossy in texture. Retractor muscles single pair, arising from posterior-third of trunk very close to nerve cord on its either side; their line of attachment concave, covering 10-17 mm in width. Oesophagus slender and thin-walled; intestine with 28-34 coils extending beyond retractor base; rectum moderately long and with a small thin-walled baloon-like caecum at its proximal part; distal part attached to body wall by broad and well developed wing muscles; anus placed at anterior end of trunk almost at the level of nephridiopores. Contractile vessel twice as thick as oesophagus and both connected to retractor muscles by mesenteries; with 11-13 spirally coiled latero-terminal unbranched thread-like villi, some of which, when extended, may exceed trunk length. Spindle muscle arising from body wall near anus, passing over rectal caecum and along intestinal coils but not attached posteriorly. Fixing muscles paired - one arising ventrally from left side of posterior part of anterior body wall and attaching by three branches to posterior part of oesophagus just before onset of intestinal coiling, while the other, comparatively thicker and broader arising dorso-ventrally from right side of anterior-third of body wall and attaching just behind the rectal caecum. Nephridia completely free, brown, cylindrical anteriorly swollen, extending beyond the retractor base; nephrosotomes small and simple; nephridiopores ventro-lateral to body wall just behind anus. Gonads present as transverse bands at the retractor bases. Nerve cord firmly attaching to body

wall by numerous nerve fibres.

Remarks : The species may be readily distinguished from *T. lageniformis* reported from this coast by the presence of long, unbranched thread-like villi of the contractile vessel.

Retractor muscles remain free from each other throughout except in one where these muscles are united anteriorly about one-fourth of their length. The number of fixing muscles is only 2, f_2 of the paralectotype is absent here.

The villi of the contractile vessel do not show any beaded structure which was observed in *D.peruvianum* by Collin (1892) as well as in the paralectotype of *T hennahi* by Rice (in Rice and Stephen, 1970). Further, oesophageal protuberances, as described by Collinn (1892) and used by Stephen and Edmonds (1972) as a key to differentiate *T hennahi* from *T zostericola*, are absent in the present material.

The present observation corroborates that of Wesenberg-Lund (1955), and Rice and Stephen (1970). The number of tentacular stems as reported in the literature for *T. hennahi* is 5 (Gray, 1828) or 4 (Stephen, 1964; Stephen and Edmonds, 1972) and for *D. peruvianum* is 4 (Collin, 1892). The fact that the tentacles derived from six main stems as observed in the present material is supported by Rice (in Rice and Stephen, 1970) on re-examination of Gray's type specimens. The examined specimens agree well with the redescription of the type specimens of *T hennahi* by Rice and Stephen (1970) excepting the absence of fixing muscle, f_2, in the present ones. Moreover, the present specimens show close resemblances with *T. zostericola* (Chamberlain, 1919) in the number of tentacular stems, place of origin of retractors, attachment of fixing muscles and nature of contractile vessel villi. Hence, it is suggested to consider *T. zostericola* as a junior synonym of *T. hennahi*. This is to mention here that this view is also supported by Dr. E.B. Cutler (in a personal communication).

Distribution: This species is an intertidal form known only from the eastern Pacific. The finding of this species in the Indian coast is very noteworthy.

In India : Nicobars.

Elsewhere : Pacific Ocean : California (Chamberlain, 1919; Fischer, 1952); Baja California (Fisher, 1952); Peru (Gray, 1828; Collin, 1892; Stephen, 1967); Chile (Fischer, 1941b; Wesenberg-Lund, 1955; Amor, 1965, 1970; Tarifeno, 1975).

Subgenus **Lagenopsis** Edmonds

Themiste (Lagenopsis) Edmonds, 1980, *Rec. S. Aust. Mus.*, **18** (1) : 33.
Themiste (Lagenopsis) : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 53

Diagnosis : Contractile vessel with short and finger-like villi.

Type Species : Themiste lageniformis Baird, 1868.

Distribution : Indian and Pacific Oceans.

Remarks: Only one species, viz., *T. lageniformis* of this subgenus is widely distributed in tropic and subtropic of the Indo-West Pacific region with a few records from the Atlantic. Other members of this subgenus are restricted in distribution.

14. **Themiste (Lagenopsis) lageniformis** Baird
(Figs. 24, 25, 92-97)

Themiste lageniformis Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 98-99, pl.10, figs. 3-3c.
Dendrostoma signifer Selenka and de Man, 1883, *Reisen im Archipel der Philippen von Dr. C. Semper*, (2) **4** (1) : 86-87, pl.2 fig. 21, pl.11, figs. 163-169.
Phascolosoma pyriformis : Sato, 1939, *Sci. Rep. Tohoku Univ.*, (4) **14** : 404-406, pl.21, fig.16, text-figs. 44-45.
Dendrostoma robertsoni Stephen and Robertson, 1952, *Proc. R. Soc. Edin.*, **64**, B (22) : 438-439, pl.1, figs. 3,4.
Dendrostomum signifer : Edmonds, 1956, *Aust. J. Freshwat. mar. Res.*, **7** (3) : 297-299, pl.1, fig. 2.
Golfingia pyriformis : Haldar, 1975, *Proc. internat. Symp. biol. Sipuncula and Echiura*, **1** : 61.
Themiste lageniformis : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 152

Type locality : Australia ? *Location of types* : British Museum (Natural History), London.

Material examined : 3 exs., Pamban, Tamil Nadu, 21.ii.1913, Coll. S.W.Kemp; 5 exs., Mandapam Camp, Tamil Nadu, 6.i.1964, Coll. V. K. Premkumar ; 4 exs., North of Havelock Island, South Andamans, 1.iii.1971, Coll. V.K.Premkumar; 7 exs., South of Havelock Island, South Andamans, 20.ii.1974, Coll. K.V. Surya Rao; 15 exs., Bombay, Maharashtra, "intertidal rocky bed", 7.iv.1974, Coll. B.P. Haldar; 38 exs., near Rameswaram temple, Tamil Nadu, "from rocks", 28.ii.1975, Coll. B.P.Haldar; 80 exs., Dhanuskodi, near Rameswaram, Tamil Nadu, "from rocks", 2.iii.1975, Coll. B.P. Haldar; 11 exs., Quilon, Kerala, 3.i.1976, Coll. P.K. Chandra; 32 exs., Okha, Gujarat, 12.iv.1977, Coll. K.N. Reddy; 25 exs., Pirotan Island, Gulf of Kutch, Gujarat, "from coralline sand", 20.iv.1977, Coll. B.P. Haldar; 10 exs., Port Blair, South Andamans, "from burrows in rocks at lower intertidal zone", 29.iv.1978, Coll. B.P. Haldar; 16 exs., Chidyatapu, South Andamans, "from crevices of corals", 25.iv.1978, Coll. B.P. Haldar; 12 exs., Minicoy, Lakshadweep, "reef edge of lagoon", 14.xii.1979, Coll. B.P. Haldar; 5 exs., North of Androth, Lakshadweep, 20.xii.1979, Coll. A. Misra; 4 exs., Agatti, Lakshadweep, 4.iv.1984, Coll. A. Misra; 6 exs., Kavaratti, Lakshadweep, 6.ii.1986, Coll. D.R.K. Sastry.

Description : Trunk 5-30 mm in length with maximum width 17 mm just above the base of retractors, grayish to white or light brown to brown in colour; smooth and opaque - skinned and rounded or pointed posteriorly; pear-or-flask-shaped in contracted stage, and long and also less stout in relaxed ones with a tendency to curve ventrally. Introvert, if fully everted, 3-5 mm in length when trunk length is of 12-30 mm *i.e.* about one-third to one-fifth of trunk length; darker than trunk and without hooks. Tentacles white, unpigmented; arising from 4-5 primary stems, each of which dividing into 2-3 substems which in turn giving rise to tentacules. Tentacules digitiform, measuring 1.0-2.5 mm in length. Collar smooth, white, lying behind tentacular crown and followed usually by blue or dark blue pigmented band.

Papillae are of uniform size all over trunk and introvert base; very small flat, transparent and round; measuring 0.01-0.03 mm in diameter and with central pore. Body surface dividing into small, incomplete areas by longitudinal and transverse faint lines and each area carrying a papilla, rarely two.

Muscle layers of the body wall continuous. Retractor muscles single pair and stout, and arising by broad roots from posterior third to fifth of trunk and remaining free for most of their length. Oesophagus very long, extending up to base of retractor muscles and then turning up to join the intestinal coil. Intestinal tract with 14-22 coils; rectum moderately long and with rectal caecum; anal part of rectum being attached to body wall by broad and thin wing muscles. Spindle muscle originating from the rectal wall but not fixed posteriorly. Fixing muscles three in number; first one (f_1) very short, arising either a little posterior from base of left retractor muscle or between base of retractor muscles and attached to oesophageal loop; second one (f_2) arising at midtrunk level from right dorso-lateral body wall and attached to beginning of rectum, posterior to rectal caecum; third one (f_3) arising either close to mid-dorsal line from right side or right dorso-lateral body wall at anterior third of trunk or mid-trunk level and attached to beginning of rectum next to attachment of f_2 or last intestinal coil. In some specimens fourth one (f_4) is found to attach post-oesophageal gut to body wall. Contractile vessel tubular and with numerous, short and branched villi; extending along oesophagus up to base of retractor muscles but rarely extending furthermore along the oesophagus. Nephridia whitish, thin, flabby, and translucent; one-third to one-fourth as long as trunk, completely free from body wall and opening either at same level or a little behind the anus. Eggs spherical and measuring 0.17 mm in diameter.

Remarks : The species may be differentiated from the other congeneric species reported from this coast by the presence of short and finger-like villi of the contractile vessel.

The number of tentacular stems as reported in the literature is 4-6 (Baird, 1868); 5-6 (Selenka and de Man, 1883) and 4 (Ikeda, 1904; Stephen and Edmonds, 1972; Edmonds, 1980; Pilger, 1982). Moreover, Wesenberg-Lund (1963) alone reported the presence of rectal caecum in *T robertsoni*. In two widely separated population of *T. lageniformis* from Okha, Gujarat, and Dhanuskodi, Tamil Nadu, the author obtained some examples with 4 tentacular stems in which internal morphology is same with those specimens having 5 tentacular stems. Out of 15 specimens collected from Bombay coast 5 with fully retracted introvert measuring 5-6 mm trunk length appear to be immature forms. They do not possess any hooks on introvert although Awati and Pradhan (1935) found feebly developed hooks in younger stages but they opined that those hooks fall off in adults.

A specimen from Minicoy, Lakshadweep, earlier reported as *Golfingia pyriformis* by the author (1975), has been found on re-examination to be *T lageniformis*.

From the description of Stephen and Robertson (1952) *T. robertsoni* can not be differentiated from *T. lageniformis* excepting the arrangement of papillae on the body especially at the posterior end and at the base of introvert. The rest of the differentiating characters of *T. robertsoni s* given by Stephen and Robertson (1952) are the length and number of polian tubules (= contractile vessel villi), lighter and longer retractors, number and position of fixing muscles and tentacular arrangement. Firstly, they provided neither any measurement nor any number of contractile vessel villy by which it can be differentiated from *T. lageniformis*. Secondly, Wesenberg-Lund (1963) stated in *T. robertsoni* "broad and strong retractors arise further backwards than in type". So the character "lighter and longer

retractors" is untenable for species differentiation. Thirdly, fixing muscle is a thin and fine strand of muscle which may easily be damaged and sometimes difficult to see. So it has little taxonomic importance.

On the basis of the foregoing discussion the author is of opinion that *T. robertsoni* may be merged with *T lageniformis.* Similar view is also expressed by Dr. E.B. Cutler in a personal communication.

Previous Indian Records : Gujarat (Haldar, 1975; Cutler and Cutler, 1979a); Maharashtra (Awati and Pradhan, 1935); Lakshadweep (Haldar, 1975); Tamil Nadu : Krusadai Island (Gravely, 1927), Hare Island (Reddiah, 1975), Mandapam Camp (Haldar, 1975; Rajulu, 1975b), Andamans : MIddle and South (Haldar, 1975).

Distribution : This is widely distributed in tropic and subtropic of the Indo-West Pacific region with a few records from the Atlantic.

In India : Gujarat; Maharashtra; Lakshadweep; Kerala; Tamil Nadu; Andamans.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Leroy, 1936); Mombasa (Cutler, 1977a); Madagascar (Hammerstein, 1915; Cutler and Cutler, 1979a); Off south-east of South Africa (Cutler, 1977a); Singapore (Selenka and de Man, 1883); Australia : Northern Territory, Western Australia (Edmonds, 1980).

(b) *Atlantic Ocean* : Gulf of Guinea; Luderitz Bay (Fischer, 1914a); Cape Province (Fischer, 1922b; Wesenberg-Lund, 1959a); Tristan da Cunha (Wesenberg-Lund 1963); Argentina (in Cutler and Cutler, 1979a).

Class PHASCOLOSOMATIDEA Cutler and Gibbs

Phascolosomida Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 167
Phascolosomatidea Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 53.

Diagnosis : Tentacles arranged in a single crescent or near circle dorsal to mouth but enclosing nuchal organ; without peripheral tentacles; introvert hooks usually present, recurved and arranged in rings; spindle muscle attached posteriorly with a solitary exception *(P. pectinatum).*

Key to orders of PHASCOLOSOMATIDEA known from the Indian coast

Anterior end of trunk modified into horny epidermal or calcareous anal shield; retractor muscles single pair	...	Aspidosiphoniformes Cutler and Gibbs

Anterior end of trunk not midified to from anal shied; retractor muscles two pair ... Phascolosomatiformes Gibbs and Cutler

Order **PHASCOLOSOMATIFORMES** Cutler and Gibbs

Phascolosomaformes Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 166.
Phascolosomatiformes Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 53.

Diagnosis : Anterior end of trunk not modified to form anal shield; retractor muscles two pair.

Family **PHASCOLOSOMATIDAE** Stephen and Edmonds

Phascolosomatidae Stephen and Edmonds, 1972, *The Phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 269.
Phascolosomatidae : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 54.

Diagnosis : Longitudinal muscle layer of body wall either divided into bands or continuous; papillae usually most closely placed at posterior end of trunk.

Type genus : Phascolosoma Leuckart, 1828.

Distribution : Widely distributed in tropical and temperate waters.

Remarks : Stephen and Edmonds (1972) included two genera, viz., *Phascolosoma* and *Fisherana* under this family while Cutler and Gibbs (1985) placed three genera, viz., *Phascolosoma* (combined subgenera *Phascolosoma s.s.* and *Satonus* of Stephen and Edmonds, 1972), *Antillesoma* (Stephen and Edmonds' subgenus of *Phascolosoma*) and *Apionsoma* [= *Golfingia (Mitosiphon)* Fisher, 1950a, *Golfingia (Phascolana)* Wesenberg-Lund, 1959a, *Golfingia (Siphonoides)* Murina, 1967a and *Fisherana* Stephen, 1964]

Key to genera of **Phascolosomatidae** known from the Indian coast

1.	Contractile vessel with villi; without introvert hooks	....	*Antillesoma* Stephen and Edmonds
	Contractile vessel without villi, usually with introvert hooks	...	2
2.	Longitudinal muscle layer of body wall divided into bands	....	*Phascolosoma* Leuckart
	Longitudinal muscle layer of body wall continuous	....	*Apionsoma* Sluiter

Genus **Antillesoma** Stephen and Edmonds

Phascolosoma (Antillesoma) Stephen and Edmonds, 1972. *The Phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 277. (in part).
Phascolosoma (Rueppellisoma) Stephen and Edmonds, 1972. *The phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 271 (in part).
Antillesoma : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 55.

Diagnosis : Introvert variable in length, reaching up to three quarters of trunk length; without hooks; tentacles numerous, arranged around nuchal organ dorsal to mouth; longitudinal muscle layer divided into separate anastomosing bands; retractor muscles two pair, lateral pair often extensively fused giving the appearance of a single pair; contractile vessel with many digitiform villi, spindle muscle attached posteriorly.

Type species : Phascolosoma antillarum Grube and Oersted, 1858.

Distribution : Tropical and temperate waters.

Remarks : This is now a monotypic genus formed by synonymising eight species previously distributed over two subgenera *Antillesoma* and *Rueppellisoma* of the genus *Phascolosoma* (*vide*, Cutler and Cutler, 1983).

15. **Antillesoma antillarum** (Grube and Oersted) (Figs. 26, 27 98-103)

Phascolosoma antillarum Grube and Oersted, 1858, *Vidensk. Meddr dansk naturh. Foren*, **1858** : 117-118.
Phascolosoma fuscum Keferstein, 1862, *Nachr. Ges. wiss. Gottingen*, **1862** : 67.
Phascolosoma nigriceps Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 90, pl. 11, figs. 1, 1A.
Phascolosoma aethiops Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 90.
Phymosoma antillarum : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) 4 (1) : 57-58, pl. 7, figs. 93-96.
Phymosoma asser Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 59-60, pl. 1, fig. 3; pl. 7, fig. 97-101.
Phymosoma pelma Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 60, pl.1, fig.4; pl.7, fig.102.
Physcosoma weldonii Shipley, 1892, *Proc. Camb. phil. Soc. biol. Sci.*, **7** : 77-78.
Phymosoma onomichianum Ikeda, 1904, *J. Coll. Sci. imp. Univ. Tokyo*, **20** (4) : 26-38, text-figs. 7, 56-58.
Physcosoma gaudens Lanchester, 1905b, *Proc. zool. Soc. Lond.*, **1905** : 38, pl. 2, fig. 2.
Physcosoma antillarum : Gerould, 1913, *Proc. U.S. nat. Mus.*, **44** (1959) : 420-421, pl. 62, figs. 19,20.
Physcosoma similis Chen and Yeh, 1958, *Acta zool . Sin.*, **10** : 274-276, text-figs, 3,4.
Phascolosoma schmidti Murina, 1975c, *Vest. Zool.*, **197**: 57-59, fig. 3.
Phascolosoma antillarum : Cutler and Cutler, 1983, *Zool. J. Linn. Soc.*, **77** : 182-184, fig. 1.
Antillesoma antillarum : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 156.

Type locality: West Indies. *Location of types*: Formerly in the Zoological Museum, Humboldt University, East Berlin, "But specimens are missing" (Cutler and Cutler, 1983).

Material examined : 3 exs., west point of Casurina Bay, Great Nicobar, "inside a dead coral in the intertidal zone", 2.iv.1966, Coll. A. Daniel; 2 exs., Rangat Bay, Middle Andamans, "in fissure between rocks near high water mark", 22.x.1972, Coll. B.P. Haldar; 1 ex., eastern side of Neil Island, South Andamans, "inside coral crevices in lower littoral zone:, 29.x.1972, coll. B.P. Haldar; 2 exs., Port Blair, South Andamans, 17.ii.1974, Coll. K.V. Surya Rao; 7 exs., Adatra beach, Okha, Gujarat, "breaking boulders", 5.iv. 1977, Coll. K.N. Reddy; 9 exs., north-east of Agatti, Lakshadweep, "inside coral rocks on exposed reef", 24.xii.1979, Coll. B.P. Haldar.

Description : Trunk 9-30 mm long with maximum width 18 mm, stout, pear-shaped or subspherical, and posterior extremity rounded or pointed. Introvert 3-9 mm and about one-third to more than three-fourths the length of trunk. Tentacles 38-61 in number, measuring 1.5-3 mm in length and arranged in a single crescent, placed dorsal to mouth; each one with two narrow longitidunal brown or grayish stripes on its ventral surface. Collar, a smooth white zone devoid of papillae and hooks, situated below tentacular crown and sharply distinguished from rest part of intovert. Skin thin, opaque, anterio-posteriorly dark brown and mid-trunk yellow to light brown; anterior extremity of trunk with quadrangular or pentangular raised areas separated by grooves and each represented separately by an oval papilla made up of chitinous platelets; anal papillae smaller, paler and concial in shape than supra-anals which are larger, darker and rough in texture. Papillae at posterior extremity of trunk larger than mid-trunk papillae but smaller than that of introvert base and anterior extremity of trunk. In general, dorsal papillae slightly larger than ventral.

Longitudinal muscle layer divided into bands which frequently anastomosed : 12-15 anteriorly, 30-36 posteriorly and 21-29 at retractor bases. Retractor muscles two pair, originating more or less at same level from middle third of trunk; attachment of ventral and dorsal pair of retractor muscles varying, former stout and arising from muscle bands 2-5 (1-5, 2-4, 3-5), while latter slender and arising from muscle bands 6-8 (5-8, 6-9, 7-8); both dorsal and ventral retractor of each side uniting immediately to form a single retractor of muscle. Intestine with 16-25 coils attached anteriorly and posterioly by stout spindle muscle. Fixing muscle single, arising from longitudinal muscle band 1 anterior to the base of left ventral retractor and runs up to the beginning of rectum; rectum long and without caecum. Contractile vessel covered with numerous and fairly long tubular villi extending up to second intestinal coil; villi reaching up to 3 mm in length and some of them showing ramification at their tips.Nephridia light to dark brown, usually half the length of trunk but sometimes slightly extending beyond bases of retractors and attached to trunk throughout except for posterior extremities; nephridiopores more or less at the same level of anus between longitudianl muscle bands 1 and 2 or 2 and 3. Gonads lying at the bases of ventral retractor muscles. Eggs elliptical and measuring 0.12 mm x 0.09 mm present in the body cavity.

Remarks : The species, the only representative of the genus, may be easily differentiated from the spices of the allied genera by the presence of numerous contractile vessel villi and tentacles. The number of tentacles varies from 30-200 [about 30 (Ikeda, 1904), 50-60 (Stephen and Edmonds, 1972), 50-80 (Selenka and de Man, 1883), about 200 (Fisher, 1952; Cutler, Cutler and Nishikawa, 1984)] in this species. The study of a population from the Lakshadweep reveals that the number is usually correlated to the size of the animal. Again, the number of longitudinal muscle bands varies from 14-30 [14-28 (Ikeda, 1904), 20-30 (Selenka and de Man, 1883; Gerould, 1913; Fisher, 1952; Stephen and

Edmonds, 1972)]. The number of longitudinal muscle bands in the present specimens corresponds within the range mentioned above except in the specimens from Great Nicobar where these muscle bands repeatedly divide behind the retractor bases resulting 30-36 longitudinal muscle bands at posterior extremity. Re-examined type of *Physcosoma weldonii* Shipley, 1892 which is conspecific with *Phascolosoma antillarum* has 17-34 longitudinal muscle bands (Cutler and Cutler, 1983). So this is not an unusual feature. Rectal caecum as reported by Fisher (1952), Rice and Stephen (1970), and Cutler and Cutler (1983) is absent in the specimens examined and is not mentioned by Selenka and de Man (1883) and Ikeda (1904). Specimens from Neil Island and Port Blair were tentatively identified by the present author as *Phascolosoma gaudens* (Lanchester) due to presence of one pair of retractor muscles but on careful re-examination it is observed that there is a split at the place of attachment in each of the retractor muscle as in fig. 1B (Cutler and Cutler, 1983) and thereby these specimens are confirmed as *A. antillarum*. Cutler and Cutler's (1983) work on "An examination of the *Phascolosoma* subgenera *Antillesoma* ... (Sipuncula)" included seven more species in addition to three by Stephen and Edmonds (1972) under the synonymy of *P. antillarum* solely on the number of retractor muscles and their nature of fusion along much of the length of each pair.

In "A classification of the phylum Sipuncula" Gibbs and Cutler (1987) treated subgenus *Antillesoma* of the genus *Phascolosoma* as a distinct genus. The author accepts this view because *Antillesoma* differs from *Phascolosoma* by the presence of contractile vessel villi, absence of introvert hooks, larger number of tentacles and lateral pair of the paired retractor muscles fused to the great extent.

This is the first record from the mainland of India.

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a); Port Blair, South Andamans (Johnson, 1971); Off Ganges Delta, 20°49'N, 88°40' E, 445 m (Cutler, 1977a). Cutler (1977a) missed Johnson's record while mentioning "Not yet recorded from the Indian Ocean".

Distribution : This is a cosmopolitan species found in tropical and subtropical, shallow waters.

In India : Off Ganges Delta; Great Nicobars; Middle and South Andamans, Minicoy and Agatti of Lakshadweep; Gujarat.

Elsewhere :

(a) *Indian Ocean*: Durban (Wesenberg-Lund, 1963); Mozambique (Fischer, 1895); Madgascar (Hammarstein, 1915); Mauritius (Selenka and de Man, 1883; Wesenberg-Lund, 1959b); Maldives (Shipley, 1903a); Ceylon (Shipley, 1903b); Indonesia (Selenka and de Man, 1883, Sluiter, 1886, 1891, 1902; Fischer, 1895, 1922a).

(b) *Pacific Ocean*: Baja California (Fisher, 1952); Panama Gulf (Cutler, 1977a); west coast of Middle America (Keferstein, 1867); Puntarenas, Costa Rica (Grube and Oersted, 1858); Chile (Baird, 1868) ; Hawaii (in Fisher, 1952); New Caledonia (Cutler and Cutler, 1983); Loyalty and New Britain (Shipley, 1902); Japan (Ikeda, 1904; Sato, 1934a, 1939; Murina 1975c; Cutler and Cutler, 1981; Cutler, Cutler and Nishikawa, 1984); Korea and Formosa (Sato, 1939); Palau Island (Sato, 1935, 1939); China (Fischer, 1914b; Chen and Yeh, 1958); Philippines (Selenka and de Man, 1883);

Amboina (Augener, 1903); Makassar Strait (Cutler, 1977a); Thailand (Fischer, 1923b); Malaysia (Lanchester, 1905c).

(c) *Atlantic Ocean* : Jamaica (Baird, 1868); Bahamas (Shipley, 1892); Key West, Florida (Gerould, 1913); east coast of Middle America (Keferstein, 1867); Panama (Fischer, 1895; Fisher, 1952); Cuba (Murina, 1967a); West Indies (Grube and Oerested, 1858; Keferstein, 1863, 1865a; Baird, 1868; Fischer, 1895; Leroy, 1936); Surinam, Barbados, Puerto Cabello (Selenka and de Man, 1883); Barbados (Fischer, 1922a); Brazil, Venezuela, Columbia and Dutch Guiana (in Fisher, 1952); Sierra Leone (Longhurst, 1958); Gold Coast (Cutler and Cutler, 1983).

Genus **Phascolosoma** Leuckart

Phascolosoma Leuckart, 1828, *Breves animalium quorandam maxima ex parte marinorum descriptiones.* Heidelberg : 22, fig. 52.
Phascolosomum Diesing, 1851, *Systema helminthum*, **2**:63 (in part).
Phymosomum Quatrefages, 1865b, *Historie naturelle des Anneles marins et d'eau douce.* Paris, **2** : 621.
Phymosoma Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 54 (Emendation of *Phymosomum*).
Physcosoma Selenka, 1897, *Zool. Anz.*, **20** : 460.
Physconosoma Bather, 1900, Echinoderma, *Zool. Rec.*, **37**:77-78.
Phascolosoma : Gibbs and Cutler, 1987. *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 54.

Diagnosis : Introvert variable in length, ranging from one-third to twice the trunk length; hooks (absent in *P. meteori*) recurved and arranged in numerous rings; tentacles arranged around nuchal organ and placed dorsal to mouth; longitudinal muscle layer of body wall divided into separate, often anastomosing bands; retractor muscles two pair, lateral pair sometimes partially, rarely completely fused; contractile vessel single, lacking villi; spindle muscle attached posteriorly (except in *P. pectinatum*); with paired nephridia.

Type species : *Phascolosoma granulatum* Leuckart, 1828.

Distribution : Tropical and temperate seas; polar seas only rarely.

Remarks : Stephen and Edmonds (1972) divided the genus into four subgenera, viz., *Phascolosoma s.s.*, *Satonus*, *Antillesoma* and *Rueppellisoma* based largely on information available in the literature. After reviewing the work on the *Phascolosma* subgenera *Antillesoma*, *Rueppellisoma* and *Satonus* Cutler and Cutler (1983) made a comment, "the criteria used for this separation were erroneous". Recently, Cutler and Gibbs (1985) elevated *Antillesoma* (= *Rueppellisoma*) to the generic rank, and Gibbs and Cutler (1987) retained the subgenus *Phascolosoma* and erected a new subgenus *Edmondsius* replacing *Satonus* because its type species, *Phymosoma nigritorquatum* Sluiter, had uncertain status and "consider this species to be *incertae sedis*" (Cutler and Cutler, 1983). Of the two subgenera only *Phascolosoma* is known from the Indian Coast and other one is monotypic.

Subgenus **Phascolosoma** Leuckart

Phascolosoma Leuckart, 1828, *Breves animalium quorandam maxima ex parte marinorum descriptions.* Heidelberg: 22, fig. 52.
Phascolosoma (Phascolosoma s.s.) : Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 289-290.
Phascolosoma (Rueppellisoma) Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural Hsotry), London : 271 (in part).
Phascolosoma (Antillesoma) Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura.* Trustees of the British. Museum (Natural History), London : 277 (in part).
Phascolosoma (Satonus) Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura,* Trustees of the British Museum (Natural History), London : 282 (in part).
Phascolosoma (Phascolosoma) : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 54.

Diagnosis : Spindle muscle attached posteriorly; hooks without accessory spinelets at base.

Type species : Phascolosoma granulatum Leuckart, 1828.

Distribution : Tropical and temperate seas; polar seas only rarely.

Remarks : This subgenus contains second largest number of species (eighteen species and subspecies according to Cutler and Cutler, 1990)under the phylum and the largest number of species in the Indian coast. The other subgenus *Edmondsius* (monotypic) is unrepresented here.

Key to species of subgenus **Phascolosoma** known from the Indian coast.

1.	With accessory tooth on concave edge of hook	...	2
	Without accessory tooth on concave edge of hook	...	8
2.	Hook with triangular area alongside of streak	...	3
	Hook without triangular area alongside of streak	...	6
3.	Nephridia more than half as long as trunk	...	4
	Nephridia half or less than half as long as trunk	...	5
4.	With clear crescentic area in the hook	...	*P. (P.) stephensoni* (Stephen)
	Without clear crescentic area in the hook	...	*P. (P.) pacificum* (Keferstein)
5.	With posteriorly directed spiniform, conical papillae on posteriodorsal surface of introvert	..	*P.(P.)perlucens* Baird

	Without posteriorly directed concial papillae on introvert	...	*P. (P.) scolops* (Selenka and de Man)
6.	Central clear streak of hook having expansion basally and at its middle	...	*P. (P.) nigrescens* Keferstein
	Central clear streak of hook having no such expansion	...	7
7.	Skin papillae of mid-trunk covered with large polygonal chitinous plates	...	*P. (P.) japonicum* Grube
	Skin papillae of mid-trunk covered with small polygonal chitinous plates	...	*P. (P.) granulatum* Leuckart
8.	Apex of hook bending to form a right angle to main axis	...	*P. (P.) albolineatum* Baird
	Apex of hook bending to form an obtuse angle to main axis	...	9
9.	Circular muscle layer separating into bands	...	*P. (P.) arcuatum* (Gray)
	Circular muscle layer not separating into bands	...	*P. (P.) agassizii* Keferstein

16. Phascolosoma (Phascolosoma) agassizii Keferstein (Fig. 119)

Phascolosoma agassizii Keferstein, 1866, *Nachr. Ges. wiss. Gottingen*, **1866** : 218.
Phascolosoma lordii Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 92.
Phymosoma agassizii : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 78-79.
Physcosoma agassizii : Fischer, 1895, *Abh. Geb. naturw. Hamburg*, **13** : 10.
Phascolosoma agassizii : Fisher, 1952, *Proc. U.S. natn. Mus.*, **102** (3306) : 424-430, pl.36, figs. 3-6; pl.37, figs.4-15; pl. 38, figs. 16-29; pl.39, fig. 1.
Phascolosoma (Phascolosoma) agassizii : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 152-153.

Type locality : Mendocino, California. *Location of type* : Museum of Comparative Zoology, Harvard University, Massachusetts, U.S.A.

Material examined : 1 ex., Pirtoan Island, Gulf of Kutch, 20.iv.1977, Coll. K.N. Reddy; 3 exs., Diu , Union Territory, "from rock platform", 26.i.1978, Coll. B.P. Haldar; 2 exs., Chidyatapu, South Andamans, "from dead coral in mangrove zone", 30.iv.1978, Coll. B.P. Haldar; 3 exs., Neil island, South Andamans "from dead corals", 5.v.1978, Coll. B.P. Haldar; 1 ex., Kavaratti, Lakshadweep, 4.ii.1986, Coll. D.R.K. Sastry.

Description: Trunk 15-90 mm long and 17 mm in maximum width near posterior part of middle third of trunk, cylindrical, semitranslucent creamy-white to pinkish-gray, posterior extremity either bluntly rounded or gradually narrowed down to rounded tip. Introvert 6-42 mm long, when fully stretched, about as long as trunk but in completely retracted condition less than half; 3-6 brown transverse bands on dorsal surface. Tentacles 17-24 in number, digitiform, arranged in semicircle and placed dorsal to mouth. Collar smooth, white, following tentacular crown. Hooks in 14-24 rows, first few rows small and colourless, others light brown to brown in colour with pointed apex, curvature varying greatly forming an obtuse angle, central narrow clear streak and without any expansion at base, indistinct triangular area, without accessory tooth and also with basal bar provided with or without warts, measuring 0.046-0.060 mm in height and 0.055-0.063 mm in width at base.

Papillae between hook rows very small and those at introvert base, anal region and posterior extremity of trunk larger measuring 0.22-0.27 mm in height and 0.16-0.26 mm in diameter, conical, dark brown in colour; on mid-dorsal trunk papillae structurally similar but less in height in comparison to introvert base and in general, mid-dorsal papillae larger than mid-ventral ones.

Longitudinal muscles grouped into anastomosing bands: 14-19 anteriorly, 18-22 in mid-trunk region, 18-21 posteriorly. Circular muscle layer not separating into bands. Retractor muscles two pair : ventral pair arising from anterior edge of posterior third of trunk from muscle bands 2-6 (1-6, 2-5, 2-7, 3-7) and dorsal pair arising a little ahead of ventrals from muscle bands 5-6 (4-5, 4-6, 4-7, 5-7, 6-7) ; dorsal and ventral of either side fusing in their course before reaching anal level. Oesophagus long and slender tube attached to fused retractor units; intestinal tract with 16-28 coils; rectum moderately long with oval or round caecum. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle originating from first muscle band anterior to base of left dorsal retractor and after bifurcation attached to post-oesophageal gut and rectum near caecum. Wing muscles well developed. Contractile vessel inconspicuous. Nephridia light brown to mapple-wood in colour; about half as long as trunk, reaching between base of dorsal and ventral retractors in majority of specimens; anterior half to two-thirds of them attached to body wall and opening at same level of anus between muscle bands 2-3 or 3-4. Gonads, in some specimens, present at base of ventral retractors and spherical eggs measuring about 0.13 mm in diameter.

Remarks: The species shows variations in external characters such as colour, size and shape of larger papillae of anal region and posterior end of trunk, and the introvert hooks. It is closely related to *Phascolosoma japonicum* but differing from the latter in dark brown and conical preanal papillae, hooks having indistinct triangular space and presence of caecum.

In some specimens 5-11 thin strands of longitudinal muscle band are present. In few cases anastomosis of longitudinal muscle bands is rare and in some others anastomosis observed either at the anterior part of the trunk or below the base of ventral retractors. Only 10 rows of hook observed in two specimens of 30-35 mm long from Diu and Minicoy although Fisher (1952) reported 75 rows of hooks of a 20 mm long specimen. Over and above, number of 13 tentacles counted in a 38 mm long specimen from Neil Island differs from Johnson's specimen collected at Okha, Gulf of Kutch where he in 1971 recorded 35 tentacles.

Fisher (1952) opined that this species is a cold water form and confined between Alaska and California and expressed doubts whether records of this species as summed up by Fischer (1922c) were

valid for this species or not. Edmonds (1956, 1980) considered Fischer's (1919a, 1926b) record of *P. agassizii* from Western Australia to be *Phascolosoma rottnesti* Edmonds by comparing Fischer's figs. 3 and 5. Inspite of Fisher's comment *P. agassizii* was reported from various localities of temperate and tropical waters by Stephen (1960), Wesenberg-Lund (1963), Stephen and Cutler (1969), Johnson (1971), and Cutler and Cutler (1979a).

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a); Okha, Gujarat (Johnson, 1971).

Distribution : The species is one of the most common sipunculans in the intertidal zone of temperate and tropical waters of both the hemispheres. It is reported at a depth of 220 m from Monterey Bay, California (Fisher, 1952).

In India : Gujarat : Okha, Pirotan Island; Diu; Lakshadweep : Minicoy, Kavaratti; South Andamans : Chidyatapu, Neil Island.

Elsewhere :

(a) *Indian Ocean* : Off Mozambique (Cutler and Cutler, 1979a); South Africa (Wesenberg-Lund, 1963; Stephen and Cutler, 1969); Grand Comore Island (Cutler and Cutler, 1979a); Mauritius (Fischer, 1922a); Diego Garcia (Cutler and Cutler, 1979a); Maldives (Shipley, 1903a); Gulf of Mannar (Shipley, 1903b); west coast of Sumatra and Timor (Fischer, 1922a); Western Australia : Shark Bay (Fischer, 1919a, 1926b), Rottnest Island (Fischer, 1926b).

(b) *Pacific Ocean* : Thailand (Fischer, 1923b); Billiton (Fischer, 1922a); Ponape, East Caroline Islands (Fischer, 1895); Port Jackson (Fischer, 1922a); Loyalty (Shipley, 1899a); Tahiti (Fischer, 1922a); Panama (Keferstein, 1866, 1867; Selenka and de Man, 1883; Augener, 1903); Puntarenas (Selenka and de Man, 1883); California (Keferstein, 1866, 1867; Selenka and de Man, 1883; Augener, 1903, Chamberlin, 1919, 1920; Fischer, 1922a; Fisher, 1952; Wesenberg-Lund, 1954a); Vancouver Island (Baird, 1868; Selenka and de Man, 1883; Fischer, 1914b); Alaska (Fisher, 1952).

(c) *Atlantic Ocean* : Bermuda and Villifranche (Fischer, 1922a); Senegal (Stephen, 1960a); western Africa (Fischer, 1914a); Liberia (Fischer, 1914b); Gulf of Guinea (Wesenberg-Lund, 1959c); Angola (Fischer, 1895; Wesenberg-Lund, 1957c); west coast of South Africa (Stephen and Cutler, 1969).

17. **Phascolosoma (Phascolosoma) albolineatum** Baird
(Figs. 30, 104-113)

Phascolosoma albolineatum Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 91-92.
Phymosoma albolineatum : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) *4* (1) : 71-72, pl.9., figs. 128-129.
Physcosoma albolineatum : Fischer, 1913, *Jb. hamb. wiss. Anst.*, **30** : 99.
Phascolosoma andamanensis Johnson, 1971, *J. Bombay nat. Hist. Soc.*, **68** (3) : 603-605, pl. 1, figs.1-7.
Phascolosoma albolineatum : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 153.

Type locality: Philippine Islands. *Location of type*: British Museum (Natural History), London.

Material examined: 3 exs., Great Coco Island, North Andamans, "excavated from coral rock", 3.xii.1889, Coll. R.I. M.S. "Investigator", 5 exs., Andaman Sea, 14°54'30" N, 96°13'00" E, 8 m, 26.i.1897, Coll. R.I.M.S. "Investigator", 8 exs., Trinket, Nancowry Harbour, Nicobars, "amongst stones and corals", 17 exs., Casurina Bay, Great Nicobar, Nicobars, 14.iii.1966; Coll. A. Daniel; 31 exs., Mayabunder, North Andamans, "from coral beach", 15.x.1972, Coll. B.P. Haldar; 8 exs., Port Okha, Gujarat, "from dead corals at low tide", 5.iv.1977, Coll K.N. Reddy; 3 exs., Pirotan Island, Gujarat, "under coral boulders", 20.iv.1977, Coll. B.P. Haldar; 11 exs., eastern side of Minicoy, Lakshadweep, "low water mark", 10.xii.1979, Coll. B.P. Haldar; 27 exs., south-west reef edge, Kavaratti, Lakshadweep, 4.i.1980, Coll. B.P. Haldar; 42 exs., Neil Island, South Andamans, "under stones", 22.ii.1980, Coll. B.P. Haldar, 30 exs., Bangaram, Lakshadweep, "from fissures among coral rocks lying in the low tide marks", 7.iv.1984, Coll. B.P. Haldar; 15 exs., Agatti, Lakshadweep, "from coastal embankment", 8.iv.1984, Coll. B.P. Haldar; 9 exs., Minicoy, Lakshadweep, 12.ii.1986, Coll. D.R.K. Sastry.

Description: Trunk 11-64 mm long with maximum width 17 mm in mid-trunk region, tapering posteriorly; thin-skinned, off-white to pale-straw in colour. Introvert 7.25-44 mm long, more than a half to three-fourths of trunk length, straw coloured, clearly demacrated from trunk by a marked constriction of drak brown colour, narrower and with irregular 5-7 brown bands anteriodorsally. Tentacles 10-20 in number, fleshy, finger-like and arranged nearly in ring dorsal to mouth and also wth greenish tinge on ventral surface. Collar, a smooth nearly white zone, present just behind the tentacular crown. Hooks in 15-30 rows lying behind collar; each hook dark brown, stout with strongly curved (at right angle to main axis) apex, without accessory tooth, clear transparent streak (wide at base and gradually narrowed towards apex), a clear triangular space (towards base of convex side) and a short transverse bar having several minute warts close to its posterior end; hooks measuring 0.05-0.08 mm in height and 0.05-0.10 mm in width at base; anterior few rows small and light coloured.

Papillae on introvert brown coloured, conical, large and closely aggregated at basal part, measuring 0.116-0.164 mm in height and 0.152-0.188 mm in basal width and gradually smaller anteriorly. Between every two rows of hooks a row of small perforated round, transparent papillae measuring 0.006-0.008 mm in diameter present; papillae, behind the rows of hooks, transparent and oval, measuring 0.052 mm x 0.048 mm; on the whole, dorsal ones larger than ventrals, Papillae at posterior end of trunk largest of all and sub-conical, measuring 0.24-0.28 mm in height and 0.175-0.190 mm in basal width but less in abundance that of introvert base; papillae in mid-trunk region small and oval in shape, more scatterly placed and measuring 0.16-0.18 mm x 0.105-0. 115 mm whereas smaller at anterior end of trunk than introvert base.

Longitudinal muscle layer grouped into 17-23 bands: 17-20 anteriorly, 19-21 posteriorly and 20-23 in mid-trunk region. Retractor muscles two pair, originating nearly from middle of trunk; a stout ventral pair from muscle bands 2-6 (3-6, 2-4 or 2-5) and a slender dorsal pair more anteriorly from muscle bands 5-6 (4-5, 6-7 or 6-8), dorsal and ventral retractors of each side fuse with each other and two fused retractor units held together by mesenteries. Oesophagus long and straight tube running more than half of its length over the retractor unit being attached by mesenteries; intestinal coils 12-27 in

number; rectum moderately long (12 mm for 45 mm trunk length); anus opening almost at same level as nephridiopores. Contractile vessel simple and without villi. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle single, arising from first longitudinal muscle band on left side of nerve cord at same level of the base of dorsal retractors; this muscle after bifurcation attached to last intestinal coil or at the beginning of rectum by main thick branch whereas the thinner branch attached to behind the rectal caecum, where present, or to post-oesophageal gut. Wing muscles broad and well developed attaching anal part of rectum to body wall. Nephridia, light brown to brown coloured, about one-half to one-third as long as trunk and anterior half attached to bodywall. Eggs spherical, measuring 0.10-0.12 mm in diameter.

Remarks : The species may be readily recognised by the shape of the hook, the apex of which is so strongly bent that it forms a right angle to the base and a clear triangular space (towards base of convex side).

In living state the animal shows a beautiful light vermilion colour but in preserved state the colour becomes pale straw. Both sharp and blunt (tip becomes either broken or worn out) apical tooth occur in the same row. In some specimens from Neil Island, South Andamans, in addition to 20 thick and strong longitudinal muscle bands there are also present some thin strands. In some, anastomosation is highly marked where the thin longitudinal muscle bands present. Dorsal and ventral retractor muscles in several specimens are equally strong and the union of retractors on each side varies from specimen to specimen. Rectal caecum, an elongated structure, present in 20% of the specimens examined though its absence is noted in the holotype (re-examined by Stephen and Edmonds, 1972) and in Australian specimens (Edmonds, 1980). In most of the specimens the anal opening is mounted on anal cone or knob-like projection. In young individuals introvert bands may be absent. Absence of left or right nephridium in a few specimens is an abnormal case.

P. andamanensis was described by Johnson (1971) from Port Blair, Andaman Islands. The author made a through search in several localities of Port Blair in 1978 and 1980 but was able to collect only *P. albolineatum*. In the absence of Johnson's type specimens the author has to depend on his description and illustrations (pl.1, figs. 1-7). Internal anatomy of *P. albolineatum* closely agrees with Johnson's description. Papilla (fig.7) on mid-dorsal trunk is similar as figured by the author and hooks of the examined specimens show no difference except the presence of bar with warts at base of hooks. Absence of bar and presence of warts at the base of hook of *P. albolineatum* are noticed in the figure given by Edmonds (1980), and Cutler, Cutler and Nishikawa (1984). So, the author feels the absence of only warts or bar with warts at the base of hook is of little biological significance to differentiate the species and hence, a suggestion is being made to consider *P. andamanensis* as a junior synonym of *P. albolineatum*. And as a result, specimens of Little Andaman reported as *P. andamanensis* by the author in 1976 are, no doubt, *P. albolineatum*.

Previous Indian Records : Port Blair, South Andamans (Johnson, 1971); Little Andaman (Haldar, 1976).

Distribution : This is a shallow water tropical species widely distributed in the Indo-West Pacific region.

In India : Gujarat, Lakshadweep; Andamans and Nicobars.

Elsewhere :

(a) *Indian Ocean* : Somali coast (Murina, 1981b), east coast of Africa (Fischer, 1926a); Natal (Fischer, 1922a); Diego Garcia (Cutler and Cutler, 1979a); south coast of Java and Timor (Fischer, 1922b).

(b) *Pacific Ocean* : Japan (Sato, 1939; Cutler, Cutler and Nishikawa, 1984); Korea (Sato, 1939); Formosa (Fischer, 1922a; Sato, 1939); Tokara Island (Tokioka, 1953); West Caroline Islands (Ikeda, 1924; Sato, 1935); Marshall Islands (Cutler, Cutler and Nishikawa, 1984); Indo-China (Leroy, 1942); Philippines (Baird, 1868); Amboina (Augener, 1903); Queensland (Edmonds, 1980).

18. **Phascolosoma (Phascolosoma) arcuatum** (Gray)
(Figs. 28, 29, 120-125)

Sipunculus arcuatus Gray, 1828, *Spicilegia Zoologica*, London, Treiitel, Wurtz and Co., and W. Wood, (1) : 8.
Phascolosoma arcuatum : Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 88.
Phymosoma lurco Selenka ane de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) 4 (1) : 61-63, pl.1, fig.5; pl.8, figs.103-110.
Physcosoma rhizophora Sluiter, 1891, *Natuurk. Tikdschr. Ned. Indie*, **50** : 119-121, pl.1., figs.5-9; pl.2, figs.10-12.
Physcosoma lurco : Fischer, 1895, *Abh. Geb. naturw. Hamburg*, **13** : 12.
Phymosoma deani Ikeda, 1905, *Annotnes zool. Jap.*, **5** : 171-172, pl.8, figs. 5-8.
Phascolosoma lurco : Edmonds, 1956, *Aust. J. mar. Freshwat. Res.*, **7** : 290-291, text-fig.10.
Physcosoma esculenta Chen and Yeh, 1958, *Acta zool. sin.*, **10** : 273-274, text-figs. 1-2.
Phascolosoma (Phascolosoma) arcuatum : Haldar, 1989, *Rec. zool. Surv. India*, **85** (4) : 533-538.

Type locality : India. *Location of type* : Brtish Museum (Natural History), London.

Material examined : 2 exs., Cox's Bazar, Chittagong District, Bangladesh (formerly East Bengal under India), "mudflats in the tidal creeks at low tide, near the mouth of Bagkhali River", 27.ii.1938, Coll. B.N. Chopra; 3 exs., Mayabunder, North Andamans, "from rock crevices", 13.x.1972, Coll. B.P. Haldar; 8 exs., Chemaguri, Sagar Island, West Bengal, "in mangrove mudflat of River Mooriganga above M.H. W.S.", 6.xi.1979, Coll. B.P. Haldar; 11 exs., Gangasagar, Sagar Island, West Bengal, "from black humus soil of mouth of River Hooghly", 3.iii.1980, Coll. B.P. Haldar; 20 exs., Canning, West Bengal, "from mudflat of River Matla at M.H. W.S.", 19.ix.1984, Coll. A Misra; 21 exs., Jharkhali, Sundarbans, West Bengal, "in mangrove mudflat of a canal connected to River Herobhanga below M.H.W.N.", 22.ix.1984, Coll. B.P. Haldar; 15 exs., Bakkhali, 24-Parganas, West Bengal, "from a canal connected to the Bay of Bengal, at M.H.W.N.", 5.iii. 1985, Coll. B.P. Haldar.

Description : Trunk 33-65 mm long and 15-32 mm wide, stout and about uniformly cylindrical; pale brown to brown coloured but anterior and posterior extremities dark brown. Introvert slender, retracted in most of the specimens, 40-102 mm long. Tentacles 8-10 in number, finger-like, arranged in a horseshoe-shape and placed dorsal to mouth. Collar white, lies behind tentacular crown, followed

by closely set 58-65 complete rows of hooks on introvert; a zone of scattered hooks present behind regular rows of hooks; hook dark coloured, measuring 0.050-0.065 mm in height and 0.055-0.065 mm in width at base and sharply bent apex forming an obtuse angle, with clear central streak running from apex to base and lacking a separate triangular area.

Papillae dark brown to blackish brown, distributed all over the body; mid-trunk papillae sparsely distributed, more or less round in top view, small, 0.2 mm in height; at introvert base, anterior and posterior extremities of trunk these are comparatively larger and densely aggregated, mammiform 0.35-0.50 mm in height but those between rows of hooks small, elliptical in top view, measuring 0.075 mm x 0.060 mm.

Circular and longitudinal muscle layers grouped into bands. Circular muscle bands narrow, numerous, and closely placed. Longitudinal muscles 18-22 separate, stout and with less anastomosing bands. Retractor muscles two pair, originating more or less at the same level from posterior fifth or sixth of trunk; out of which two broad posterior ones from muscle bands 1-3 (2-3 or 2-4) and two slender anterior ones, just or a little ahead of and under the cover of the former, from muscle bands(s) 1 or 1-2, immediately after their origin two posterior ones uniting together to form a single posterior muscle to which anterior ones joining on the way and thereby forming a single wide and stout retractor muscle. Oesophagus long and narrow, anterior half attached to retractor unit; intestinal coils 42-72 in number. Spindle muscle stout, passing through intestinal coils remains attached to posterior extremity of trunk and anteriorly in front of anus; rectum short and without caecum. Contractile vessel simple and without villi. Fixing muscle absent but broad well developed wing muscles present. Nephridia tubular, brown to dark coloured, one-third as long as trunk and attached to body wall for two-thirds of their length and opening at same level as anus between muscle bands 4-5 or 5-6. Nephrostomes small and funnel-shaped. Gonads present at base of anterior retractors.

Remarks : This species may be identified by the structure of introvert hooks and the nature of retractor muscles which are fused immediately after their origin to form a single retractor unit.

Usual arrangement of retractor muscles is totally reverse in this species of *Phascolosoma, i.e.*, anterior muscles arise behind and ventral to posterior ones. Nature of fusion of these muscles shows deviation from Selenka and de Man's (1883) figure (pl.8, fig. 103) and Rice and Stephen's (1970) figure (pl.1, fig.1). Specimens from Cox's Bazar show no anastomosation in the longitudinal muscle bands whereas those from Mayabunder show marked anastomosation. *Physcosoma rhizophora* described by Sluiter (1891) which possesses 17 longitudinal muscle bands that scarcely anastomose and 50 rows of hooks, is very similar to specimens from Cox's Bazar.

After critical examination of Ikeda's type specimen *Phymosoma deani* and careful reading and comparison of illustrations of Chen and Yeh's *Physcosoma esculenta* Cutler and Cutler (1981) synonymised these two species under the present one. The present author reserves his comment in this regard.

Perusal of literature on Sipuncula so far reveals no Indian estuarine species excepting an anonymous species of *Physcosoma* Selenka (=*Phascolosoma* Leuckart) which has been recorded from a brackish pond in a mangrove zone at Port Canning, Lower Bengal by Annandale (1907). After a

thorough search at the aforesaid locality the present author has collected a good number of examples of *P. arcuatum* only. Therefore, every probability is that Annandale's specimen which is not traceable now belongs to *P. arcuatum*. Incidentally, the specific type locality of *P. arcuatum* from India was not given in the original description by Gray (1828) or in Rice and Stephen's (1970) work.

The species can thrive well in semiterrestrial habitat and found throughout the intertidal zone starting from above the mean high water spring tide to below the mean low water spring tide levels, being exposed to a marked degree of varying salinity ranging from 0.5% to 15% in different areas of the Hooghly Matla estuarine system in West Bengal. Similar observations were also made by Harms and Dragendorff (1933) and Green (1975) on the occurrence of the species in other mangrove belts of Australo-oriental region.

Previous Indian Records : India. [No specific locality, Gray (1828)] West Bengal (Haldar, 1985a, b).

Distribution : This is a Indo-West Pacific species found in tropical shallow waters.

In India : West Bengal; North Andamans; India.

Elsewhere:

(a) *Indian Ocean* : Bangladesh (present record); Singapore and Malacca (Selenka and de Man, 1883); Malay (Lanchester, 1905c; Chuang, 1965); Java (Sluiter, 1891); Western Australia (Edmonds, 1980).

(b) *Pacific Ocean* : Philippines (Selenka and de Man, 1883; Fischer, 1922a; Ikeda, 1905); China (Fischer, 1914b; Leroy, 1936; Chen and Yeh, 1958); South China Sea (Murina, 1964b); Indo-China (Leroy, 1936); Sunda Island (Harms and Dragendorff, 1933); Queensland in Australia (Fischer, 1895; Edmonds, 1956, 1980; Green, 1975).

19. **Phascolosoma (Phscolosoma) granulatum** Leuckart
(Figs. 31, 114-116)

Phascolosoma granulatum Leuckart, 1828, *Breves animalium quorundam maxima ex parte marinorum descriptiones*. Heidelberg : 22, text-fig.5.
Phascolosoma laeve Cuvier, 1830, *Regne animal*, **3** : 243.
Sipunculus verrucosus Cuvier, 1830, *Regne animal*, **3** : 243-244.
Sipunculus papillosum Thompson, 1840, *Ann. Mag. nat. Hist.*, **5** : 101.
Syrinx papillosum : Forbes, 1841, *A History of British star-fishes* : 247.
Syrinx granulatum : McCoy, 1845, *Ann. Mag. nat. Hist.*, **15** : 272.
Sipunculus multitorquatus Quatrefages, 1865a, *C.r. hebd. Seanc. Acad. Sci. Paris*, **40** (13) : 621.
Sipunculus spinicaudus Quatrefages, 1865a, *C.r. hebd. Seanc. Acad. Sci. Paris*, **40** (13) : 621.
Phascolosoma jeffreysii Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 88-89.
Phascolosoma fasciatum Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 89.
Phascolosoma loveni Koren and Danielssen, 1877, [In] Sars, M., *Fauna Littoralis Norwegiae*, **3** : 128.
Physcosoma granulatum : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr.C. Semper*, (2) **4** (1) : 79-82, pl.10, figs. 147-151, pl.11, figs.152-155.

Phymosoma granulatum : Collin, 1892, *Arch. Naturgesch*, **58**:181.
Phymosoma herouardi Herubel, 1903, *Bull. Soc. zool. Fr.*, **28** : 107.
Phascolosoma lanzarotae Harms, 1921, *Arch Entw. Mech. Organ.*, **47** : 307.
Phascolosoma granulatum : Wesenberg-Lund, 1957a, *Bull. Res. Coun. Israel*, **6B** (3 & 4) : 194-197, text-figs. 1-2.
Phascolosoma (Phascolosoma) granulatum : Cutler and Cutler, 1990, *Proc. biol. Soc. Wash.*, **103**(3) : 709-710, figs. 2A, 5A, 6F.

Type locality : Cette, France. *Location of type* : Not known.

Material examined : 3 exs., Little Andamans. "low water tide marks", 3.iii.1961, Coll. A. Daniel; 2 exs., Rameswaram, Gulf of Mannar, Tamil Nadu, 8.ii.1973, Coll. K.V. Rama Rao; 4 exs., Rangat Bay, Middle Andamans, "under loose stones", 26.ii.1980, Coll. B.P. Haldar.

Description : Trunk 15-35 mm in length and 15 mm in maximum width in mid-trunk region, thick and opaque-skinned, cylindrical, gradually narrowed down posteriorly, gray to dark brown in colour with darker patches on dorsal side. Introvert fully retracted in almost all the specimens examined; 12-28 mm in length, about as long as trunk; with irregular transverse bands on dorsal side. Tentacles 15-19 in number, short, digitiform and with bluish tinge on inner surface. Hooks in 25-35 rows, dark brown, with sharp and strongly curved apical tooth, small accessory tooth and without triangular area; provided with narrow, clear, transparent streak without any expansion and also basal bar with warts; measuring 0.040-0.055 mm in height and 0.05-0.06 mm in width at base.

Papillae covering whole body surface but especially dense at introvert base and extremities of trunk where papillae conical and dark tan in colour, measuring 0.20-0.25 mm in height and 0.18-0.22 mm in diameter but on ventral surface of the trunk these becoming dome shaped and scatterly placed and covering with small polygonal chitinous plates; between rows of hooks papillae small, oblong, arranged in rows and measuring 0.018 mm x 0.021 mm.

Longitudinal muscles gathered into slightly anastomosing bands : 18-20 anteriorly, 20-22 in mid-trunk region and 23-25 posteriorly. Retractor muscles two pair and more or less equally strong; ventral pair arising from posterior edge of middle third of trunk from muscle bands 1-5 or 2-6 and dorsal pair a little anterior to ventrals from muscle bands 5-9 or 6-10; dorsal and ventral retractors of the same side fusing with each other in their course. Oesophagus long and slender; intestinal tract with 8-12 coils; rectum long, straight tube and without rectal caecum; anal part fixed to the body wall by wing muscles. Spindle muscle strong and attached both anteriorly and posteriorly. Fixing muscle single, originating from first or second muscle band at same level of the base of left dorsal retractor muscle and attached to first intestinal coil. Contractile vessel without villi. Nephridia brown coloured, about half as long as trunk, reaching up to base of dorsal retractor muscles, anterior half to three-fifths of their length attached to body wall and opening more or less at same level of anus between muscle band 2 and 3.

Remarks : The species may be easily distinguished from *Phascolosoma nigrescens* by the less number of rows of hooks (in *P. nigrescens* 28-55 complete rows besides some incomplete and scattered hooks) and absence of an expansion of clear transparent streak either at base or towards concave side

of hook.

The specimens at hand are mostly medium sized. The number of rows of hooks in the adult (60 mm trunk length) and immature form (4 mm trunk length) is reported to be 60 (Selenka and de Man, 1883 and Wesenberg-Lund, 1957a) and 13 (Cutler and Cutler, 1979b) respectively. Similarly, the number of tentacles varies between 26 and 10 (Selenka and de Man, 1883, and Cutler and Cutler, 1979b). Clear triangular area in the smaller, paler hooks as observed by Cutler and Cutler 1979b) is neither present in the specimens examined nor reported so far in the literature. This species appears to lack rectal caecum (Stephen and Edmonds, 1972) and is without contractile vessel villi (Stephen and Edmonds, 1972; Zavodnik and Murina, 1976) but Wesenberg-Lund (1957a) stated the presence of rectal caecum in three specimens and contractile vessel villi in several ones. Neither of these structures are observed in the specimens studied. In a specimen from Rameswaram Island, Gulf of Mannar, the fixing muscle is bifurcated and attached to post-oesophageal gut and beginning of rectum.

Previous Indian Records : None

Distribution: The species is tropico-temperate shallow water form although reported once from a depth of 1504-2050 m in northern Atlantic (in Murina, 1981b).

In India : Andaman Islands; Rameswaram, Gulf of Mannar (Tamil Nadu).

Elsewhere :

(a) *Indian Ocean* : Red Sea (Wesenberg-Lund, 1957b); Djibouti (Herubel, 1903); Somali coast (Murina, 1981b); Zanzibar (Collin, 1892; Fischer, 1895); Buffalo Bay, South Africa (Wesenberg-Lund, 1959a); Mauritius (Wesenberg-Lund, 1959b); Mergui Archipelago (Haldar, 1975).

(b) *Pacific Ocean* : Korea (Sato, 1939); West Caroline Islands (Sato, 1935).

(c) *Atlantic Ocean* : Off Brazil (Cutler and Cutler, 1979b); Cape Verde Islands (Sluiter, 1912; Fischer, 1914a, 1931; Wesenberg-Lund, 1959a; Cutler and Cutler, 1979b); West Africa (Fischer, 1895); Cape of Good Hope and False Bay (Wesenberg-Lund, 1959a); Azores (Baird, 1868); Selenka and de Man, 1883; Fischer, 1922a; Chapman, 1955); Ireland (Thompson, 1840; McCoy, 1845; Fischer, 1913; Southern, 1913a); British Isles (Forbes, 1841; Stephen, 1934); Norway (Koren and Danielssen, 1877); France (Leuckart, 1828; Selenka and de Man, 1883; Cuenot, 1922; Fischer, 1922a); Tangier (Herubel, 1924); Morocco (Herubel, 1925); Mediterranean Sea (Keferstein, 1865a; Fischer, 1913, 1926a); Minorca (Selenka and de Man, 1883); Sicily (Keferstein, 1865a; Selenka and de Man, 1883; Augener, 1903; Fischer, 1913), Neapal (Keferstein, 1865a; Selenka and de Man, 1883; Fischer, 1895, 1922a); Adriatic Sea (Keferstein, 1865a; Selenka and de Man, 1883; Fischer, 1922b; Zavodnik and Murina, 1975, 1976); Rhodes and Beiruth (Fischer, 1922a); Haifa (Stephen, 1958).

20. **Phascolosoma (Phascolosoma) japonicum** Grube
(Figs. 117, 118)

Phascolosoma japonicum Grube, 1877, Vierundfunfzigster Jahresbericht der Schles. Gesellschaft fur vaterlandischer Cultur, Breslau : 73.

Phymosoma japonicum : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 76-78, pl.2, figs.18-19, pl.10, figs. 145-146,
Physcosoma japonicum : Selenka, 1887, *J. Linn. Soc.* (Zool.), **21** : 220.
Physcosoma yezoense Ikeda, 1924, *Jap. J. Zool.*, **1** : 32-34, pl.1, figs. 3-6.
Physcosoma glaucum Sato, 1930, *Sci. Rep. Tohoku Imp. Univ.*, (4) **5** : 15-17, pl.1, fig.6, pl.2, figs. 7-8, text-fig.4.
Phascolosoma golikovi Murina, 1975c, *Vest. Zool.*, No. 197 : 54-55, fig.1.
Phascolosoma japonicum : Haldar, 1991a, *Rec. zool. Surv. India*, **87**(1) : 153.

Type locality : North Japan. *Location of type* : Zoological Museum , Humboldt University, East Berlin.

Material examined : 1 ex., Tangassery near Quilon, Kerala, 24.i.1976, Coll. P.K. Chandra; 2 exs., Dwaraka, Gujarat, "from rock crevices", 10.iv.1977, Coll. K.N. Reddy; 1 ex., Pirotan Island, Gulf of Kutch, 20.iv.1977, Coll. D.R.K. Sastry; 2 exs., Minicoy, Lakshadweep, "under coral boulders on reef edge", 14.xii.1979, Coll. B.P. Haldar; 3 exs., Peel Island, South Andamans, "under stones at low tide", 15.ii.1980, Coll. B.P. Haldar.

Description : Trunk 18-40 mm long and 4-9 mm wide, both ends tapering gradually, semitransparent to opaque-skinned, yellowish gray to light brown in colour. Introvert, partially retracted in all but one, distinctly narrower than trunk, 8-25 mm long, nearly half as long as trunk and without any transverse band on dorsal surface. Tentacles 18-20, finger-shaped and arranged in a semicircle. 30-35 rows of hooks lying behind tentacular crown; hook dark brown in colour having broad base, a small accessory tooth, central clear streak without any expansion, without clear triangular area but with basal bar with warts, measuring 0.035-0.040 mm in height and 0.040-0.045 mm in width at base.

Papillae small, perforated, arranged in a ring between every two rows of hooks and measuring 0.013 mm in height and 0.016 mm in width; larger cone-shaped papillae densely packed at posterior extremity of trunk and introvert base where they are not posterioly directed, measuring 0.20-0.25 mm in height and 0.18-0.23 mm in width; those in mid-trunk region measuring 0.09-0.12 mm in height and 0.13-0.17 mm in width and covering with large polygonal chitinous plates.

Longitudinal muscle layer grouped into 20-26 highly anastomosing bands. Retractor muscles two pair : ventral pair arising from posterior edge of middle third trunk from muscle bands 2-7 (2-8, 3-9) while slender dorsal pair from mid-trunk level from muscle bands 5-6, (6-8); dorsal and ventral of either side fusing at anal level into a single unit. Oesophagus long and tubular; intestinal coils 10-16 in number; rectum short and without rectal caecum; anal part fixed to body wall by strong wing muscles. Spindle muscle strong and attached at both ends. A single fixing muscle originating at same level of the base of left dorsal retractor and attached to first intestinal coil. Contractile vessel without villi. Nephridia brown in colour, almost half as long as trunk, extending nearly base of dorsal retractors and attached to body wall by anterior halves and opening nearly at same level as anus between muscle bands 2 and 3.

Remarks : The species closely resembles *Phascolosoma agassizii* but differs from the latter by the hooks having breadth greater than height, and also by the absence of rectal caecum.

In a specimen from Minicoy, Lakshadweep, single fixing muscle after bifuraction is attached to post-oesophageal gut and first intestinal coil and in the other, the number of longitudinal muscle bands is 30 as observed by Wesenberg-Lund (1963) in the study of a specimen from South Africa. The single specimen from Tangassery, Kerala, possesses only left dorsal retractor and ventral retractors span only 3 muscle bands. Distinct clear triangular area on the convex side of hook is neither shown in fig. 145 of Selenka and de Man (1883) nor in -text-fig. 2 of Sato (1930). The same is stated by Fisher (1952), and described and figured by Wesenberg-Lund (1963).

Two Pacific records of this species from Vancouver Island (Chamberlin, 1920) and Port Jackson (Selenka and de Man, 1883 and Fischer, 1922a) were re-examined by Fisher (1952) and Edmonds (1956) respectively and identified the species as *Phascolosoma agassizii* Keferstein and *Phascolosoma noduliferum* Stimpson respectively.

Phascolosoma yezoense (Ikeda, 1924), *Phascolosoma glaucum* (Sato, 1930) and *Phascolosoma golikovi* Murina (1975c) were considered as junior synonyms of *Phascolosoma japonicum* Grube (1877) by Cutler and Cutler (1981, 1983) as the species were erected on the basis of one or two individuals and their characters fall within the variational range of *Phascolosoma japonicum.*

Previous Indian Records : None,

Distribution : This is wide spread in Indo-Pacific shallow water. This has not so far been recorded from the Atlantic except for Buffels River (29°S) on the west coast of South Africa (Wesenberg-Lund, 1963).

In India : Gulf of Kutch; Gujarat; Lakshadweep; Kerala; Andamans.

Elsewhere :

(a) *Indian Ocean* : Mombasa (Cutler, 1977b); South Africa (Fischer, 1916; 1922a, 1922b; Stephen, 1942b; Wesenberg-Lund, 1963; Stephen and Cutler, 1969); Mergui Archipelago (Selenka, 1887; Haldar, 1975).

(b) *Pacific Ocean* : Japan (Grube, 1877; Selenka and de Man, 1883; Ikeda, 1904, 1924; Sato, 1937a, 1939; Murina, 1975d; Cutler, Cutler and Nishikawa, 1984); Formosa and Korea (Sato, 1930); Philippines (in Wesenberg-Lund, 1963); New Britain (Fischer, 1895); Fiji (in Fischer, 1922a); New Zealand (Cutler, 1977b).

(c) *Atlantic Ocean* : Buffels River (Wesenberg-Lund, 1963).

21. **Phascolosoma (Phascolosoma) nigrescens** Keferstein
(Figs. 32, 126-128)

Phascolosoma nigrescens Keferstein, 1865a, *Z. wiss. Zool.*, **15** : 424, pl.31, fig.2, pl.32, figs. 14-15.
Sipunculus (Phymosomum) nigrescens : Quatrefages, 1865b, *Histoire naturelle des Anneles marins et d'eau douce.* Paris, **2** : 623.

Phascolosoma planispinosum Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 93.
Phymosoma nigrescenes : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) 4 (1) : 72-74, pl.9, figs. 130-137.
Physcosoma nigrescens : Fischer, 1913, *Jb. hamb. wiss. Anst.*, **30** : 98.
Phascolosoma nigrescens : Haldar, 1991a, *Rec. zool. Surv. India*, **87**(1) : 154.

Type locality : Fiji. *Location of type* : Zoological Museum, Humboldt University, East Berlin.

Material examined : 5 exs., Mandapam Camp, Tamil Nadu, 6.i.1964, Coll. V.K. Premkumar; 7 exs., West of Havelock Island, South Andamans, 20.ii.1974, Coll. K.V.Surya Rao; 10 exs., near Rameswaram temple, Tamil Nadu, "from crevices of rocks at low tide", 28.ii.1975, Coll. B.P.Haldar; 2 exs., Camorta, Nicobars, 25.i.1976, Coll. D.R.K. Sastry; 4 exs., Okha, Gujarat, "from corals at low tide", 9.iv.1977, Coll. B.P.Haldar ; 11 exs., Androth, Lakshadweep, "from calcareous rock platform", 19.xii.1979, Coll. B.P.Haldar ; 5 exs., Mayabunder, North Andamans, "from dead corals", 28.ii.1980, Coll. B.P.Haldar ; 14 exs., Rangat, Middle Andamans, "from sandpool surrounded by dead corals", 4.iii.1980, Coll. B.P. Haldar; 15 exs., Agatti, Lakshadweep, 5.iv.1984, Coll. A. Misra; 6 exs., Minicoy, Lakshadweep, 18.ii.1986, Coll. D.R.K. Sastry.

Description : Trunk 7-36 mm long and 3-17.5 mm wide, off-white to light dirty yellow in colour but posterior part somewhat darker, thick-skinned and tapering posteriorly. Introvert, partially retracted in majority of specimens, 7-50 mm long but narrower than trunk. Tentacles 20-22 in number, short, digitiform, arranged in an incomplete ring-like manner and placed dorsal to mouth. Collar white, smooth and lying behind tentacular crown. 28-55 complete rows of hooks followed by some incomplete rows and scattered hooks; each hook brown to dark brown in colour having gently curved and pointed apex but blunt accesory tooth; with a clear transparent streak having slight expansion at middle but basal expansion variable; basal bar with warts and lacking a separate triangular area, and measuring 0.09-0.10 mm in height and 0.085-0.10 mm in width at base.

Papillae covering the whole body surface but dark coloured, largest, mamiform and closely placed at introvert base and posterior end of trunk; measruing about 0.2 mm in height and 0.15-0.2 mm in width at base; between rows of hooks papillae conical, measuring 0.05-0.08 mm in height and 0.08-0.11 mm in width at base while those at anterior third of trunk concial, flask-shaped and measuring 0.20-0.25 mm in height and 0.25-0.30 mm in width at base.

Longitudinal muscles grouped into bands which frequently anastomose : 20-27 anteriorly, 28-32 in mid-trunk region and 23-29 posteriorly. Retractor muscles two pair, stout ventral pair originating from anterior edge of posterior third of trunk from muscle bands 3-8 (2-6, 2-8 or 3-9) and weak dorsal pair from mid-trunk region from muscle bands 6-8 (4-5, 4-7, 5-9, 6-9 or 7-10); dorsal and ventral of each side fusing in their course. Oesophagus thin-walled and being attached to fused retractor units; intestinal tract with 16-35 coils; rectum short and without rectal caecum. Spindle muscle strong and attached at both ends. Fixing muscle(s) 1 (bifurcated)-2, being attached to post-oesophageal gut and in some cases either to first intestinal coil or at beginning of rectum. Contractile vessel simple and without villi. Wing muscles well developed. Nephridia brown coloured, about half as long as trunk; anterior half fixed to body wall and opening at same level as anus between muscle bands 2-3 or 3-4. Gonads prominent in some specimens. Eggs elliptical, measuring 0.11 mm x 0.12 mm.

Remarks: The identification of these specimens depends largely on the structure of the introvert hooks where apex is pointed but gently curved and separate triangular area is lacking.

In most of the specimens dark pigmented transverse bands on dorsal surface of the introvert are either present or feebly developed. These are absent in the specimens from South African waters as referred to by Wesenberg-Lund (1963). Cutler and Cutler 1979a) observed a separation of a triangular area the anterior basal region at least in a few hooks as found in *Phascolosoma scolops*. This character is neither observed in the present specimens nor by any other workers. The number of longtitudinal muscle bands reported by earlier workers shows a wide range of variations *i.e.*, 20 (Edmonds, 1980; Wesenberg-Lund, 1963); 20-24 (Edmonds, 1956); 22-26 (Haldar, 1975); 22-30 (Sato, 1939); 25-30 (Selenka and de Man, 1883; Stephen and Edmonds, 1972). The number of longitudinal muscle bands in the present specimens falls within this range (20-32). Regarding the presence or absence of rectal caecum there is a difference of opinion : Fisher (1952), Wesenberg-Lund (1963) and Edmonds (1980) noted its presence whereas Sato (1939), Edmonds (1956), and Stephen and Edmonds (1972) clearly stated its absence. On the other hand, Selenka and de Man (1883) did not mention anything about it. Similrly, opinion varies about the presence or absence of contractile vessel villi. Its presence was confirmed by Selenka and de Man (1883), and Stephen and Edmonds (1972) while its absence was recorded by Sato (1939), Edmonds (1956, 1980) and Wesenberg-Lund (1963). The specimens under study show neither the presence of rectal caecum nor the contractile vessel villi. On re-examination it is found that the vessel villi which the author in 1975 reported for this species are actually bulbous swellings.

Previous Indian Records : Krusadai Island, Gulf of Mannar (Gravely, 1927); Madras (Haldar, 1975); South Andamans (Haldar, 1976); Great Nicobar (Cutler, 1977a).

Distribution : This is a common circumtropical and subtropical shallow water species.

In India : Gujarat; Lakshadweep : Minicoy, Androth and Agatti; Tamil Nadu : Madras, Mandapam Camp, Rameswaram and Krusadai Island; Andamans : North, Middle and South; Nicobars : Camorta and Great Nicobar.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Selenka and de Man, 1883; Stephen, 1941, 1965; Wesenberg-Lund, 1957b); Somalia -- Gulf of Aden (Herubel, 1904b; Murina, 1970, 1981b; Cutler and Cutler, 1979a); Mombasa (Cutler, 1977a); Zanzibar (Lanchester, 1905b; Stephen and Robertson, 1952); Mozambique (Fischer, 1913; Cutler and Cutler, 1979a); Grand Comore Island (Cutler and Cutler, 1979a); Madagascar, (Fischer, 1895; Herubel, 1908; Hammarstein, 1915; Cutler, 1965; Cutler and Kristeur, 1968 ; Cutler and Cutler, 1979a); east coast of South Africa (Fischer, 1913; Stephen, 1942b; Wesenberg-Lund, 1963; Cutler, 1977a) ; Mauritius (Selenka and de Man, 1883; Fischer, 1922b; Wesenberg-Lund, 1959b); Diego Garcia (Cutler and Cutler, 1979a); Chagos (Fischer, 1922b); Off south of Sultanate of Oman (Stephen, 1941); Maldives (Shipley, 1903a); Ceylon (Fischer, 1922b); Off Burma (Cutler and Cutler, 1979a); Off Singapore (Cutler, 1977a); Malay (Lanchester, 1905c); south-west of Sumatra and Cocos Keeling (Cutler and Cutler, 1979a); Western Australia : Broom (Edmonds, 1980); Cape Jaubert (Fischer, 1921); Shark Bay (Fischer, 1919a, 1926b); Cape Dennison (Edmonds, 1956).

(b) *Pacific Ocean* : Japan (Cutler, Cutler and Nishikawa, 1984); Formosa (Sato, 1939); West Caroline Island (Fischer, 1895; Sato; 1939); Philippines (Selenka and de Man., 1883; Cutler, 1977a); South China Sea (Murina, 1964b); Amboina (Augener, 1903); Edam (Fischer, 1922a); Queensland (Monro, 1931; Edmonds, 1956, 1980); New South Wales (Edmonds, 1980); Vulcan Island (Fischer, 1926); New Britain (Collin, 1901); Fiji (Keferstein, 1865a; Selenka and de Man, 1883); Funafuti (Shipley, 1898); Honolulu (Fischer, 1922a).

(c) *Atlantic Ocean* : Cuba (Murina, 1967a); Costa Rica (Fischer, 1913); St. Berthelemy (Fischer, 1922a); Off Brazil (Cutler and Cutler, 1979b); east coast of South America (Fischer, 1922b); Cape Verde Island (Fischer, 1913; Wesenberg-Lund, 1959a); Off French Guinea (Wesenberg-Lund, 1959a); Gold Coast (Fischer, 1895); Annobon (Fischer, 1913; Stephen, 1942a); Angola (Wesenberg-Lund, 1954a); Ascension (Stephen, 1942a); Cape Penninsula (Wesenberg-Lund, 1963); Tristan da Cunha (Stephen, 1942a).

22. **Phascolosoma (Phascolosoma)pacificum** Keferstein
(Figs. 33, 129, 130)

Phascolosoma pacificum Keferstein, 1866, *Nachr. Ges. wiss. Gottingen*, **1866** : 8-9.
Phymosoma pacificum : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 63-65, pl.1, fig.6, pl.7, figs. 111-112.
Physcosoma pacificum : Shipley, 1898, *Proc. zool. soc. Lond.*, **1898** : 470, pl.37, fig.6.
Phascolosoma pacificum : Haldar, 1991a, *Rec. zool. Surv. India*, **87**(1) : 154.

Type locality : Kingsmill Islands (Gilbert-and Tarawa Island). *Location of types* : Zoological Museum, Humboldt University, East Berlin.

Material examined : 2 exs., Havelock Island, South Andamans, 21.ii.1974, Coll. K.V. Surya Rao; 2 exs., Quilon, Kerala, 3.i.1979, Coll. P.K. Chandra; 10 exs., Okha, Gujarat, 9.iv.1977, Coll. K.N. Reddy; 5 exs., Veraval, Gujarat, 24.i.1978, Coll. D.R.K. Sastry; 7 exs., Port Blair, South Andamans, "from rocks at lower intertidal zone, " 29.iv.1978, Coll. B.P. Haldar; 8 exs., Minicoy, Lakshadweep, "reef edge", 12.xii.1979. Coll. B.P. Haldar; 9 exs., Mayabunder, North Andamans, "from crevices of corals:, 28.ii.1980, Coll. B.P. Haldar; 7 exs., Agatti, Lakshadweep, 12.ii.1986, Coll. D.R.K. Sastry; 5 exs., Minicoy, Lakshadweep, 14.ii.1986, Coll. D.R.K. Sastry.

Description : Trunk 28-62 mm long, majority of specimens between 45 and 54 mm, with maximum width 23 mm at posterior part of middle third of trunk, thick-skinned with rough texture, light brown to rusty brown in colour. Introvert, 32-86 mm long, more than trunk length, brown in colour, generally having irregular pigmented bands on dorsal surface. Tentacles 27-30 in number, digitiform and arranged nearly in a ring dorsal to mouth. 60-98 complete rows of hooks besides some incomplete rows and scattered hooks behind; each hook large, brown to dark brown in colour with sharp and strongly curved apical tooth; with clear central streak and triangular area, and basal bar with warts, measuring 0.07-0.10 mm in height and 0.85-0.10 mm in width at base.

Papillae covering the whole introvert and trunk surface but tallest at posterior end of trunk;

between anterior most rows of hooks papillae almost round in shape, measuring 0.02 mm in diameter and between posterior rows of hooks these are conical, measuring 0.10-0.12 mm in height and 0.10-0.13 mm in width at base, but gradually becoming taller behind the rows of hooks, measuring 0.15-0.18 mm in height and 0.20-0.22 in width at base; those at posterior end of trunk measuring 0.20-0.24 mm in height and 0.24-0.27 mm in width at base.

Longitudinal muscles grouped into bundles with considerable anastomosation : 20-23 anteriorly, 35-40 at posterior edge of middle third of trunk. Retractor muscles two pair; ventral pair stout, arising from posterior edge of middle third of trunk from muscle bands 2-8 (2-10, 3-10, 3-11, 4-10) and dorsal pair more anteriorly from muscle bands 4-7 (3-6, 5-9, 5-10, 6-10); dorsal and ventral retractor muscle of same side soon uniting with each other. Intestinal tract with 14-27 coils; rectum short and without caecum. Spindle muscle strong, attached at both ends. Fixing muscle single, originating from longitudinal muscle band 1 on either right or left of nerve cord and attached to last or last but one intestinal coil or anterior part of rectum. Contractile vessel without villi. Nephridia light brown to rusty brown in colour, very long, extending up to base of ventral retractor muscles or nearly to posterior extremity of trunk; almost fully attached to body wall and opening in front of anus between muscle bands 2-3 or 3-4. Gonads lying at base of ventral retractor muscles; eggs round to elliptical in shape, measuring 0.02 mm in diameter or 0.05 x 0.04 mm found in body cavity.

Remarks: The species may be easily recognised from other congeneric species known from this coast by the hook structure, almost fully attached long nephridia and strong spindle muscle.

The variation in number of longitudinal muscle bands from 20-40 is also observed by Selenka and de Man (1883) [35-40, in the posterior half of the body proper], Sato (1939) [30], Edmonds (1956, 1980) [20-38], Haldar (1975) [31-33], and Cutler and Cutler (1979a) [35-40]. In two specimens one from Mayabunder, North Andamans, and the other from Minicoy, Lakshadweep, right nephridium is very short and left nephridium shows bifurcation at its distal end. One specimen from Kavaratti, Lakshadweep, is without dorsal retractor muscles. Three specimens (one from Havelock, South Andamans, and two from Minicoy, Lakshadweep) possess 200-257 complete and incomplete rows of hooks. Some of the hooks of a specimen from Agatti, Lakshadweep, are without clear triangular area.,

Previous Indian Records: India (Selenka and de Man, 1883); Minicoy, Lakshadweep (Shipley, 1903a); Bay of Bengal (Haldar, 1975); Andamans (Haldar, 1976); Nicobars (Haldar, 1975, 1976).

Distribution: This is a widespread member of the Indo-West Pacific shallow water family. Only once it is recorded from a depth of 400-800 m from the Bay of Bengal (Haldar, 1975) which is unusually deep for this species (Cutler and Cutler, 1979a).

In India : Gujarat : Okha, Verval; Lakshadweep : Minicoy, Agatti, Kavaratti; Kerala; Andamans: North, Middle and South; Nicobars; Bay of Bengal.

Elsewhere :

(a) *Indian Ocean*: Red Sea (Selenka and de Man, 1883; Stephen, 1952; Wesenberg-Lund, 1957b); Zanzibar (Augener, 1903; Stephen and Robertson, 1952); Madagascar (Fischer, 1914b; Cutler

and Cutler, 1979a); Mauritius (Selenka and de Man, 1883; Wesenberg-Lund, 1959b); Diego Garcia (Fischer, 1922b; Cutler and Cutler, 1979a); Chagos (Fischer, 1922b); Maldives (Shipley, 1903a); Waingapu (Sluiter, 1902).

(b) *Pacific Ocean* : Japan (Ikeda, 1904; Cutler, Cutler and Nishikawa, 1984); Formosa (Sato, 1939); West Caroline Islands : Palao (Fischer, 1895); Yap (Sato, 1935), Guam (Edmonds, 1971); Eniwetok (Cutler and Cutler, 1979a); Indo-China (Leroy, 1942); Philippines (Selenka and de Man, 1883; Ikeda, 1905); Recif Polo Kalappa (Wesenberg-Lund, 1937a); Makassar and Banda-Neira (Selenka and de Man, 1883); Amboina (Selenka and de Man, 1883; Sluiter, 1891; Fischer, 1895; Augener, 1903); New Guinea (Selenka and de Man, 1883); Australia : Northern Territory (Edmonds, 1980), Queensland (Monro, 1931; Edmonds, 1956 , 1980); Loyalty (Shipley, 1899a); New Britain (Shipley, 1899a; Fischer, 1926a); Rotuma and Funafuti (Shipley, 1898); Fiji (Selenka and de Man, 1883); Kingsmill Islands (Keferstein, 1866); Marquesas (Fischer, 1895).

23. **Phascolosoma (Phascolosoma) perlucens** Baird
(Figs. 34, 136-141)

Phascolosoma perlucens Baird, 1868, *Proc. zool Soc. Lond.*, **1868** : 90-91, pl.10.fig.2.
Phymosoma dentigerum Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 67-68, pl.1, fig. 7, pl.9, figs.118-123,
Physcosoma dentigerum : Sluiter, 1891, *Natuurk. Tijdschr. Ned. Indie*, **50** : 118.
Physcosoma microdentigerum ten Broeke, 1925, *Bijdr. Dierk.*, **24** : 88-89, figs. 8-10.
Phascolosoma dentigerum : Fisher, 1952, *Proc. U.S. natn. Mus.*, **102** (3306) : 432-434, pl.39, figs. 4-7.
Phascolosoma perlucens :Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 155.

Type locality : Jamaica. *Location of types* : British Museum (Natural History), London.

Material examined : 4 exs., Port Blair, South Andamans, 4,ii.1959, Coll. K.K. Tiwari; 5 exs., Casurina Bay, Nicobars, 14.iii. 1966, Coll. A. Daniel; 11 exs., Appa Island, Gulf of Mannar, Tamil Nadu, 26.xii.1970, Coll. K. Reddiah, 9 exs., Little Andamans, "from sandstone along with cirripedia, *Lithotrya nicoborica*", 28.iii.1971, Coll. A Daniel; 1 ex., Neil Island, South Andamans, 3.x.1972, Coll. S. Chakrapany; 2 exs., Havelock Island, South Andamans, 5.x. 1972, Coll. S. Chakrapany; 7 exs., Rangat, Middle Andamans, 21.x.1972, Coll. S. Chakrapany; 16 exs., Krusadai Island, Gulf of Mannar, Tamil Nadu, 2.xii.1974, Coll. N.K. Unithan (C.M.F.R.I., Mandapam Camp); 10 exs., Tangasseri near Quilon, Kerala, "in laterite rocks exposed at low tide", 24.i.1976, Coll. B.P. Haldar; 35 exs., Okha, Gujarat, 6.iv. 1977, Coll. K.N. Reddy; 27 exs., Pirotan Island, Gujarat, "breaking coral rocks", 20.iv.1977, Coll. B.P. Haldar; 7 exs., Veraval, Gujarat, 24.i.1978, Coll. D.R.K. Sastry; 3 exs., Diu, Union Territory, 29, i.1978, Coll. D.R.K. Sastry; 15 exs., Port Blair, South Andamans, "from coraline limestone", 29.iv.1978, Coll. B.P. Haldar; 9 exs., Chidyatapu, South Andamans, "breaking dead corals", 30.iv.1978, Coll. B.P. Haldar; 4 exs., Neil Island, South Andamans., "from dead basal part of a living coral, *Acropora diversa*", 3.v.1978, Coll. B.P. Haldar; 2 exs., Minicoy, Lakshadweep, "from dead basal part of a living coral, *Acropora humilis*", 14.xii.1979, Coll. B.P. Haldar; 18 exs., Bangaram, Lakshadweep, "breaking coral boulders", 26.xii.1979, Coll. B.P. Haldar; 3 exs., Off Waltair Bay, Andhra Pradesh, 10 m, 27.iii. 1982, Coll.K. Satyanarayan Rao (Andhra University), 10 exs., Kavaratti, Lakshadweep, "from reef flat", 27.iii.1984, Coll. B.P. Haldar; 16 exs., Agatti, Lakshadweep, "from

coral boulders dredged from lagoon bottom",6.iv.1984,Coll.B.P.Haldar;12 exs.,Kavaratti, Lakshadweep, 6.ii.1986, Coll. D.R.K. Sastry; 8 exs., Minicoy, Lakshadweep, 18.ii.1986. Coll. D.R.K. Sastry.

Description : Trunk 30-75 mm in length and 7-13.5 mm in width in middle third of trunk; yellowish gray to pale brown in colour, slender, thin- skinned and posterior part gradually tapering to a point. Introvert, partially retracted in majority of specimens, 15-23 mm long, about a half to three-fourths as long as trunk; brown pigmented bands on anteriodorsal surface. Tentacles 12-15, short, digitiform with greenish pigmentation on mid-ventral surface. Hooks in 17-23 rows and some incomplete rows of hooks present behind them; each hook light to dark brown in colour with sharply bent apex, accessory tooth on its concave edge, clear narrow streak in its middle and clear triangular area on its convex edge; height of hook being more than width, measuring 0.060 mm in height and 0.056 mm in width at base.

Papillae between two rows of hooks very small, rounded, 0.01 mm in diameter with a central opening; behind the rows of hooks papillae elliptical, measuring 0.025 mm in long diameter; on posteriodorsal surface of introvert papillae large but unequal in size, measuring 0.4-0.6 mm in height and 0.25-0.35 mm in width at base; dark brown, conical, sharp spiniform and posteriorly directed. On the trunk papillae varying in sizes : on ventral surface these are very small and sporadically distributed; on dorsal surface of its anterior two-thirds these are still small and of unequal in sizes, measuring 0.065-0.090 mm in width at base; towards posterior end of trunk papillae gradually attaining larger in size, measuring 0.2-0.3 mm in height and 0.16-0.22 mm in width at base and turning elliptical in top view, conical in shape and dark brown in colour. A small papilla at posterior end of trunk round in top view whereas a papilla in middle half of posterior part of trunk elliptical in top view.

Longitudinal muscles divided into 19-22 anastomosing bands : 20-21 anteriorly, 21-22 at posterior to base of ventral retractors and 19-21 posteriorly. Retractor muscles two pair : stout ventral pair originating from posterior edge of middle third of trunk from muscle bands 4-6 (3-6, 3-7) whereas weak dorsal pair from middle of trunk from muscle bands 5-6 or 6-7. Oesophagus long and attached to fused retractor units; intestinal coils 16-20 in number; rectum long, straight tube and without rectal caecum; anal opening placed on a raised area. Contractile vessel simple and without villi. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle single, originating from first muscle band anterior to base of left dorsal retractor and attaching to first intestinal coil. Nephridia brown coloured, short, less than half the trunk length, not extending up to base of dorsal retractors and posterior third free from body wall and opening at same level as anus between third and fourth muscle bands. Eggs elliptical, measuring 0.13 mm x 0.10 mm.

Remarks : The species may be easily recognised by the large but unequal dark brown, conical, sharp spiniform papillae which are posteriorly directed on posteriodorsal surface of introvert, and also by the shape of introvert hooks.

Expansion of clear streak near the middle as mentioned by Fisher (1952), Edmonds (1980), and Cutler, Cutler and Nishikawa (1984) is present in the majority of the specimens examined. The number of tentacles varies from 12-18 [12-14 (Stephen and Edmonds, 1972), 12-15 (Fisher, 1952) and 18 (Cutler, 1977a)]. Anastomosation of longitudinal muscle bands in the examined specimens show some

variations : in some, anastomosation are more frequent than others as observed by Fisher (1952). In the type specimen re-examined by Rice (in Rice and Stephen, 1970) these bands show little anastomosis whereas frequent anastomosing nature of these bands has been mentioned by Stephen and Edmonds (1972). Bifurcation of fixing muscle as observed by Fisher (1952) and in the type specimen by Rice (in Rice and Stephen, 1970) is absent in the specimens examined by the author and also by Stephen and Edmonds (1972) and Edmonds (1980). Well developed subspherical rectal caecum as observed by Fisher (1952) is absent in the Indian and Australian forms as well as in the type specimen. The number of tentacles also varies.

Johnson (1971) described *Phascolosoma spinosum* on the basis of 5 specimens collected from Port Blair, Andaman Islands, He compared his species to *P. dentigerum* (=*P. perlucens*) on the basis of literature and was able to differentiate his species from the latter by papillae, hook and retractor muscles. The specimens collected from Port Blair, South Andamans, and elsewhere are described here as *P. perlucens* which closely resembles *P. spinosum*. The differences in the nature of the hook were also observed in the figures given by Selenka and de Man (1883), Fisher (1952), and Cutler, Cutler and Nishikawa (1984). Secondly, fusion of retractor muscles "immediately after their origin" may be due to the contraction of the muscles to the maximum as evident from his fig. 2, pl.2 where introvert is retracted about two thirds of its length. Thirdly, at the posterior region of the trunk papillary spines absent. In the examined specimens papillae do not take the shape of sharp spine as observed on the posteriodorsal surface of the introvert. So, on the basis of above discussion the author is of opinion to merge the species *P. spinosum* with *P. perlucens*.

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a); Port Blair, South Andamans (Johnson, 1971).

Distribution : This is an Indo-Pacific tropical shallow water form relatively uncommon in the Indian Ocean but appears to be circumtropical except one record from South Atlantic (56°S).

In India: Gujarat; Diu; Lakshadweep; Kerala; Gulf of Mannar; Andhra Pradesh; Andamans and Nicobars.

Elsewhere :

(a) *Indian Ocean* : Madagascar (Cutler, 1965; Cutler and Cutler, 1979a); Mahe (Fischer, 1922b); 3°51'5" S, 56°08' E (Murina, 1972); Maldives (Rice, 1969, 1976b); Port Victoria, Northern Territory (Fischer, 1922b).

(b) *Pacific Ocean* : Langkuas Island, North of Java and Java Sea (Fischer, 1922a); Billiton (Sluiter, 1886); Batavia (Sluiter, 1891); Philippines (Selenka and de Man, 1883; Fisher, 1952); Amboina (Augener, 1903); South China Sea (Murina, 1964b); Japan and East Caroline Islands (Cutler, Cutler and Nishikawa, 1984); Marshall Islands (Fisher, 1952; Cutler, Cutler and Nishikawa, 1984); Eniwetok Atoll and Hawaiian Islands (Fisher, 1952); Queensland (Monro, 1931; Edmonds, 1980); Rotuma and Funafuti (Shipley, 1898); Gulf of Panama (Fischer, 1922a; Fisher, 1952; Cutler, 1977a); Mexico and Baja California (Fisher, 1952).

(c) *Atlantic Ocean* : Barbados and St. Berthelemy (Fischer, 1922a); Jamaica (Baird, 1868);

Caracas Bay (ten Broeke, 1925).

24. **Phascolosoma (Phascolosoma) scolops** (Selenka and de Man) (Figs. 35, 147-151)

Phymosoma scolops Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 75-76, pl.2, fig.17, pl.10, figs. 138-144.
Physcosoma scolops : Shipley, 1898, *Proc. zool. Soc. Lond.*, **1898** : 470.
Phymosoma nahaense Ikeda, 1904, *J. Coll. Sci. imp. Univ. Tokyo*, **20** (4) : 29-31, pl.1, fig.8, pl.3, figs. 59-62.
Phascolosoma dunwichi Edmonds, 1956, *Aust. J. mar. Freshwat. Res.*, **7** (3) 292-293, text-figs. 12-13.
Phascolosoma scolops : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 155.

Type locality : Philippines. *Location of types* : Zoological Museum, Humboldt University, East Berlin.

Material examined : 1 ex., Little Andamans, 12.iii.1971, Coll. A. Daniel; 2 exs., Off Cochin, 19°17'N, 75°48'E, 37 m, dredge, 6.iii.1974, Coll. V. Nandakumar; 1 ex., Okha, Gujarat, 5.iv.1977, Coll. D.R.K. Sastry; 1 ex., Dwaraka, Gujarat, 10.iv.1977, Coll. D.R.K. Sastry; 2 exs., Daman, Union Territory, 9.ii.1978, Coll. J. Pattanayak; 1 ex., Port Blair, South Andamans, 29.iv. 1978, Coll. D.R.K. Sastry; 2 exs., Agatti, Lakshadweep, 3 m, dredge, 24.xii.1979, Coll. B.P. Haldar; 22 exs., Chidyatapu, South Andamans, "under stones", 15.ii.1980, Coll. B.P. Haldar; 3 exs., Bangaram, Lakshadweep, 7.iv.1984, Coll. A. Misra.

Description : Trunk 12-22 mm in length and 1.5-4 mm in width in fully stretched condition, thin-skinned and translucent, grayish-white to light brown in colour. Introvert, narrower than trunk, 17-32 mm long, nearly one and a half times as long as trunk, generally with several pigmented brown coloured irregular bands on dorsal surface. Tentacles 10-16 in number, filamentous, with greenish tinge inside and arranged almost in a ring placed dorsal to mouth. Hooks in 13-21 rows found behind the smooth zone which is situated posterior to tentacular crown; some scattered hooks present posterior to regular rows. Hook brown in colour with strongly curved apex, accessory tooth, clear triangular area, clear dark-bordered central streak without any expansion, a transverse bar having several minute warts; measuring 0.040-0.055 mm in height and 0.035-0.045 mm in width at base.

Skin covered with irregularly arranged darker papillae; papillae conspicuously large, tall, conical and crowded round the posterior end and at introvert base but not posteriorly directed; measuring 0.22-0.28 mm in height and 0.18-0.23 mm in width at base and those at mid-trunk region 0.08-0.12 mm in height and 0.10-0.12 mm in width at base. Small perforated papillae measuring 0.012-0.016 mm in width occuring between rows of hooks.

Longitudinal muscle layer grouped into 19-21 rarely anastomosing bands. Retractor muscles two pair : strong and broad ventral pair arising from posterior edge of middle third trunk from muscle bands 2-6 (2-7, 3-7), and weak and narrow dorsal pair arising slightly in front of ventrals from muscle bands 5-6 (6-7); dorsal and ventral of either side fusing anteriorly either at anal level or at the beginning of introvert. Oesophagus long and narrow tube; with 10-15 intestinal coils; rectum long and without rectal caecum, anal part of rectum attached to body wall by delicate wing muscles. Strong spindle

muscle attached at both ends. Fixing muscle single, originating near base of left dorsal retractor and bifurcated towards intestinal attachment : one attached to post-oesophageal gut or first intestinal coil and other to beginning of rectum. Contractile vessel without villi. Nephridia about half as long as trunk, thin-walled, brown tube extending nearly to base of dorsal retractors and attached to body wall by anterior halves to two-thirds and opening at same level of anus.

Remarks : The hooks of this species closely resemble those of *Phascolosoma japonicum* but differs from the latter in the possession of distinctly clear triangular area.

In the specimens from Bangaram, Lakshadweep, dorsal surface of introvert is devoid of pigmented irregular bands. In one specimen from Chidyatapu, South Andamans, both the dorsal retractors are very thin immediately after their origin. The number of rows of hooks is reported to be different by various workers : 3 (Cutler and Cutler, 1979a), 10-12 (Wesenberg-Lund, 1937c), 15 (Wesenberg-Lund, 1957c), 15-17 (Selenka and de Man, 1883), 15-20 (Haldar, 1976), 15-45 (Edmonds, 1956, 1980), 32 (Wesenberg-Lund, 1957b). So, the number of rows of hooks in the specimens studied falls within the aforesaid range (10-32). Size of the hooks and the number of rows increase as the specimens grow older. This has also been referred to by Wesenberg-Lund (1937a), Cutler and Cutler (1979a) and Edmonds (1980). Accessory tooth is absent in a few specimens but distinctly visible in others but the same is absent in *Phascolosoma scolops mossambicense* (pl.10, fig.144 of Selenka and de Man, 1883), while their nominate species possesses such structure (pl.10, fig.139 of Selenka and de Man, 1883). Wesenberg-Lund's (1957b) specimens from Ghardaqa, Red Sea, and some of the specimens of Sato (1930) from Mutsu Bay, Japan, possess no such structure. Re-examination of Selenka and de Man's specimens from Philippines by Stephen and Edmonds (1972) showed the absence of rectal caecum though Augener (1903) and Wesenberg-Lund (1957b) reported the presence of the same.

Phascolosoma dunwichi Edmonds was synonymised with *Phascolosoma scolops* by Edmonds (1980) as the former does not possess rectal caecum. *Phymosoma nahaense* Ikeda was treated as a junior synonym of *P. scolops* by Cutler and Cutler (1981) as "they represent nothing more than aberrant individuals within the large population of *Phascolosoma scolops*"

Previous Indian Records : North-west of Bombay, 20°33' N, 70°09' E (Cutler and Cutler, 1979a); Minicoy, Lakshadweep (Shipley, 1903a); Gulf of Mannar (Shipley, 1903b); Andamans and Nicobars (Haldar, 1976); Andaman Sea, 11°52' N, 95°50' E (Cutler and Cutler, 1979a).

Distribution : This is a widespread circumtropical and subtropical shallow water form but extends its range southwards up to 45° S.

In India : Gujarat; Okha and Dwaraka; Daman; Lakshadweep : Minicoy, Agatti and Bangaram; north-west of Bombay; Off Cochin; Gulf of Mannar; Andamans and Nicobars; Andaman Sea.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Selenka and de Man, 1883; Augener, 1903; Herubel, 1904a; Fischer, 1913, 1914b; Wesenberg-Lund, 1957b; Stephen, 1965); Gulf of Aden (Herubel, 1904b); Somalia and Mombasa (Cutler and Cutler, 1979a); Zanzibar (Fischer, 1892; Lanchester, 1905b;

Stephen and Robertson, 1952); Mozambique (Kalk, 1958; Stephen and Cutler, 1969; Cutler and Cutler, 1979a); east coast of South Africa (Sluiter, 1898; Stephen and Cutler, 1969); Off south-east of South Africa (Cutler and Cutler, 1979a); Madagascar (Herubel, 1908; Hammarstein, 1915; Cutler, 1965; Cutler and Cutler; 1979a); Gulf of Oman (Haldar, 1975; Cutler and Cutler, 1979a); Maldives (Shipley, 1903a); Diego Garcia (Cutler and Cutler, 1979a); Ceylon (Shipley, 1903b); Penang (Lanchester, 1905c); Singapore (Selenka and de Man, 1883; Lanchester, 1905a); Timor (Sluiter, 1902); Great Australian Bight (Cutler, 1977a); Tasmania (in Augener, 1903; Benham, 1922).

(b) *Pacific Ocean* : Japan (Ikeda, 1904, 1924; Sato, 1930, 1937a, 1939; Cutler, Cutler and Nishikawa, 1984); Korea and Formosa (Sato, 1939); China (Leroy, 1942; Chin, 1947); Thailand (Cutler and Cutler, 1979a); Philippines (Selenka and de Man, 1883); Sulu Sea (Selenka, 1885); Bohol (Augener, 1903); Billiton (Sluiter, 1891); Java Sea (Fischer, 1922a); Labuan, Pandan and Sulu Island (Sluiter, 1902); Aru Island (Wesenberg-Lund, 1937a); West Caroline Islands (Sato, 1939); New Britain (Fischer, 1926a); Queensland (Monro, 1931; Edmonds, 1956, 1980); Port Jackson (Fischer, 1922a; Whitelegge and Hill, 1899); New Zealand (Augener, 1903); Kermadec Island (Benham, 1922); Tonga (Collin, 1901); Loyalty Island (Shipley, 1899a); Funafuti (Shipley, 1898); Christmas Island (Shipley, 1899b); Hawaii (Cutler and Cutler, 1979a).

(c) *Atlantic Ocean* : West Indies (Fischer, 1922a; ten Broeke, 1925); Canary Islands (Wesenberg-Lund, 1959a); Gold Coast, Rolas Island, Sao Thome, Annobon (Fischer, 1914a; Wsenberg-Lund, 1959c); Gulf of Guinea (Cutler and Cutler, 1979b); Angola (Fischer, 1914a; Wesenberg-Lund, 1957c); Ascension (Stephen, 1942a); St. Helena (Wesenberg-Lund, 1959a); west coast of South Africa (Stephen, 1942a, 1942b; Wesenberg-Lund 1959a, 1963).

25. **Phascolosoma (Phascolosoma) stephensoni** (Stephen) (Figs. 142-146)

Physcosoma stephensoni Stephen, 1942b, *Ann. Natal. Mus.*, **10** : 250, p.11, figs. 3-5.
Phascolosoma heronis Edmonds, 1956, *Aust. J. mar. Freshwat. Res.*, **7** (3) : 293-295, fig. 14.
Phascolosoma (Phascolosoma) stephensoni : Haldar, 1991a, *Rec. zool. Surv. India*, **87** (1) : 156.

Type locality : Isipingo Beach, Durban. *Location of types* : Royal Scottish Museum, Edinburgh.

Material examined: 1 ex., Tangaseri near Quilon, Kerala, "in crevices of laterite rocks exposed at low tide", 12.ii,1976, Coll. B.P. Haldar ; 1 ex., Kadmat, Lakshadweep, "breaking dead corals", 11.iv.1984, Coll. B.P. Haldar.

Description : Trunk 28 and 36 mm long with maximum width 11 and 14 mm in middle third trunk region; posterior end tapering to a point, pale straw coloured and with dark brown patches dorsally, and opaque-skinned. Introvert, partially retracted in both, 25 and 31 mm, nearly as long as trunk, bearing 10-12 brown coloured irregular bands dorsally. Tentacles 20 in number, finger-shaped, arranged almost in a ring lying dorsal to mouth and with greenish tinge on ventral surface. 27 complete rows of hooks and 15 incomplete rows of hooks separated by a gap of 10 and 15 mm, hooks on posterior rows being smaller; each hook brown coloured with strongly curved and pointed apex with a small

accessory tooth on its concave edge; with gently curved clear narrow streak along with clear triangular area and clear crescentic area on its convex and concave side respectively and also with transverse bar with minute warts at its anterior end; hooks from anterior rows measuring 0.1 mm in height and 0.08 mm in width at base and those of posterior rows 0.072 mm in height and 0.057 mm in width at base.

Papillae between rows of hooks elliptical, measuring 0.05 mm x 0.04 mm; densely packed, rusty red, conical at introvert base and measuring 0.35-0.42 mm in height and 0.25-0.30 mm in width at base; at anterior part of trunk papillae numerous, dark brown, less conical and smaller than introvert base whereas those at posterior end of trunk sporadically arranged, dark brown, conical and of same size as introvert base; mid-trunk papillae scatterly placed, lighter in colour, dome-shaped and measuring 0.1 mm x 0.06 mm in top view.

Longitudinal muscle layer divided into 18-29 anastomosing bands : 20 anteriorly, 26-28 in mid-trunk rgion and 18 posteriorly; bands weak and slender. Retractor muscles two pair : a stout and broad-based ventral pair arising from posterior edge of middle third of trunk from muscle bands 1-9 whereas a slender and narrow-based dorsal pair arising from mid-trunk level from muscle bands 6-8; dorsal and ventral retractor muscles of each side fusing with each other at anal level. Oesophagus long, passing over fused retractor units fastening by mesenteries; intestine with 10-12 coils, rectum short and with tubular rectal caecum and its anal part attached to body wall by wing muscles. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle single, originating from first muscle band a little distance anterior to left dorsal retractor muscle and attaching to post-oesophageal gut and beginning of rectum near rectal caecum, after bifurcation. Contractile vessel without villi. Nephridia light brown in colour, three quarters of the trunk length, extending beyond base of ventral retractor muscles and attached to body wall about two-thirds of their length. Nephridiopores lying between muscle bands 2-3, more or less at same level of anus.

Remarks : The species may be easily recognised by the presence of clear crescentic area on the concave side of the hook in addition to prominent clear triangular area on its convex side.

The shape of the hook as observed in *Phascolosoma heronis* (Edmonds, 1956, fig.14) and *P. stephensoni* (Wesenberg-Lund, 1963, fig.7) as well as that examined by the author differ from that of *P. stephensoni* (Stephen, 1942b, fig.4). Moreover, an extra basal bar as described and figured by Wesenberg-Lund (1963), has not been mentioned and figured either by Stephen (1942b) or Edmonds (1956, 1980) and the specimens examined by the author do not possess the same. Regarding rectal caecum Dr. G. Smaldon of Royal Scottish Museum has communicated to Edmonds that in Stephen's dissected holotype it is present. There is no mention about it in Stephen's (1942b) original description. In *P. stephensoni* Edmonds (1980) observed this character which is also present in the author's examined material but Wesenberg-Lund (1963) reported it being totally absent. Comparing with Stephen's specimens of *P. stephensoni* from Inhaca, Mozambique, Edmonds (1980) synonymised *P. heronis* Edmonds, 1956 with the former.

The present record of this species from Kerala and Lakshadweep is of great importance because it has been reported only from extreme end of the Western Indian Ocean (Stephen, 1942b; Wesenberg-Lund, 1963) as well as from the Pacific Ocean (Edmonds, 1956, 1980). Thus the present report from Kerala and Lakshadweep bridges the distributional gap of the concerned species.

Previous Indian Records : None.

Distribution : This is a tropical and subtropical form occuring in the intertidal area of the Indo-West Pacific region.

In India : Kerala and Lakshadweep.

Elsewhere :

(a) *Indian Ocean* : Durban (Stephen, 1942b; Wesenberg-Lund, 1963); south coast of South Africa (Wesenberg-Lund, 1963); Mozambique (Stephen's unpublished material in Edmonds, 1980; Wesenberg-Lund, 1963).

(b) *Pacific Ocean* : Queensland (Edmonds, 1956, 1980); New South Wales; Norfolk Is.; Lord Howe Is.; Solomon Is. and Hawaii (Edmonds, 1980).

(c) *Atlantic Ocean* : Bay of Guinea (Cutler, 1977a).

Genus Apionsoma Sluiter

Apionsoma Sluiter, 1902, *Siboga Exped.*, **25** : 42
Golfingia (Mitosiphon) Fisher, 1950a, *Ann. Mag. nat. Hist.*, (12) **3** (30) : 550.
Golfingia (Phascolana) Wesenberg-Lund, 1959a, *Atlantide Rep.*, **5** : 183.
Fisherana Stephen, 1964, *Ann. Mag. nat. Hist.*, (13) **7** (80) : 460.
Golfingia (Siphonoides) Murina, 1967b, *Zool. Zh.*, **46** : 1334.
Apionsoma : Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 163.

Diagnosis : Introvert variable in length, reaching 10-12 times the trunk length; hooks (absent in *A. trichocephala*) recurved and with accessory spinelets at base in some species; tentacles (absent in *A. trichophala*) arranged around nuchal organ dorsal to mouth; muscle layers of body wall continuous; retractor muscles two pair; contractile vessel without villi; paired nephridia single or bilobed.

Type species : Apionsoma trichocephala Sluiter, 1902.

Distribution : Widely distributed in the Indian, Pacific and Atlantic Oceans, some members penetrate into deeper water.

Remarks : This genus includes many species previously dealt under different subgenera of *Golfingia* and the genus *Fisherana*. In the higher classification of taxa Gibbs and Cutler (1987) placed *Apionsoma trichocephala* Sluiter as the type species of this genus though the precise nature of its oral disc is not known.

Out of a total of eight species under this genus only one has so far been reported from the Indian coast and the present study includes two more species including an anonymous.

Key to species of **Apionsoma** known from the Indian coast

1.	With hooks and tentacles	...	2
	Without hooks and tentacles	...	*A trichocephala* Sluiter
2.	Introvert much longer than trunk; hooks with accessory comb of spinelets at base	...	*Apionsoma misakiana* (Ikeda)
3.	Introvert shorter than trunk, hooks without accessory comb of spinelets at base	...	*Apionsoma* sp.

26. **Apionsoma trichocephala** Sluiter
(Figs. 36, 152-156)

Apionsoma trichocephalus Sluiter, 1902, *Siboga Exped.*, **25** : 42-44, pl.4, figs. 8-11.
Phascolosoma pusillum Sluiter, 1912, *Result. Camp. scient. Prince Albert* I, **36** : 14-15.
Golfingia (Apionsoma) trichocephalus : Wesenberg-Lund, 1959a, *Atlantide Rep.*, No.5 : 189-190
Golfingia (Phascolana) tenuissima Wesenberg-Lund, 1959a, *Atlantide Rep.*, No.5 : 183-185, figs. 2-5.
Golfingia (Phascolana) longirostris Wesenberg-Lund, 1959a, *Atlantide Rep.*, No.5 : 186-188, fig.6.
Golfingia (Phascolana) trichocephala : Murina, 1972, *Researches in Marine Fauna*, 11 (19) 5 : 303.
Golfingia trichocephala : Cutler, 1973, *Bull. Am. Mus. nat. Hist.*, **152** (3) : 139-145, figs. 21 A-E.
Golfingia (Mitosiphon) trichocephala : Cutler, 1977a, *Galathea Rep.*, **14** : 140-141.
Golfingia (Apionsoma) trichocephala : Cutler, 1979, *Zool. J. Linn. Soc.*, **65** : 373, 383.
Golfingia (Mitosiphon) trichocephala : Edmonds, 1980, *Rec. S. Aust. Mus.*, **18** (1) : 23-24, fig. 34.
Apionsoma trichocephala : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.*, **29** (4/6) : 301-302.

Type locality : Off Java, 7°25'S, 113°16'E, at 56 m. *Location of Types* : Zoological Museum, Amsterdam.

Material examined : 21 exs., Off Bombay, 19°25'N, 72°30'E, 18 m, dredge, 26.iii.1974, Coll. S. Chakrapany; 25 exs., Off Lawson's Bay, 17°44'N, 83°22'E., 30 m, grab, sandy mud, 12.xii.1976; Coll. D. Sudarsan; 37 exs., Off Okha, 22°30' N, 69°20 E, 8 m, 6.iv.1977, Coll. B.P. Haldar; 9 exs., Waltair, Andhra Pradesh, 24.iii.1983, Coll. K. Satyanarayana Rao.

Description : Trunk sausage-shaped, 5-8 mm in length and 3 mm in maximum width in mid-trunk rgion, fully extended and ventrally curved; anteriorly tapering towards introvert and posteriorly pointed abruptly; whitish or yellowish white and semi-transparent so as to make nephridia and nerve cord visible. Introvert usually very long, thin, narrow and tubular; about 4.5-8 times as long as trunk, depending on the state of contraction and ending in a flat disc and without any tentacle and hook. Body apparently smooth but scattered, small papillae visible all over the trunk and above nephridiopores under high magnification, and also closely spaced at posterior end of the former; trunk papillae slightly elevated, more or less circular to oval in top view, light yellowish with central opening; papillae of

introvert base larger than those of posterior end of trunk and without central pore so that the large and medium sized platelets arranged haphazardly with their interspaces filled with small granular platelets.

Muscle layers of the body wall continuous. Retractor muscles two pair : dorsal or anterior shorter and rather weaker, arising from just behind nephridiopores and posterior or ventral arising about 1.5 mm behind dorsal or anterior pair and closer to nerve cord; dorsal or anterior united with ventral or posterior of the same side immediately after its origin. Oesophagus long with 20-31 intestinal coils and attached posteriorly by spindle muscle; rectum short, genuflected and without caecum but with wing muscles; position of anus variable - between the bases of dorsal and ventral retractors. Contractile vessel villi not observed. Nephridia paired, brown or orange coloured; fragile and free from body wall; about 2 mm long; anterioposteriorly bilobed, each being unequal and curly in disposition; nephridiopores lying a little anterior to base of dorsal or anterior retractors. "Genital festoons" of Wesenberg-Lund lying slightly behind the bases of posterior retractors.

Remarks: The species may be readily recognised from the other two congeners of this coast by the sausage-shaped trunk which is abruptly pointed posteriorly; very long, thin, narrow and tubular introvert; brown or orange coloured nephridia which is visible through semitransparent skin and without hooks and tentacles.

The specimens fit well with the anatomical features illustrated in fig.4 (*Golfingia tenuissima*) by Wesenberg-Lund (1959a) except the position of anus. According to Cutler (1973) "the relative position of anus, nephridia and the origin of the retractors are not constant ... but the anus may be on a level with the origin of the anterior pair of retractors or at some distance posterior to both pairs of muscles"

The species was reported nearly 60 years after its original description in 1902 from St. Helena and Off Angola and since then it has been recorded from several places. Wesenberg-Lund (1959a) first recognised it as a golfingiid and placed under a new subgenus *Apionsoma* for this species only.

The species was treated from time to time under different subgenera of the genus *Golfingia* as shown in the synonymy list. Cutler and Gibbs (1985) removed the subgenus *Apionsoma* from *Golfingia* (Golfingiidae) and gave it the generic status under Phascolosomatidae and subsequently the concerned species was considered as a type species (*vide*, Gibbs and Cutler, 1987). Here, the author reserves his comment for the present.

Previous Indian Records: Off Veraval, Arabian Sea, 21°08'N, 69°48' E, 35 m (Cutler and Cutler, 1979a).

Distribution : This is a shallow and warm water circumtropical form recorded from various places.

In India : Off Veraval, Arabian Sea, 21°08' N, 69°48' E; 35 m; Off Lawson's Bay, Waltair; Off Bombay and Off Okha.

Elsewhere :

(a) *Indian Ocean* : Durban (Wesenberg-Lund, 1963; Stephen and Cutler, 1969; Cutler and Cutler, 1979a); Madagascar (Cutler and Cutler, 1979a); Gulf of Aden and Red Sea (Murina, 1970); Singapore Island (Cutler, 1977a); Java Sea (Sluiter, 1902); Rottnest Island, Western Australia (Edmonds, 1980).

(b) *Pacific Ocean* : East China Sea (Murina,1976); Southern Pacific (Murina, 1978); Off coast of New South Wales (Murina, 1972); New Zealand, Coral Seal and Tasman Sea (Cutler, 1977a); Moreton Bay, Queensland (Edmonds, 1980); Japan (Cutler, Cutler and Nishikawa, 1984).

(c) *Atlantic Ocean* : Off New Jersy and Off Cape Hatteras (Cutler, 1973); Texas and Florida (Cutler, 1979); Off Cape Verde Island (Sluiter, 1912); St. Helena and Off Angola (Wesenberg-Lund, 1959a).

27. **Apionsoma misakiana** (Ikeda)
(Figs. 131-135)

Phascolosoma misakiana Ikeda, 1904, *J. Coll. Sci. imp. Univ. Tokyo*, **20** (4) : 7-9, pl.1, fig.3, pl.3, figs. 30-33.
Phascolosoma hespera Chamberlain, 1919, *Pomona Coll. J. Ent.*, **12** : 31.
Golfingia misakiana : Amor, 1975, *Physis*, **34** (88) : 117, fig.3.
Golfingia (Apionsoma) misakiana : Cutler and Cutler, 1981, *Publs Seto mar. biol. Lab*, *26* (1/3) : 59-60.
Apionsoma misakiana : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.*, **29** (4/6) : 300-301, figs. 10 J, 12 B.

Type locality : Misaki, Japan. *Location of types* : Type material lost. Neotype deposited at National Science Museum, Tokyo, by Cutler and Cutler (1981).

Material examined : 1 ex., north-east end of lagoon, Agatti, Lakshadweep, dredged, 4 m, coralline bed, 24.xii.1979, Coll. B.P. Haldar; 2 exs., Dwaraka, Gujarat, "in rocks", 12.i.1990, Coll. B.P. Haldar.

Description : Trunk 49 mm in length and 5 mm in maximum width; slender, cylindrical and gray coloured; thin-skinned and transparent; gradually tapering both anteriorly and posteriorly and not sharply delimited from introvert. Introvert, about less than half retracted inside, of uniform diameter throughout, twice as long as trunk. Tentacles short, filiform and about 8 in number. Hooks in 38-40 rows and the distance between two rows only 0.07 mm; each hook transparent, small, measuring 0.034 mm in height and 0.04 mm in width at base and terminating into a sharp but gently curved pointed apex having 5-6 spinelets at base but devoid of spinelets in posteriormost rows.

Papillae between rows of hooks perforated, dome-shaped, arranged in rows and measuring 0.073 mm in basal diameter and 0.03 mm in height; papillae elsewhere numerous, minute, fusiform in shape, concolorous with skin and rather closely placed. Papillae variable in size, being appreciably taller at anterioposterior ends of trunk including introvert base but shorter elsewhere.

Muscle layers of the body wall continuous. Retractor muscles two pair : posterior or dorsal pair

narrower than other pair originating posterior to anus and remaining free until reaching anterior or ventral pair; anterior or ventral pair lying closer to nerve cord than the other pair and originating a little ahead of nephridiopores; in other words, both the pair originating more or less equidistant from anus where anterior pair lying in front of anus; right and left halves of both the pair of retractor muscles fusing to form right and left retractor units which remain free up to introvert tip. Oesophagus very long, slender and attached to retractor units; intestinal tract with 34 coils extending almost to posterior end of trunk. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle absent but wing muscles present. Contractile vessel not observed. Nephridia about one-fourth of trunk length, slender, brown coloured and bilobed but lobes are of unequal size : small one directed laterally while the large one posteriorly; two lobes directly continuous with each other and completely free from body wall; nephrostomal funnel present at the junction of two lobes; their external openings lying anterior to anus.

Remarks : The species may be readily differentiated from other two congeneric species of this coast by the presence of accessory comb of spinelets at base of hooks.

Only three species viz., *Phascolosoma pectinata*, *Apionsoma murinae bilobatae* and *Apionsoma misakiana* have hooks with an accessory comb of spinelets at base and bilobed nephridia. But the present specimen differs from the first one in the absence of longitudinal muscle bands and caecum, and in the presence of posterior spindle muscle and position of attachment of anterior or ventral retractor muscles in front of nephridiopores. From the second one it differs in the absence of large posterior papillae and position of attachment of retractor muscles in the body. Lastly, it differs from the third one in the reverse position of roots of retractor muscles, attachment of the said muscles at the extreme anterior end of trunk and absence of fixing muscle.

Reported length of introvert in relation to the length of trunk in *A. misakiana* is 4 times (Ikeda, 1904; Rice, 1978), 6-8 times (Fisher, 1952), 9 times (Cutler and Cutler, 1979a) and may reach up to 10-12 times (Cutler, 1979). In this species introvert length is an extremely extensible and plastic in nature as opined by Cutler and Cutler (1981). Furthermore, regarding retractor muscles Cutler, Cutler and Nishikawa (1984) stated, "four equal sized retractor muscles originate just anterior to the middle of trunk, both pair close to and about equal distance from the ventral nerve cord" whereas Ikeda (1904) stated, "ventral pair originates at the middle of body proper, while the dorsal pair do so far more anteriorly".

Above mentioned published information indicates that there is a good deal of variations among the individuals from different localities. But all these may be considered as local variations.

On the basis of the variations presently studied the material examined should be considered as *A. misakiana.*

Previous Indian Records : None

Distribution : This species appears to be circumtropical and subtropical form occurring from intertidal zone to a depth of 166 m (Cutler and Cutler, 1980a).

In India : Lakshadweep, Gujarat.

Elsewhere :

(a) *Indian Ocean* : Mombassa and Madagascar (Cutler and Cutler, 1979a); Tanzania (Cutler, 1979), East Africa (Murina in Cutler, 1979); Rodriques Island (in Cutler, Cutler and Nishikawa, 1984); Western Australia (Fischer, 1919a, 1926b).

(b) *Pacific Ocean* : California : Balboa and Laguna beach (Chamberlain, 1919); Montery Bay to Gulf of California (Fisher, 1952); Peru (Amor, 1975), French Polynesia (Cutler and Cutler, 1979a); Japan (Ikeda, 1904; Cutler, Cutler and Nishikawa, 1984); New South Wales (Edmonds, 1980).

(c) *Atlantic Ocean* : Florida (Rice, 1978); Bahamas (Cutler and Cutler, 1980b); Brazil (Cutler and Cutler, 1980a); Gulf of Mexico (unpublished records, in Cutler and Cutler, 1980a).

28. **Apionsoma** sp.
(Figs. 37, 157-160)

Material examined : 1 ex., South Point, Port Blair, South Andamans, "rock crevices", 17.ii.1974, Coll. K.V. Surya Rao.

Description : Trunk 8 mm in length and 8 mm in maximum width at anterior fourth of trunk but anterior and posterior end comparatively narrower, curved ventrally, rough, moderately thick-skinned and grayish tan in colour. Introvert, slightly less than half, retracted inside 6.5 mm long, cylindrical, dark brown in colour. Tentacles 12 in number, white, digitform, measuring 0.2 mm in length. Hooks arranged in approximately 50 rows covering distal half of introvert; small, bidentate, brown coloured with strongly bent apex; central clear streak dilated at its upper half and with expansion at base; with basal bar provided with or without warts, measuring 0.045-0.055 mm in both height and width at base.

Papillae uniformly covering whole introvert and trunk; between the hook rows papillae small, round and light yellowish in colour while those at posterior end of trunk wart-like, largest, dome-shaped, light yellow in colour, measuring 0.15-0.20 mm in height and 0.23-0.28 mm in width at base; papillae size and shape gradually decreasing from posterior end of trunk upwards.

Muslce layers of body wall entirely continuous. Retractor muscles two pair : dorsal one weaker and thinner than ventral one arising from anterior fourth of trunk further away from nerve cord under the cover of the latter which arising from middle of trunk close to nerve cord by broad base of 2 mm; both the pair united anteriorly. Oesophagus long, extending up to the base of ventral retractor muscles; intestine with 13 coils, extending up to posterior end of trunk; rectum long but without rectal caecum. Contractile vessel simple; spindle muscle attached posteriorly. Fixing muscle single, originating at same level of base of left dorsal retractor muscle but close to nerve cord and attached to first intestinal coil. Nephridia long, more than half of trunk length, thin and flabby; completely free and opening at same level of anus. Gonads lying at the base of ventral retractor muscles.

Remarks : The anonymous species may be easily differentiated from the other two congeneric species dealt with here by the length of introvert which is shorter than trunk and bidentate nature of the hooks.

In the key to species of subgenus *Apionsoma* given by Cutler, 1979 (now elevated to generic level by Cutler and Gibbs, 1985) there are only two species, viz., *capitata* and *lobostoma* with introvert shorter than trunk and hooks without accessory comb of spinelets at base. The presently examined specimen is also coming under the said category. Though the introvert is not full everted, the author considers that the arrangement of tentacles is of phascolosomatid nature. The original description of *A. capitata* is supplemented by Cutler (1979), and Cutler and Cutler (1980c) as there are large number of specimens (both published and unpublished) belonging to this species with them. "The extreme variability in the density and size of trunk papillae" (Cutler, 1979) and "large, scattered, wart-like papillae are found all over the trunk but are denser posteriorly" (Cutler and Cutler, 1980c) for the species *A. capitata* helped the author to compare with his specimen. Otherwise, it differs from *A. capitata* by the possession of bidentake hooks (Gerould's description lacks the nature and structure of hooks but Stephen and Edmonds' (1972) illustration 40 D is from Gerould's specimen) and origin and attachment of fixing muscle.

In *A. lobostoma* spindle muscle is attached posteriorly - a fact which is omitted by Stephen and Edmonds (1972) and nature of tentacular array whether it is dorsal to mouth or not is not clear in Fischer's (1895) description. Cutler (1979) had doubt in this respect and the author also concurs with Cutler. *A. lobostoma* differs from the examined specimen by thin and transparent skin, truncated cone-shaped papillae, length and attachment of nephridia and finally anus - nephridiopore position.

On the basis of above mentioned differences it may be concluded that the examined specimen is closer to *A. capitata* than to *A. lobostoma.*

Furthermore, from the distributional point of view *A. capitata* is a deep water Atlantic form and is endemic to the Atlantic Ocean as gathered from Cutler and Cutler's (1980c) published and unpublished data. Hence, its occurence in the intertidal zone may be a surprise finding. Whereas *A. lobostoma* originally described from Samoa (Fischer, 1895) is reported from Maldive Islands (Shipley, 1903a) and Madagascar (Hammarstein, 1915) but the last two authors have not provided any description.

Going through the description and figures Dr. E. B. Cutler remarked, "It may well be a real biological entity ....." but due to paucity of material at hand the author for the present is undecisive about its specific status.

Order **ASPIDOSIPHONIFORMES** Cutler and Gibbs

Aspidosiphoniformes Cutler and Gibbs, 1985, *Syst. Zool.*, **34** (2) : 167.
Aspidosiphoniformes : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 55.

Diagnosis : Anterior end of trunk modified into horny epidermal or calcareous anal shield; retractor muscles single pair.

Family ASPIDOSIPHONIDAE Baird

Aspidosiphonidae Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 100 (in part).
Loxosiphonidae Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 103.
Aspidosiphonidae : Stephen and Edmonds, 1972, *The Phyla Sipuncula and Echiura.* Trustees of the British Museum (Natural History), London : 215.
Aspidosiphonidae : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 55.

Diagnosis : Anal shield marked the anterior end of trunk; introvert axis lying on the same axis as trunk or shifted ventrally, longitudinal muscle layer of body wall either continuous or divided into bands.

Type genus : *Aspidosiphon* Diesing, 1851.

Distribution : Usually in tropical and temperate seas.

Remarks : The members of this family are usually borers that live in calcareous rock or coral. The family was divided into five genera by Stephen and Edmonds (1972), who accepted Stephen's (1964) new genus *Paraspidosiphon* which was created by splitting of the genus *Aspidosiphon*. But this splitting was not accepted by Cutler (1973), Murina (1975b), Cutler and Cutler (1979a, 1980a,b) including the author in 1978. They retained the genus *Aspidosiphon* and treated *Paraspidosiphon* as its subgenus. Further, Edmonds (1980) invalidated the monotypic genus *Centrosiphon* Shipley by transferring the type of that genus to *Golgfingia* Lankester due to the presence of golfingiid-like tentacular arrangement, introvert hooks and internal anatomy. The author reserves his comment as no specimen like this is available with him in spite of serious efforts made while collecting sipunculans in the Gulf of Mannar area [type locality of *C. herdmani* is Cheval paar, Ceylon (presently Sri Lanka), coast of the Gulf of Mannar]. Moreover, Gibbs and Cutler (1987) retained only three genera, viz., *Aspidosiphon*, *Cloeosiphon* and *Lithacrosiphon* under this family.

Key to genera of Aspidosiphonidae known from the Indian coast

1.	Introvert arising from centre of anal shield; shield with a large number of calcareous units	...	*Cloeosiphon* (Quatrefages)
	Introvert arising ventral to anal shield	...	2
2.	Shield with a large number of horny units	...	*Aspidosiphon* Diesing
	Shield with a single solid calcareous unit	...	*Lithacrosiphon* Shipley

Genus **Aspidosiphon** Diesing

Aspidosiphon Diesing, 1851, *Systema helminthum*, **2** : 67-68 (restricted).
Pseudaspidosiphon Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 102 (in part).
Aspidosiphon : Theel, 1875, *Bih. K. svenska Vetenskakad. Handl.*, **3** (6) : 17.
Aspidosiphon : Cutler and Cutler, 1989, *Proc. biol. Soc. Wash.*, **102**(4) : 827-837.

Diagnosis: Introvert usually longer than trunk and with recurved hooks arranged in rings; shield invariably present at anterior and usually at posterior end of trunk; introvert arising from ventral side of anal shield; tentacles arranged in a horseshoe-shaped ring dorsal to mouth enclosing nuchal organ. Longitudinal muscle layer of body wall either continuous or divided into anastomosing, sometimes ill-defined, bands; retractor muscles single pair, more or less fused; contractile vessel without villi; spindle muscle attached posteriorly; with paired nephridia.

Type species : Aspidosiphon muelleri Diesing, 1851.

Distribution : Inhabitants usually of tropical and temperate seas.

Remarks: Stephen (1964) divided the genus *Aspidosiphon* into two genera, viz., *Aspidosiphon* and *Paraspidosiphon* mainly on the basis of the nature of the longitudinal muscle layer of the body wall. As already mentioned author and others did not support this division but considered *Paraspidosiphon* as a subgenus.

Subgenus **Aspidosiphon** Diesing

Aspidosiphon Diesing, 1851, *Systema helminthum*, **2** : 67-68.
Pseudaspidosiphon Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 102 (in part).
Aspidosiphon (Aspidosiphon) : Cutler, 1973, *Bull. Am. Mus. nat. Hist.*, **152** (3) : 174.
Aspidosiphon (Aspidosiphon) : Cutler and Cutler, 1989, *Proc. biol. Soc. Wash.*, **102** (4) : 842.

Diagnosis : Longitudinal muscle layer of body wall continuous except near anal shield.

Type species : Aspidosiphon muelleri Diesing, 1851.

Distribution : Usually in tropical and temperate seas.

Remarks: This subgenus contains about 25* species and subspecies, majority of which inhabit in limestone or coral reef. Out of them only 3 species are hitherto known from the Indian coast and the present study includes one more species to this list.

Key to species of **Aspidosiphon** known from the Indian coast.

1.	Introvert hooks unidentate	...	2
	Introvert hooks bidentate	...	3

* According to Cutler and Cutler (1989) this subgenus contains only 13 species and subspecies.

2.	Retractor muscles arising from caudal shield	...	*A. (A.) exhaustus* Sluiter
	Retractor muscles arising well in front of caudal shield	...	*A. (A.) gracilis* Baird
3.	Retractor muscles arising from cuadal shield	...	*A. (A.) tortus* Selenka and Bulow
	Retractor muscles arising well in front of caudal shield	...	*A. (A.) elegans* (Chamisso and Eysenhardt)

29. Aspidosiphon (Aspidosiphon) elegans (Chamisso and Eysenhardt) (Figs. 42, 161-166)

Sternaspis elegans Chamisso and Eysenhardt, 1821, *Nova Acta Acad. Caesar Leop. Carol*, **10** : 351-352, pl.24, figs. 5a-e.
Sipunculus elegans : de Blainville, 1827, Dictionnaire des sciences naturelles Vers., **49** : 310, pl.26, figs. 2a-c.
Loxosiphon elegans : Diesing, 1851, *Systema helminthum*, **2** : 70.
Phascolosoma (Aspidosiphon) elegans : Grube, 1868a, *Verh., zool. bot. Ges. Wien*, **18** : 645-647, pl.8, fig.5.
Aspidosiphon elegans : Grube, 1868b, *Jber. Scheles. Ges. Vaterl. Kult.*, **45** : 49.
Aspidosiphon exilis Sluiter, 1886, *Natuurk. Tijdschr. Ned. Indie*, **45** : 497, pl.3, figs. 11-12.
Aspidosiphon spinalis Ikeda, 1904, *J. Coll. Sci. imp. Univ. Tokyo*, **20** (4) : 47-49, figs. 12, 81-85.
Aspidosiphon (Aspidosiphon) elegans : Cutler and Cutler, 1989, *Proc. biol. Soc. Wash.*, **102**(4) : 842-844, figs.3, 5A, 6.

Type locality : "Small islands of the Pacific Ocean" *Location of types* : Not known.

Material examined : 1 ex., Krusadai Island, Gulf of Mannar, Tamil Nadu, 2.xii.1974, Coll. N. K. Unithan (C.M.F.R.I., Mandapam Camp); 9 exs., Okha, Gujarat, "from dead corals", 9.iv.1977, Coll. B.P. Haldar; 14 exs., Dwaraka, Gujarat, "from dead corals lying under water during low tide", 10.iv.1977, Coll. B.P. Haldar.

Description : Trunk 18-45 mm long and 4.5-9 mm wide, slender, cylindrical, pale straw coloured and with slightly opaque to semi transparent skin. Introvert, partially retracted in all the specimens, 11-25 mm long, about a half to five-sixths of trunk length, and narrower and thinner than trunk. Tentacles 7-9 in number, attached basally and free terminally. Hooks in 15-20 rows, nearly transparent, anterior few rows white but the rest brown coloured; bidentate, sharply curved with pointed apical teeth and 3-5 warts at base; with clear transparent central streak having posteriorly directed tongue-like extension, being absent in anterior few rows; measuring 0.054-0.073 mm in height and 0.05-0.06 mm in width at base. Spines dark brown, not arranged in rows and covering the rest part of introvert; varying in shapes from different views, and measuring 0.054-0.080 mm in height and 0.040-0.073 mm in width at base; in general, spines smaller on ventral surface than on dorsal and again, posteriodorsal ones larger.

Anal shield brown to dark brown in colour and quite prominent in contrast to body wall; oval to circular in shape and made up of small, irregular-shaped granular or flat chitinous plates which are dark brown in the centre while lighter in colour along the peripheral part. Caudal shield brown to light brown in colour and sometimes not clearly demarcated from trunk; with 19-24 radial furrows, none of them reaching the centre and 2-4 incomplete concentric furrows peripherally.

Papillae transparent, flat, elliptical in shape, mainly confined at anterior and posterior end of trunk and made up of irregular-shaped plates of different sizes with central opening; measuring 0.084-0.12 mm x 0.063-0.085 mm; large papillae present at posterior end of trunk. Papillae on the mid-trunk region sparsely distributed and being smaller than those at anterior part of trunk. Between rows of hooks papillae tubular, transparent and measuring 0.02-0.04 mm in height.

Longitudinal muscle layer of the body wall continuous. Retractor muscles single pair originating by broad, flat roots from posterior fourth to sixth of trunk and soon fusing to form a single retractor unit. Oesophagus long, narrow tube running dorsal to retractor unit up to mid-trunk level and running upwards to join with intestinal coil; intestinal tract with 16-32 coils reaching up to posterior end of trunk; rectum straight, long, narrow tube and usually with small round rectal caecum at its beginning; anal part of rectum attached to body wall by a pair of wing muscles. Spindle muscle delicate, attached both anteriorly and posteriorly. Fixing muscle not observed. Contractile vessel light brown, accompanying oesophagus up to its attachment to retractor unit and without villi. Nephridia long, pale yellow to brown, thin-walled, cylindrical tube and extending nearly to roots of retractor muscles; almost fully attached and opening 1.5-2.5 mm posterior to anal aperture which lies very close to anal shield.

Remarks : The species may easily be recognised by the structure of bidentate hooks which are sharply bent and with clear streak having posteriorly directed tongue-like extension and posteriorly placed dorsal spines larger and sharply bent.

In this collection maximum length of introvert is found to be five-sixths of trunk length while earlier records reveal that the introvert is slightly shorter than the trunk (Sato, 1935, 1939), as long as trunk (Selenka and de Man, 1883; Ikeda, 1904; Edmonds, 1980) or twice as long as trunk (Wesenberg-Lund, 1957b). Specimen from the Gulf of Mannar possesses less number of spines on the introvert than that of the specimens from Gujarat and the apical tooth of the former is blunt rather than sharp as observed in the latter specimens. This fact corroborates the findings of Cutler and Cutler (1979a). Rectal caecum is present in most of the specimens and this supports the statement of Selenka and de Man (1883), and Stephen and Edmonds (1972).

A. (A.) homomyarius was described by Johnson (1964) from 10 dissected specimens out of 30 collected at Okha, Gujarat (western coast of India). Repeated attempts were made around Okha and its adjoining areas to locate the species but without success and the nearest ally collected from the said locality fits well with Johnson's description. Johnson's type specimens could not be located. He compared this species where the longitudinal muscle layer is continuous with his other new species where the logtitudinal muscle layer is grouped into bands in the same paper but failed to compare with any existing related species whrere the longitudinal muscle layer is continuous. He never used the name *A. (A.) elegans*. A careful reading of the description as well as comparison of illustrations reveal no significant difference with *A. (A.) elegans*. Furthermore, Edmonds (1980) pointed out that like *A. exilis*

"*A. homomyarius* is also closely related to *A. elegans*" without further clarification. The present material differs from *A. (A.) homomyarius* in the shape of the hooks (latter being more bent) and spines only. This may have appeared different because of orientation under microscopic slide. Structure of hooks of the present material resembles closely with figures 74 and 75 of Edmonds (1980), and shape and structure of spines are very similar to figures 73, 77 and 78 of Edmonds (1980) and figures 11 and 12 of Sluiter (1886). Presence and absence of rectal caecum (absent in *A. homomyarius*) which corroborates Selenka and de Man (1883) and Edmonds (1980) respectively are observed in the examined specimens. The microscopic details of both the shields as in figures 3 and 4 of Johnson agree well with the figures drawn by the author. Only tangible difference is the number of rows of hooks (15-20 *versus* 60-70). In the literature of *A. elegans* this figure is highly variable : 7-40 (Cutler and Cutler, 1981), 15-30 (Edmonds, 1980), 25 (Wesenberg-Lund, 1954a), about 50 (Sato, 1939), 35-100 (Selenka and de Man, 1883; Stephen and Edmonds, 1972). In this respect the number of rows of hooks in *A. (A.) homomyarius* (60-70) from Okha, Gujarat and *A. (A.) elegans* (15-20) from Okha and Dwaraka, Gujarat lie on either extreme end of the varia'>'e figure (7-100).

Hence, it is proposed that *A. (A.) homomyarius* may be treated as junior synonym of *A. (A.) elegans* as it lacks any feature distinctive of a species.

Previous Indian Records : Krusadai Island, Gulf of Mannar, Tamil Nadu (Gravely, 1927); Okha, Gujarat (Johnson, 1964).

Distribution : This species is a shallow water form and widespread in the Indo-Pacific region except two records from the Atlantic Ocean.

In India : Gujarat, Tamil Nadu.

Elsewhere :

(a) *Indian Ocean* : Red Sea (Gurbe, 1868a; Selenka and de Man, 1883; Herubel, 1904b; Fischer, 1914b; Wesenberg-Lund, 1957b; Cutler and Cutler, 1979a); Tanganyika (Lanchester, 1905b); Mozambique (Cutler, 1977b); Diego Garcia (Cutler and Cutler, 1979a); Penang (Lanchester, 1905a); Cocos-Keeling Islands (Cutler and Cutler, 1979a).

(b) *Pacific Ocean* : Japan (Ikeda, 1904; Cutler, Cutler and Nishikawa, 1984); Formosa (Sato, 1939); Philippines (Selenka and de Man, 1883); Billiton (Sluiter, 1891); Tausend Island (Sluiter, 1886); Gisser (Sluiter, 1902); West Caroline Islands (Sato, 1935); East Caroline and Marshall Islands (Cutler, Cutler and Nishikawa, 1984); Hawaii and Queensland (Edmonds, 1980); Funafuti (Shipley, 1898; Whitelegge and Hill, 1899); New Hebrides (Cutler and Cutler, 1979a); Loyalty Islands (Shipley, 1899a); Pacific Island (Chamisso and Eysenhardt, 1821).

(c) *Atlantic Ocean* : Tortugas (Wesenberg-Lund, 1954a); Caesarea and Mediterranean (Wesenberg-Lund, 1957a).

30. **Aspidosiphon (Aspidosiphon) exhaustus** Sluiter

Aspidosiphon exhaustum Sluiter, 1912, *Result. Camp. scient. Prince Albert I*, **36** : 20-21, pl.1, fig. 11.

Aspidosiphon exhaustum : Murina, 1972, [In] *Investigation of Marine Fauna*, **11** (19) : 295.
Aspidosiphon exhaustus : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.*, **29** (4/6) : 305.

Type locality : Off Morocco, 36°43'2" N, 8°40'30" W, 310-749 m. *Location of type* : Oceanographic Museum, Monaco.

Material examined : None.

Description : Trunk 17 mm long and 2 mm wide. Introvert about as long as trunk, thin and thread-like anteriorly. Hooks arranged in numerous rows, small, transparent and with a long bent point. Anal shield oval, grayish-brown in colour but darker than trunk; with 12 radial furrows on the posterior border but granular centrally. Caudal shield with 10 furrows originating from the periphery but not reaching the centre. Skin pale in colour and smooth to naked eye. Retractor muscles single pair and fusing soon after their origin from caudal shield. Intestinal coils numerous. Spindle muscle emerging from last intestinal coil being attached posteriorly. Nephridia long, attached to trunk wall by their greater part and open almost at same level as anus.

Remarks : No material of this species is available with the author for examination. The main features of the type specimen as given by Sluiter (1912) is dealt with under description.

Since its first report by Sluiter (1912) the species was not referred further till Murina (1972) recorded the same from three scattered localities. Cutler and Cutler (1979a, 1980a), and Cutler, Cutler and Nishikawa (1984) reported the species from various places of the world from shallow to deeper waters (3-1080 m). As a result of their (1979a) study of specimens collected from off coast of India as well as south-east Africa and Madagascar they supplemented with more informations related to diagnostic characters. These are as follows :

Introvert is longer than the trunk and armed with unidentate hooks (0.013-0.035 mm) in rows distally and a region of straight spines proximally. Anal shield is medium to dark brown, with well defined margins, short grooves dorsally and granular region ventrally. Caudal shield is less pigmented but usually well defined and has about 20-25 furrows radiating from the periphery. Attachment of nephridia to the trunk wall varies from 50-100% of their length. Abnormal fusion and separation of retractor muscles found in a single specimen collected from off coast of India. A rectal caecum is present.

Due to lack of material the author at the moment has nothing to comment but from the reported descriptions it appears to be *A. muelleri* Diesing.

Previous Indian Records : North-west Bombay, Arabian Sea, 20°21' N, 69°58' E, 75 m (Cutler and Cutler, 1979a).

Distribution : This is a deep-water species but recorded from several sublittoral zones also. This species is absent in the eastern Pacific Ocean.

In India : North-west Bombay, Arabian Sea.

Elsewhere :

(a) *Indian Ocean* : Red Sea (in Murina, 1978); Mozambique Channel and Durban (Cutler and Cutler, 1979a); Great Australian Bight (Murina, 1978).

(b) *Pacific Ocean* : Gulf of Tonkin/Indo-China (in Cutler and Cutler, 1979a); Japan (Cutler, Cutler and Nishikawa, 1984); Off coast of New South Wales and Off Easter Island (Murina, 1972).

(c) *Atlantic Ocean* : Off Uruguay (Cutler and Cutler, 1980a); Off Morocco (Sluiter, 1912); Off Congo (Murina, 1972).

31. **Aspidosiphon (Aspidosiphon) gracilis** Baird
(Figs. 43, 167-174)

Pseudaspidosiphon gracile Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 103, pl.10, figs. 1, 1a.
Aspidosiphon gracilis : Selenka and de Man, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 122-123, pl.2, fig.22, pl.14, figs. 209-213.
Aspidosiphon gracilis : Cutler and Cutler, 1989, *Proc. biol. Soc. Wash.*, **102** (4) : 845.

Type locality : Philippine Islands. *Location of types* : British Museum (Natural History), London.

Material examined: 6 exs., South Point, Port Blair, South Andamans, 1.xi. 1933, Coll. H.S. Rao; 7 exs., Neil Island, South Andamans, "from dead corals", 28.ix.1972, Coll. S. Chakrapany; 3 exs., Rangat Bay jetty, Middle Andamans, "from coral rock", 21.x.1972, Coll. S. Chakrapany; 15 exs., Corbyn's Cove, Port Blair, South Andamans, 29.iv.1978, Coll. B.P. Haldar; 2 exs., Atlanta Point, Port Blair, South Andamans, " subtidal", 21.v.1978, Coll. B.P. Haldar; 5 exs., Chidyatapu, South Andamans, "from dead coral", 25.v.1978, Coll. B.P. Haldar; 4 exs., near Burmese temple, Mayabunder, North Andamans, "crevices in granite", 27.ii.1980, Coll. B.P. Haldar.

Description : Trunk 29-50 mm long, 5.0-6.5 mm wide, grayish white to light brown in colour, slender and abruptly concial posteriorly. Introvert, partially retracted in some specimens, 48-72.5 mm long and 2-3 mm wide, thin-walled, whitish except the hooked region, arising ventral to anal shield. Tentacles 10-12, small, white uniting with each other basally leaving the tips free and forming a crown dorsal to mouth. 33-45 rows of hooks including some incomplete rows; each hook unidentate with width of base greater than height, measuring 0.020-0.030 mm in height and 0.025-0.035 mm in width at base,. Posterior to rows of hooks lying numerous scattered spines with sharply pointed and four-cornered bases measuring 0.020-0.040 mm long.

Anal shield light brown in colour, weakly developed and indistinctly marked off from the trunk, Caudal shield yellowish brown, distinguishable from trunk, sharply conical, having 25-29 radial furrows, half of them reaching to tip of shield, together with pads carrying 3-10 small papillae. Both the shields composed of small chitinous platelets surrounding the papillae.

Trunk surface shows numerous small quadrangular areas; each area being sculptured by dark platelets of papilla against light coloured turnk. Each papilla with numerous small platelets surround-

ing a clear central pore and measuring 0.04-0.05 mm in diamter. Papillae of anal and caudal shield as well as of introvert being similar to those of trunk but introvert ones smaller in size. Papillae in between rows of hooks and among spines small, tubular and measuring 0.015-0.020 mm in height.

Longitidunal muscle layer continuous, but above anal level this layer tending to separate into bands. Retractor muscles single pair, arising from posterior sixth of trunk, running separately and fusing to form a single muscle at anterior part of trunk. Oesophagus long and slender; intestinal coils 17-26 in number; rectum short, straight tube and usually without rectal caecum. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle absent but wing muscles present. nephridia tubular, two-fifths to three-fifths as long as trunk, fully attached to body wall and open a little behind anus; their anterior end whitish in contrast to dark tan colour of the rest part. Nephrostomal funnel short, whitish, thin-walled and curly. Body cavity, in some specimens, contains eggs measuring 0.15 mm x 0.10 mm.

Remarks: The species may easily be recognised from the others of this subgenus by the presence of single pointed hooks, sharply pointed spines with four-cornered bases and quadrangular sculptured areas on the trunk.

The length of the introvert in the examined specimens is about one and a half times as long as trunk but according to Selenka and de Man (1883), Stephen and Edmonds (1972) and Edmonds (1980) it is about as long as trunk. The number of rows of hooks is 33-45 in the present material whereas Selenka and de Man's (1883) specimen from Philippines (Caminguin) posseses 120 rows of hooks. The specimens from the North Andamans are tough and thick-skinned whereas the specimens from the South Andamans are thin and transparent. The fusion of rectractor muscles is variable : fusion occurs at the anterior part of trunk in the specimens presently examined but the same has been reported to occur soon after their origin (Selenka and de Man, 1883; Stephen and Edmonds, 1972) and also at the level of posterior third of trunk (fig.94, Edmonds, 1980). In general, rectal caecum is absent as reported in the literature but a single specimen from Atlanta Point, Port Blair, possesses an elongated rectal caecum. Hook is actually single pointed in the present specimens and this finding agrees with Selenka and de Man (1883) and Edmonds (1980) but Stephen and Edmonds (1972) stated "hooks with two points".

Previous Indian Records : None.

Distribution : It is Indo-West Pacific tropical shallow water form relatively uncommon in the Indian Ocean and one of the few forms which have been recorded and described.

In India : North, Middle and South Andamans.

Elsewhere :

(a) *Indian Ocean* : Gulf of Aden (Herubel, 1904a; Murina, 1970).

(b) *Pacific Ocean* : Philippine Island (Baird, 1868; Selenka and de Man, 1883); Indonesia (Sluiter, 1902); Amboina (Augener, 1903); Queensland (Gibbs, 1978b; Edmonds, 1980).

32. **Aspidosiphon (Aspidosiphon) tortus** Selenka and Bulow

Aspidosiphon tortus Selenka and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 119-120, pl.14, figs. 196-201.
Aspidosiphon tortus : Reddiah, 1975, *Proc. internat. Symp. Biol. Sipuncula and Echiura*, Kotor, **1** : 299.

Type locality : Philippines. *Location of type* : National Museum, Wellington, New Zealand.

Description : Trunk 25 mm in length, posterior half transparent. Ground colour of skin glossy gray but anterior third light brown. Introvert bears regularly arranged rows of hooks on its anterior part whereas irregularly arranged spines on its posterior part. Papillae of two types, distinctly recognisable as dark spots found on the posterior two-thirds of trunk.

Anal shield dark brown in colour and oval in form; dorsal half furrowed whereas ventral half covered with closely placed warts. Caudal shield thin-skinned, circular and concolorous with anal shield; from its centre furrows radiate to the periphery.

Longitudinal muscle layer not separated into bands but on the dorsal anterior part showing slight indication of separation. Retractor muscles single pair, arising from caudal shield together by two roots placed close to each other. Oesophagus running up to union point of retractor muscles; then proceeding upwards to join with intestinal coil; intestinal coil numerous. Spindle muscle originating in front of anus, passing through intestinal coils and attached to centre of caudal shield. Fixing muscle single, passing through retractor muscles. Only fairly well developed left nephridium present and it is attached to trunk wall by two-thirds of its length.

Remarks : Specimen of this species is neither available in author's collection nor examined by him from other sources. The description of the species dealt herewith is based on Selenka and Bulow's (1883) account of a single specimen (type material).

Selenka and Bulow's (1883) figure 199 indicates that the hooks are bidentate in nature - a character not mentioned in the original description. Stephen and Edmonds (1972) stated the presence of regularly arranged spines while original description shows "unregelmassing mit Stacheln". Mention may be made that Stephen and Edmonds (1972) omitted the presence of fixing muscle.

Reddiah (1975) reported the species from Rameswaram Island (Peninsular India). But the author failed to locate Reddiah's (1975) specimens.

The author has not studied the type material as well as the material recorded by Reddiah (1975). But from the description it appears to be *A. muelleri* Diesing.

Previous Indian Records : Rameswaram Island, Tamil Nadu (Reddiah, 1975).

Distribution : This species appears to be an intertidal form in the Indo-West Pacific region.

In India : Tamil Nadu.

Elsewhere :
(a) *Indian Ocean* : Gulf of Aden (Herubel, 1904b).

(b) *Pacific Ocean* : Siam (Fischer, 1923b); Philippines (Selenka and de Man, 1883).

Subgenus **Paraspidosiphon** Stephen

Aspidosiphon Diesing, 1851, *Systema helminthum*, **2** : 67 (in part).
Pseudaspidosiphon Baird, 1868, *Proc. zool. Soc. Lond.*, **1868** : 102.
Paraspidosiphon Stephen, 1964, *Ann. Mag. nat. Hist.*, (13) **7** (80) : 457.
Aspidosiphon (Paraspidosiphon) : Cutler, 1973, *Bull. Am. Mus. nat. Hist.*, **152** (3) : 178.
Aspidosiphon (Paraspidosiphon) : Cutler and Cutler, 1989, *Proc. biol. Soc. Wash.*, **102** (4) : 851.

Diagnosis : Longitudinal muscle layer of body wall divided into bands.

Type species : Aspidosiphon steenstrupii Diesing, 1859.

Distribution : Inhabitants usually of tropical and temperate seas.

Remarks: About 22* species and subspecies are included under this subgenus and most of them bore in limestones or coral rock. Of these, only 2 species and subspecies are hitherto known from the Indian coast and the present study includes one more species and subspecies.

Key to species of **Paraspidosiphon** known from the Indian coast

1.	Introvert hooks unidentate	...	2
	Introvert hooks bidentate	...	3
2.	Retractor muscle arising in front of caudal shield by broad base; longitudinal muscle bands 38 in number	...	*A. (P.) klunzingeri* Selenka and Bulow
	Retractor muscles arising well in front of caudal shield by narrow base; longitudinal muscle bands 22-27 in number	...	*A. (P.) pachydermatus* Wesenberg-Lund
3.	Retractor muscles arising from posterior fourth to sixth of trunk; hooks with posteriorly directed tongue-like extension of clear streak	...	*A. (P.) steenstrupii* Diesing

* According to Cutler and Cutler (1989) this subgenus contains only 7 species.

Retractor muscles arising from posterior seventh to tenth of trunk; hooks without tongue-like extension of clear streak	...	*A. (P.) steenstrupii ambonensis* Augener

33. **Aspidosiphon (Paraspidosiphon) klunzingeri** Selenka and Bulow (Fig. 189)

Aspidosiphon klunzingeri Selenka and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper*, (2) **4** (1) : 115-116, pl.13, figs. 187-189.
Paraspidosiphon klunzingeri : Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura*. Trustees of the British Museum (Natural History), London : 247-248, figs. 28 G-H.
Aspidosiphon (Paraspidosiphon) klunzingeri : Cutler and Cutler, 1979a, *Bull. Mus. natn. Hist. nat., Paris*, (4) **1** (A/4) : 974-975.

Type locality : Kosier, Red Sea. *Location of type* : Not known.

Material examined : 2 exs., North side of east end of Macpherson's Strait near Cheringatapam, Baratang, South Adnamans, "breaking down the rock with hammer", 20.i.1924, Coll. H.S. Rao; 1 ex., Havelock Island, South Andamans, "from coral rock area", 9.x.1972, Coll. B.P. Haldar.

Description : Trunk 15-35 mm long and 3-5 mm wide, yellowish in colour, cylindrical and thick-walled. Introvert, partially retracted in all the spcimens, half as long as trunk, slender and thin-walled. Tentacles few in number, short and finger-like. Hooks in 37-42 rows, light coloured, unidentate and strongly curved apex with transparent clear streak extending almost to tip; measuring 0.05-0.06 mm in height and 0.04-0.05 mm in width at base. Spines unidentate, resembling small hooks but without clear streak and irregularly arranged behind the hooked zone.

Anal shield distinct, dark brown in colour and oval in shape with 9-11 unequal furrows dorsally and granulated region ventrally and laterally. Caudal shield also distinct, conical in shape with 18-22 radial furrows.

Papillae covering anterior and posterior end of trunk close to shields big and rounded but, in general, on trunk and between rows of hooks small and subconical.

Longitudinal muscle layer divided into about 38 narrow slightly anastomosing bands. Retractor muscle single, arising in front of caudal shield by broad base covering both sides of nerve cord. Intestine with numerous coils extending up to posterior end of trunk; rectum short and with a rectal caecum. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle absent but wing muscles present. Contractile vessel simple. Nephridia long, cylindrical tube, reddish in colour and extending up to posterior end of trunk; attached for about two-thirds of their length and open a little behind anus between muscle bands 4-5.

Remarks : This species may be readily differentiated from the other species of this subgenus

known from this coast by the presence of unidentate hooks and about 38 slightly anastomosing longitudinal muscle bands.

As no additional specimen is available with the author so the description is based on the material previously studied and already published by him in 1976.

Though the longitudinal muscle bands are anastomosing in nature but their number is more or less constant as evident in the literature : 38 (Selenka and Bulow, 1883; Stephen and Edmonds, 1972), 37-39 (Cutler and Cutler, 1979a) and 40 (Wesenberg-Lund, 1957b). Stephen and Edmonds (1972) differentiated this species from *A. (P.) cumingii* by the absence of single rectal caecum but Selenka and Bulow's (1883) descriptions as well as the translated parts of Stephen and Edmonds (1972) in parenthesis relating the said portion of the two species reveal otherwise. In *A. (P.) klunzingeri* "am Rectum sitzt ein grosser, an beiden Seiten vielfach gelappter Blindsack". (On the rectum there is a large caecum from the sides of which numerous lappets or lobes arise) and in *A. (P.) cumingii* "Das letzte Ende des Mastdarmesist dicht mit langen zottenartigen Gebilden besetzt" (numerous villi, appendages or caeca are attached to the last part of the alimentary canal). Only Cutler and Cutler (1979a,b) voiced against this complexity between the two otherwise closely related species where morphological differences are not distinct except number of longitudinal muscle bands [27-38 in *A. (P.) cumingii* and 38 in *A. (P.) klunzingeri]*. In addition, *A. (P.) cumingii* possesses numerous villi on the contractile vessel. In *A. (P.) klunzingeri* numerous lappets or appendages on the rectum were not observed by the author in 1976 and this fact supports Edmonds' (1956) observation. Moreover, Wesenberg-Lund (1959a, 1963), and Cutler and Cutler (1979b) did not mention these structures. So it appears to the author that these structures are not a constant feature.

For the present, the material available with the author has been assigned to this species due to possession of 38 longitudinal muscle bands and simple contractile vessel. Further studies on more material are needed for clarification. However, Cutler and Cutler (1989) in their revisionary work placed this species as a junior synonym of *A. (P.) laevis.*

Previous Indian Records : Baratang and Havelock Island, South Andamans (Haldar, 1976).

Distribution : This species is an inhabitant of shallow warm water and especially of coralline substrata around the globe except for eastern Pacific. Only once it has been recorded at a depth of 138 m from Durban (Cutler and Cutler, 1979a).

In India : South Andamans

Elsewhere :

(a) *Indian Ocean* : Red Sea (Selenka and Bulow, 1883; Herubel, 1904a; Wesenberg-Lund, 1957b); Durban (Sluiter, 1898 in Stephen, 1942b; Wesenberg-Lund, 1963; Cutler and Cutler, 1979a); Madagascar (Cutler and Cutler, 1979a).

(b) *Pacific Ocean* : Amboina (Fischer, 1896); Funafuti (Shipley, 1898); Loyalty Islands and New Britain (Shipley, 1899a); Hawaii (Cutler and Cutler, 1979a).

(c) *Atlantic Ocean* : Cape Verde Islands (Sluiter, 1912; Wesenberg-Lund, 1959a; Cutler and Cutler, 1979b); Gulf of Guinea (Wesenberg-Lund, 1959c); West Africa (Fischer, 1914a).

34. **Aspidosiphon (Paraspidosiphon) pachydermatus** Wesenberg-Lund (Figs. 46-48, 186-188)

Aspidosiphon pachydermatus Wesenberg-Lund, 1937c, *Bull. Mus. r. Hist. nat. Belg.*, **13** (36) : 9-16, text-figs. 4-9

Paraspidosiphon pachydermatus : Stephen and Edmonds, 1972, *The Phyla Sipuncula and Echiura*. Trustees of the British Museum (Natural History), London : 250-251, fig. 29E-G.

Type locality : Recif Polo Kalappa, Malay. *Location of type* : Royal Natural History Museum of Belgium, Brussels.

Material examined: 1 ex., Marine jetty, Port Blair, South Andamans, "washed up on beach after strom", ?.xii.1976, Coll. A.K. Dattagupta.

Description : Trunk 138 mm in length and 42 mm in maximum width at posterior end of trunk; nearly cylindrical, brown in colour, thick and tough-skinned with annular furrows. Introvert much narrower than trunk, cylindrical, completely retracted inside, a little more than one-third as long as trunk, its distal fourth flesh coloured bearing hooks and the rest up to introvert base rusty brown coloured. Tentacles about 20 in number, finger-shaped and measuring about 1 mm in length. Hooks arranged in numerous rows, only anterior 22 rows present and the rest worn out; each hook unidentate, bluntly pointed and transparent except light yellowish apical part where central streak restricted; measuring 0.10-0.12 mm in height and 0.15-0.19 mm in width at base; a few tall hooks of 0.15 mm in height and 0.11 mm in width are also observed.

Anal shield oval in shape, 8.5 mm long dorso-ventrally and maximum width 10.5 mm at the dorsal end; with 19 furrows, most prominent at dorsal end and long furrows alternate with short ones. Caudal shield terminal in position, 10.5 mm in diameter and with alternating short and long 37 furrows, none reaching the central conical protrusion. Both the shields dark brown in colour and made up of small chitinous bodies which usually coalesce with each other to form a hard and rough surface.

Papillae of trunk nearly transparent, dome-shaped and measuring 0.22-0.32 mm and 0.15-0.29 mm long and short diameter respectively at base; papillae arranged in groups of 3-9 in each and large number of such groups present in each annular zone of trunk. Papillae on the proximal three-fourths of introvert transparent, nearly circular in outline, measuring 0.05-0.08 mm in diamater and arranged in rows whereas paipillae on the distal one-fourth of introvert between two rows of hooks transparent, tubular and measuring 0.03-0.04 mm in height. A lot of mushroom-like fine papillae arising from dermal layer about 0.05 mm in height and with broad free distal end penetrating hypodermis through small pores.

Longitudinal muslce layer divided into thick and broad slightly anastomosing bands : 22 bands at anal level, 27 in mid-trunk region and 24 near caudal shield. Circular muscle layer also divided into bands. Retractor muscles single pair, arising 26 mm ahead of caudal shield from muscle bands 2-6 and

immediately fusing to form a single retractor muscle; after a short distance of their union the retractor muscle splitting into two more or less separate bands, lying one above the other and for accomodating oesophagus the upper one forming a groove. Oesophagus very long, slender, thread-like, less than half its length attached and embedded in the groove formed by the upper half of retractor muscle; a thin sheet of broad membrane attaching post-oesophageal gut to retractor muscle where the former leaving the latter and some fibres of spindle muscle anchoring post-oesophageal gut just before coiling. Intestine with 37 tight coils; rectum about 25 mm long, more or less straight and without rectal caecum; anus lying 8 mm behind the dorsal border of anal shield. A large number of blind, tubular branched structures (1-2 mm long) in the form of cluster borne on a stem running alongside the whole rectum except anal part and the stem in turn attached to rectal wall by mesenteries. Wing muscles broad, spreading over 14 muscle bands and attaching anal part of rectum to body wall. A delicate net-like membranous flap, a posterior continuation of wing muscles, attached to body wall above the distal part of rectum. Spindle muscle attached posteriorly to centre of caudal shield as a delicate thread, progressively stronger and becoming as strong as a muscle band anteriorly at the beginning of intestinal coil where it bifurcates; the main branch attached to muscle band 13 and extended further forward dorsally along the same muscle band being fused to rectal wall up to distal part of rectum where delicate membranous flap of wing muscles terminate; the slender ventral branch inserting just in front anus after bifucation being fused with rectum. Fixing muscle absent. Contractile vessel very long, simple but with a number of bulbous swellings and accompanying oesophagus up to distal part of post-oesophageal gut. Nephridia long, tubular, rusty red in colour and about three-sevenths of trunk length; attached to body wall by their anterior halves and open between muscle bands 3-4 (right one) and 2-3 (left one) just behind anus. Nephrostomal funnel white, short, wide and thin-walled with frilled margin.

Remarks : This species may be easily recognised from others of this subgenus from this coast by the nature of the anal and the caudal shields, and peculiar feature associated with the rectum, and of the retractor muscle and the spindle muscle.

The examined specimen differs from *A. (P.) gigas* Sluiter in the presence of hooks/spines on the introvert, the features associated with the rectum and anterior attachment of spindle muscle. On the other hand both the external and internal structures agree well with Wesenberg-Lund's (1937c) description of *A. pachydermatus* except in some minor details. According to Wesenberg-Lund (1937c) 24 longitudinal muscle bands are present in the middle part of the trunk whereas in the key she referred to only 22 longitudinal muscles. In the present specimen the said number ranges from 22-27. Secondly, in her specimen the proximal part of retractor splits up into 5 more or less separate muscles but here it is observed that the said muscle splits up into 2 more or less separated muscles and lie one above another ventral to oesophagus. Thirdly, nephridia are not completely free in the present specimen. This species is so far not recorded from anywhere else but Stephen and Edmonds (1972) mentioned the existence of two specimens from Philippines in the collection of United States National Museum.

The author is not in a position to agree with Dr. E. B. Cutler's view (a personal communication) that *A. pachydermatus* is "a big, old *A. klunzingeri*" because the former differs the latters as follows : (i) origin of retractor muscles from posterior fifth of trunk *vs.* just in front of caudal shield; (ii) splitting nature of retractor muscle unit after fusion of paired retractor muscles *vs.* single retractor muscle and its non-splitting nature; (iii) bifurcated nature of spindle muscle *vs.* non-bifurcated spindle muscle; (iv) rectum with caecum *vs.* rectum without caecum; (v) hook broader than high *vs.* hook higher than broad.

Further studies on more material are needed to solve the querry raised by Dr. Culter. However, Cutler and Cutler (1989) in their revisionary work placed this species as a junior synonym of *A. (P.) laevis.*

Previous Indian Records : None.

Distribution : The species appears to be an intertidal form associated with the coral reef in the Indo-West Pacific region and the second record outside the type locality.

In India : South Andamans.

Elsewhere : Pacific Ocean : Malay (Wesenberg-Lund, 1937c); Philippines (in Stephen and Edmonds, 1972).

35. **Aspidosiphon (Paraspidosiphon) steenstrupii steenstrupii** Diesing (Figs. 38-41, 175-181)

Aspidosiphon steenstrupii Diesing, 1859, *Sber. Akad. Wiss. Wien,* **37** : 767, pl.2, figs. 1-6.
Aspidosiphon fuscus Sluiter, 1882, *Natuurk. Tijdscher. Ned. Indie,* **41** : 86-110, pl.1-2.
Aspidosiphon makoensis Sato, 1939, *Sci. Rep. Tohoku Univ.*, (4) **14** : 419-421, pl.21, fig.22, text-figs. 51-54.
Aspidosiphon formosanus Sato, 1939, *Sci. Rep. Tohoku Univ.*, (4) **14** : 421-424, pl.21, fig.23, text-figs. 55-57.
Aspidosiphon exostomum Johnson, 1964, *Ann. Mag. nat. Hist.*, (13) **7** (76 & 77) : 331-332, pl.7, figs.1-9.
Paraspidosiphon steenstrupii : Rice, 1969, *Am. Zool.*, **9** : 804, figs. 1, 5c.
Aspidosiphon (Paraspidosiphon) steenstrupii : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.*, **29** (4/6) : 308/309, text-figs. 13B and G.

Type locality : St. Thomas. *Location of type* : Not known.

Material examined : 5 exs., Ross Island, South Andamans, 26.iii.1952, Coll. H.C. Ray; 3 exs., Long Island, Middle Andamans, 25.i.1959, Coll. K.K. Tiwari; 8 exs., Little Andamans, 17.iii.1961, Coll. A. Daniel; 11 exs., Mandapam Camp, Tamil Nadu, 26.i.1973, Coll. K.V. Rama Roa; 4 exs., Camorta, Nicobars, 25.i.1976, Coll. D.R.K. Sastry; 7 exs., Beyt Island, Gujarat, "in rocks", 7.iv.1977, Coll. B.P. Haldar; 12 exs., Dwaraka, Gujarat, "in rocks", 10.iv.1977, Coll. B.P. Haldar; 4 exs., Pirotan Island, Gujarat, 19i.iv.1977, Coll. D.R.K. Sastry; 17 exs., Diu, Union Territory, 10.ii.1978, Coll. J. Pattanayak; 22 exs., Port Blair, South Andamans, "in dead corals in sand pool", 22.v.1978, Coll. B.P. Haldar; 17 exs., Chidyatapu, South Andamans, "in dead corals exposed at low tide", 26.v.1978, Coll. B.P. Haldar; 8 exs., Minicoy, Lakshadweep, "from outer reef edge", 12.xii.1979, Coll. B.P. Haldar; 15 exs., Bangaram, Lakshadweep, 25.xii.1979, Coll. P. Roy ; 10 exs., Agatti, Lakshadweep, 3.iv.1984, Coll. A. Misra; 11 exs., Kavaratti, Lakshadweep, 3.iv.1984, Coll. A. Misra; 11 exs., Kavaratti, Lakshadweep, 7.ii.1986, Coll. R.K. Chakraborty; 5 exs., Viringilli near Minicoy, Lakshadweep, 17.ii.1986, Coll. D.R.K. Sastry.

Description : Trunk 22-66 mm long, 7-26 mm wide near caudal shield, thin-skinned except anterior and posterior end, pale straw to yellowish gray in colour. Introvert, retracted in most specimens, 15-40 mm long, light brown in colour and distinctly narrower and thinner than trunk.

Tentacles 15-20 in number, short, finger-like; arranged more or less in a ring and placed dorsal to mouth. Hooks in 30-60 rows, measuring 0.06-0.11 mm in height and 0.09-0.12 mm in width at base; yellowish to brown in colour, bidentate with clear streak having posteriorly directed tongue-like extension and almost covering half of internal space. Spines spathe-like lying posterior to rows of hooks, measuring 0.05-0.07 mm in height, covering maximum area of remaining portion of introvert; dark brown, irregularly placed and more or less straight.

Anal shield distinctly marked off from the trunk, ungrooved, oval in shape, made of densely packed small, dark brown chitinous bodies. Caudal shield usually less distinguished from trunk, hemispherical or knob-like in shape depending on the state of contraction; light to dark brown in colour; marked with 10-15 almost complete radial furrows and about half of them inter-radial ones; peripheral part of the shield having semicircular furrows.

Papillae covering the trunk flat, somewhat elliptical in shape, measuring 0.12 mm x 0.10 mm - 0.16 mm x 0.13 mm; made up of polygonal chitinous plates having several perforations on their surface; between rows of hooks tubular and cylindrical papillae measuring 0.025-0.036 mm in height present. Some other polygonal chitinous plates covering the trunk surface between the papillae also present.

Longitudinal muslce layer divided into 15-27 externally visible anastomosing bands : 15-20 anteriorly, 21-24 in midtrunk region and 25-27 posteriorly. Retractor muscles single pair, moderately broad, arising from muscle bands 3-8 (2-8, 2-9, 3-9, 3-10) and either fusing immediately or remaining separate for about two-fifths to one-half of their length. Oesophagus long, its major part being attached with and running over fused retractor unit; intestinal coils 17-33 in number; rectum long and usually with round or pear-shaped rectal caecum. Spindle muscle attached both anteriorly and posteriorly. Wing muscles present. Contractile vessel without villi. Nephridia long, tubular, thin, transparent or yellow to dark brown in colour; about one-half to three-fourths of trunk length and open at same level as anus between muscle bands 2-3 or 3-4; their anterior one-half to fifth-sixths attached to body wall. Gonads, in some specimens, prominent at base of retractor muscles. Eggs measuring 0.15 mm in diameter lying in the body cavity.

Remarks : The species can be distinguished from the others of this subgenus by the structure of bidentate hooks having posteriorly directed tongue-like extension of clear streak and long spathe-like spines on the introvert.

The introvert, in the present material, is about three-fourths of the trunk length although earlier records reveal that it is slightly shorter than trunk (Selenka and de Man, 1883), as long as trunk (Selenka and de Man, 1883; Stephen and Edmonds, 1972) or sometimes longer than the trunk (Cutler, Cutler and Nishikawa, 1984). A couple of specimens from Port Blair, South Andamans, collected on 22.v.1978 possess 77-80 complete rows of hooks in addition to a good number of incomplete ones. The calcareous deposit with 7-10 mm in height is sometimes observed on the anal shield and the sames is also reported by Shipley (1903a) and Fischer (1922a). Fixing muscle as reported by Selenka and de Man (1883, in a specimen from Philippines), Ikeda (1904) and Sato (1939) is also observed in 10% of the material examined. It originates above the base of right retractor muscle and attaches to the first

part of the rectum or behind the rectal caecum, if present. It sometimes bifurcates before termination and in such case other branch attaches to the post-oesophageal gut. The number of longitudinal muscle bands as observed in the specimens is 15-27. But Selenka and de Man (1883), and Stephen and Edmonds (1972) reported 16-25 whereas Wesenberg-Lund (1959a) recorded 20-30 bands for this species.

On examination of a large population of *Aspidosiphon (P.) steenstrupii* from different localities, it is noted that the origin of retractor muscles takes place anywhere between posterior fourth to sixth of trunk and fusion or separation of two retractor muscles occurs at any length within the trunk depending on the degree of contraction or extension of the introvert.

The author in 1975 reported *A. (P.) formosanus, A. (P.) makoensis* and *A. (P.) steenstrupii* as three distinct species but by virtue of their similar charcteristics Cutler and Cutler (1981) synonymised the first two species with the third. The present author, at the moment, is endorsing this view.

In the vicnity of the type locality of *A. (P.) exostomus* Johnson (1964) and also other places of Port Blair the author collected a good number of specimens of *A. (P.) steenstrupii*. The description and illustrations of *A. (P.) exostomus* agree well with *A. (P.) steenstrupii*. Stephen and Edmonds (1972) were unable to differentiate *A. (P.) exostomus* from *A. (P.) steenstrupii*. Johnson (1964) has not compared this species with any other member of this genus but justified the inclusion of this species in the genus *Aspidosiphon*. The figures of hooks and spines (pl.7, figs. 8 and 9) as given by Johnson (1964) are exactly similar to the illustrations drawn by Selenka and de Man (1883) and Sato (1939) and the figures drawn by the author on the strcutures mentioned above. Spines are not the unique characters of *Lithacrosiphon*, it is also found in many members of *Aspidosiphon*. Cone-shaped calcareous deposit on the anal shield, absence of rectal caecum (in some of the present material) and 77-80 rows of hooks [*versus* 100 in *A. (P.) exostomus*] are observed in a few specimens examined. On the basis of the place of origin of retractor muscles and their fusion or separation, *A. (P.) exostomus* can be placed on one extreme end of the variation in the population of *A. (P.) steenstrupii*. But 18-34 longitudinal muscle bands present in *A. (P.) exostomus* has so far not been reported in *A. (P.) steenstrupii*. This may be explained that in addition to regular bands as observed in *Phascolosoma albolineatum* some thin strands are probably participating in anastomosation.

On the bais of the above discussion the author is of the opinion that *A. (P.) exostomus* may be merged with *A. (P.) steenstrupii*.

Previous Indian records : Minicoy, Lakshadweep; (Shipley 1903a; Haldar, 1975); North and South Andamans (Johnson, 1964; Haldar, 1975, 1976); Nicobars (Haldar, 1976).

Distribution : This is a circumtropical shallow water species excepting for the eastern Pacific and it is fairly common and widely spread in the Indo-Pacific area.

In India : Gujarat; Diu; Lakshadweep; Tamil Nadu; Andamans; Nicobars.

Elsewhere :

(a) *Indian Ocean* : Somali coast (Murina, 1981b); Gulf of Aden (Herubel, 1904a); Zanzibar

(Stephen and Robertson, 1952); Durban (Stephen, 1942b); Madagascar (Cutler and Cutler, 1979a); Off south-east of South Africa (Cutler, 1977a); Mauritius (Selenka and de Man, 1883); Maldives (Shipley, 1903a); Gulf of Mannar (Shipley, 1903b); Penang (Lanchester, 1905c); south coast of Java and Timor (Sluiter, 1902; Fischer, 1922a); Cocos-Keeling Islands (Cutler and Cutler, 1979a).

(b) *Pacific Ocean*: Japan (Ikeda, 1904; Cutler, Cutler and Nishikawa, 1984); Riukiu (Ikeda, 1904; Sato, 1939); Korea and Formosa (Sato, 1939); Philippines (Selenka and de Man, 1883); Guam (Edmonds, 1971; Cutler, Cutler and Nishikawa 1984); East Caroline Islands (Cutler, Cutler and Nishikawa, 1984); West Caroline Islands (Ikeda, 1924); Amboina (Augener, 1903); Indo-China (Leroy, 1942); Thailand (Fischer, 1923b); Malay Archipel (Sluiter, 1882); Bantam (Sluiter, 1886); Batavia and Billiton (Sluiter, 1891); Queensland (Monro, 1931; Edmonds, 1956, 1980); New Guinea (Fischer, 1926a); Loyalty Islands (Shipley, 1899a); New Hebrides (Leroy, 1936); Tahiti (Fischer, 1922a).

(c) *Atlantic Ocean* : Florida (Rice, 1976); Bahamas (Shipley, 1899a); Cuba (Murina, 1967b); Caracas Bay (ten Broeke, 1925); Barbados (Rice, 1969); Puerto Rico (Rice, 1969; Cutler, 1977a); St. Berthelemy (Fischer, 1922a); St. Thomas (Baird, 1868; Fischer, 1922a); Cape Verde Islands (Fischer, 1914a; Cutler and Cutler, 1979b); Brazil (Fischer, 1931); St. Helena (Wesenberg-Lund, 1959a).

35a. **Aspidosiphon (Paraspidosiphon) steenstrupii ambonensis** Augener (Figs. 49, 190-195)

Aspidosiphon ambonensis Augener, 1903, *Arch. Naturgesch.*, **69** : 325-328, figs. 5-8.
Aspidosiphon steenstrupii var. *ambonensis* Augener : Fischer, 1922a, *Ark. Zool.*, **14** (19) : 24-26, figs. 24, 26 28, 29.
Paraspidosiphon ambonensis : Stephen and Edmonds, 1972, *The phyla Sipuncula and Echiura,* Trustees of the British Museum (Natural History), London : 240-241, figs. 29K, 30C.
Aspidosiphon (Paraspidosiphon) havelockensis Haldar, 1978, *Bull. zool. Surv. India*, **1** : 37-41, figs. 1A-C, 2A-H.

Type locality : Amboina, Moluccas. *Location of types* : Zoological Museum, Humboldt University, East Berlin.

Material examined: 1 ex., eastern side of Neil Island, South Andamans, "from dead coral rock", 30.ix.1972, Coll. B.P. Haldar; 3 exs., Havelock Island, South Andamans, "from dead coral rock", 5.x.1972, Coll. B.P. Haldar; 4 exs., Neil Island, South Andamans, "from under water dead corals during low tide", 2.v.1978, Coll. B.P. Haldar; 3 exs., Rangat, Middle Andamans, "from dead corals", 26.ii.1980, Coll. B.P. Haldar.

Description : Trunk 18.5-34.5 mm long, 6.5-13 mm wide in mid-trunk region; thin-skinned creamy yellow to creany white in colour. Introvert, almost fully everted in the smallest one, 9-12.5 mm long, colourless, much narrower and thinner than trunk. Tentacles 8-12 in number, short, finger-like and attached by their sides but tips remaining free. Hooks in 25-46 rows, light yellow in colour, bidentate with colourless, transparent streak and sometimes a tail-like process at base of concave side; measuring

0.032-0.042 mm in height and 0.036-0.046 mm in width at base. Spines single pointed, usually tetrahedral in shape, light coloured than hooks covering proximal to hooked region, more or less regularly arranged and measuring 0.028-0.036 mm in height and 0.020-0.040 mm in width at base.

Anal shield distinctly marked off from trunk, ungrooved, round (1.5 mm in diameter) to oval (2 mm x 2.5 mm) in shape, light brown to dark brown in colour and made up of densely packed small chitinous bodies. Caudal shield somewhat conical or knob-like in shape, light coloured than anal shield; central part ungrooved, made up of small chitinous bodies whereas peripheral part having semicircular and incomplete radial furrows.

Papillae covering anterior and posterior end of trunk close to shields composite in nature; 3-4 papillae bordered by a pigmented rim, measuring 0.072 mm in diameter; papillae in mid-trunk region small, round, flat and colourless; measuring 0.044 mm in diameter; between rows of hooks and amongst spines tubular papillae (0.016 mm in height) with rounded base (0.024 mm in diameter) present.

Longitudinal muscle layer grouped into externally visible anastomosing bands; 14-20 anteriorly; 18-26 in mid-trunk region and 19-28 posteriorly. Retractor muscles single pair, arising from posterior seventh to tenth of trunk spanning 4-6 muscle bands starting from first to third muscle bands and fusing together for greater part of their length. Oesophagus long, narrow tube and following retractor unit till fusion; intestinal coils 14-23 in number and extending up to centre of caudal shield; rectum about one-fourth of trunk length and usually with small, round rectal caecum nearly on mid-rectum. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle usually absent but wing muscles present. Nephridia tubular, thin and transparent, grayish-white to light brown in colour; about one-half to one-third of trunk length and their posterior one-third to one-fourth free from body wall; open a little behind anus between muscle bands 2-3 (rarely 3-4). Gonads prominent at base of retractor muscles. Eggs with striated double coats, oval in shape and measuring 0.11 mm x 0.10 mm.

Remarks : This subspecies differs from the nominotypical subspecies in the nature of transparent streak of the hook, shape of spine and nature of trunk papillae.

The position and attachment of retractor muscles and their fusion or separation, the number of longitudinal muscle bands, and the nature of anal and caudal shields in the examined specimens stand within the range of the nominate species. The presence or absence of rectal caecum and fixing muscle are not constant characters even in the nominate species. Variation in the introvert-trunk length ratio and the number of hook rows has already been discussed along with the nominate species.

A.(P.) ambonensis resembles closely with *A. (P.) steenstrupii* in the internal morphology (except fixing muscle) and externally in the nature of anal and caudal shields as well as other features except the papillae, hooks and spines. On examination of Augener's (1903) both the type specimens as well as the specimens collected from the type locality, Fischer (1922a) placed *A. (P.) steenstrupii fasciatus* in the synomny of *A. (P.) steenstrupii* and reduced *A. (P.) ambonensis* to the subspecific status of *A. (P.) steenstrupii*. The reason for this change according to Fischer (1922a) are that the hook and its clear area has been wrongly illustrated, platelets of the mid-trunk papillae have not been clearly represented and the fixing muscle is present at least in the specimen from Polo Edam.

On the basis of Augener's (1903) figure 6 (hook) Stephen and Edmonds (1972) considered *A. (P.) ambonensis* and *A. (P.) steenstrupii* to be separate species and placed *A. (P.) steenstrupii ambonensis* of Fischer in the synomny of *A. (P.) ambonensis* without assigning any reason for it.

In the examined specimens shape and nature of clear area of the hook and structure of papilla near the caudal shield resemble on one hand with Fischer's (1922a) figures 24 and 29 respectively and on the other hand shape of spine and mid-trunk papilla with Augener's (1903) figures 7 and 8 respectively.

On the basis of above discussion the author considers that Fischer's (1922a) justification was correct in reducing *A. (P.) ambonensis* to the subspecific status of *A. (P.) steenstrupii* and the examined specimens should be regarded as *A. (P.) steenstrupii ambonensis* Augener sensu Fischer. Further, on the same ground the author merges his species *A. (P.) havelockensis* with *A. (P.) steenstrupii ambonensis*. Agreeing with my conclusions (pers. comm. in 1988) Cutler and Cutler (1989) presently consider both *A. (P.) havelockensis* and *A. (P.) steenstrupii ambonensis* to be junior synonyms of *A. (P.) tenuis*.

Previous Indian Records : Neil and Havelock Islands, South Andamans (Haldar, 1978).

Distribution : This is an Indo-West Pacific form found in corals in the intertidal zone. Except the Andamans it is not reported elsewhere from the Indian Ocean.

In India : South and Middle Andamans.

Elsewhere : Pacific Ocean : Gulf of Siam (Fischer, 1923b); Java Sea (Augener, 1903; Fischer, 1922a); Amboina (Augener, 1903).

Genus **Cloeosiphon** Grube

Cloeosiphon Grube, 1868b, *Jber. Schles. Ges. Vaterl. Kult.*, **45**:48.
Cloeosiphon : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 57.

Diagnosis : Introvert longer than trunk armed with numerous rows of recurved hooks, evaginating from centre of anal shield; anal shield made up of numerous small rhomboidal calcareous plates; tentacles arranged in a horse shoe-shaped ring encircling nuchal organ, but not mouth; Muscle layers of body wall continuous; retractor muscles one pair but due to extensive fusion appearing to be a single muscle with two short roots; spindle muscle attached posteriorly; contractile vessel without villi; nephridia paired.

Type species : Loxosiphon aspergillus Quatrefages, 1865.

Distribution : Common inhabitant of coral reefs of most tropical seas.

Remarks : Besides *C. aspergillus*, four more species, viz., *C. mollis* Selenka and Bulow (1883),

C. javanicus Sluiter (1886), *C. japonicus* Ikeda (1904) and *C. carolinus* Ikeda (1924) have been described under this genus. Fischer's (1922a) discussion on *C. mollis, C. javanicus* and *C. japonicus* and Sato's (1935) discussion on *C. carolinus* resulted aforesaid four species to be synonymous with *C. aspergillus*. Presently, this is a monotypic genus.

36. **Cloeosiphon aspergillus** (Quatrefages)
Figs. 50-53, 182-185)

Loxosiphon aspergillus Quatrefages, 1865b, *Historie naturelle des Anneles marins et d'eau douce.* Paris. **2** : 605, pl.20, fig. 20.
Cloeosiphon aspergillum : Grube, 1868b, *Jber. Schles. Ges. Vaterl. Kult.* **45** : 48-49.
Cloeosiphon mollis Selenka and Bulow, 1883, *Reisen im Archipel der Philippinen von Dr. C. Semper,* (2) **4** (1) : 128, pl.14, figs. 217-218.
Echinosiphon aspergillum Sluiter, 1884, *Natuurk. Tijdschr. Ned. Indie,* **43** : 26-38, pl.1, figs. 1-15.
Cloeosiphon japonicum Ikeda, 1904, *J. Coll. Sci. imp. Univ. Tokyo,* **20** (4) : 49-53, figs.13, 86-89.
Cloeosiphon carolinus Ikeda, 1924, *Jap. J. Zool.*, **1** : 34-37, pl.1, figs. 7-11.
Cloeosiphon aspergillum : Sato, 1935, *Sci. Rep. Tohoku Univ.*, (4) **10** : 321-324, pl.4, fig.20.
Cloeosiphon aspergillus : Cutler, Cutler and Nishikawa, 1984, *Publs Seto mar. biol. Lab.*, **29** (4/6) : 310-311, pl.2, fig.5, text-fig. 14A.

Type locality : Isle of France. *Location of types* : National Museum of Natural History, Paris.

Material examined : 2 exs., Great Coco Island, North Andamans, "excavated from coral rock", 3.xii.1889, Coll. R.I. M.S. "Investigator"; 3 exs., Andaman Sea, 14°54'30" N,. 96°13'00" E, 8 m, 26.i.1987, Coll. R.I.M.S. "Investigator"; 4 exs., Port Blair, South Andamans, 4.ii.1959, Coll. K.K. Tiwari; 6 exs., Great Nicobar, Nicobars, 15.iii.1966, Coll. A. Daniel; 2 exs., Appa Island, Gulf of Mannar, Tamil Nadu, 26.ii.1970, Coll. K. Reddiah; 5 exs., Krusadai Island, Gulf of Mannar, Tamil Nadu, 2.xii.1974, Coll. N.K. Unithan (C.M.F.R.I., Mandapam Camp); 8 exs., Rameswaram Island, Gulf of Mannar, Tamil Nadu, 28.xii.1974, Coll. B.P. Haldar; 2 exs., Tangasseri near Quilon, Kerala, 24.i.1976, Coll. B.P. Haldar; 4 exs., Camorta, Nicobars, 30.i.1976, Coll. D.R.K. Sastry; 9 exs., Veraval, Gujarat, 26.iii.1977, Coll. B.P. Haldar; 6 exs., Dwaraka, Gujarat 10.iv.1977, Coll. D.R.K. Sastry; 11 exs., Pirotan Island, Gulf of Kutch, Gujarat, "from dead corals", 19.iv.1977, Coll. B.P. Haldar; 3 exs., Veraval, Gujarat, 23.i.1978, Coll. J. Pattanayak; 7 exs., Diu, Union Territory, 30.i.1978, Coll. J. Pattanayak; 15 exs., Port Blair, South Andamans, "from dead corals", 29.iv.1978 and 22.v.1978, Coll. B.P. Haldar; 4 exs., Havelock Island, South Andamans, 9.v.1978, Coll. B.P. Haldar; 6 exs., Chidyatapu, South Andamans, "from corals in mangrove zone", 25.v.1978, Coll. B.P. Haldar; 12 exs., Kalpeni, Lakshadweep, "from corals exposed at low tide", 9.xii.1979, Coll. B.P. Haldar; 3 exs., Minicoy, Lakshadweep, "from dead coral at lagoon bed", 13.xii.1979, Coll. B.P. Haldar; 5 exs., Kavaratti, Lakshadweep, "from inner reef edge", 5.i.1980, Coll. B.P. Haldar; 8 exs., Mayabunder, North Andamans, "from coral rocks lying in the low tide marks", 27.ii.1980, Coll. B.P. Haldar; 10 exs., Agatti, Lakshadweep, "from corals dredge at lagoon bottom", 9.iv.1984, Coll. A. Misra; 5 exs., Kavaravatti, Lakshadweep, 6.ii.1986, Coll. D.R.K. Sastry; 6 exs., Minicoy, Lakshadweep, 14.ii.1986, Coll. D.R.K. Sastry.

Description : Trunk 25-98 mm long, 6-19 mm wide, cylindrical grayish white or light to deep brown in colour, rounded or bluntly pointed posteriorly. Introvert, partially or completely retracted in

all excepting for a few, 9-30 mm long, slender, arising from centre of anal shield. Tentacles 8-10 in number, uniting to form a funnel-like crown, the nature (whether nuchal or peripheral) of which difficult to ascertain as the tentacular crown not fully exposed. Hooks in 15-26 complete rows, bidentate, brown in colour, with sharply pointed apical teeth having transverse bar and warts at base, and measuring 0.05-0.10 mm in both height and width; clear area of hook having irregularly branched or unbranched processes on concave side.

Anal shield white, rounded or knob-like, 1.2-4.9 mm in diameter; shield having spirally arranged numerous quadrate or rhomboidal calcareous facets, being largest at introvert base and gradually smaller towards shield base; each facet bearing deep brown circular pore on its top surface.

Papillae truncated, cone-shaped, 0.01-0.05 mm in height and0.03-0.13 m in width at base, being densely crowded and largest at both ends of trunk; but sparsely distributed and small on the rest part of trunk; papilla light brown at its basal part while colourless at its upper part having a perforation at its apical truncated end. Papillae between every two rows of hooks tubular, perforated, transparent and measuring 0.01-0.02 mm in height.

Muscle layers of the body wall continuous. Retractor muscles single pair, arising by broad base from posterior fifth of trunk close to nerve cord and fusing shortly after their origin. Oesophagus long, tubular and completely attached to fused retractor unit; intestinal coils 10-16 in number and extending up to posterior end of trunk; rectum long, straight tube and without any rectal caecum; anal aperture prominent, transverse fissure lying dorsal posterior border of anal shield. Spindle muscle attached both anteriorly and posteriorly. Fixing muscle single, arising from posterior fourth of trunk close to nerve cord and attaching to beginning of rectum passing between retractor muscles. Wing muscles present. Contractile vessel simple and without villi. Nephridia light to dark brown in colour, usually visible from outside, long extending to the base of retractor muscles and completely attached to body wall; their openings lying at same level of anus but closer to nerve cord than to anus.

Remarks : The species may easily be recognised by its unique white round or knob-like anal shield which is made up of spirally arranged numerous quadrate or rhomboidal calcareous facets, even when an incomplete specimen with anal shield be collected.

This is found only in coral habitat in abundance and one of the commonest sipunculan species met with along the Indian coast. But it is very difficult to collect an intact specimen as it is often damaged while extraction from its burrow.

Though the shape of the anal shield is unique but depending on the state of contraction at the time of fixation it shows variable shapes like depressed disc (a few in the present material), pineapple and spheroid to pineapple the latter two shapes were also observed by Edmonds (1980), and Cutler, Cutler and Nishikawa (1984) respectively. Further, in the present material two types of population observed one with thin, transparent less papillated, smooth and of uniform grayish white in colour and the other with thick, opaque, more papillated, to some extent rough skin and light to deep brown in colour. Similar findings were noted by Shipley (1899a) for *C. aspergillus* and by Ikeda (1904) for *C. japonicum*.. The latter author indicated "these differences are sexual" The present author feels that such differences may depend on the microhabitat. Rectal caecum is totally absent in the present

material and the same was noted by Sluiter (1884), Stephen and Edmonds (1972) and Edmonds (1980) but its presence was reported by Ikeda (1924) and Sato (1935 - normally present but not in all).

From the distributional point of view this species is not recorded so far from the Atlantic Ocean and Mediterranean Sea except Quatrefages' collection from the Isle of France.

Previous Indian Records : Minicoy, Lakshadweep (Shipley, 1903a); Gujarat and North Andamans (Haldar, 1975).

Distribution : This species is a tropical shallow water coral dwelling form of the Indo-West Pacific region.

In India : Gujarat, Diu; Kerala; Lakshadweep; Tamil Nadu; Gulf of Mannar; Andamans and Nicobars.

Elsewhere :

(a) *Indian Ocean* : Tanganyika (Lanchester, 1905b); Zanzibar (Fischer, 1892; Lanchester, 1905b; Stephen and Robertson, 1952); Madagascar (Cutler, 1965; Cutler and Cutler, 1979a); Mauritius (Selenka and de Man, 1883; Fischer, 1895); Maldives (Shipley, 1903a; Rice, 1969); Ceylon (Shipley, 1903b); Penang (Lanchester, 1905c); west coast of Sumatra (Fischer, 1922a); Singapore and south of Bali (Cutler, 1977a); Cocos-Keeling Islands (Cutler and Cutler, 1979a).

(b) *Pacific Ocean* : Japan (Ikeda, 1904; Cutler, Cutler and Nishikawa, 1984); Formosa (Sato, 1939); Philippines (Selenka and Bulow, 1883; Cutler, 1977a); Uhoy, Ibo, Zamboango and Luzon (Selenka and de Man, 1883); Amboina (Augener, 1903); West Caroline Islands (Ikeda, 1924; Sato, 1935); East Caroline Islands (Cutler, Cutler and Nishikawa, 1984); Jaluit (Ikeda, 1924); Indo-China (Leroy, 1942); Thailand (Fischer, 1923b; Cutler and Cutler, 1979a); Indonesia (Sluiter, 1884, 1891, 1902; Fischer, 1922a); Queensland (Monro, 1931; Edmonds, 1956, 1980); New Guinea (Fischer, 1926a); Loyalty Islands (Shipley, 1899a); New Hebrides (Leroy, 1936); Fiji Islands (Selenka and de Man, 1883; Fischer, 1922a); Funafuti (Shipley,, 1898; Whitelegge and Hill, 1899); Samoa (Fischer, 1895; Augener, 1903); Christmas Island (Shipley, 1899b).

(c) *Atlantic Ocean* : Isle of France (Quatrefages, 1868b).

Genus **Lithacrosiphon** Shipley

Lithacrosiphon Shipley, 1903a, [In] Gardiner, J.S. *Fauna and Geography of Maldive and Laccadive Archipelagoes*. **1** : 139.
Lithacrosiphon : Gibbs and Cutler, 1987, *Bull. Br. Mus. nat. Hist.*, (Zool.), **52** (1) : 57.

Diagnosis : Introvert almost equal to trunk, armed with numerous rows of recurved hooks, arising ventral to anal shield, anal shield composed of single solid calcareous structure; tentacles arranged in a horseshoe-shaped ring enclosing nuchal organ, but not mouth; longitudinal muscle layer divided into anastomosing bands; retractor muscles single pair but fused almost completely; spindle muscle attached posteriorly, contractile vessel without villi; nephridia paired.

Type species : Lithacrosiphon maldivensis Shipley, 1902.

Distribution : Widely distributed in tropical seas.

Remarks : Critically reviewing the genus Cutler and Jurczak (1975) concluded that out of eight species described so far, only *L. maldivensis* Shipley and *L. cristatus* (Sluiter) are valid. They, however, questioned the status of the ninth species, *i.e., L. uniscutatus* (type material untraceable) which was subsequently merged with *L. cristatus* by Cutler and Cutler (1981). None of the aforesaid species is so far reported from the Indian coast except a subspecies of *L. cristatus i.e., L. cristatus lakshadweepensis* very recently. *L. maldivensis*, originally described from Maldives, is not available in the present material from Lakshadweep, the nearby area.

37. **Lithacroshiphon cristatus lakshadweepensis** Haldar
(Figs. 44, 45, 196-202)

Lithacrosiphon cristatus lakshadweepensis Haldar, 1991a, *Rec. zool. Surv. India*, 87(1); 158-159, figs. 6-13.

Type locality : Lakshadweep. *Location of type* : National Zoological Collections of the Zoological Survey of India, Calcutta.

Material examined : 3 exs., Minicoy, Lakshadweep, 12.ii.1986, Coll. D.R.K. Sastry; 2 exs., Chorwad, Veraval, Gujarat, "breaking dead corals", 7.i.1990, Coll. B.P. Haldar.

Description : Trunk 14-21 mm in length and 6-8 mm in width at posterior third of trunk; light brown in colour with extremities darker. Introvert retracted, 7-11 mm in length and 2-5 mm in width, usually narrower than and about half as long as trunk, arising ventrally from anal shield at right angle to anterior trunk just opposite to anus. Tentacles not more than 10 in number. Hooks two types : transparent and bidentate hooks arranged in 14-19 complete rows on the distal end of introvert and closely placed but irregularly arranged brown unidentate hooks which are gradually enlarged posteriorly found on the proximal end of introvert; a few scattered hooks of both uni-and bidentate present in the intermediate region. Bidentate hook having 3-4 anterior warts, a transparent crescent-shaped concave area inside and measuring about 0.04 mm in height and width at base. Unidentate hook measuring about 0.05 mm in height and 0.04 mm in width at base. Spines measuring 0.04-0.05 mm in height present on the proximal part of introvert behind unidentate hooked zone.

Anal shield 1.7-3.9 mm in length, prominent, hard, calcareous and cone-shaped structure borne on a pad of skin; length of the shield is non-proportional to the trunk length; 20-25 longitudinal furrows converging towards its rounded apex.

Skin thin in mid-trunk region but thicker and opaque at anterior and posterior end. Papillae on trunk flat and may be categorised into three groups : (i) a narrow region just posterior to anal shield closely beset with irregular- shaped papillae which are made up of small transparent plates in the centre, surrounded by large light brown coloured plates; (ii) a comparatively wide region in posterior part of trunk beset with complex papillary structure of 2-5 papillae, each without boundary wall and

surrounded by thick ridge made up of overlapping plates; oval, light brown to brown coloured in general and each papilla larger than that of the first and the third group; (iii) mid-trunk papilla transparent, flat and elliptical in shape, composed of numerous irregular plates having a few rows of small plates surrounding the central dermal pore. Transparent tubular papillae about 0.015 mm in height lying scattered in the hooked zone of introvert.

Longitudinal muscle layer gathered into 8-15 thin, broad and frequently anastomosing bands; above the nephridiopores and below the retractor base these muscle bands form a continuous sheet. Circular muscle layer continuous. Retractor muscles one pair, arising from posterior end of trunk at a distance of one-seventh of trunk length and immediately fusing with each other up to an extent of four-fifth to five-sixth of their length to form a single retractor unit. Oesophagus narrow and being attached to retractor unit; intestine with 13-15 coils extending from middle to tip of posterior trunk; rectum long and with a small baloon-like caecum attached to its middle part, Spindle muscle attached to both ends. Fixing muscle absent but wing muscles present. Contractile vessel simple and two-thirds as long as trunk; attached almost throughout their entire length and opening between muscle bands 1 and 2 at same level of anus. Gonads at retractor bases well developed.

Remarks : In nature superficial layer at the rounded apex of the anal shield has been worn out in some specimens, thereby revealing hard, white, calcareous material beneath. And in some others, anal shield is of short height and flat top as if, chopped obliquely and is colonised by bryzoons.

The nominotypical subspecies exhibits wide tropical distribution usually in shallow water of the Pacific Ocean, viz., Malay, Timor, Queensland, Japan, Guam, Ponape Island, Marshall Islands, Saipen, Gilbert Islands, Hawaii, Solomon Islands and west coast of Panama, and Western Atlantic Ocean, viz., the Caribbean and Brazil. Very recently it is recorded from the Indian Waters (Haldar, 1991).

External appearance and internal morphology of the present material show much resemblances with the description of *Lithacrosiphon uniscutatus* (Ikeda). But the characters which forced the author in 1991 to place his specimens under *L. cristatus* (Sluiter) were the presence of both unidentate and bidentate hooks on the proximal and distal part of the introvert respectively. The specimens readily differ from *L. cristatus* (Sluiter) from other far-off localities by the number of longitudinal furrows on anal shield 20-25 (*versus* 30-50), number of longitudinal muscles bands 8-15 (*versus* 13-24), origin of retractor muscles in the posterior part of trunk *i.e.*, one-seventh of trunk length (*versus* one-fifth of trunk length) and also length of fused retractor unit *i.e.*, four-fifths to five-sixths of their length (*versus* three-fifths to three-fourths of their length).

Previous Indian Records : Lakshadweep.

Distribution : This subsepcies is a shallow water coral dwelling form endemic to Indian waters.

In India : Gujarat, Lakshadweep.

DISCUSSION

Sipuncula comprises more than 200 species in 17 genera under 6 families known from the world; of these, over half of their number in 15 genera is on record from the Indian Ocean. The fauna of the entire Indian coast represents as many as 37 species and subspecies in 10 genera under 5 families, all of which are presently taken into account. The remaining seven genera, viz., *Xenosiphon, Siphonomecus, Phascolopsis, Golfingia, Thysanocardia, Phascolion* and *Onchnesoma*, are unknown from this coast (Table I). Present study clearly indicates that the sipunculan fauna of the Indian coast may be considered rich, as it is represented by more than one third of the total species known from the Indian Ocean.

Collections have been made from different areas of the Indian coast, viz., Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal and, also Lakshadweep, Krusadai, Andaman and Nicobar groups of islands, all being equipped with an array of ecological niches. The individuals are more destructive than constructive in nature, since these, like the boring algae, sponges and polychaetes, are extremely harmful to the reef particularly in the insular areas where luxuriant coral growths prevail. Besides, these are devoured by different animals like fishes, gastropods and even certain tribal groups of people.

Attempts are made to highlight certain relevant aspects on habits and habitats, distribution and affinities in relation to abundance of sipunculans in the Indian coast. The habits, which are interestingly variable, include sandy and muddy bottoms, sand pools, in and under rubbles and boulders made of coral and cement, in clefts or interstices of, and under beach rocks, coralline limestones, compact substrata and also estuary *cum* friable reefs with or without mangroves.

The generally sand-burrowing species of the genera *Sipunculus* and *Siphonosoma*, which are so far known from the coral communities of the Lakshadweep, some parts of Gujarat, Gulf of Mannar and also the Andamans and Nicobars, are recorded new for the non-coralline sandy beaches in West Bengal, Andhra Pradesh and Tamil Nadu. The species of these genera are usually large and cylindrical in shape. Of these, *Siphonosoma australe* from Tamil Nadu is the largest, measuring 407 mm in trunk length. The burrow of *Sipunculus indicus* possesses two apertures close to the surface-one of them leading straightway and the other obliquely -both meeting together shortly below. To catch the animal, a long and sharply pointed stick, made of mid-rib of coconut leaf, is firmly but gently pressed into burrow through the oblique aperture. Amongst the other forms, *Siphonosoma australe* and *Phascolosoma arcuatum* exhibit variable textures of their burrows, which may be either of sandy mud or muddy sand or exclusively sandy or muddy, depending on their habitats. It is interesting to note that *P. arcuatum* also inhabits rock crevices and under dead corals in the Andamans and presents a markedly different external features from the mud-dwelling form so as to appear to be a distinct species. The length of the burrows is also variable, being 20-62 cm for *S. australe*, 15-20 cm for *P. arcuatum* and of moderate size for the remaining sand-burrowers. The shape of the burrow of *P. arcuatum* is subcylindrical, anteriorly narrow and posteriorly widened and hooked with two unequal arms-longer one opening on the surface and the shorter one ending blindly underneath - while that of all other species is cylindrical.

TABLE - I
Comparison of Sipunculan fauna of the World Oceans, Indian Ocean and the Indian coast

Genera		No. of Species		
		World Oceans	Indian Ocean	Indian coast
I.	Family **SIPUNCULIDAE**			
	1. *Sipunculus*			
	S. (Sipunculus)	8	4	4
	S. (Austrosiphon)	2	2	1
	2. *Xenosiphon*	1	1	-
	3. *Siphonosoma*	10	5	4
	4. *Siphonomecus*	1	-	-
	5. *Phascolopsis*	1	-	-
II.	Family **GOLFINGIIDAE**			
	6. *Golfingia*	12	6	-
	7. *Nephasoma*	23	8	3
	8. *Thysanocardia*	3	2	-
III.	Family **PHASCOLIONIDAE**			
	9. *Phascolion*	23	14	-
	10. *Onchnesoma*	4	1	-
IV.	Family **THEMISTIDAE**			
	11. *Themiste*			
	T (Themiste)	13	3	1
	T. (Lagenopsis)	11	7	1
V.	Family **PHASCOLOSOMATIDAE**			
	12. *Phascolosoma*			
	P. (Phascolosoma)	35	20	10
	P. (Edmondsius)	1	1	-
	13. *Apionsoma*	6	5	3
	14. *Antillesoma*	1	1	1
VI.	Family **ASPIDOSIPHONIDAE**			
	15. *Aspidosiphon*			
	A. (Aspidosiphon)	24	14	4
	A. (Paraspidosiphon)	20	7	3
	16. *Cloeosiphon*	1	1	1
	17. *Lithacrosiphon*	2	2	1

The burrow of the rock-boring species, as observed in the field, may occur at any angle to the surface of the rock. They may be short, straight and rounded posteriorly, as in *Lithacrosiphon cristatus lakshadweepensis*, or, straight, wide, decreasing in width anteriorly and terminating posteriorly in a rounded fashion, as in *Antillesoma antillarum* and *Themiste lageniformis*, or, long, narrow and sinuous, as in *Aspidosiphon steenstrupii*, or, exceedingly long and winding, as in *Cloeosiphon aspergillus* and *Phascolosoma perlucens*. These burrows, each with smooth surface and tight-fitting individuals, are not usually interlinked with one another; it has only one oval or circular opening on any surface of rock. The diameter of the opening is smaller than that of the burrow. A single rock may consist of a number of burrows harbouring two or more species. There is, however, no hard and fast rule to determine the dominance of species in relation to the type of rocks. The boring of hard rocks is made by mechanical abrassions and chemical activities of the creatures, as studied by Yonge (1963), Rice (1969), Rice and MacIntyre (1972), and Williams and Margolis (1974). The species of *Phascolosoma*, *Aspidosiphon* and *Cloeosiphon* are most common in the coralline limestone in western Gujarat, Lakshadweep, Krusadai, Andamans and Nicobars. *Phascolosoma perlucens*, *Antillesoma antillarum* and *Aspidosiphon steenstrupii*, are found in burrows of all types of rocks as mentioned above. Quite a number of species, viz., *Antillesoma antillarum*, *Phascolosoma albolineatum*, *P. nigrescens*, *P. pacificum*, *P. agassizii*, *P. perlucens*, *P. stephensoni*, *Aspidosiphon elegans*, *A. gracilis*, *A. klunzingeri*, *A. steenstrupii*, *Apionsoma misakiana*, *Themiste lageniformis*, *Lithacrosiphon cristatus lakshadweepensis* and *Cloeosiphon aspergillus*, are observed to inhabit burrows in the coral reef community; of these, the first four also occur infrequently in the crevices of beach rocks or dead corals like some of *P. arcuatum*. Over and above, there are certain other species, viz., *Phascolosoma granulatum*, *P. japonicum*, *P. scolops* and *Themiste hennahi*, that have been found to occur only amidst the interstices of, or beneath rocks, boulders, stones, etc.

In addition to their foregone intertidal burrowing habitats, certain species like *Phascolosoma albolineatum*, *P. perlucens*, *P. scolops*, *Apionsoma trichocephala*, *Cloeosiphon aspergillus* and *Lithacrosiphon cristatus lakshadweepensis* could also be collected as dredged samples from depths ranging from 3-37 m.

Amongst the material examined, *Sipunculus norvegicus* occurs in the deep water (1591-1164 m), and *Nephasoma pellucidum* and *Apionsoma trichocephala* in the shallow water (8-30m), while the rest are found mainly in the intertidal zone. Incidentally, the occurrence of the last two named species from the shallow water is presently confirmed, as these were reported by Murina (1978) from elsewhere at variable depths of 1072 m and 4563 m respectively.

It is interesting to note that Hyman (1959) stressed on the exclusive occurrence of the sipunculans in the marine habitat. Subsequently, Wesenberg-Lund (1963) and Green (1975) reported certain species including *Siphonosoma australe* and *Phascolosoma arcuatum* respectively from the estuarine habitat, too. Presently, *Siphonosoma rotumanum* has also been found in backwater of Andhra Pradesh over and above the aforesaid couple of species. The adaptability to the tolerance of salinity ranging from 33.43% to 5.85% or still below, say 0.5% is really remarkable for such species in these habitats.

The number of species, as already cited from the Indian coast, represents about 83% of the West Pacific (from East China Sea to New Guinea), 50% of the North Pacific (the Far East), 42% of the East

Pacific (California to Peru, Hawaii and Christmas Island) and 80 % of the South Pacific (east coast of Australia, New Zealand and adjacent Islands). Of these, seven species including *Sipunculus nudus, Nephasoma pellucidum, Themiste lageniformis, Antillesoma antillarum, Phascolosoma perlucens, P. scolops* and *Aspidosiphon elegans* are known to exhibit overlapping distribution in all the aforesaid sectors of the Pacific,though quite a many of the rest are common from one sector to another, as the case may be. On the other hand, 50 % of the species occur in the North Atlantic (Greenland to French Guiana and Iceland to Gulf of Guinea) and 36% in the South Atlantic (Brazil to Falkland and Congo to Tristan da Cunha); of these, about ten species including *Sipunculus nudus, Nephasoma pellucidum, Phascolosoma agassizii, P. granulatum, P. nigrescens, P. scolops, Apionsoma trichocephala, Apionsoma misakiana, Aspidosiphon exhaustus* and *A. steenstrupii* are mutually overlapping.

Fifteen species occur in the tropico-temperate belts of the globe, of which four species, viz., *Sipunculus nudus, Phascolosoma scolops, Apionsoma trichocephala* and *Aspidosiphon exhaustus*, show more or less world-wide distribution. Only four species, viz., *Phascolosoma perlucens, P. nigrescens, Antillesoma antillarum* and *Aspidosiphon klunzingeri*, are found in the circumtropical belt.

Two monotypic genera, viz., *Antillesoma* and *Cloeosiphon* , are more or less widely distributed in the Indian coast. The occurrence of *Lithacrosiphon cristatus*, hitherto known from the Pacific and Atlantic, is of great geographical interest, since this species is not only a new record for the Indian Ocean, but also show distinct geographical variation, being described as *Lithacrosiphon cristatus lakshadweepensis* from the area. Genus *Themiste* is so far represented by only one species from the Indian coast, to which is presently added one more, *i.e., T hennahi*, as a new record; this species was not even known earlier from the Indian Ocean. Each of the genera, viz., *Nephasoma* and *Apionsoma*, includes three species; only one species of the latter genus could not, however, be determined. Of the four species of *Siphonosoma, S. rotumanum* constitutes new locality record for the Indian Ocean. Of the five species of *Sipunculus*, three are very common, one is known only from the deep water and the fifth one could not, however, be determined, while out of ten species of *Phascolosoma, P. granulatum, P. japonicum* and *P. stephensoni*, constitute new records for the Indian coast. Further, five species of *Aspidosiphon* are so far known from the Indian coast; presently two more species, *A. pachydermatus* and *A. gracilis*, are recorded for the first time, the former from the Indian Ocean and the latter from the Indian coast.

Table II presents the distributional pattern of the sipunculan fauna of the Indian region, divided into following convenient zones.

Zone I	Arabian Sea : Off-shore waters	(4)
Zone II	Lakshadweep	(17)
Zone III	Northern West coast : Gujarat and Maharashtra	(15)

Zone IV	Southern West coast : Kerala	(7)
Zone V	Southern East coast : Tamil Nadu and adjacent islands in the Gulf of Mannar	(14)
Zone VI	Northern East coast : Andhra Pradesh, Orissa and West Bengal	(7)
Zone VII	Andamans	(25)
Zone VIII	Nicobars	(14)
Zone IX	Bay of Bengal : Off-shore waters	(4)

(Figures in parenthesis indicate the number of species)

The paucity of species in different zone surveyed may be due to several factors, such as, absence of suitable habitats (Zones IV and VI), or, lack of intensive survey (Zones I and IX). The abundance of species in the remaining zones may be clearly explained by their habitats being surrounded by luxuriant growth of coral communities, as earlier reported by Gardiner (1903) and also observed in the field by the author.

Finally, the species inhabiting in their respective ecological niches in the Indian coast and waters may be enumerated in terms of relative percentage. As reconciled from the survey data comprising 1640 individuals at hand, the maximum number is represented by 40.5% of the entire bulk as rock-borers and the minimum, 5.4 % as mud-burrowers. Of the remaining material, 18.9 % are sand-burrowers, 28.8% occur under rocks, stones and coral boulders, or on sand, or in rock crevices, or sea bottoms as dredged samples. The exact habitats of material constituting 6.4% , either reviewed from literature or from old samples not provided with detailed data.

As to the status and abundance, some of the species like *Themiste lageniformis, Phascolosoma perlucens, P. albolineatum* and *Aspidosiphon steenstrupii steenstrupii* have been found to be widely distributed in the Indian coast, which represent the bulk of the fauna approximately estimated within a range of 11 to 16.5% and the species known to be rare in the Indian coast are *Siphonosoma rotumanum, Nephasoma filiforme, N. rutilofuscum, Themiste hennahi, Aspidosiphon exhaustus, A. tortus, A. klunzingeri, A. pachydermatus* and *Apionsoma misakiana.*

Table - II : DISTRIBUTION OF SIPUNCULANS IN INDIAN COAST AND WATERS

		Arabian Sea	Laksha-dweep	Northern West Coast	Southern West Coast	Southern East Coast	Northern East Coast	Andamans	Nicobars	Bay of Bengal	Remarks
		I	II	III	IV	V	VI	VII	VIII	IX	X
1.	*Sipunculus norvegicus*	P	-	-	-	-	-	-	-	P	IPA
2.	*S. nudus* *	H(a)	-	-	-	+	+	+,P,H(a,b)	+,C(b), P,H (b)	-	WW
3.	*S. robustus*	-	-	H(a)	-	P,R,RK	-	H(a),P, SE	+,H(a), P	-	IPA
4.	*Sipunculus sp.*	-	-	-	-	-	-	+,H(c)	-	-	-
5.	*S. indicus*	-	+,S, J(b)	-	-	-	-	+,SE	-	-	IP
6.	*Siphonosoma australe*	-	-	-	-	+,G,P	+,GR	H(b)	-	-	IP
7.	*S. cumanense*	-	+,S	+,H(a)	-	+,H(a), HR	-	+,H(a)	+,H(a)	-	IPA
8.	*S.rotumanum* ***	-	-	-	--	-	+	-	-	-	IPA
9.	*S. vastum*	-	S	-	-	-	-	+,H(a)	+	-	IP
10.	*Nephasoma filiforme*	-	-	-	-	R	-	-	-	-	IP
11.	*N.pellucidum* *	-	-	-	-	R	+	-	-	-	IPA
12.	*N.rutilofuscum*	CC	-	-	-	-	-	-	-	-	EI
13.	*Themiste hennahi* ***	-	-	-	-	-	-	-	+	-	*IP*
14.	*T. lageniformis*	-	+,H(a)	+,H(a), AP,CC	+	+,G,H(a), R	-	+,H(a)	+	-	IPA
15.	*Antillesoma antillarum**	-	+,S	+	-	-	C(a)	+,J(c)	+	C(a)	CT
16.	*Phascolosoma agassizii**	-	+,S	+,J(c)	-	-	-	+	-	-	IPA
17.	*P. albolineatum* *	-	+	+	-	-	-	+,H(b), J(c)	+	+	IP

	I	II	III	IV	V	VI	VII	VIII	IX	X
18. *P. arcuatum* *	-	-	-	-	-	+,H(e)	+	-	-	IP
19. *P. granulatum* **	-	-	-	-	+	-	+	-	-	IPA
20. *P. japonicum* **	-	+	+	+	-	-	+	-	-	IPA
21. *P. nigrescens* *	-	+	+	-	+,G,H(a)	-	+,H(b)	+,C(a)	-	CT
22. *P. pacificum* *	-	+,S	+	+	-	-	+,H(b)	H(a,b)	H(a)	IP
23. *P. perlucens* *	-	+,S	+	+	+	+	+,J(c)	+,H(a)	-	CT
24. *P. scolops*	-	+,S	+,CC	+	-	-	+,H(b)	H(b)	CC	WW
25. *P. stephensoni* **	-	+	-	+	-	-	-	-	-	IPA
26. *Apionsoma trichocephala* *	-	-	+,CC	-	-	+	-	-	-	WW
27. *Apionsoma misakiana* **	-	+	-	-	-	-	-	-	-	IPA
28. *Apionsoma sp.*	-	-	-	-	-	-	+	-	-	-
29. *Aspidosiphon elegans*	-	-	+,J(a)	-	+,G	-	-	-	-	IPA
30. *A. exhaustus*	CC	-	-	-	-	-	-	-	-	WW
31. *A. gracilis* **	-	-	-	-	-	-	+	-	-	IP
32. *A. tortus*	-	-	-	-	R	-	-	-	-	IP
33. *A. klunzingeri*	-	-	-	-	-	-	H(b)	-	-	CT
34. *A. pachydermatus* ***	-	-	-	-	-	-	+	-	-	IP
35. *A.steenstrupii steenstrupii**	-	+,H(a),S	+	-	+	-	+,H(a,b),J(a)	+,H(b)	-	IPA
35a. *A.steenstrupii ambonensis*	-	-	-	-	-	-	+,H(d)	-	-	IP
36. *Cloeosiphon aspergillus* *	-	+,S	+,H(a)	+	+	-	+,H(a)	+	-	IPA
37. *Lithacrosiphon cristatus lakshadweepensis* *	-	H(f)	+	-	-	-	-	-	-	E

N.B. : AP = Awati and Pradhan, 1935; C(a,b) = Cutler (1977a, 1977b); CC = Cutler and Cutler, 1979a; G = Gravely, 1927; GR = Ganapati and Rao, 1970; H(a,b,c,d,e & f) = Haldar (1975, 1976, 1977, 1978, 1985 a,b, 1991 a,c); HR = Haldar and Rao, 1975 ; J (a,b & c) = Johnson (1964, 1969 & 1971); P = Prashad, 1936; R = Reddiah, 1975; RK = Rajulu and Krishnan, 1969; S= Shipley, 1903a; SE = Stephen and Edmonds, 1972.

+, present record; -, no record; *, new locality record; **, new to Indian coast; ***, new to Indian Ocean.

CT, Circumtropical element; E, Endemic to India; EI, Endemic to Indian Ocean; IP, Indo-Pacific element; IPA, Indo-Pacific & Atlantic element; WW World wide, though not cosmopolitan.

SUMMARY

1. A comprehensive study of the sipunculan fauna from the Indian coast and waters is made on the basis of about 1650 specimens. These are collected mainly from the intertidal zones of peninsular region, the Lakshadweep, Andaman, Nicobar and Krusadai groups of islands, and also a few, from sublittoral waters of the Bay of Bengal and Arabian Sea.

2. Historical review on the fauna studied earlier in India and elsewhere and the author's own observations on the methods of collection and preservation are given. Accounts of classification, general morphology and terminology are also incorporated

3. A classified list of 37 species and subspecies distributed over 10 genera and 5 families is provided.

4. Under each species are cited original, synonymy and latest reference, locality and repository of type specimen wherever known, material examined, detailed description, distribution and remarks dealing with variations or peculiarities, if any, keys to different taxa are also furnished.

5. The new items of achievements are also noteworthy, as follows :

(a) *Lithacrosiphon cristatus lakshadweepensis* is recently described.

(b) Three species, viz, *Siphonosoma rotumanum, Themiste hennahi* and *Aspidosiphon pachydermatus*, are added to the fauna of the Indian Ocean.

(c) Five species, viz., *Phascolosoma granulatum, P. japonicum, P. stephensoni, Apionsoma misakiana* and *Aspidosiphon gracilis* are added to the fauna of the Indian coast as a whole.

(d) Twelve species including six of *Phascolosoma* and one each of *Sipunculus, Nephasoma, Apionsoma, Aspidosiphon, Antillesoma* and *Cloeosiphon* are recorded here in parts from the areas where these were previously unknown. It may be mentioned that the last two genera are monotypic.

(e) Five species are synonymised, viz., *Phascolosoma andamanensis* with *P. albolineatum* , *P. spinosum* with *P. perlucens, Aspidosiphon homomyarium* with *A. elegans, A. exostomum* with *A. steenstrupii steenstrupii* and *A. havelockensis* with *A. steenstrupii ambonensis.*

6. A general discussion on their habits and habitats is provided. Further, distributional affinities of the elements under study are shown in relation to the fauna from the Indian and other global oceans.

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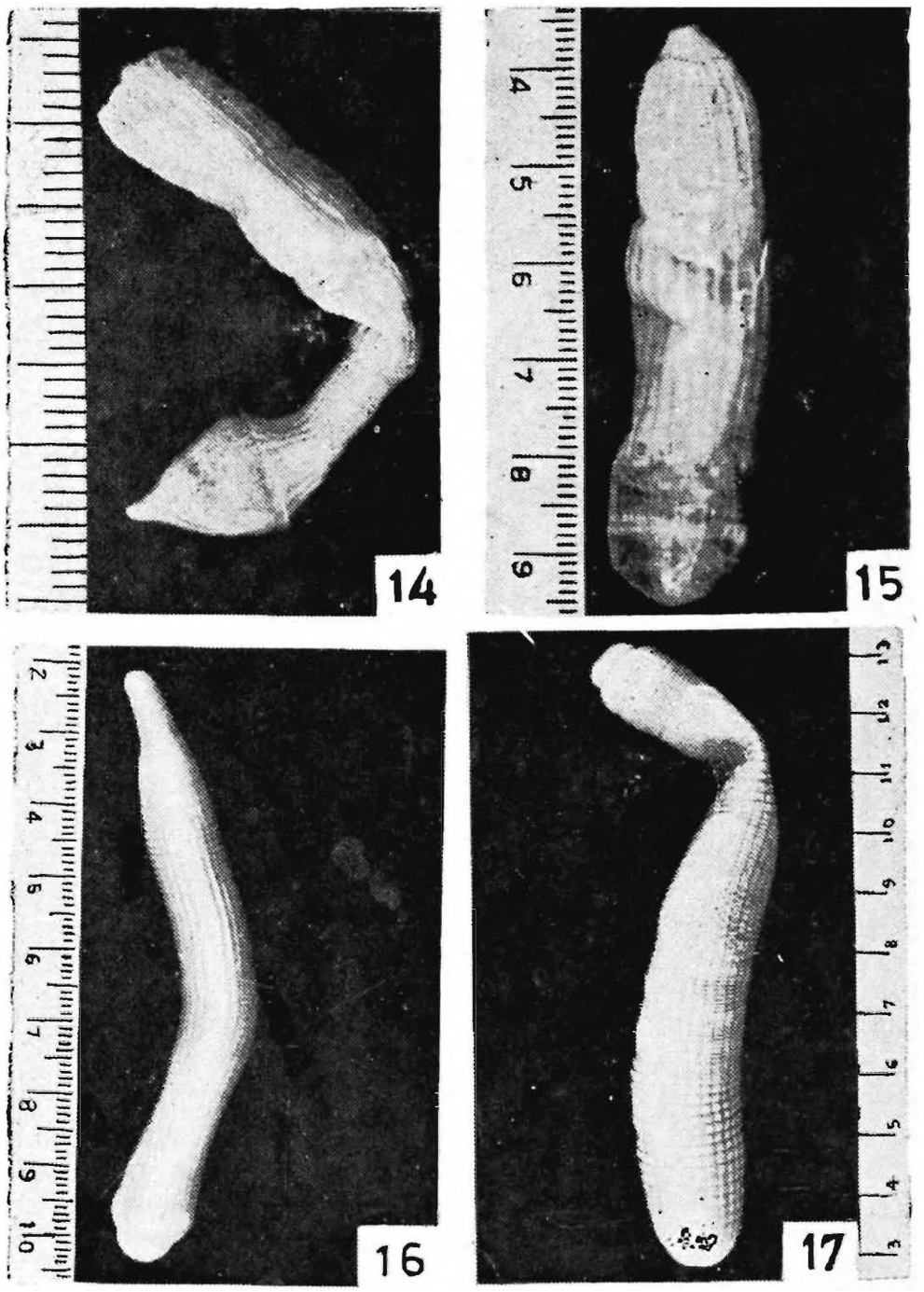
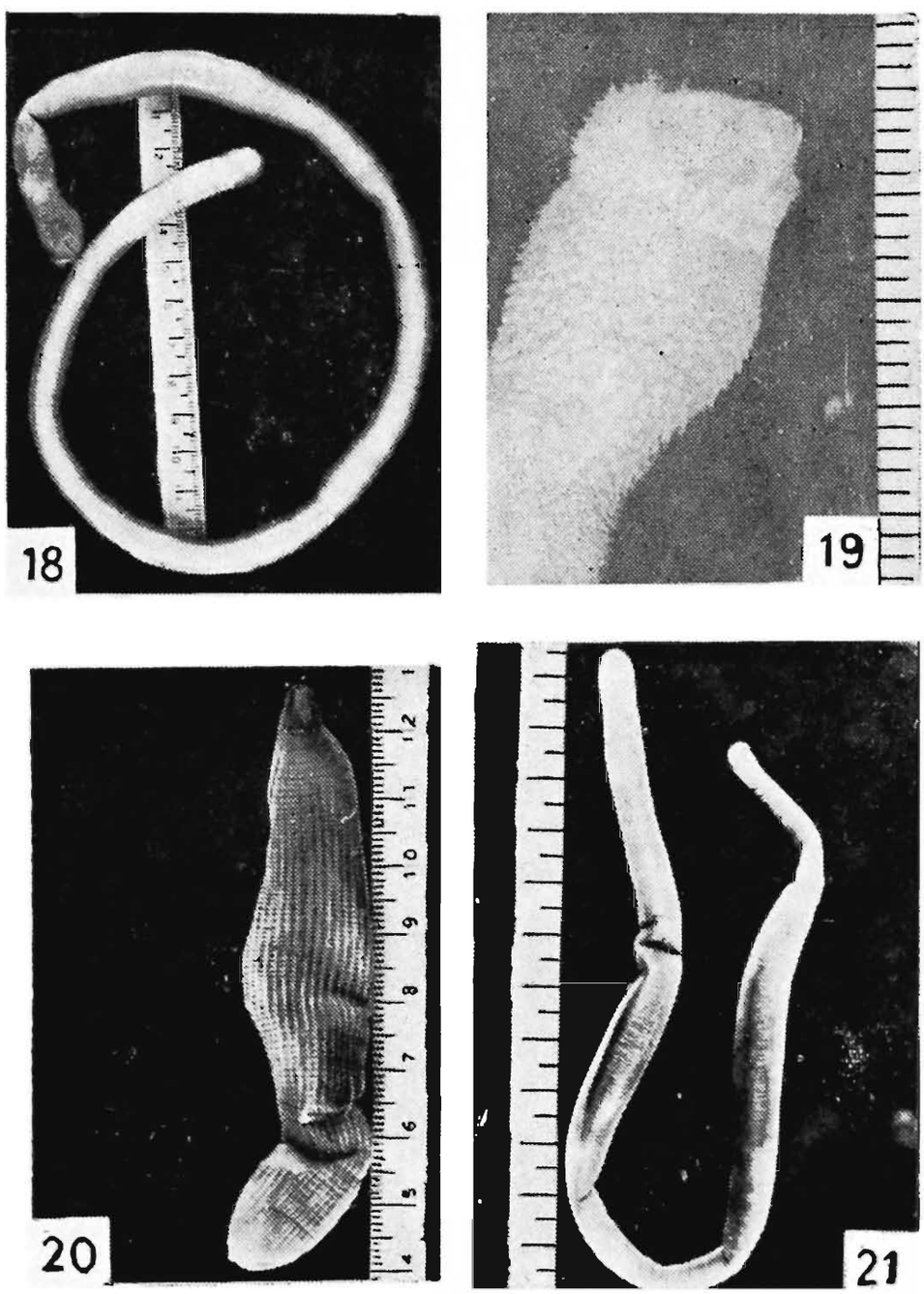
FIGURES



Figs. 14 & 15, *Sipunculus norvegicus* : Specimens with distinct (14) and indistinct (15) annular prominence at the glans region. Fig. 16, *Sipunculus nudus* : Specimen with acorn-like glans region, X 1. Fig. 17, *Sipunculus robustus*.



Figs. 18 & 19, *Sipunculus indicus* : Entire specimen (18) and tentacular crown (19). Fig. 20, *Sipunculus* sp. Fig. 21, *Siphonosoma australe.*

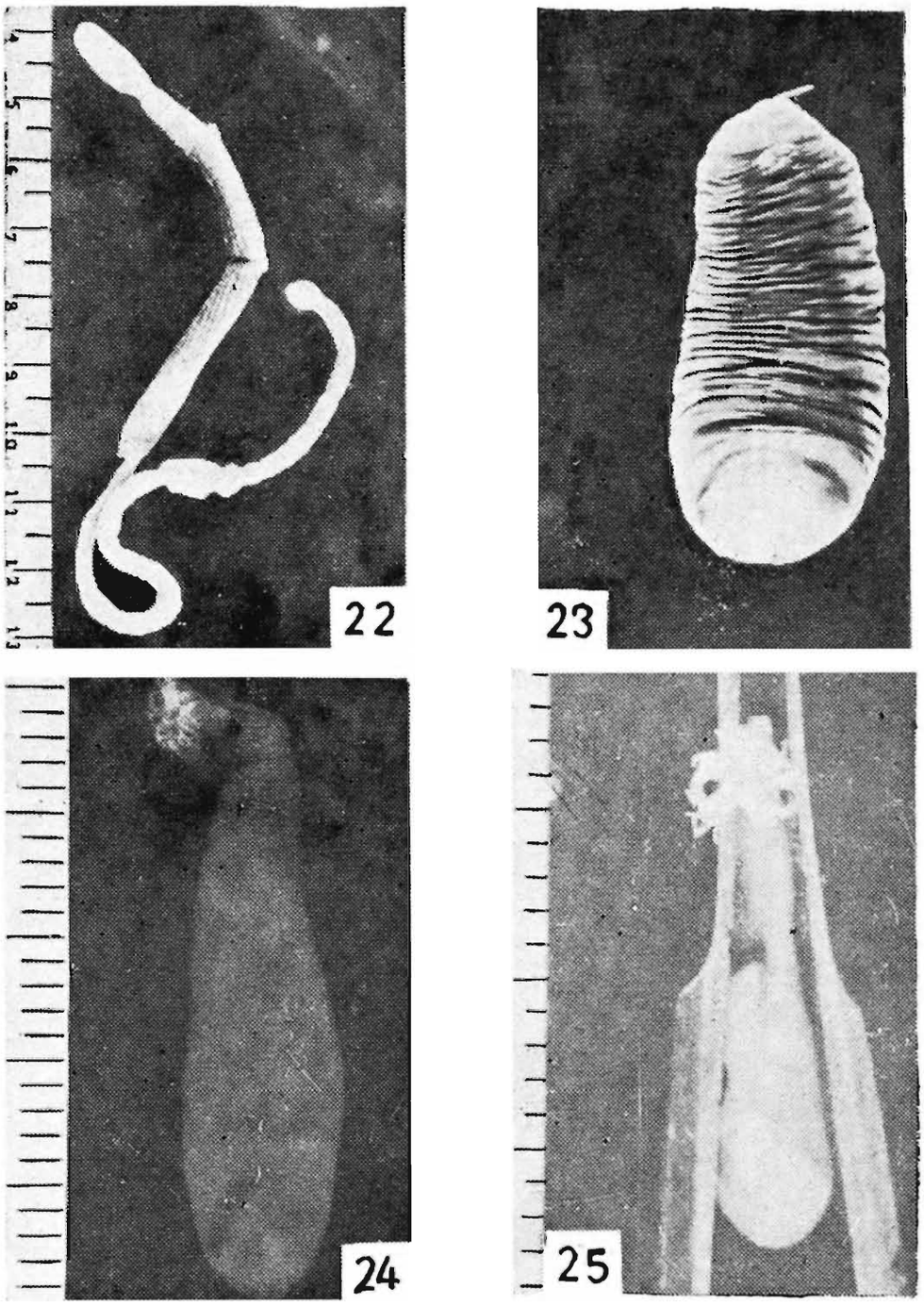
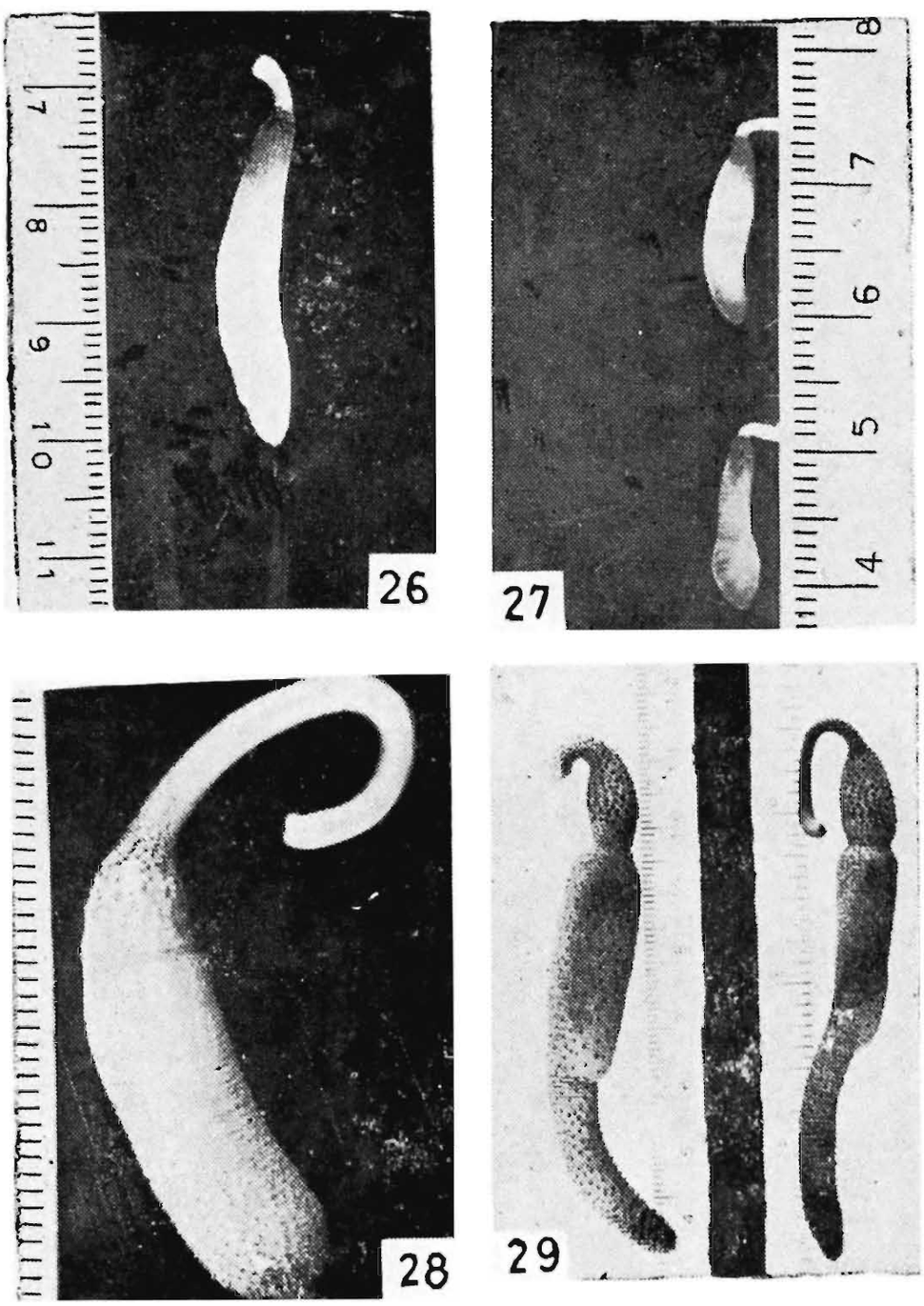


Fig. 22, *Siphonosoma cumanense* : Fig. 23, *Themiste hennahi* Figs. 24 & 25, *Themiste lageniformis* : Fully relaxed specimen (24) and tentacular crown, X 11 (25).



Figs. 26 & 27, *Antillesoma antillarum* : Specimens with introvert retracted (26) and extended (27) to different degrees. Figs. 28 & 29, *Phascolosoma arcuatum* : Specimens from coral (28) and mud (29) habitats.

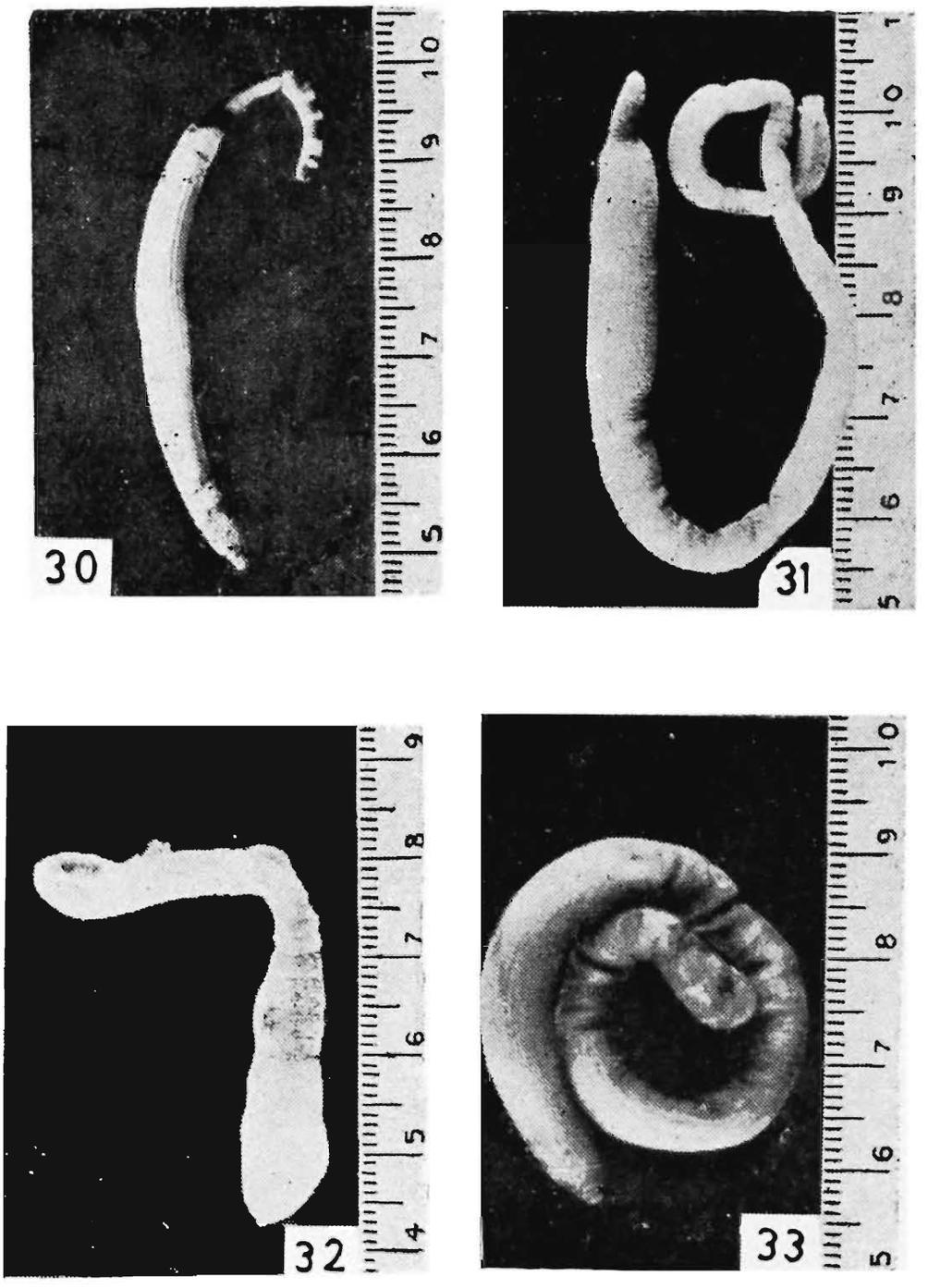
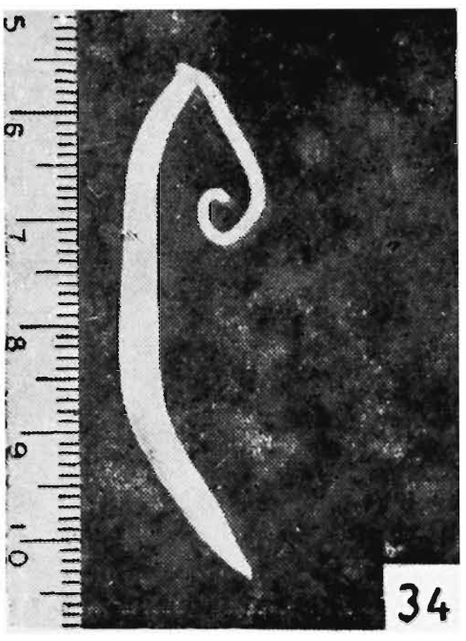
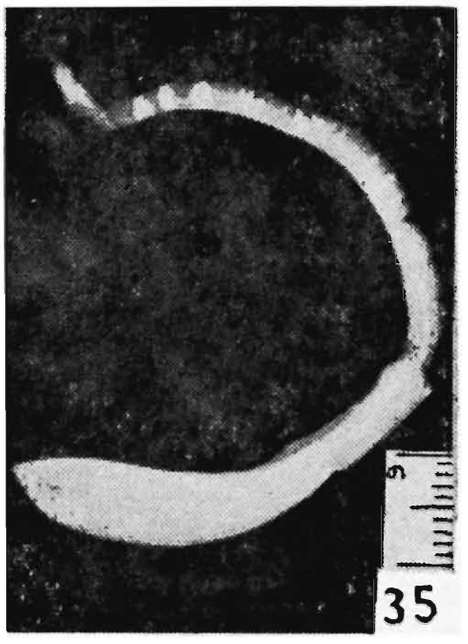


Fig. 30, *Phascolosoma albolineatum* : Note densely papillated introvert base and posterior end of trunk, and dark bands on introvert. Fig. 31. *Phascolosoma granulatum*. Fig. 32, *Phascolosoma nigrescens*. Fig. 33, *Phascolosoma pacificum*.





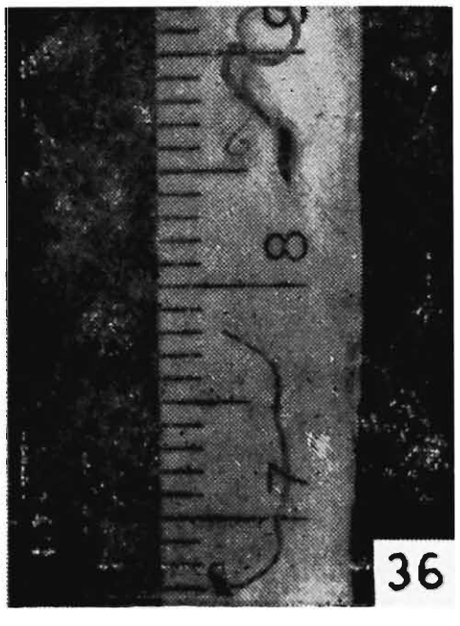
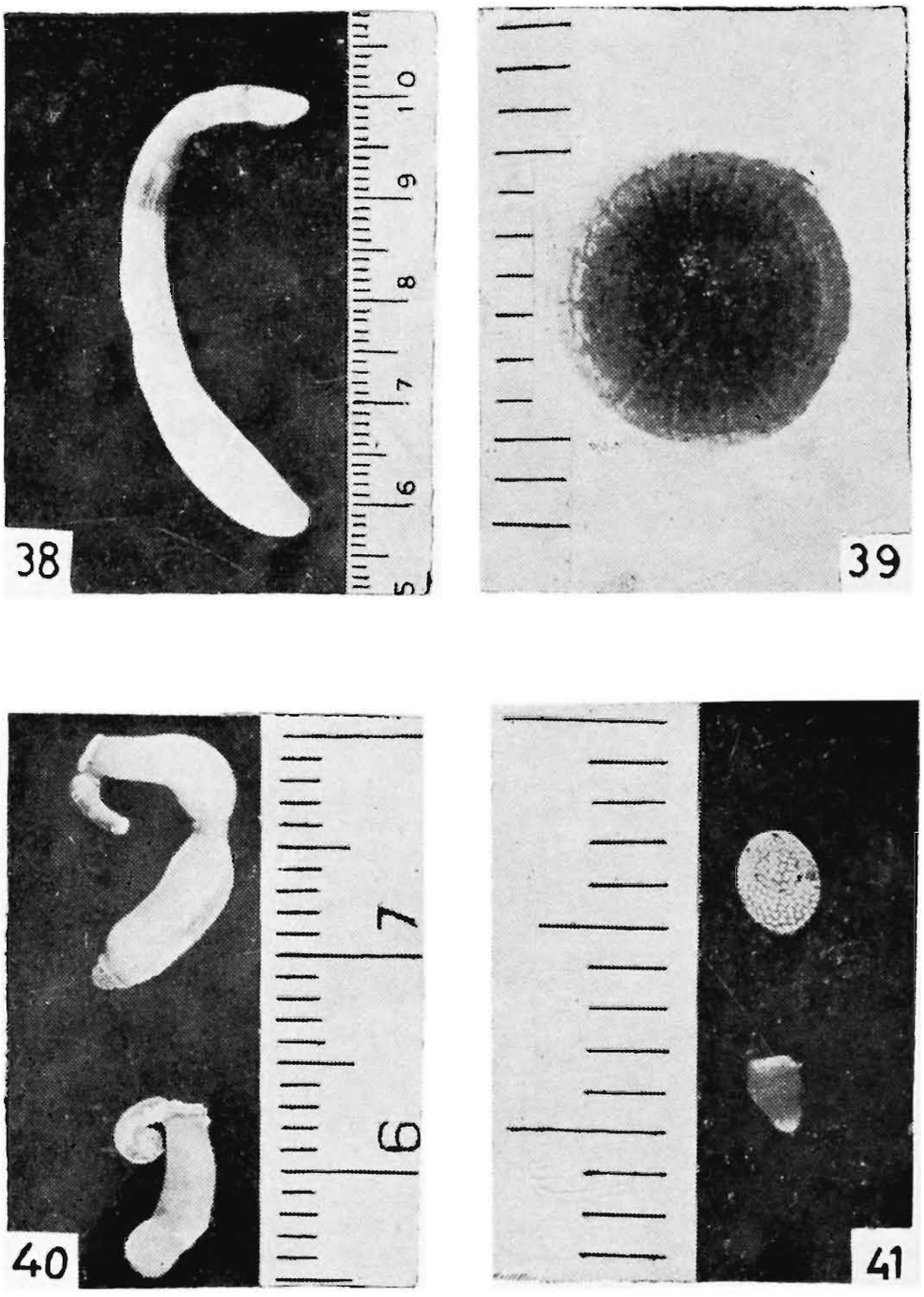


Fig. 34, *Phascolosoma perlucens* : Specimen showing anal cone. Fig. 35, *Phascolosoma scolops* : Fully extended specimen with dark bands on introvert. Fig. 36, *Apionsoma trichocephala* : Specimens with introvert extended to different degrees. Fig. 37, *Apionsoma* sp.



Figs. 38-41. *Aspidosiphon steenstrupii steenstrupii* : Specimens with conical calcareous deposition on anal shield (introvert completely retracted (38), Caudal shield of the same (39), without calcareous deposition on anal shield (40), anal (upper) and caudal (lower) sheields of the same (41).

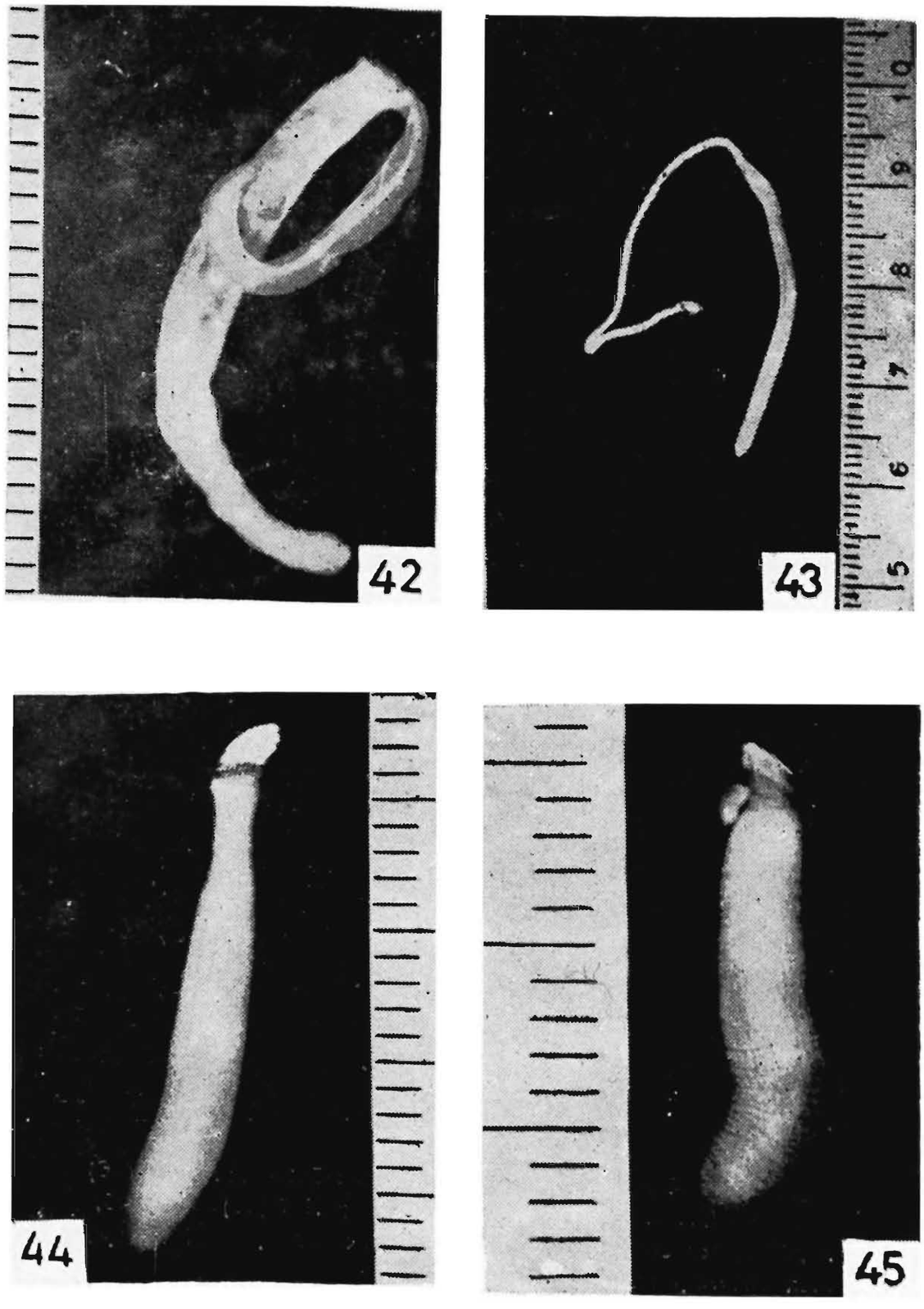
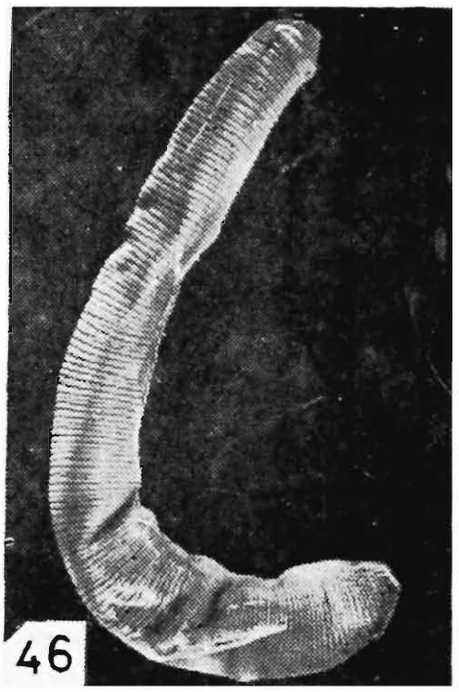
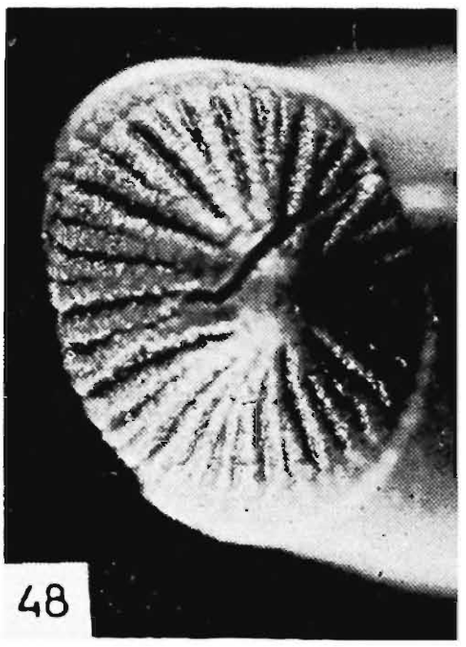


Fig. 42, *Aspidosiphon elegans*. Fig. 43. *Aspidosiphon gracilis*. Figs. 44 & 45, *Lithacrosiphon cristatus lakshadweepensis* : Specimen with worn out conical anal shield (introvert fully retracted) (44) and flat topped anal shield (45).





Figs. 46-48, *Aspidosiphon pachydermatus* : Entire specimen (46), anal shield, X 5. 5 (47) and caudal shield, X 7 (48). Fig. 49, *Aspidosiphon steenstrupii ambonensis* : Anterior part of the specimen showing anal shield, X 10.

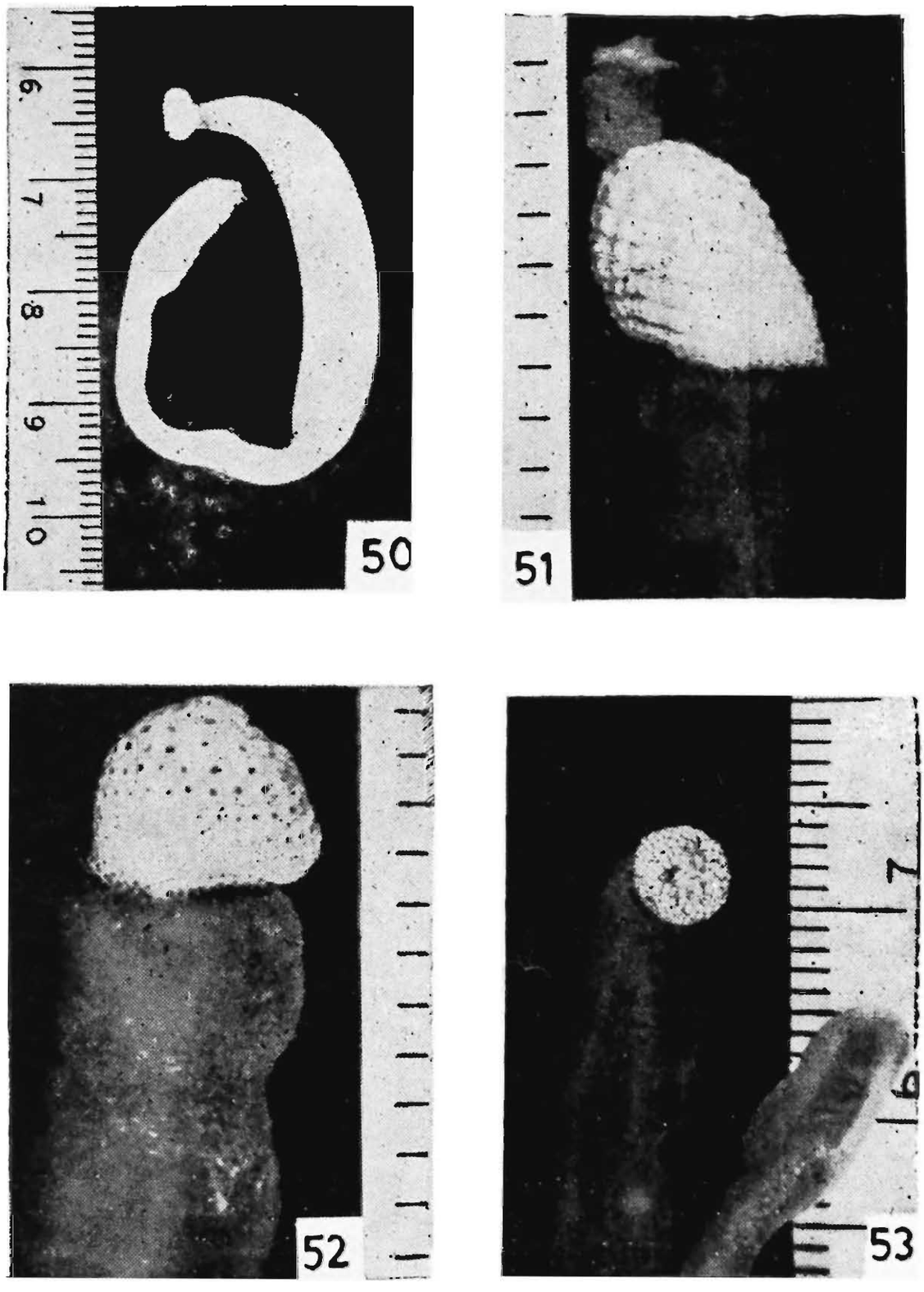


Fig. 50-53, *Cloeosiphon aspergillus* : Entire specimen with completely retracted introvert (50) and anterior part of trunk with anal shields in different views (51-53).

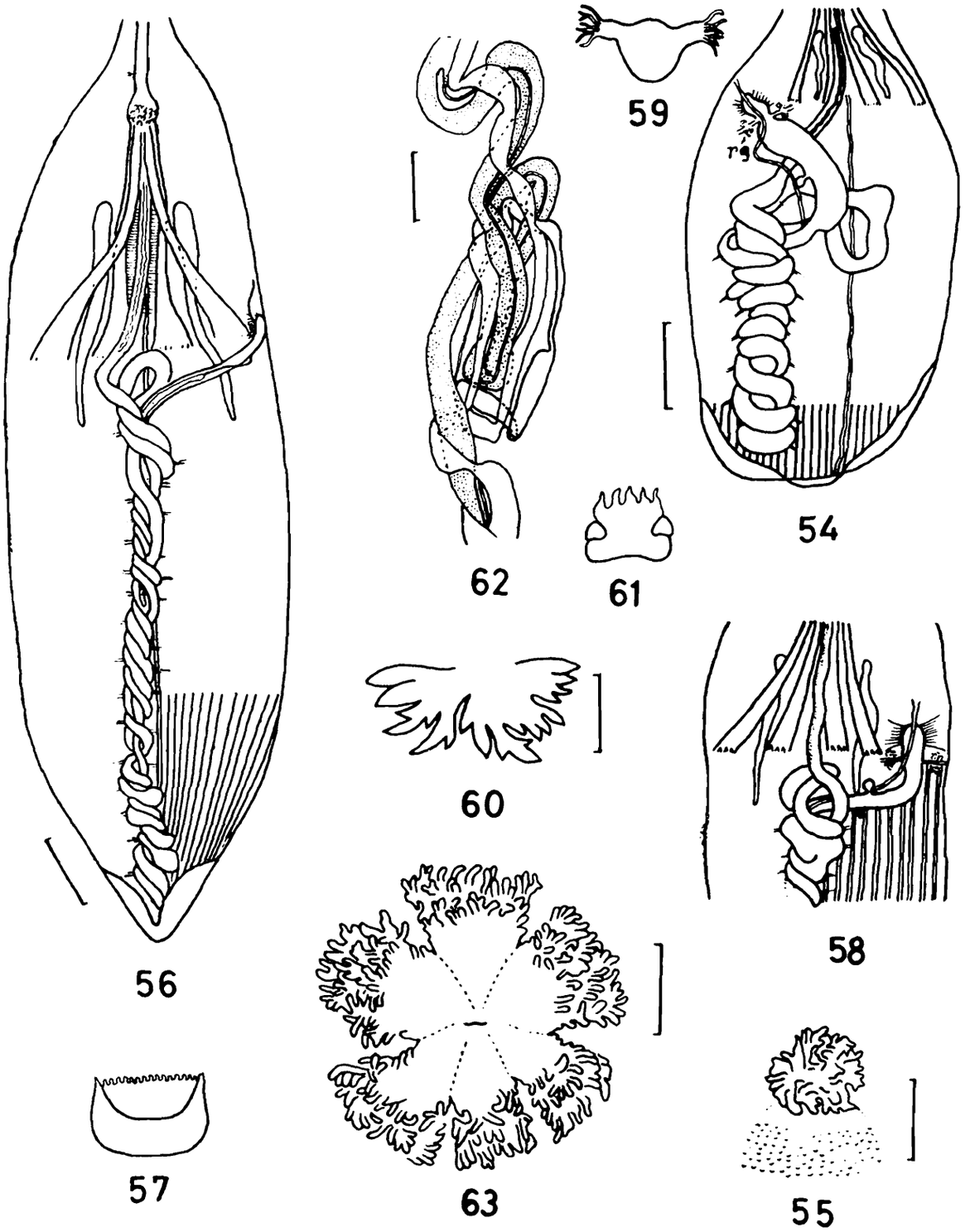
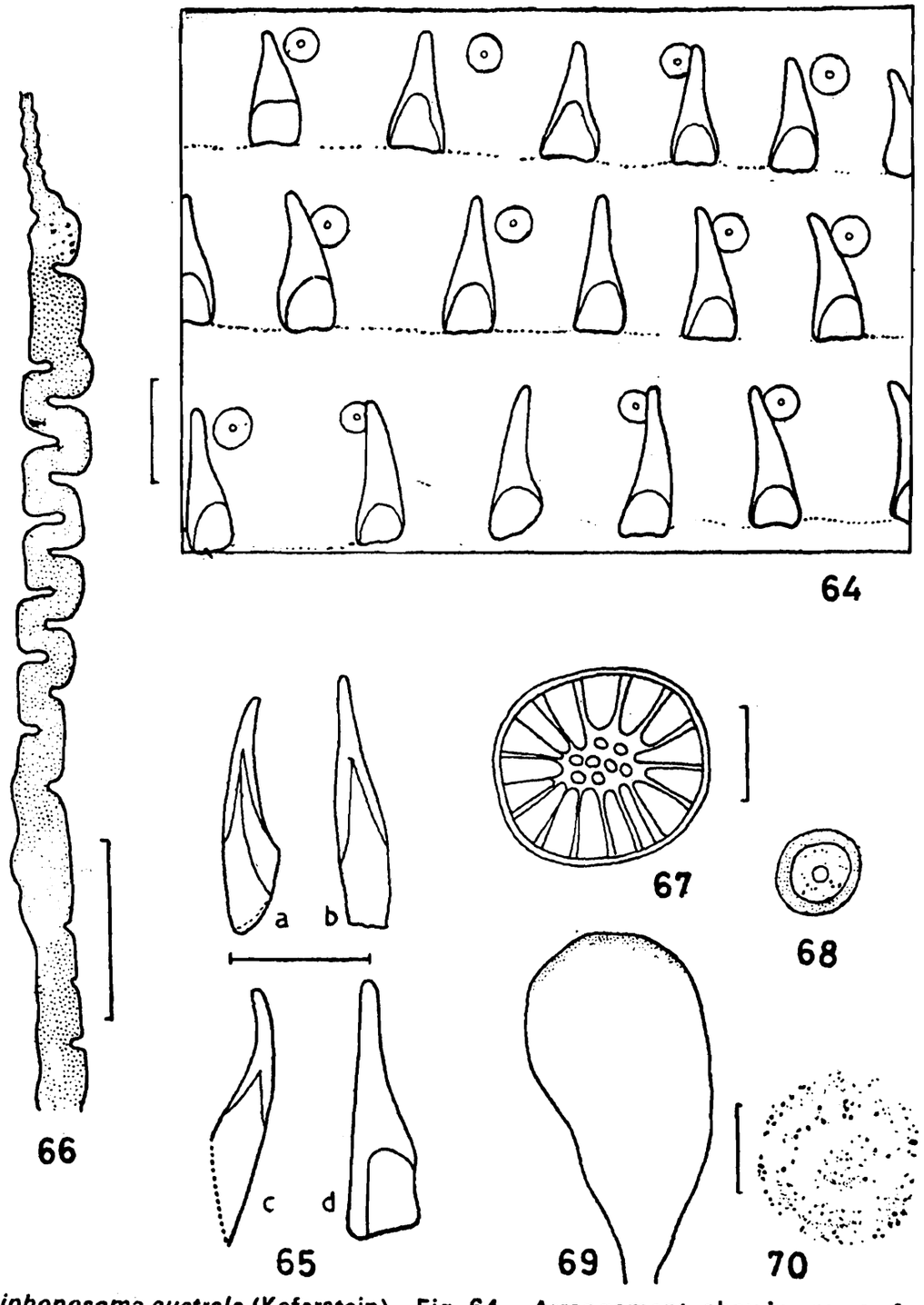
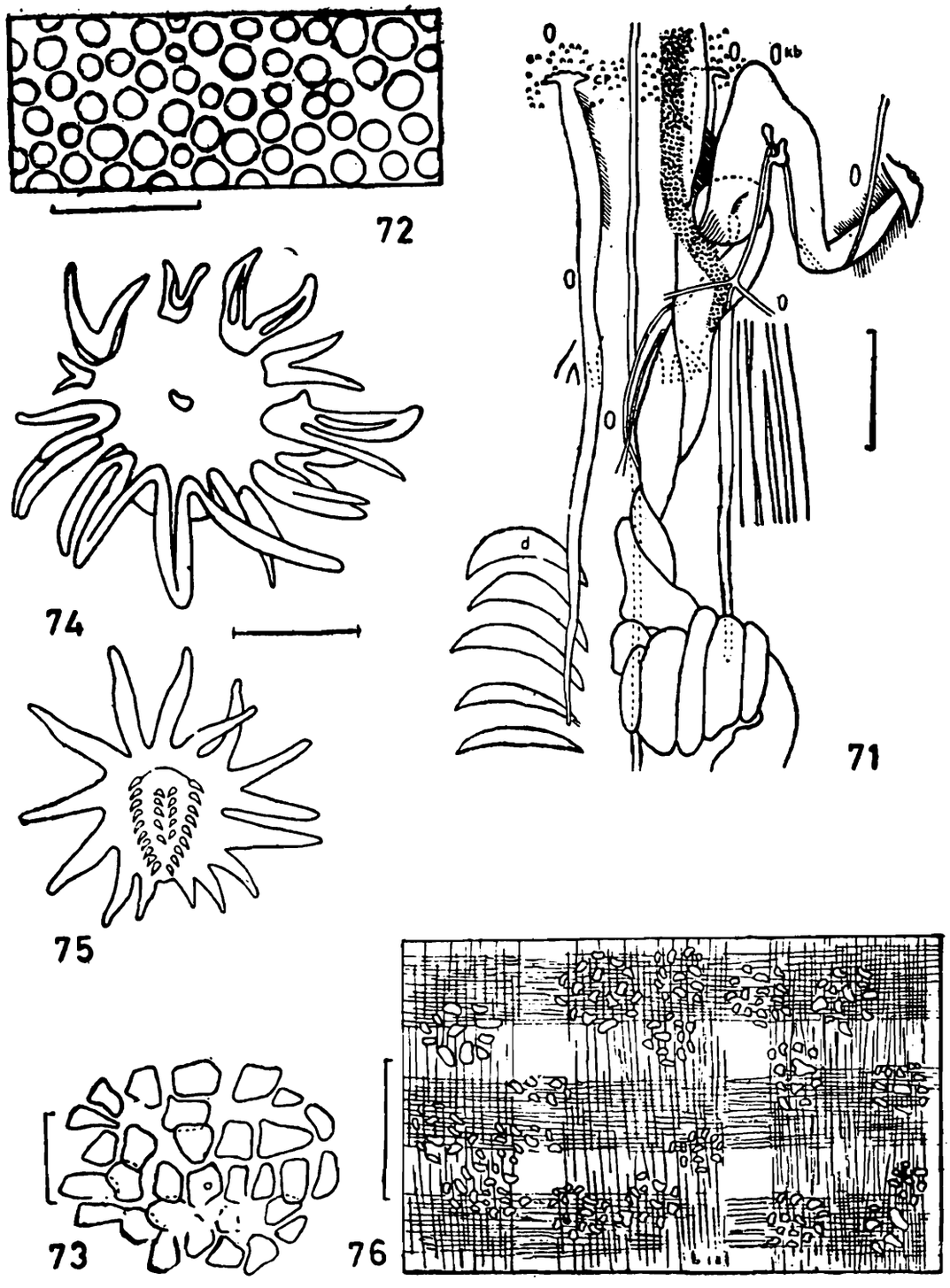


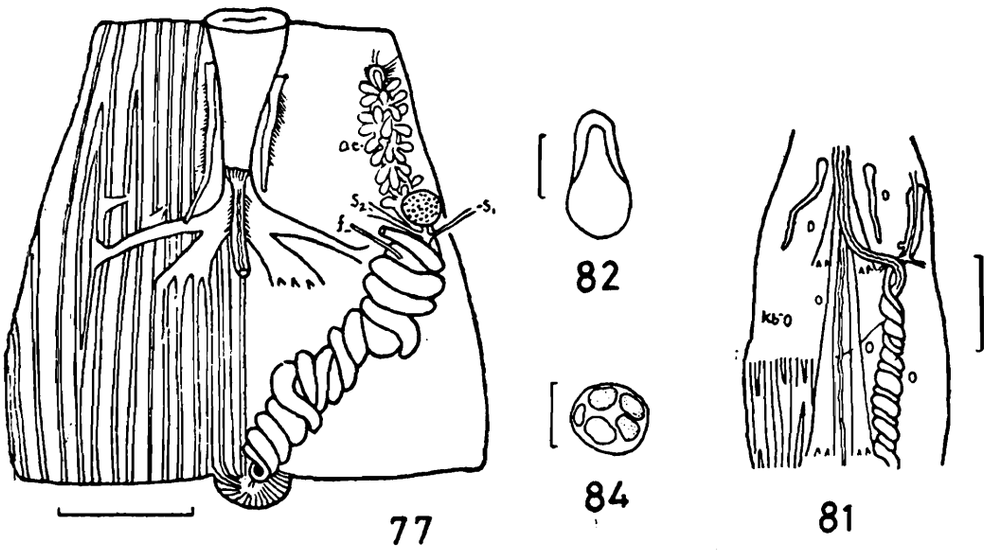
Fig. 54. *Sipunculus norvigicus* Danielssen. Dissected specimen. Figs. 55-57. *Sipunculus nudus* Linnaeus Fig. 55. Anterior region of introvers with tentacular fold. Fig. 56. Dessected specimen. Fig. 57. Brain and digitate processes (not to scale). Figs. 58, 59. *Sipunculus robustus* Keferstein. Fig. 58, Anterior region of trunk dissected. Fig. 59. Brain and digitate processes (not to scale) Figs. 60, 61. *Sipunculus* sp. Fig. 60. A portion of tentacular fold. Fig. 61. Brain and digitate processes (not to scale) Figs. 62, 63. *Sipunculus indicus* Peters Fig. 62. Post-oesophageal loop. Fig. 63. Tentacular crown. (Scales=15 mm for Figs. 54, 55, 7 mm for Fig. 55; 8 mm for Fig. 56; 2 mm for Fig. 60; 6 mm for Fig. 62; 2 mm for Fig. 63.)

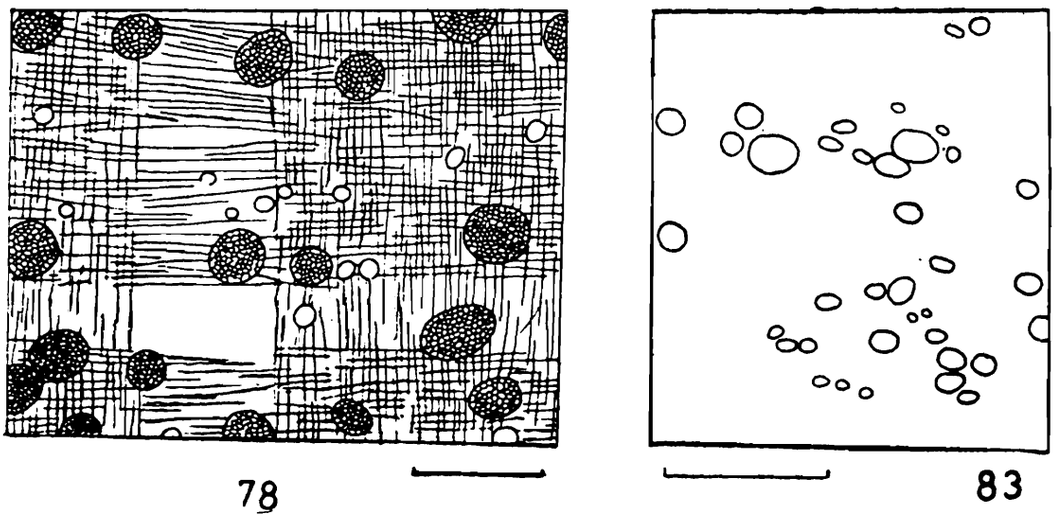


Siphonosoma australe (Keferstein) Fig. 64. Arrangement showing rows of hooks and papillae on introvert. Fig. 65. a-d. Hooks from introvert in different views. Fig. 66. Dorsal view of contractile vessel. 67. Papilla from base of introvert. Fig. 68. Papilla of introvert from rows of hooks. Fig. 69. Coelomic papilla in the vicinity of nephridiopore. Fig. 70. Papilla from middle region of trunk.
(Scales=0.2 mm for Fig. 64; 0.2 mm for. Figs. 65, 69; 3 mm for Fig. 66; 0.02 mm for Figs. 67, 68; 0.05 mm for Fig. 70.)



Siphonosoma cumanense (Keferstein)
Fig. 71. Anterior region of trunk dissected. Fig. 72. Arrangement of papillae on posterior third of introvert. Fig. 73. A papilla of Fig. 72. enlarged. Fig. 74. Top row of tentacular crown. Fig. 75. Dorsal nuchal organ. Fig. 76. Arrangement of papillae on middle region of trunk. (Scale = 3mm for Fig. 71; 0.2mm for Fig, 72 ; 0.5mm for Fig. 73; 2mm for Figs. 74, 75; 0.2mm for Fig.76).

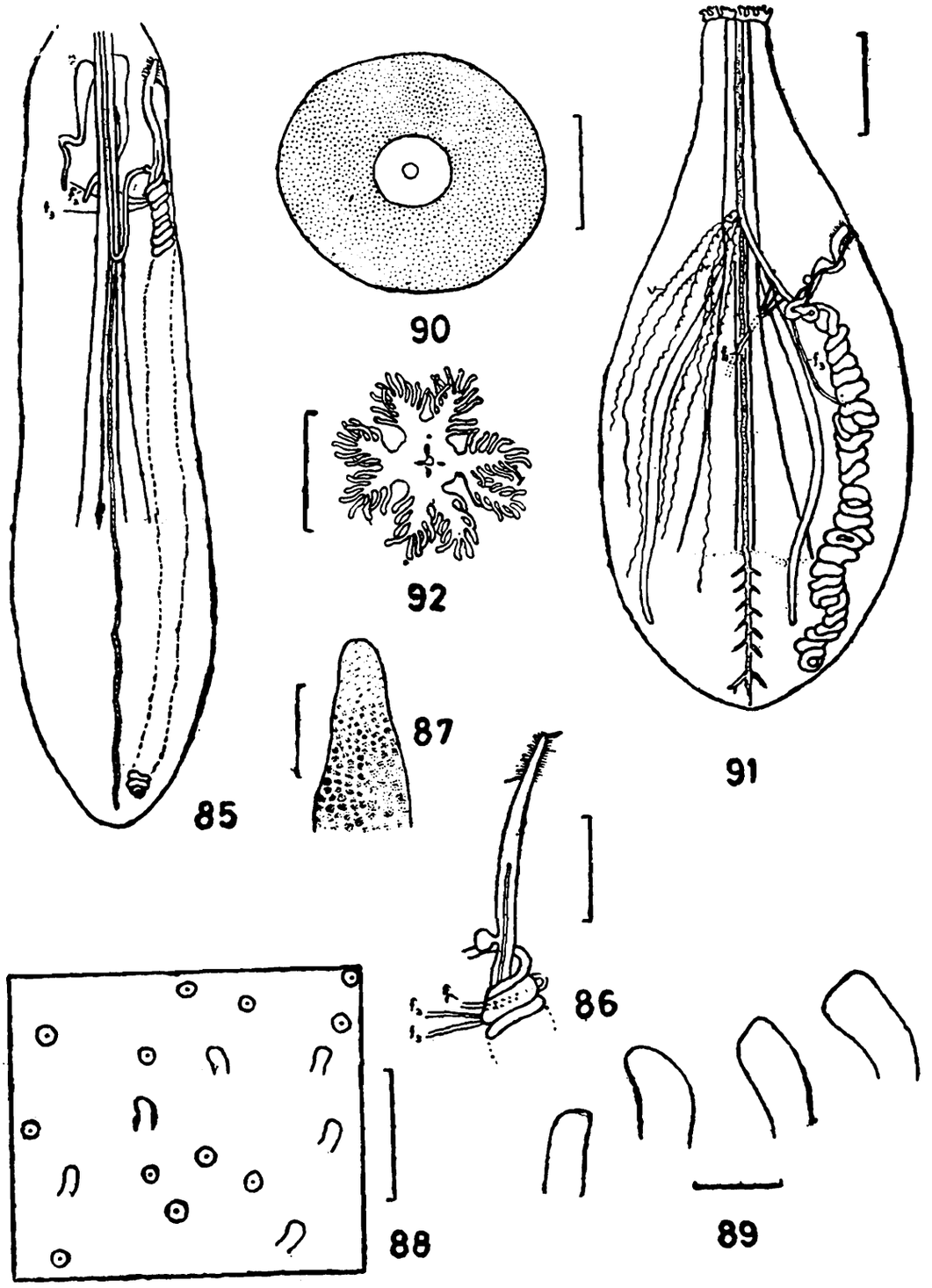




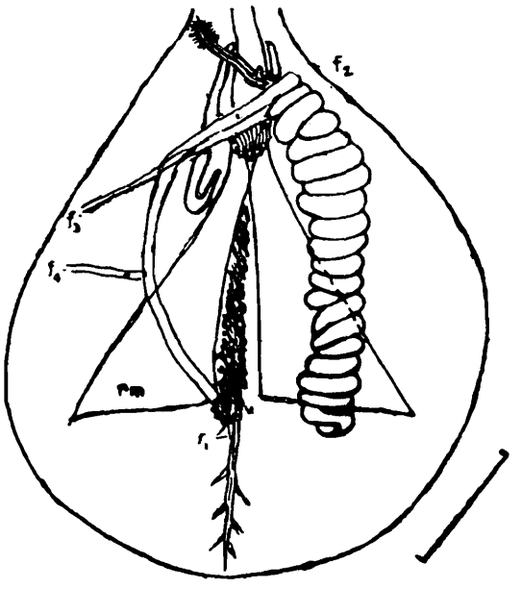
Figs. 77-80. *Siphonosoma vastum* (Selenka and Bulow)
Fig, 77 Dissected specimen. Fig. 78, Arrangement of papillae on middle region of trunk. Fig. 79, a. b. Hooks fron introvent. Fig. 80 Papilla fron posterior region of trunk.

Figs. 81-84. *Siphonosoma rotumanum* (Shipley)
Fig. 81. Anterior region of trunk dissected. Fig. 82. Hook from introvert. Fig. 83. Arrangement of papillae on posterior third of introvert. Fig. 84. A papilla of Fig. 83 enlarged.

(Scales = 10mm for Fig. 77 ; 0.01 mm for Fig. 78 ; 0.1 mm for Fig. 79 ; 0.1 mm for Fig. 80 ; 4 mm for Fig. 81 ; 0.1 mm for Fig. 82 ; 0.05 mm for Fig. 83 ; 0.02 mm for Fig. 84.)



Figs. 85-90. *Nephasoma pellucidum* (Keferstein)
Fig. 85. Dissected specimen. Fig. 86 Rectum and adjacent intestinal coil of Fig. 85 enlarged. Fig. 87. Papilla from posterior end of trunk. Fig. 88. Arrangement of hooks and papillae on introvert. Fig. 89. Hooks from introvert in different views. Fig. 90. Papilla from middle region of trunk. Fig. 91. *Themiste hennahi* Gray. Dissected specimen. Fig. 92. *Themiste lageniformis* Baird. Tentacular crown. (Scales=10 mm for Figs. 85, 91; 5mm for Fig. 86 ; 0.05 mm for Fig. 87 ; 0.2 mm for Fig. 88; 0.05 mm for Fig. 89 ; 0.02 mm for Fig. 90 ; 2 mm for Fig. 92.)



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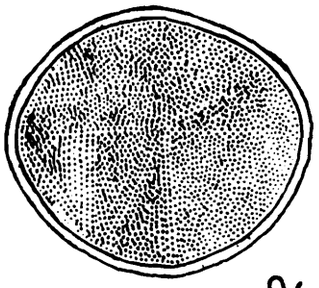

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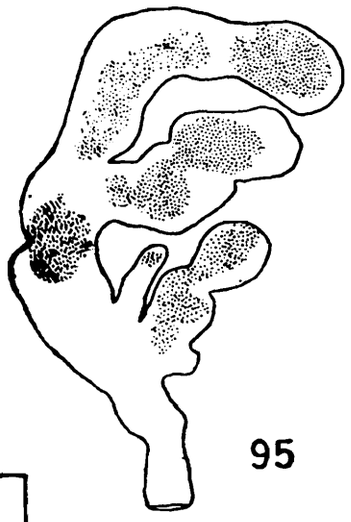

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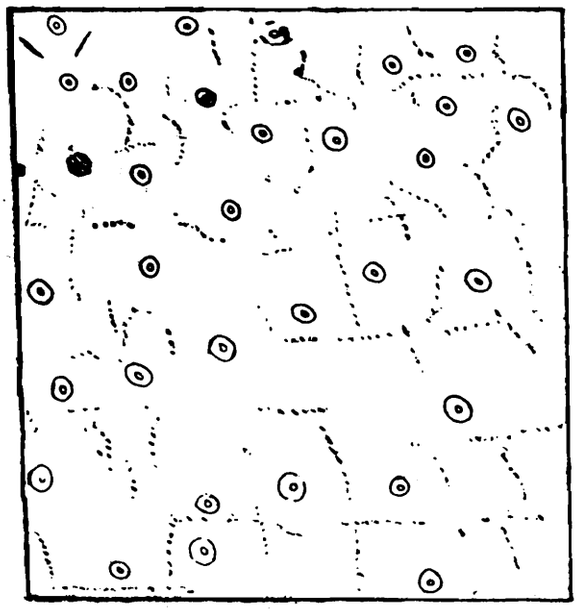

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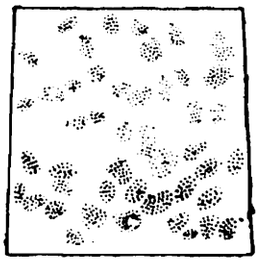
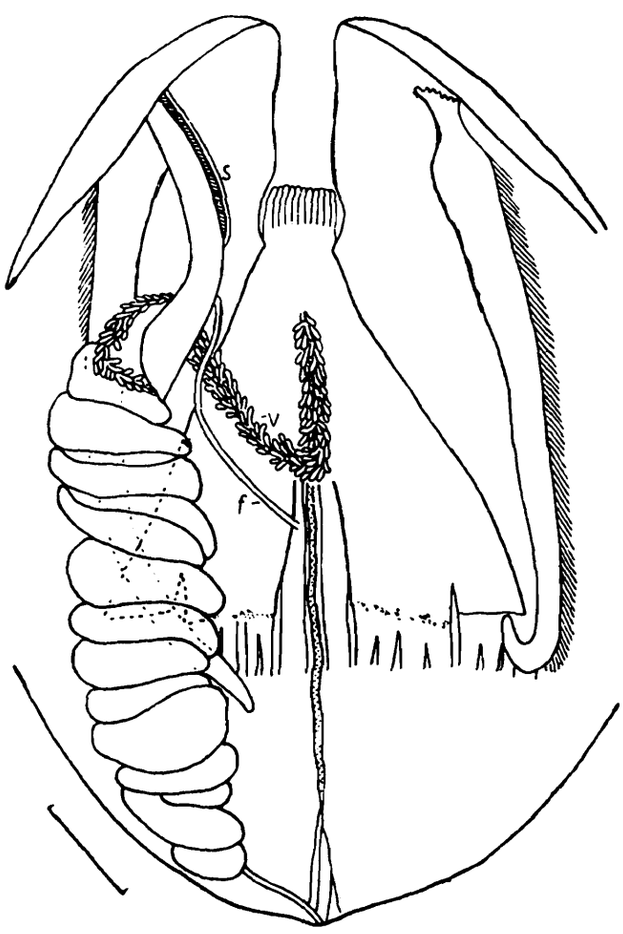


Themiste lageniformis Baird Fig. 93. Dissected specimen. Fig. 94. Egg. Fig. 95. Branched contractile vessel villi. Fig.96. Arrangement of papillae on posterior end of trunk. Fig. 97. Pigmented spots on introvert. (Scales = 8mm for Fig. 93 ; 0.2 mm for Figs. 94-97.)



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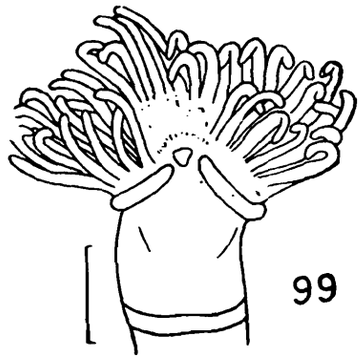

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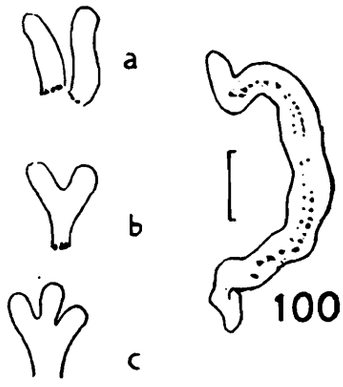

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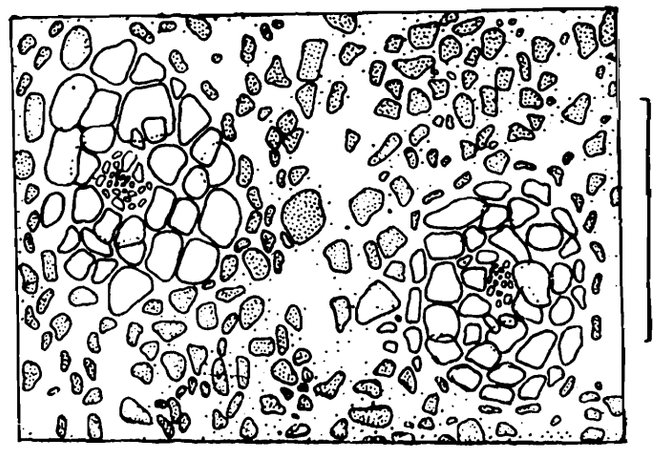
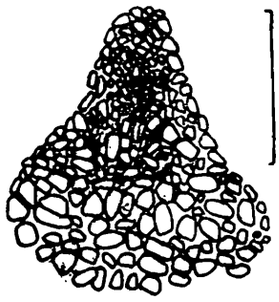
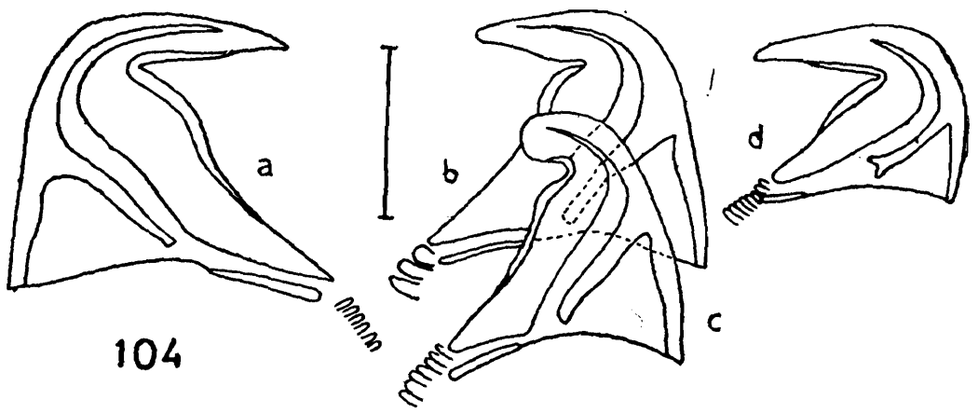


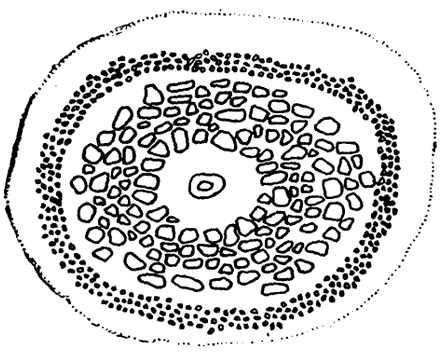


102

Antillesoma antillarum (Grube and Oersted) Fig. 98. Dissected specimen. Fig. 99. Anterior region of introvert with tentacular crown. Fig. 100. Tentacle. Fig. 101 a-c. Contractile vessel villi. Fig. 102. Papilla from introvert. Fig 103. Arrangement of papillae and chitinous plates on posterior end of trunk. (Scales = 3 mm for Fig. 98 ; 2 mm for Fig. 99 ; 0.5 mm for Figs. 100, 101 ; 0 08 mm for Fig. 102 ; 0.2 mm for Fig. 103.)



104



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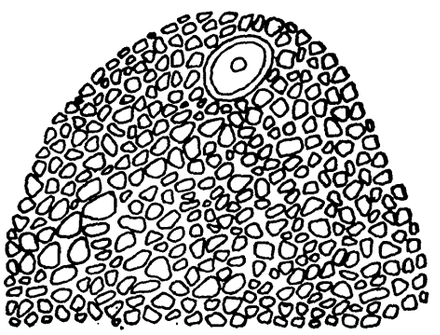

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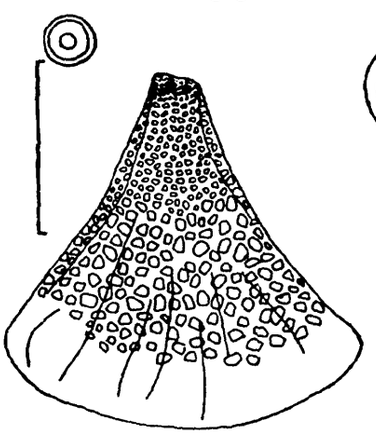
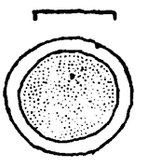
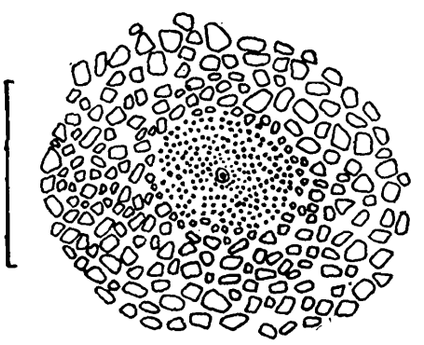


107

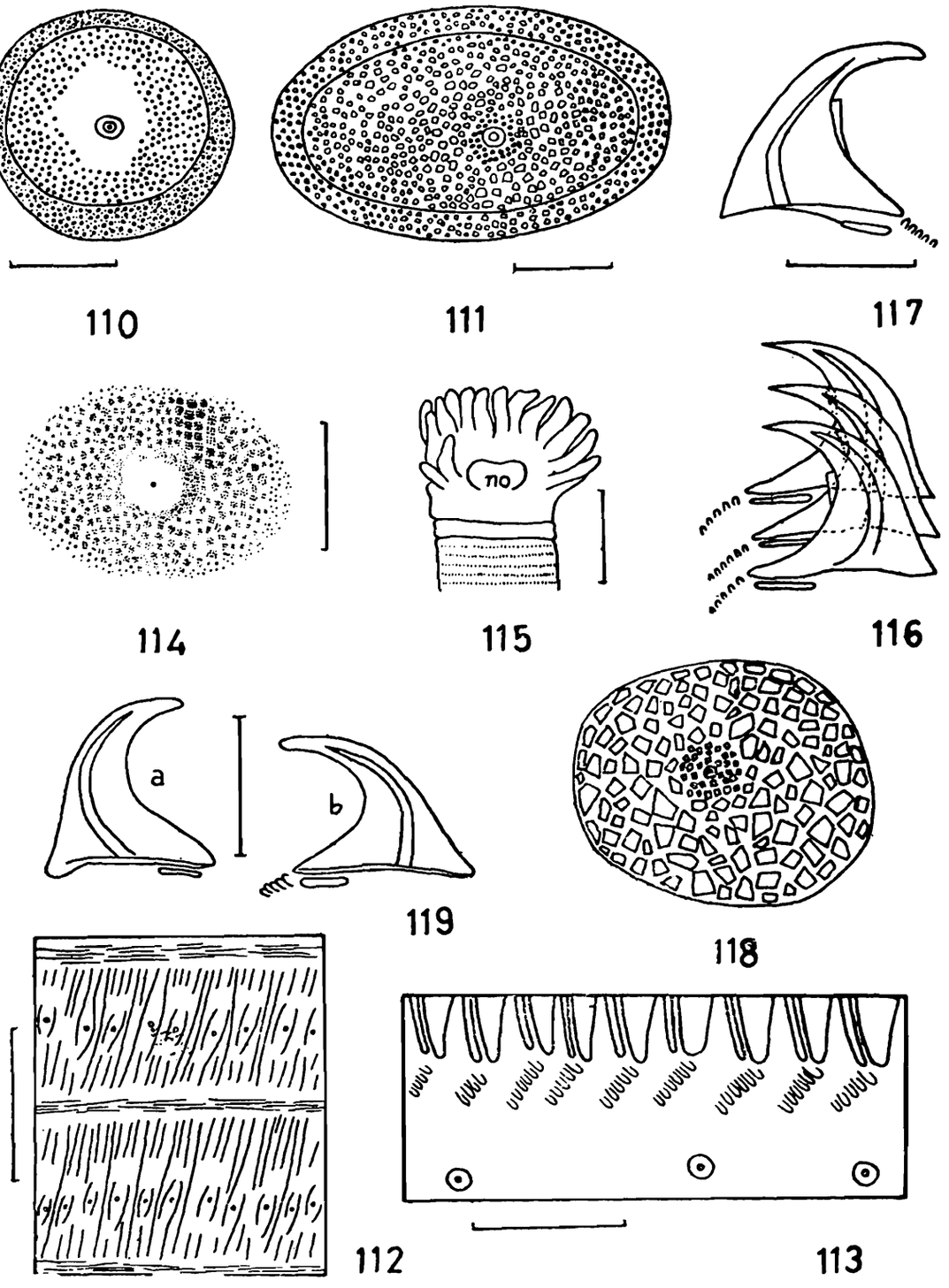


109

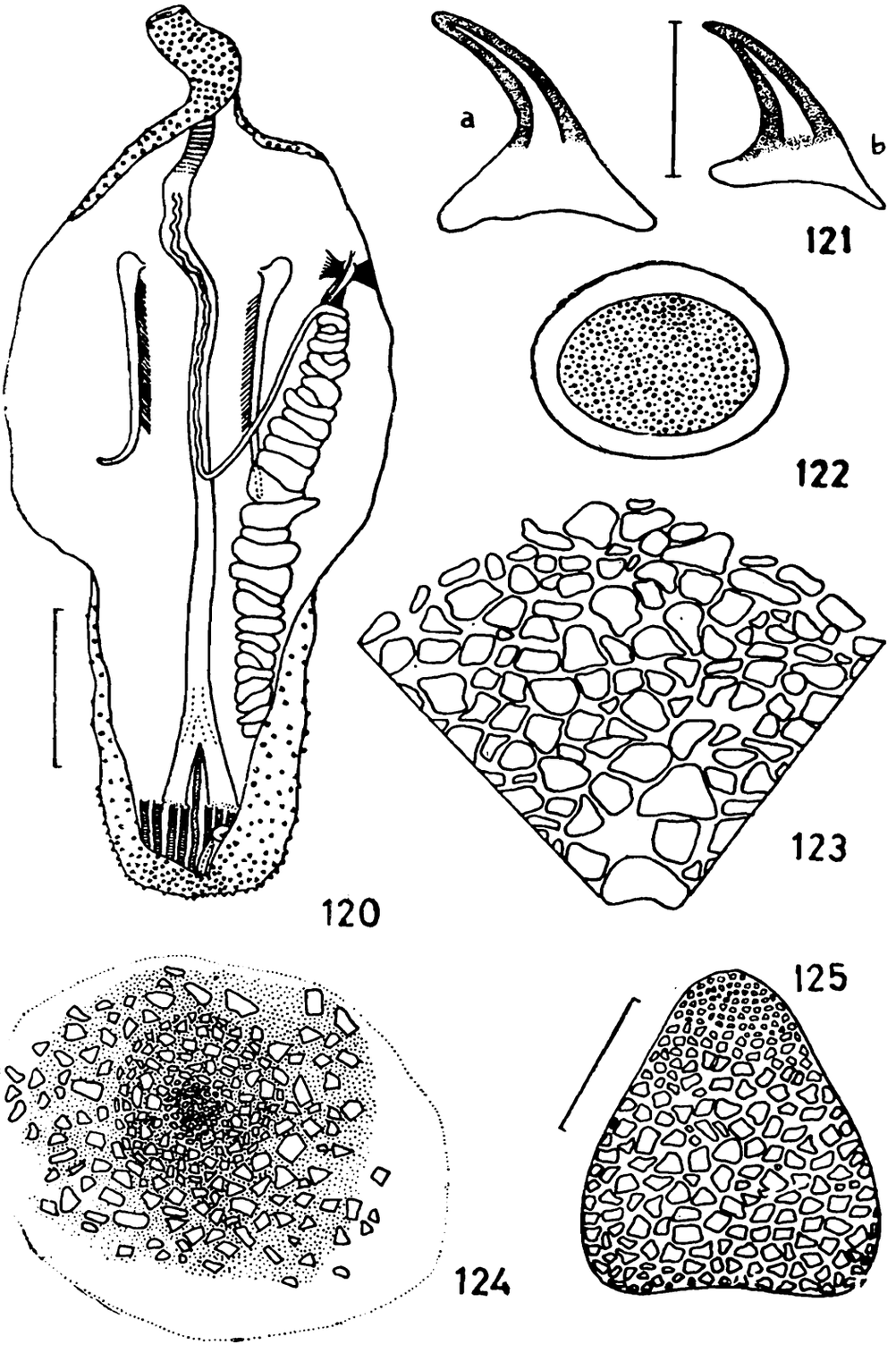


108

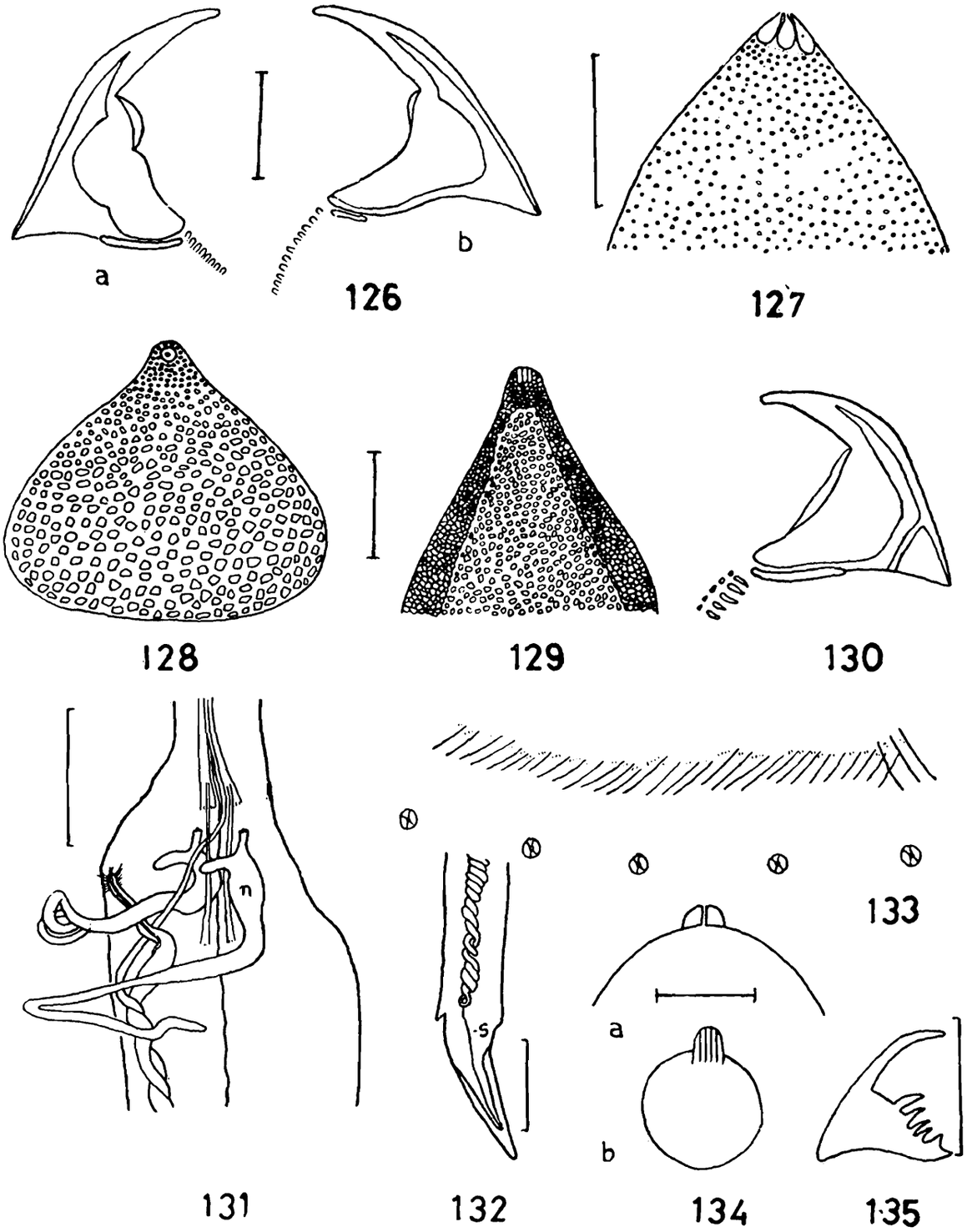
Phascolosoma albolineatum Baird Fig. 104. a-d. Hooks from introvert. Fig. 105. Papilla from middle region of introvert. Fig. 106. Papilla at base of anal cone. Fig. 107. Papilla from dorsal surface of introvert base (side view). Fig 108. Papilla from ventral surface of middle region of introvert (top view). Fig. 109. Egg. (Scales=0.05 mm for Figs. 104-106 ; 0.1 mm for Fig. 107 ; 0.03 mm for Fig. 108 ; 0.1 mm for Fig. 109.)



Figs 110-113. *Phascolosoma albolineatum* Baird. Fig. 110. Papilla of introvert from posterior rows of hooks. Fig. 111. Papilla from dorsal surface of middle region of trunk. Fig. 112 Arrangement of papillae behind rows of hooks on introvert. Fig. 113. Arrangement of hooks and papillae on introvert. Fig. 114-116. *Phascolosoma granulatum* Leuckart Fig· 114. Papilla from posterior region of introvert. Fig. 115. Anterior region of introvert with tentacular crown. Fig. 116. Hooks from introvert. Fig. 117, 118. *Phascolosoma japonicum* Grube 117. Hook from introvert. Fig. 118. Papilla from middle region of trunk. Fig. 119a, b. *Phascolosoma agassizii* Keferstein Hooks from introvert.
(Scales = 0.03 mm for Figs. 110, 116 ; 0.05 mm for Figs. 111, 118 ; 0.4 mm for Fig. 112 ; 0.05 mm for Fig 113 ; 0.1 mm for Fig. 114 ; 3 mm for Fig. 115 ; 0.03 mm Fig. 117 ; 0.05 mm for Fig. 119.)

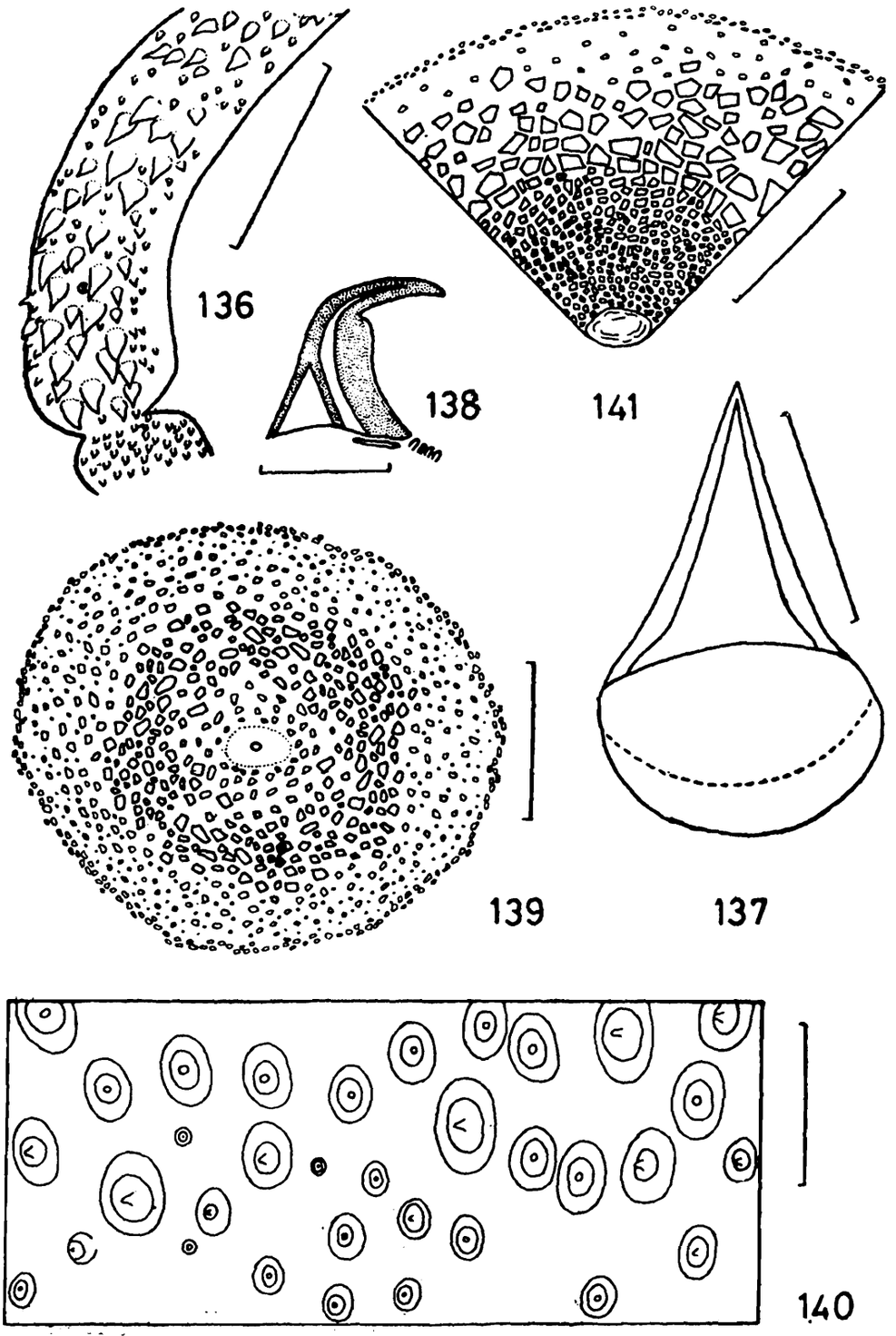


Phascolsoma arcuatum (Gray) Fig. 120. Dissected specimen. Fig. 121 a, b. Hooks from introvert. Fig. 122. Papilla of Introvert from rows of hooks. Fig. 123. A portion of papilla from base of introvert. 124. Papilla from middle third region of trunk. Fig. 125. Papilla from posterior end of trunk.
(Scales = 8 mm for Fig 120 ; 0.05 mm for Figs. 121-124 ; 0.2 mm for Fig. 125.)

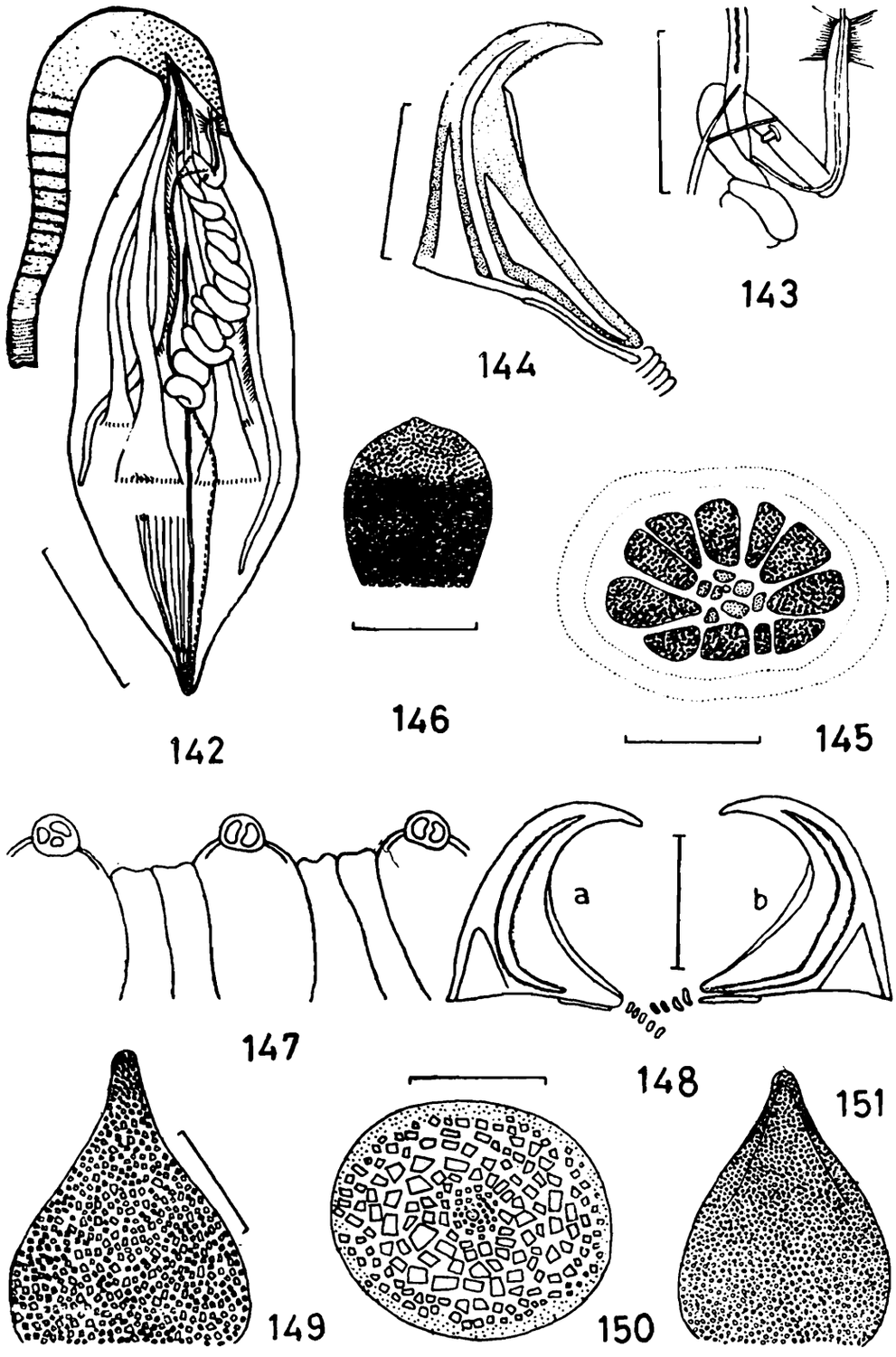


Figs. 126-128. *Phascolosoma nigrescens* Keferstein Fig. 126 a, b. Hooks from introvert. Fig. 127. Papilla of introvert from posterior rows of hooks. Fig. 128. Papilla from posterior edge of anterior third of trunk. Figs. 129, 130. *Phascolosoma pacificum* Keferstein. Fig 129. Papilla from posterior end of trunk. Fig. 130. Hook from introvert. Figs. 131-135. *Apionsoma misakiana*. (Ikeda) Fig. 131. Anterior region of trunk dissected. Fig. 132. Posterior region of trunk dissected. Fig. 133. One row each of hooks (incompletely shown) and papillae on introvert. Fig. 134 a. b. a. Papilla of Fig. 133 enlarged. b. Papilla from posterior end of trunk. Fig. 135 Hook from introvert.

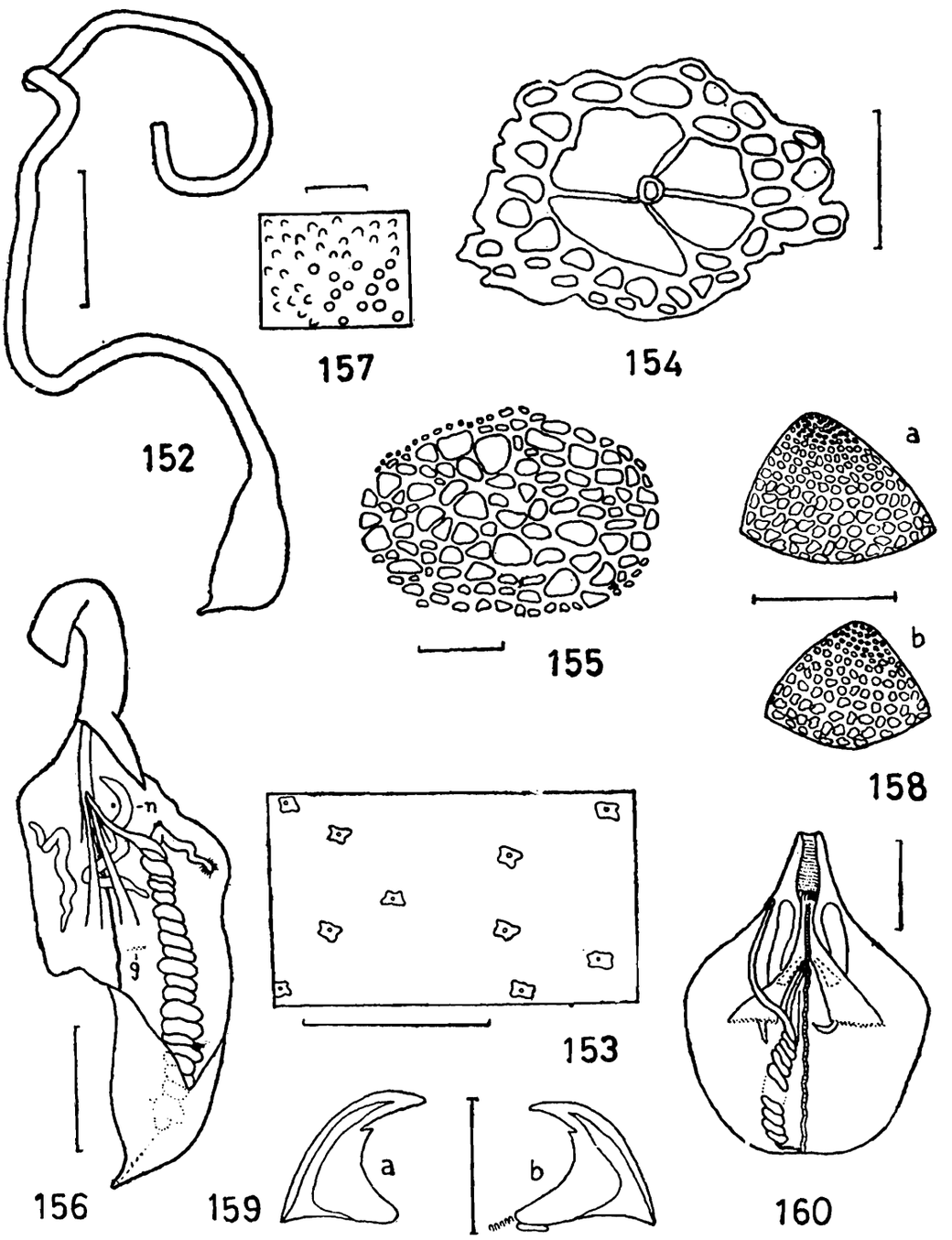
(Scales = 0.05 mm for Figs. 126, 130 ; 0.05 mm for Fig. 127 ; 0.1 mm for Figs. 128, 129 ; 4 mm for Fig. 131 ; 8 mm for Fig. 132 ; 0.04 mm for Fig. 133 ; 0.04 mm for Fig. 134 ; 0.04mm for Fig 135.)



Phascolosoma perlucens Baird. Fig. 136. Arrangement of spinous papillae on introvert. Fig. 137. Spinous papilla of Fig. 136 enlarged. Fig. 138. Hook from anterior introvert. Fig. 139. Papilla from posterior end of trunk. Fig. 140. Arrangement of papillae on middle of posterior half of trunk. Fig. 141. A portion of papilla of Fig. 140 enlarged (Scales = 2 mm for Fig. 136 ; 0.3 mm for Fig. 137 ; 0.05 mm for Fig. 138 ; 0.1 mm for Fig. 139 ; 0.8 mm for Fig. 140 ; 0.05 mm for Fig. 141.)

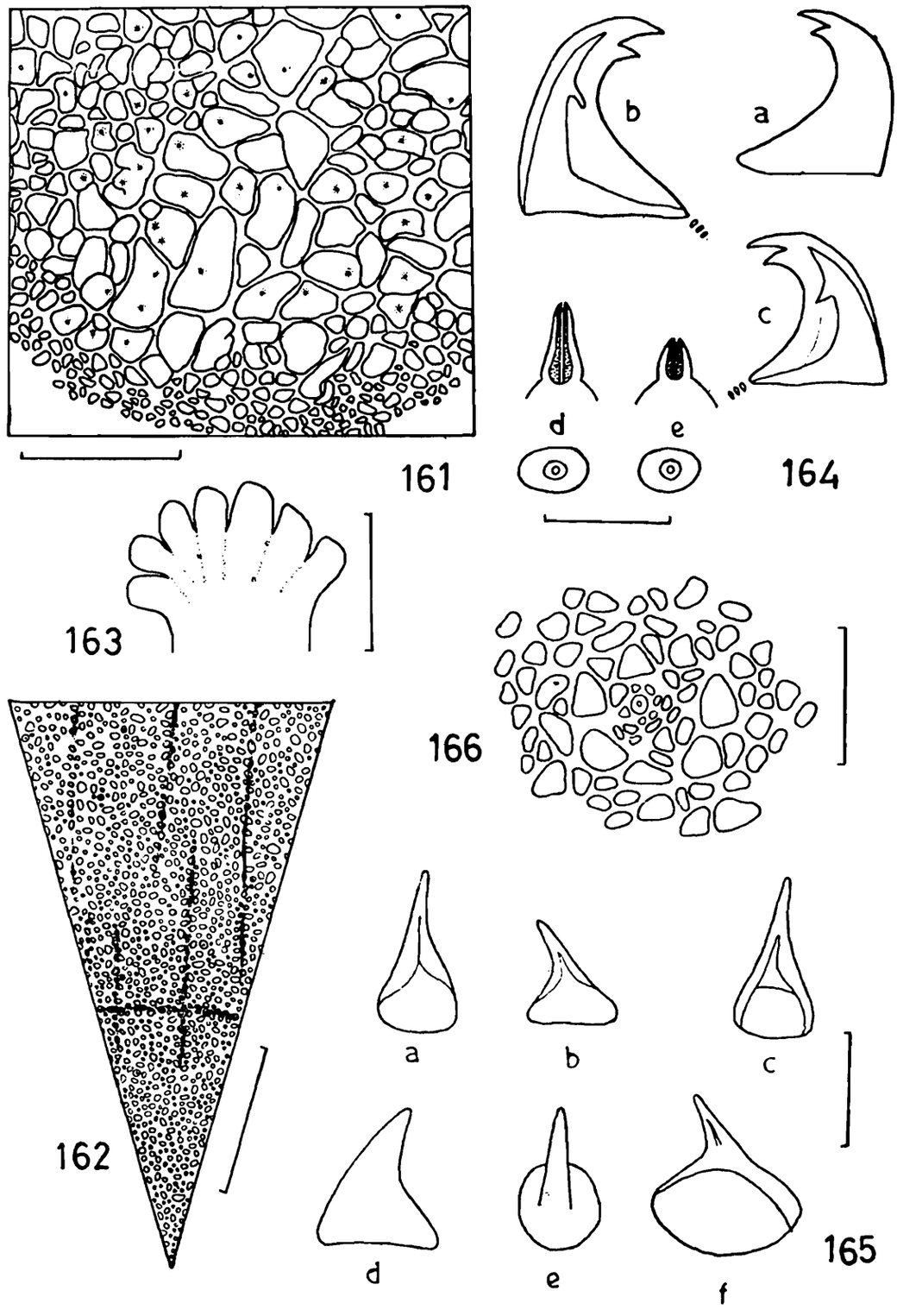


Figs. 142-146 *Phascolosoma stephensoni* (Stephen). Fig. 142. Dissected specimen. Fig. 143. Rectum adjacent oesophagus and and intestinal coil of Fig. 142 enlarged. Fig. 144. Hook from introvert. Fig. 145. Papilla of introvert from rows of hooks. Fig. 146. Papilla from base of introvert. Figs. 147-151 *Phascolosoma scolops* (Selenka & de Man) Fig. 147. Arrangement of papillae on introvert from anterior rows of hooks. Fig 148a, b. Hooks from introvert. Fig. 149. Papilla from posterior end of trunk. Fig 150. Papilla from middle region of trunk. Fig. 151. Papilla from base of introvert. (Scales = 10 mm for Fig. 142 ; 0.4 mm for Fig. 143 ; 0.05 mm for Figs. 144. 147 ; 0.02 mm for Fig 145 ; 0.3 mm for Fig. 146 ; 0.03 mm for Fig. 148 ; 0.1 mm for Figs. 149, 151 ; 0.05 mm for Fig. 150.)

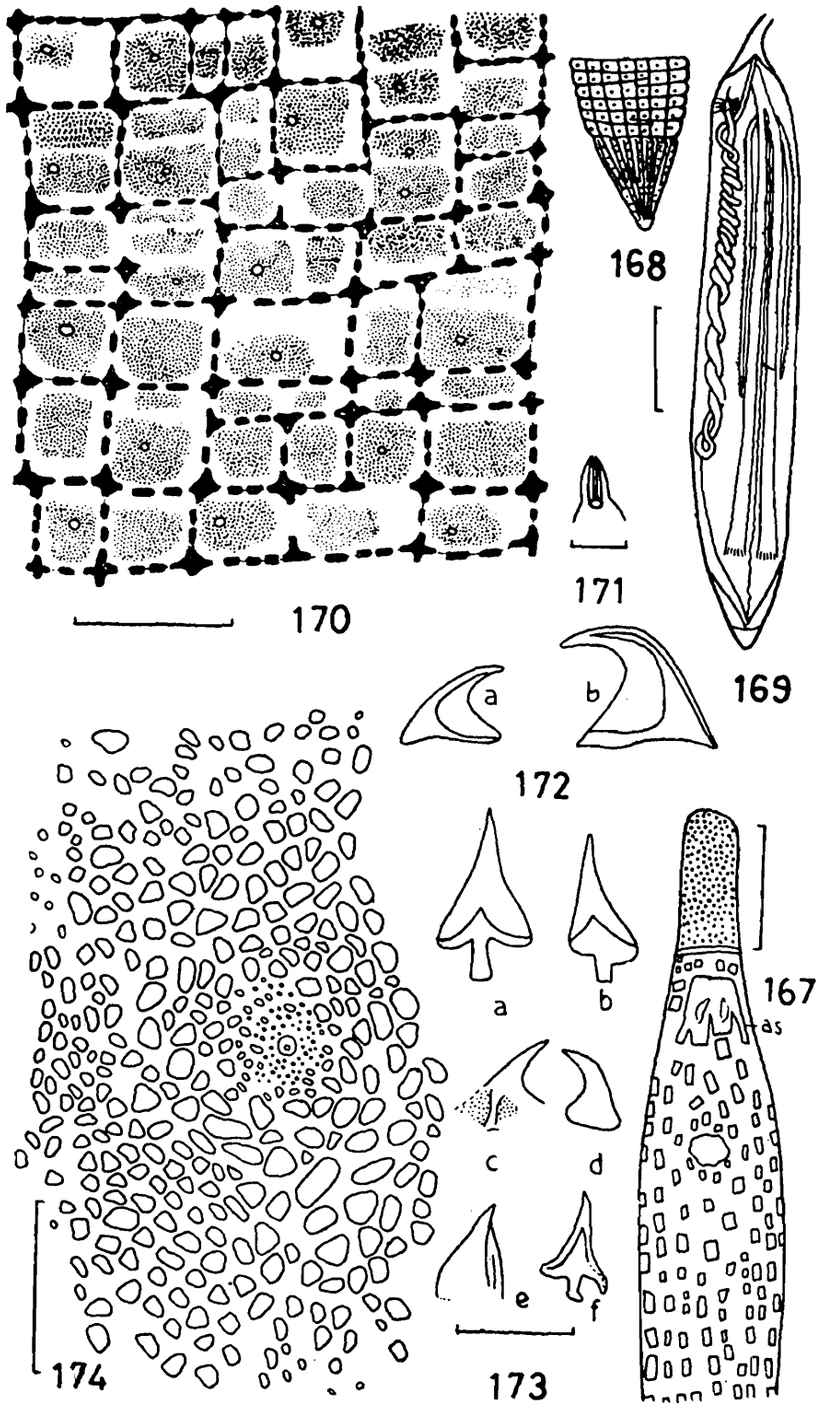


Figs. 152-157 *Apionsoma trichocephala* Sluiter Fig. 152. Entire specimen. Fig. 153. Arrangement of papillae on pesterior third of trunk. Fig. 154. Papilla of Fig. 153 enlarged. Fig. 155. Papilla from base of introvert. Fig. 156. Dissected specimen. Figs. 157-160 *Apionsoma* sp. Fig. 157. Arrangement of papillae on posterior end of trunk. Fig. 158a.b. Papillae of Fig. 157 enlarged. Fig. 159a. b. Hooks from introvert : (a) from anterior and (b) from posterior rows of hooks Fig. 160. Dissected specimen.

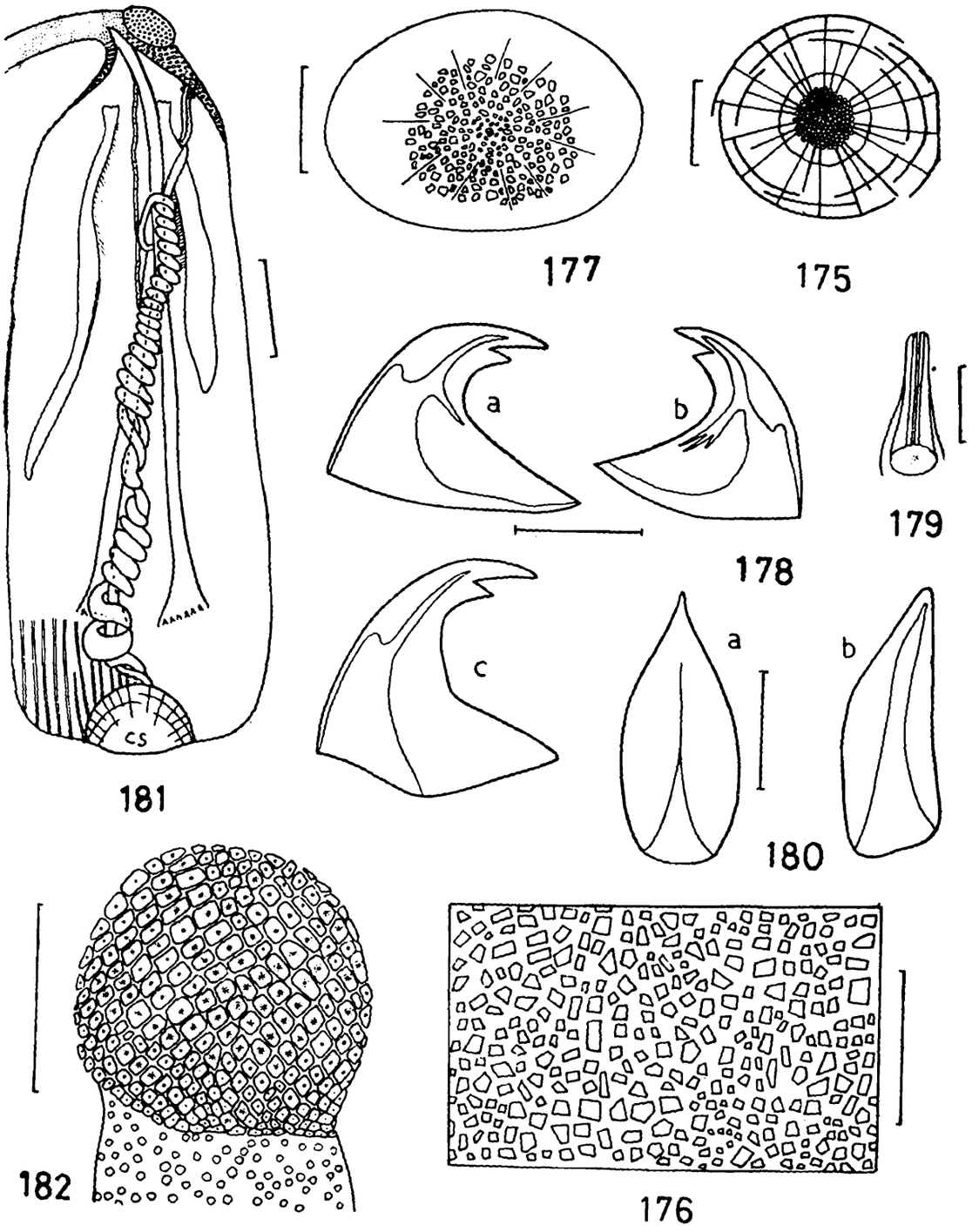
(Scales = 3 mm for Fig. 152 ; 0.2 mm for Fig. 153 ; 0.01 mm for Fig. 154. 0.01 mm for Fig. 155 ; 2 mm for Fig. 156 ; 1 mm for Fig. 157 ; 0.2 mm for Fig. 158 ; 0.05 mm for Fig. 159 ; 3 mm for Fig. 160.)



Aspidosiphon elegans (Chamisso & Eysenhardt) Fig. 161. A portion of anal shield enlarged. Fig. 162. A portion of caudal shield (pointed end below indicates centre of the shield) enlarged. Fig. 163. Dissected tentacular crown. Fig. 164 a-e. Hooks (a-c) from introvert and papillae (d & e) of introvert from rows of hooks (side and top view)· Fig. 165 a-f. Spines from posterior introvert in different views. Fig· 166. Papilla from anterior end of trunk.
(Scales = 0.3 mm for Fig. 161 ; 0.2 mm for Fig. 162; 0.5 mm for Fig. 163 ; 0.05 mm for Figs. 166. 164 (a-c); 0.04 mm for Fig. 164; (d & e) ; 0.05 mm Fig. 165.)



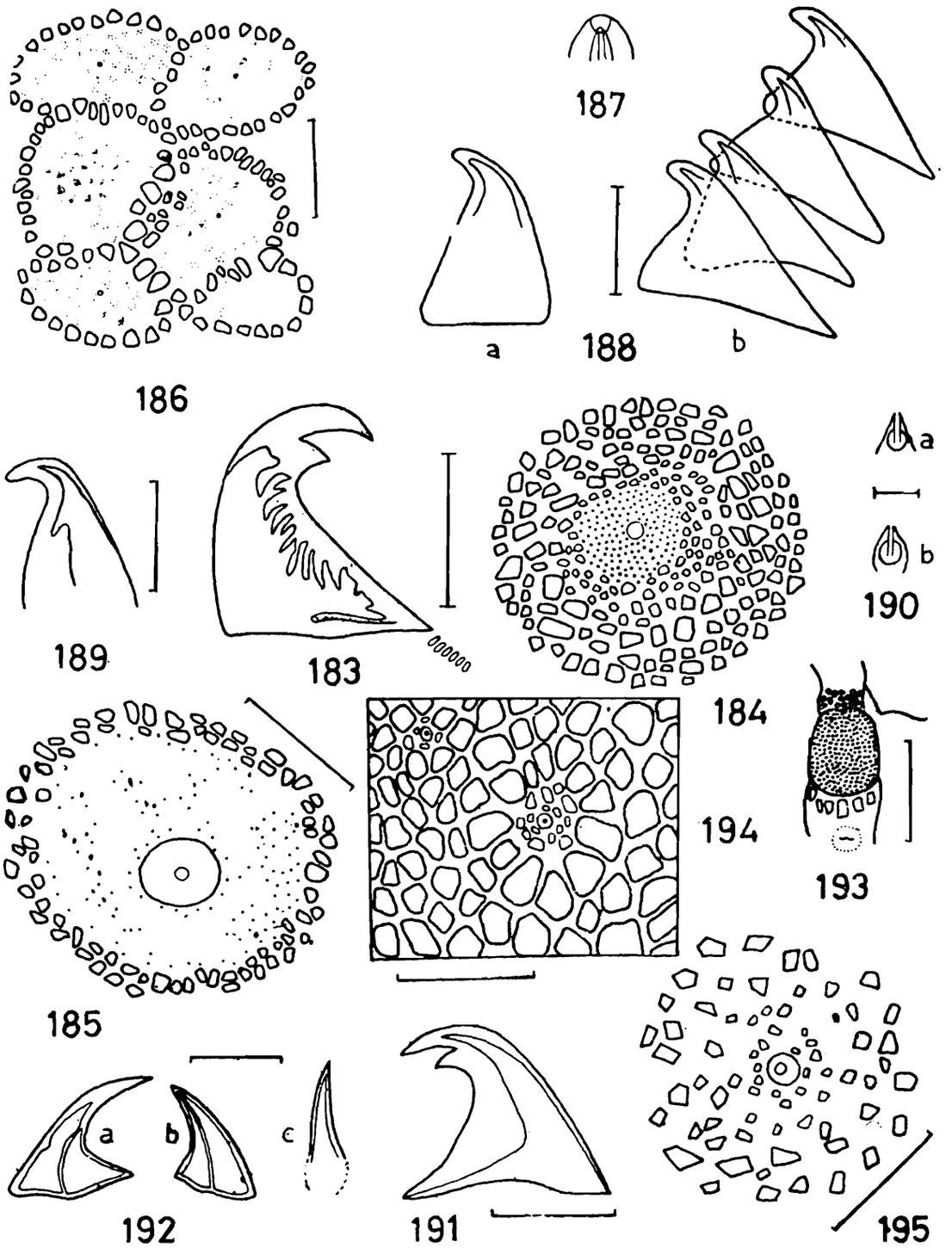
Aspidosiphon gracilis Baird Fig. 167. Anterior part of trunk with anal shield and retracted introvert. Fig. 168. Posterior part of trunk with caudal shield. Fig. 169. Dissected specimen. Fig. 170. Arrangement of papillae on posterior third of trunk. 171. Papilla of introvert from rows of hooks. Fig. 172 a,b. Hooks from introvert. Fig. Fig. 173 a-f. Spines from introvert in different views. Fig. 174. Papilla from base of introvert.
(Scales = 2 mm for Figs 167, 168 ; 5 mm for Fig. 169 ; 0.05 mm for Fig. 173 ; 0.02 mm for Fig. 171 ; 0.03 mm for Figs. 172, 173 ; 0.05 mm for Fig. 174.)



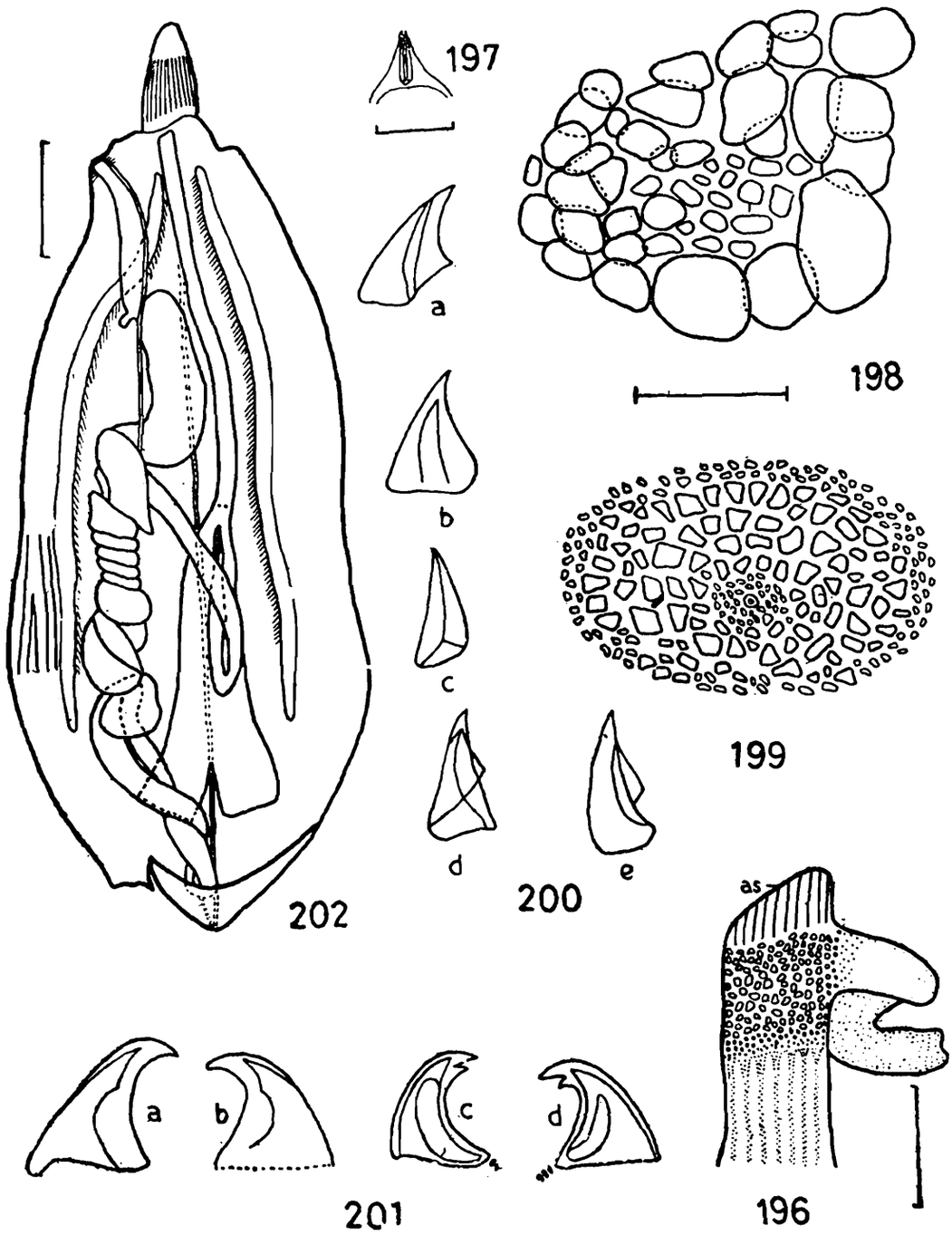
Figs. 175-181 *Aspidosiphon steenstrupii steenstrupii* Diesing Fig. 175. Caudal shield. Fig. 176. Arrangement of chitinous plates near caudal shield. Fig. 177 Papilla from middle region of trunk. Fig. 178 a-c. Hooks from introvert. Fig. 179. Papilla of introvert from rows of hooks. Fig. 180 a, b. Spines from introvert. Fig. 181. Dissected specimen

Cloeosiphon aspergillus (Quatrefages) Fig. 182. Anal shield.

(Scales = 2 mm for Fig 175 ; 0.05 mm for Fig. 176 ; 0.05 mm for Fig. 177 ; 0.05 Fig. 178 ; 0.03 mm for Figs. 179, 180 ; 10 mm for Fig. 181 ; 3 mm for Fig. 182



Figs. 183-185 *Cloeosiphon aspergillus* (Quatrefages) Fig. 183. Hook from introvert. Fig. 184. Papilla from anterior end of trunk. Fig. 185. Papilla from posterior fifth of trunk. Figs. 186-188 *Aspidosiphon pachydermatus* Wesenberg-Lund Fig. 186. Papillae from anterior end of trunk. Fig. 187. Papilla of introvert from rows of hooks Fig. 188a, b. Hooks from introvert. Fig. 189 *Aspidosiphon klunzingeri* Selenka & Bulow-Hook from introvert. Figs. 190-195 *Aspidosiphon steenstrupii ambonensis* Augener Fig. 190a, b. Papillae of introvert from rows of hooks. Fig. 191. Hook from introvert. Fig. 192a-c. Spines from introvert. Fig. 193. Anal shield and its adjacent. area. Fig. 194. Papilla from anterior end of trunk above nephridiopores. Fig. 195. Papilla from middle region of trunk.
(Scales = 0.07 mm for Figs. 183, 184 ; 0.01 mm for Fig. 185 ; 0.2 mm for Fig. 186 ; 0.1 mm for Figs. 187, 188 ; 0.04 mm for Fig. 189 ; 0.015 mm for 190 ; 0.025 mm for Fig. 191 ; 0.03 mm for Fig. 192 ; 3 mm for Fig. 193 ; 06 mm for Fig. 194 ; 0.04 mm for Fig. 195.)



Lithacrosiphon cristatus lakshadweepensis Haldar Fig. 196. Anterior part of trunk with anal shield and retracted introvert. Fig. 197. Papilla of introvert from row of hooks. Fig. 198. Papilla from basal part of anal shield. Fig. 199. Papilla from middle region of trunk. Fig. 200 a-e. Spines from introvert in different views. Fig. 201 a-d. Unidentate (a & b) and Bidentate (c & d) hooks from introvert. Fig. 202. Dissected specimen.
(Scales = 2 mm for Fig 196 ; 0.02 mm for Fig 197; 0.05 mm for Figs 198-201 ; 3mm for Fig. 202.)

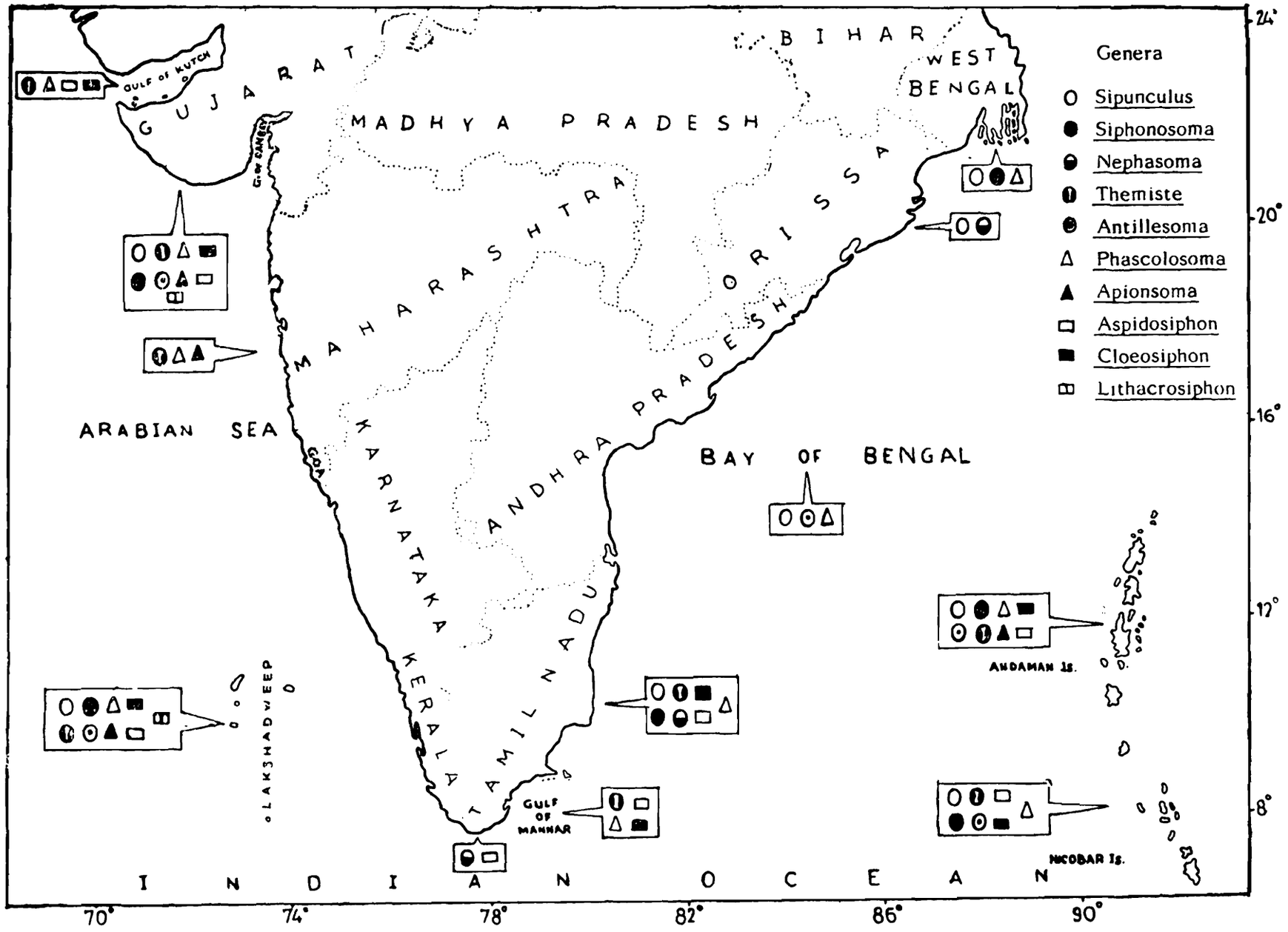


Fig. 203. The geographical distribution of the genera of sipunculans in the Indian coast.

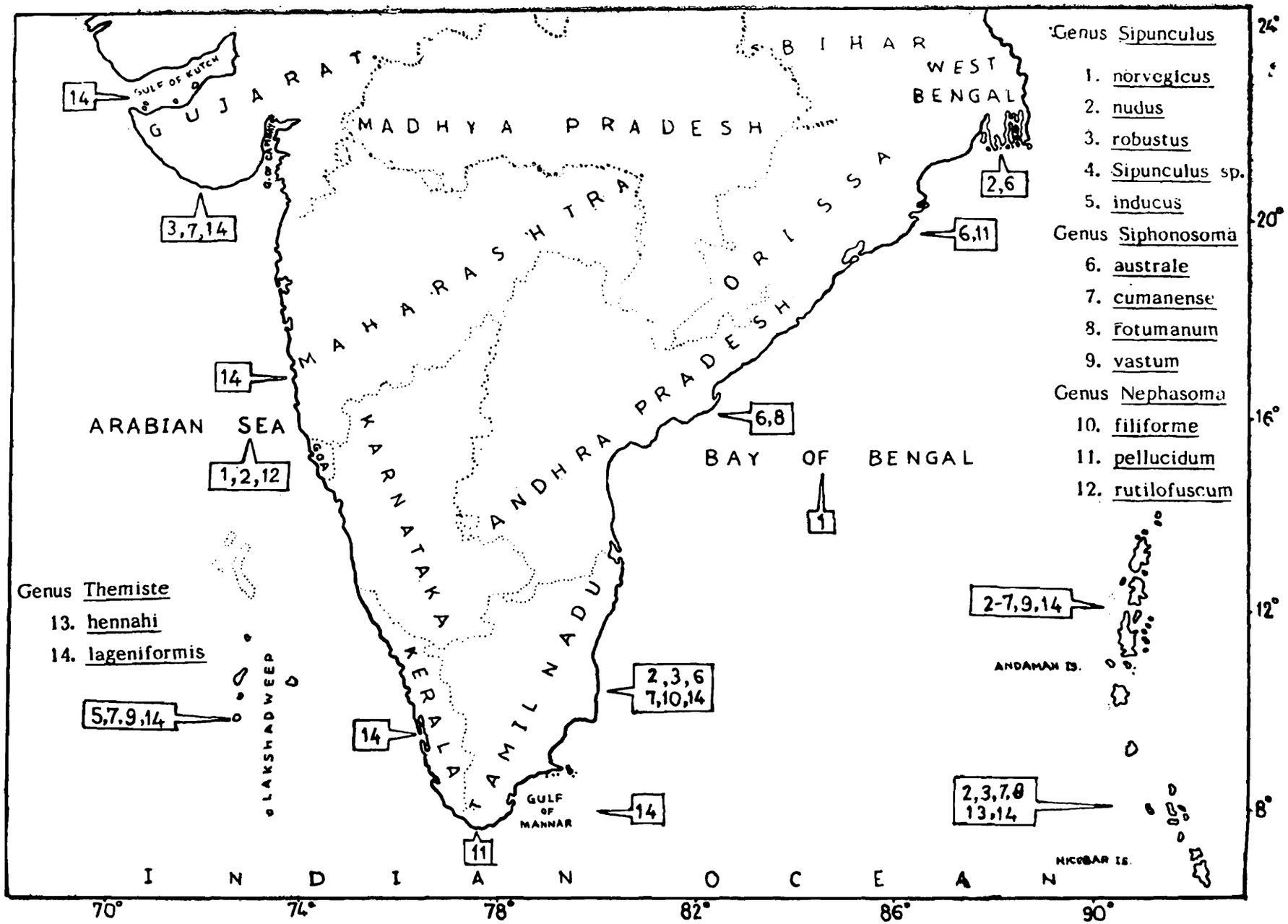


Figure 204. The geographical distribution of the species under the genera *Sipunculus* and *Siphonosoma* (Sipunculidae), *Nephasoma* (Golfingiidae) and *Themiste* (Themistidae) known from the Indian coast.

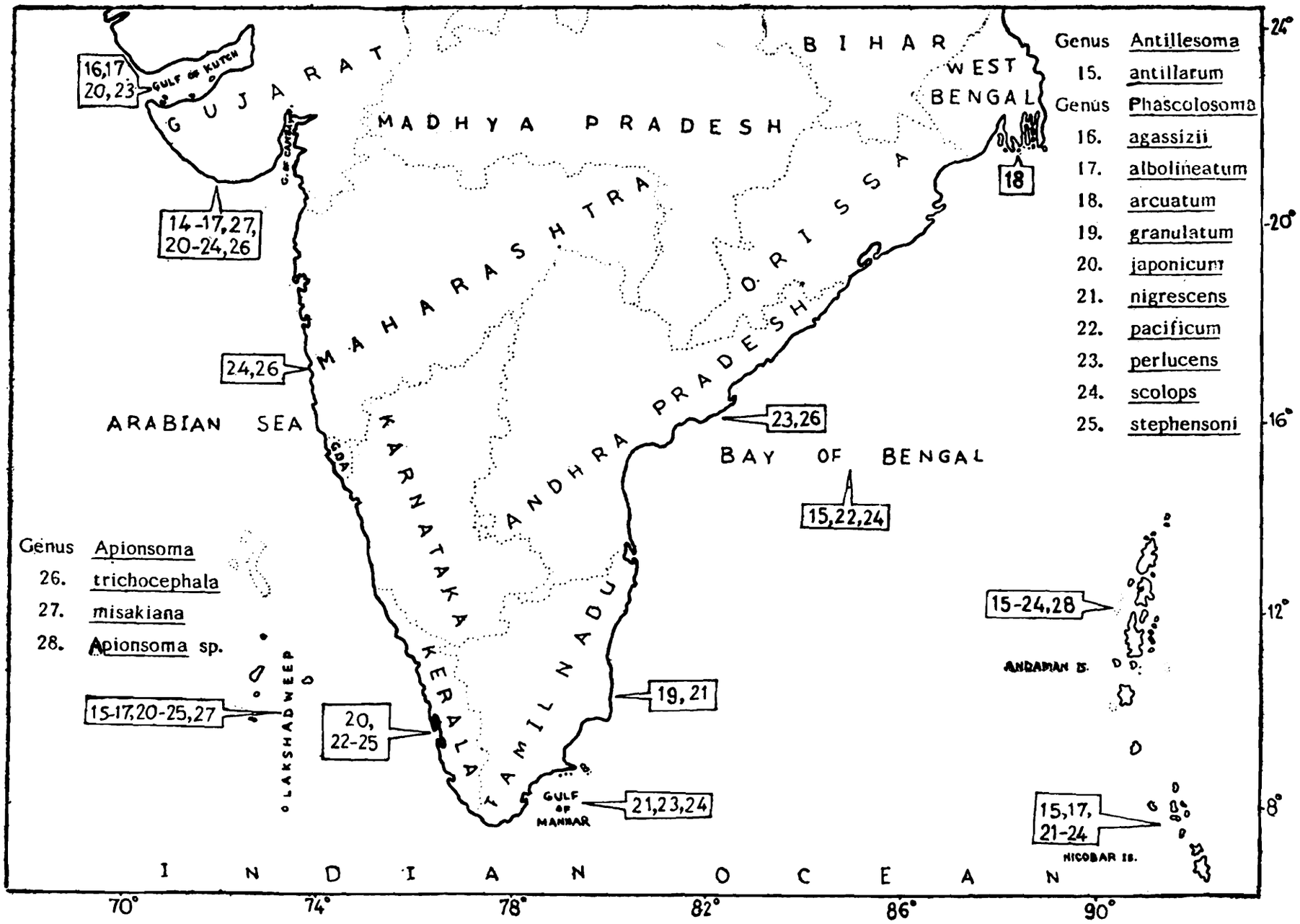


Fig. 205. The geographical distribution of the species under the genera *Antillesoma*, *Phascolosoma* and *Apionsoma* (Phascolosomatidae) known from the Indian coast.

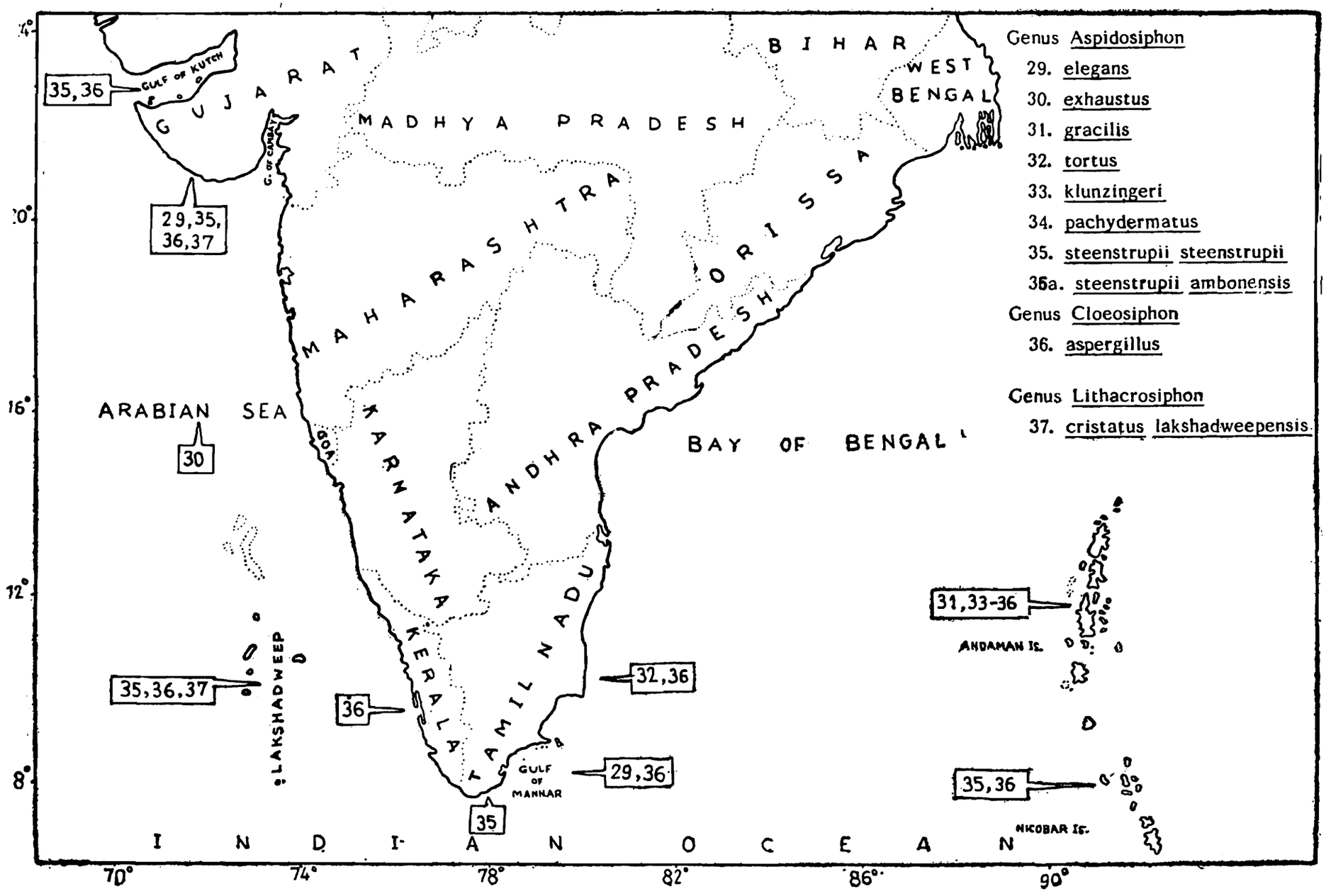


Fig. 206. The geographical distribution of the species under the genera *Aspidosiphon, Cloeosiphon* and *Lithacrosiphon* (Aspidosiphonidae) known from the Indian coast.