

PHYLUM SIPUNCULA. - Part 2. CRYPTIC FAUNA WITH EMPHASIS ON SIPUNCULANS IN HUMP CORAL *PORITES LUTEA*, THE ANDAMAN SEA, THAILAND

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ABSTRACT

A total of 15 cryptic species of sipunculans were encountered in heads of live *Porites lutea* sampled along gradients of depth (0-20 m) and gradients of turbidity ranging from blue oceanic water to muddy mangrove water. The following 8 species constituted 96% of the sipunculans encountered: *Antillesoma antillarum* (1%), *Aspidosiphon elegans* (19%), *A. steenstrupii steenstrupii* (2%), *Cloeosiphon aspergillus* (25%), *Phascolosoma nigrescens* (2%), *P. perlucens* (13%), *P. scolops* (33%), *Themiste lageniformis* (0.6%) The remaining 7 species were only identified to genera, viz., *Siphonosoma* sp., *Golfingia* spp., *Aspidosiphon* (*Aspidosiphon*) spp., *Aspidosiphon* (*Paraspidosiphon*) spp. The distribution pattern is discussed in relation to bioerosion and presence of other cryptic taxa.

INTRODUCTION

Skeletons of live and dead corals are eroded by a high number of taxa of boring organisms living a cryptic life inside the corals. Dominant members of the cryptic fauna are sponges, polychaetes, bivalves (Hein and Risk, 1975), but sipunculans, alpheid shrimps, mudlobsters, amphipods, barnacles, isopods, tanaids, crabs, echinoderms, echiurans and other taxa may locally constitute important members of the cryptic communities.

Nielsen (1986) published the first paper on molluscs encountered during a cooperative Thai-Danish project carried out on cryptic fauna of hump coral during February-March 1982. Nielsen (op.cit.) identified 22 species (mainly boring bivalves) closely associated with corals, and 26 species which regularly occur on other substrates.

The purpose of the present study is to describe cryptic sipunculans found in one species of coral, *Porites lutea*. Hump corals were collected live along a gradient of depth starting on the reef flat, continuing to the crest, and down the slope of fringing reefs. Collections were made on reefs characterized by different water quality. The latter gradient spanned reefs in clear oceanic water to reefs in mangrove water near the limit of turbidity tolerated by *P. lutea*.

MATERIALS AND METHODS

The study area is shown in Fig.1. The localities on Phuket Island were: southern part of Ao Nam Bor (very turbid water), southern part of Ao Makam (medium turbidity), Laem Pan Wa (medium turbidity), northern part of Ao Kata (clear water), southern part of Ao Patong (clear water), northern and southern parts of Ao Bang Tao (very turbid water). Islands off Phuket included western and eastern parts of Ko Phi Phi (clear water), Ko Ngai (clear water), Ko Rok (very clear water), Ko Racha Noi (very clear water), and Ko Racha Yai (very clear water). Samples were collected on intertidal reef flats (0 m), on reef crests (0.5-1 m), and on slopes of reefs (1-20 m). The tide at Phuket is regular semidiurnal (Tide Tables by the Hydrographic Department, Royal Thai Navy). The approximate depth at mean low water is indicated in Table 1 for each sample which contained sipunculans. Two samples from intertidal flats in Bang Tao and at Ko Rok did not contain sipunculans. The team mentioned below collected heads of *Porites lutea* from 9 February to 16 March 1982. Intertidal reef flats were sampled at low tide. Samples from deeper water were collected exclusively by Hans Ditlev, using Scuba gear. In most cases hammer and chisel were used to detach coral heads from the reef,

but samples from Ko Rok (20 m) and Ko Racha Yai (4 m) consisted of smaller heads lying loose on sandy bottom along the slope.

Cryptic fauna was picked from the corals in concert with breaking coral blocks into small pieces (about 1 cm length) with hammer and chisel. We pooled taxa found in live and dead parts of individual coral heads. Extracted animals, were first fixed in 10% formalin in sea water, subsequently transferred to 70% alcohol, then identified and enumerated in the laboratory. All larger sized taxa were efficiently sampled by this method. However, based on subsequent studies using a 0.5 mm sieve to sift all pieces of broken coral (unpublished data), we know that hand picking upon encounter underestimated the number of many small amphipods and polychaetes such as syllids, spionids, cirratulids, and serpulids. The collection included 3638

individuals encompassing 158 taxa from 37 samples of *Porites lutea* with a total weight of approximately 300 kg. The weight of individual heads ranged from 3-20 kg. Sponges, echiurans, isopods, tanaids and barnacles were not included. Claus Nielsen (1986) identified molluscs (866 individuals; 48 species). The present author sipunculans (1164 individuals; 15 species); Anuwat Nateewathana polychaetes to family level (1040 individuals; 21 families); Hans Ditlev alphaeid shrimps (254 individuals; 23 species); Bamroongsak Chatanathawej brachyurans (141 individuals; 25 species), galatheids (43 individuals; 3 species), and thalassinids (77 individuals; 4 species); Somchai Bussarawit echinoderms (43 individuals; 15 species) and amphipods (10 individuals; 4 species). Studies on cryptic molluscs (op.cit.), thalassinids (Chatanathawej, 1986) and the present work on sipunculans constitute the only publications from the team so far.

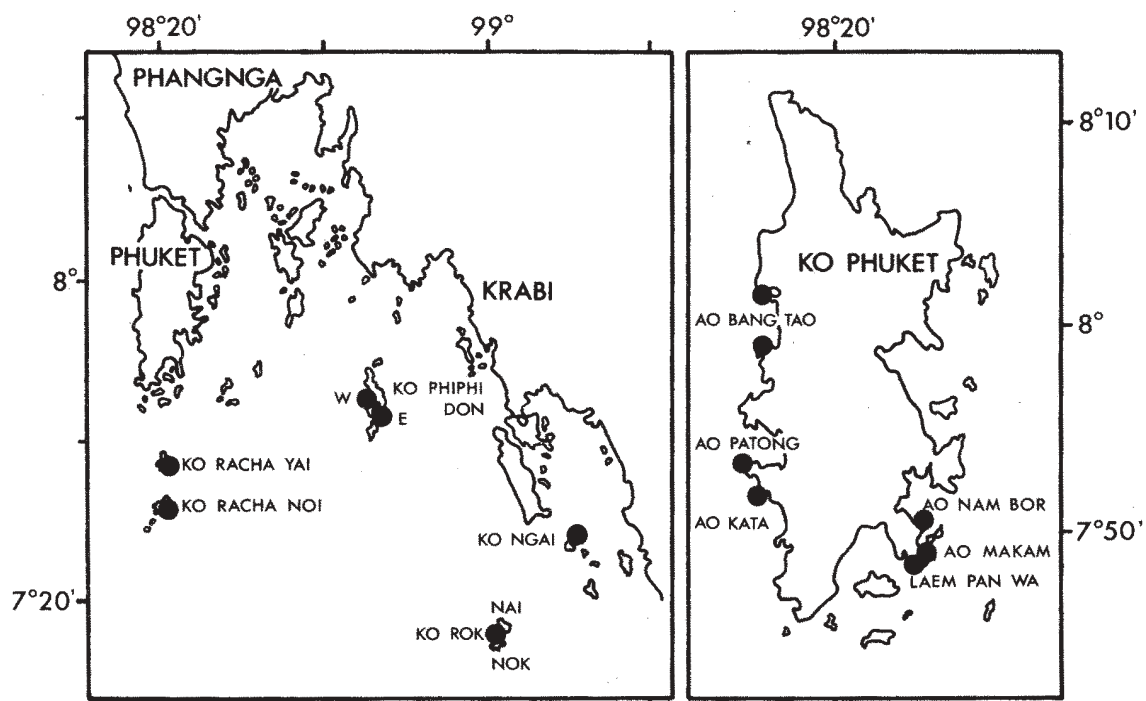


Figure 1. Maps of the study area showing the localities of the semi-quantitative sampling sites. From Nielsen (1986).

RESULTS

Taxonomic account

Eight taxa were present in large numbers and could be identified to species without difficulty. But some taxa were recorded only in low numbers thereby making it difficult to assess possible intraspecific variation of significance for identification. In addition, juvenile forms were suspected to be present. These specimens have been identified only to genus. Taxa of the latter category encompassed 7 of the species encountered, viz., *Siphonosoma* sp., *Golfingia* sp.1 and 2, *Aspidosiphon* (*Aspidosiphon*) sp. 1 and 2, *Aspidosiphon* (*Paraspidosiphon*) sp.1 and 2 (Table 1). Final classification and description of these and other sipunculan taxa are in preparation and will be published in forthcoming issues of this Bulletin. Species names applied in this account are in accordance with recent revisions of sipunculan nomenclature (Hylleberg, 1994). Reference is also given to Hylleberg (1994) for relevant literature on syno-nyms and mis-identifications quoted below.

Genus *ANTILLESOMA*

Stephen and Edmonds, 1972.

Trunk with conspicuous papillae. Introvert variable in length, often equal to trunk; hooks absent; tentacles numerous (more than 30 in adults), enclosing the nuchal organ dorsal to the mouth. Four retractor muscles, but there may be extensive fusion between the two muscles on either side giving the appearance of a single pair with a notch or split in the broad origin. Contractile vessel with many digitiform villi. Spindle muscle attached posteriorly. Longitudinal musculature divided into separate bands which anastomose and are not always visible through the epidermis. Two nephridia. Monospecific genus.

Antillesoma antillarum

(Grube and Oersted, 1858)

Synonyms are listed under the following entries in Hylleberg (1994): *aethiops* - *asser* - *fuscum* - *gaudens* - *mokyeveskii* - *nigriceps* - *pelma* = *pelmum* - *onomichianum* - *weldoni* - *schmidti* - *simile* = *similis*.

Diagnosis: Trunk stoutly built, up to 8.5 cm in length, generally about 2 cm, reddish grey or pale

brown in the middle, darker posteriorly, while the base of the introvert and anterior body are dark brown or black. Trunk diameter increases posteriorly. Introvert short with numerous finger-like tentacles; patchy dark pigment on tentacles and area around nuchal organ.

Remarks: Stephen and Edmonds (1972) recognized 6 species in the subgenus *Antillesoma*. Five of those (together with 6 other species) have subsequently been declared synonyms, leaving *A. antillarum* (formerly known as *Phascolosoma antillarum*) as the only valid species in the genus (Cutler & Cutler, 1983). Rice (1975) stated that the species should not occur in the Indian Ocean and the Eastern Atlantic, but in the wake of revisions (Hylleberg, 1994), the species has a circumtropical distribution.

Genus *ASPIDOSIPHON*

Diesing, 1851

Trunk with a hardened anal shield; generally also a posterior shield-like structure. Introvert usually longer than trunk, arising from the ventral margin of anterior shield; recurved hooks with one or two points present in numerous rings in most cases; oral disk with tentacles enclosing nuchal organ but not mouth. Two introvert retractor muscles fused to varying degrees. Contractile vessel without villi. Spindle muscle attached posteriorly. Longitudinal muscle layers continuous (subgenus *Aspidosiphon*) or in separate bands (subgenus *Paraspidosiphon*); bands are sometimes ill-defined. Two nephridia.

Aspidosiphon elegans

(Chamisso and Eysenhardt, 1821)

Synonyms are listed under the following entries in Hylleberg (1994): *brocki* - *carolinus* - *cylindricus* - *elegans yapensis* - *exilis* - *homomyarium* = *homomyarius* - *ravus* - *spinalis* - *spinosus*

Diagnosis: Trunk cylindrical, slender, up to 8 cm in length, usually much smaller, whitish grey in the middle, darker posteriorly with a caudal shield which may not be clearly differentiated. Anal shield dark brown with furrows that do not reach the centre. Introvert about the length of the trunk, with numerous rows of double pointed hooks anteriorly and spines posteriorly. Longitudinal muscle layers continuous.

Remarks: Stephen and Edmonds (1972) and Rice (1975) refer to the present species as *Aspidosiphon brocki* Augener, 1903. However, recent revisions made it synonymous with *Aspidosiphon elegans* (Cutler and Cutler, 1989). According to Stephen and Edmonds (1972), *A. elegans* can attain a length of 8 cm.

Aspidosiphon steenstrupii steenstrupii

Diesing, 1859

Synonyms are listed under the following entries in Hylleberg (1994): *exostomum* = *exostomus* - *fuscus* - *makoensis* - *ochrus* - *semperi* - *speculator* - *steenstrupii faciatus* - *trinidensis*

Diagnosis: Trunk cylindrical, slender, up to 4 cm in length, often semi-transparent in the middle region, darker anteriorly and posteriorly. Anal shield usually covered with chalky points. Caudal shield has irregular ridges at its edge. Introvert as long as the trunk; carries rows of double-pointed hooks anteriorly; brown spines posteriorly. Longitudinal musculature in separate bands

Remarks: The species has circumtropical distribution, especially common in the Indo-Pacific.

Genus *CLOEOSIPHON*

Grube, 1868

Anterior trunk with a spheroid to pineapple-shaped cap (anal shield) made up of distinct polygonal, calcareous units. Introvert longer than trunk, protruding from center of cap; tentacles enclosing nuchal organ, but not mouth; numerous rings of recurved, bidentate hooks. Two retractor muscles often almost completely fused. Contractile vessel without villi. Spindle muscle attached posteriorly. Longitudinal musculature continuous. Two nephridia. A monotypic genus.

Cloeosiphon aspergillus

(Quatrefages, 1865)

Synonyms are listed under the following entries in Hylleberg (1994): *aspergillus* - *carolinum* - *japonicum* - *javanicum* - *mollis*.

Diagnosis: Trunk long and slender, up to 5 cm in length, often translucent. Otherwise as described for the monotypic genus.

Remarks: It is a common inhabitant of coral reefs of the Indo-Pacific.

Genus *PHASCOLOSOMA*

Leuckart, 1828

Trunk sub-cylindrical, ellipsoid. Introvert and trunk usually covered with prominent conical to hemispherical papillae, often brown to red-brown in colour. Trunk papillae usually largest and most densely distributed at anterior and posterior ends, especially on dorsal side. Introvert variable in length, often equal to trunk; numerous rings of recurved hooks (few and inconspicuous in *P. meteori*), relatively few tentacles in a semi-circle around the nuchal organ dorsal to the mouth. Four introvert retractor muscles, lateral pairs sometimes partially fused. Contractile vessel single and simple, but may have bulbous vesicles. Spindle muscle attached to body wall posteriorly (except in *P. pectinatum*). Longitudinal muscles in bands which may anastomose. Two nephridia.

Phascolosoma nigrescens

Keferstein, 1865

Synonyms and mis-identifications are listed under the following entries in Hylleberg (1994): *agassizii* (in Keferstein, 1867 (part)) - *agassizii puntarenae* - *diaphanes* - *duplicigranulatum* - *evisceratum* - *extortum* - *horsti* - *lacteum* - *minutum* (ten Broke, 1925) - *planispinosum* - *puntarenae* - *spengeli* - *varians*

Diagnosis: Trunk slender, up to 3 cm in length, grayish-brown in colour, often marbled with brown flecks and bands. Introvert longer than the trunk, with the dorsal side crossed by brownish bands intermingled with lighter ones. Introvert armed with numerous rows of hooks. Characterized by a conspicuous clear streak in each hook (triangle and internal clear steak not separated), prominent swelling of proximal crescent. Approximately 20 tentacles.

Remarks: Cutler and Cutler (1990) recognized 12 synonyms which made this species a widespread, circumtropical species recorded in shallow water of all oceans.

Phascolosoma perlucens

Baird, 1868

Synonyms and mis-identifications are listed under the following entries in Hylleberg (1994): *dentigerum* - *insularis* - *microdentigerum* - *punta-*

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renae (in Wesenberg-Lund, 1959a) - *scolops* (in ten Broeke, 1925) - *spinosum* - *thomense* - *vermiculum* = *vermiculus*.

Diagnosis: Trunk slender, up to 5 cm in length, normally about 3 cm. Characterized by prominent reddish-brown conical, posteriorly directed pre-anal papillae on the dorsal base of the introvert. Introvert shorter than the trunk. Introvert armed with about 22 rows of hooks. Approximately 14 tentacles.

Remarks: Cutler and Cutler (1990) recognized 6 synonyms of this circumtropical species. It is somewhat patchily distributed in shallow water of all oceans.

Phascolosoma scolops

(Selenka and de Man, 1883)

Synonyms and mis-identifications are listed under the following entries in Hylleberg (1994): *agassizii* (in Fischer, 1919a, 1922a (part)) - *carneum* - *dunwichi* - *longicolle* (in Grube, 1840) - *nahaense* - *nigritorquatum* - *pelmum* (sensu Cutler, 1977a) - *psaron* - *riukiensis* - *rotnesti* - *rueppellii* (sensu Stephen, 1941) - *scolops adenticulatum* - *scolops mossambiciense* - *socium* (in Stephen and Edmonds, 1972) - *spongicola* = *spongicolum*

Diagnosis: Trunk slender, pale, often transparent, up to 4 cm in length. Characterized by mammiform reddish-brown pre-anal papillae, larger on the dorsal side of the introvert. Papillae larger and more densely coloured posteriorly. Introvert commonly shorter than trunk and with irregular, pigmented bands. Introvert armed with 15-20 rows of hooks, the internal clear streak is separate from the distinct triangle. Approximately 12 tentacles.

Remarks: Cutler and Cutler (1990) recognized 10 synonyms of this species which is distributed throughout the Indo-Pacific, northern Australia and Hawaii.

Genus **THEMISTE**

Grey, 1828

Trunk relatively smooth; usually pear-shaped but varies from cylindrical to globose. Introvert usually less than half the trunk length; with or without hooks; tentacles numerous, basically surrounding the mouth; tentacles arise from 4-8 primary stems

and branching in a pinnate or palmate fashion. Two retractor muscles. Contractile vessel with villi of variable number and length; usually well developed. Spindle muscle not attached to the posterior of trunk. Longitudinal musculature continuous. Two nephridia.

Themiste lageniformis

Baird, 1868

Synonyms and mis-identifications are listed under the following entries in Hylleberg (1994): *glauca* = *glaucum* - *lanchesteri* - *minor* (in Chin, 1947) - *pyriformis* - *robertsoni* - *signifer* (Selenka and de Man, 1883 (part)) - *stephensoni* (Stephen, 1942 (part)) - *tropica* = *tropicum*

Diagnosis: Trunk pyriform, reddish brown or yellow-orange, posteriorly whitish. Trunk normally less than 3 cm in length. Introvert very short with numerous slender, white tentacles. A broad white collar present behind the tentacles with white blotches elsewhere. Anus opens at the base of the introvert. Spines and hooks absent.

Remarks: Cutler and Cutler (1988) put 5 species of the genus *Themiste* into synonymy with *T. lageniformis* which is the most widely distributed species of the genus, recorded from Japan to Australia, Hawaii, and throughout the Indian Ocean, South and Southwest Africa, Cuba and Florida.

Vertical distribution of sipunculans

Four species comprised 90% of the individuals encountered in hump coral. Most common were *Phascolosoma scolops* (33%), *Cloeosiphon aspergillus* (25%), *Aspidosiphon elegans* (19%), and *Phascolosoma perlucens* (13%) which occurred in samples from 0-10 m depth (Table 1). *Phascolosoma scolops* and *Aspidosiphon elegans* were also present in the sample from 15 m at Ko Phi Phi W, while *Cloeosiphon aspergillus* was present in the sample from 20 m depth at Ko Rok. In general, heads from the intertidal flats contained a high number of species and individuals. Coral heads from the crest (0.5-1 m) contained the lowest number of individuals. It appeared that both taxa and number of individuals decreased with depth >10 m, but no firm conclusion can be drawn in this regard since only 3 samples were taken deeper than 10 m.

Table 1. Sipunculans from semi-quantitative samples of *Porites lutea*. The species are numbered as follows: 1 *Siphonosoma* sp. -2 *Antillesoma antillarum* -3 *Phascolosoma perlucens* -4 *Phascolosoma nigrescens* -5 *Phascolosoma scolops* -6 *Themiste lageniformis* -7 *Golfingia* sp.1. -8 *Golfingia* sp.2. -9 *Aspidosiphon elegans* -10 *Aspidosiphon* (*Aspidosiphon*) sp.1. -11 *Aspidosiphon* (*Aspidosiphon*) sp.2. -12 *Aspidosiphon steenstrupii steenstrupii* -13 *Cloeosiphon aspergillus* -14 *Aspidosiphon* (*Paraspidosiphon*) sp.1. -15 *Aspidosiphon* (*Paraspidosiphon*) sp.2. -A = Total number of live specimens. -B = number of species per locality. Approximate depth at mean low tide (m) is shown behind each locality.

Locality	Dept m	Species No.															A	B		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
Ao Nam Bor S	0		1			7												2		
-	0.5																	0	3	
-	1		1			17	2											20		
Ao Makam S	0		2	10		87	3			43				12				157		
-	0.5					4	1			1			1	6				13	8	
-	1.5					58				1	3		1	4				67		
Laem Pan Wa	0		1	10		5	1			33	2			19				71		
-	0.5				5									6				11	9	
-	3		1		1	67				1	3			2				75		
Ao Kata N	0		1	1		1								6				9		
-	1													2				2	5	
-	8		5	1		1					2			1				10		
Ao Patong S	0		1	9						20				1	14			45		
-	4			5		2					3			4				14	8	
-	8				3					3	3		1	11				21		
Ao Bang Tao S	0		1	28						12			1	19				61		
-	1			7						8				1				16	6	
-	7					1							4	1				7		
Ao Bang Tao N	1			1														1		
-	5				1					1				4				6	4	
Ko Phi Phi W	0			4		2				74			5	52				137		
-	3			2	3	2		1					4					12	8	
-	10			1		21				4	2		1	7				36		
-	15					6				1								7		
Ko Phi Phi E	1			7		1				3				23				34	4	
Ko Ngai	0			8		15				6				5				34		
-	0.5					6												6	8	
-	1					45			1				1	6				53		
-	1.5					7				1								8		
Ko Rok	2			7	2	3				1		1	3	11				28		
-	7			1	1								1	1				4	10	
-	15			1	3								3	4				11		
-	20	1			2								6	3	1			13		
Ko Racha Noi	3			44	2						27	2		46				121	5	
Ko Racha Yai	4			8	2	23				1				13				47	5	
Total number		1	14	155	25	381	7	1	1	217	42	3	25	288	3	1				
Total Number of live specimens																				1164

DISCUSSION

Abundance and distribution of rock-boring sipunculans

Antillesoma antillarum. Rice (1975) found it to be the second most abundant species in the

Caribbean and surrounding waters, comprising approximately 16% of the specimens collected. However, it was not recorded by Rice and Macintyre (1982) from the Atlantic Barrier Reef at Carrie Bow Cay, Belize. Rice (1975) recorded *A. antillarum* in a density of 415 individuals m⁻² in Puerto Rico. The species was regularly sampled at Phuket

Island, but never in quantity. *A. antillarum* comprised 2.3% of the 608 individuals collected at Phuket Island (about 1% of total sipunculans encountered). Surprisingly, it was never found at other islands in the Andaman Sea.

Aspidosiphon elegans. *A. elegans* comprised approximately 7% of the specimens collected in the Caribbean (Rice, 1975), and 23% at the Atlantic Barrier Reef, Carrie Bow Cay, Belize (Rice and Macintyre, 1982). The species comprised approximately 19% of the individuals in this study. It was regularly sampled at all islands. Locally it was very abundant (Table 1). All individuals of *A. elegans* obtained during this study were small, usually less than 2 cm length, and the individuals often had a bulbous swelling of variable size and degree of development at the posterior end. This bulb constituted a new individual produced by budding (asexual reproduction). I have pinched off such bulbs and kept them in sea water. In accordance with findings by Rice (1970) they developed into small sipunculans. I also found sexual reproduction in this species. Eggs are spherical. I speculate that budding may increase the fitness of cryptic *A. elegans* exposed to predation, (e.g., by gastropods feeding by insertion of the radula into the dwelling of the sipunculan). A predator may engulf the soft body of the sipunculan until it reaches the bulbous part. When fully developed, this part is separated from the parental body by a hard stalk which is a continuation of the posterior chitinous plate of the parent. The advantage should be that the bulbous juvenile has the same diameter as the dwelling of the parent. When the juvenile has developed from the bulb, it can move upwards and occupy the space of the eaten parent. Feeding can begin and the new individual can grow in length without having to enlarge its dwelling.

Aspidosiphon steenstrupii steenstrupii. Rice (1975) collected the species in the Caribbean where it comprised approximately 5% of the specimens. It was absent from littoral waters of the Florida Keys. It comprised 9% of the specimens from the Atlantic Barrier Reef (Rice and Macintyre, 1982). The species was regularly collected at islands in the Andaman Sea, but never in quantity, and comprised approximately 2% of the individuals collected (Table 1).

Cloeosiphon aspergillus. This species was the second most common species in the Andaman Sea and comprised approximately 25% of the individuals. (Table 1). Rice (1975) did not find it in the Caribbean or from the Atlantic Barrier Reef (Rice and Macintyre, 1982). In these parts of the tropics, these authors found numerous specimens of *Lithacrosiphon gurjanovae* and *L. alticonus* (*L. gurjanovae* and *L. alticonus* = *Lithacrosiphon cristatus* cf. Hylleberg, 1994). I speculate that *Lithacrosiphon* may occupy a niche similar to *Cloeosiphon* of the Indo-Pacific. The anterior end of *Lithacrosiphon* carries a hard, calcareous, cone-shaped cap which superficially may resemble the cap at the end of an introverted *C. aspergillus*. However, the introvert of *Cloeosiphon* arises on the ventral side of the cap as compared to a central point of evagination in *Cloeosiphon*. No members of the genus *Lithacrosiphon* were encountered at islands in the Andaman Sea.

Phascolosoma nigrescens. Rice (1975) and Rice and Macintyre (1982) recorded this species as *Phascolosoma varians* (= *Phascolosoma nigrescens*). It comprised approximately 0.4% of the specimens collected in the Caribbean and surrounding waters, and 3.5% at the Atlantic Barrier Reef. *P. nigrescens* was regularly collected at islands in the Andaman Sea, but never in quantity. It comprised approximately 2% of the sipunculan individuals.

Phascolosoma perlucens. Rice (1975) found *P. perlucens* remarkably abundant in the Caribbean and surrounding waters, comprising approximately 46% of the specimens collected. It was most abundant in the intertidal zone but occurred to a depth of 25 m. The distribution in the present study is similar to that found by Rice (1975). Most individuals were encountered on intertidal reef flats or upper reef slopes. Our deepest record is 15 m (Table 1). *P. perlucens* comprised 15% of the individuals from the Atlantic Barrier Reef (Rice and Macintyre, 1982). The species comprised approximately 13% of the individuals collected at islands in the Andaman Sea.

Phascolosoma scolops. Cutler and Cutler (1990) found that published records from the Atlantic need verification, and Rice (1975) and Rice and Macintyre (1982) did not find *P. scolops* in the

Caribbean or from the Atlantic Barrier Reef. It was the most common species sampled at islands in the Andaman Sea where it comprised approximately 33% of the collected individuals. (Table 1).

Themiste lageniformis. Cutler and Cutler (1988) reported *T. lageniformis* from Cuba and Florida. But the species was not encountered in the Caribbean by Rice (1975). Instead she found the related *T. alutacea*, although never in great numbers. It comprised approximately 1.5% of the specimens collected. Similarly, *T. lageniformis* was not recorded by Rice and Macintyre (1982) from the Atlantic Barrier Reef. *T. lageniformis* was regularly sampled on the east coast of Phuket Island, but never in quantity. It comprised approximately 0.6% of the collected sipunculans. Surprisingly, it was never encountered on the west coast of Phuket Island, and never at other islands in the Andaman Sea. I speculate that this pattern of distribution may be related to the mode of reproduction. Cutler and Cutler (1988) refer to studies showing that *T. lageniformis* has pelagic larvae, and may be parthenogenetic. Females in the present study contained very large eggs, indicating development of lecithotrophic larvae. A short larval life may reduce the ability of the Phuket population to colonize other islands, thereby explaining the limited geographical distribution (Table 1).

Bioerosion by cryptic fauna

Bioerosion results in weakened corals which may detach and become destroyed during storms (Otter, 1937). Hein and Risk (1975) estimated the amount of skeletal material excavated by boring sponges and sipunculid polychaetes in Florida. An average of 28% of the skeleton was eroded by these two groups considered to be the quantitatively most important bioeroding organisms, although bivalves could locally be very destructive. Hutchings (1983) found that polychaetes were the dominant borers of newly available substratum. Otter (1937) found that the sipunculans *Aspidosiphon steenstrupii steenstrupii*, *Cloeosiphon aspergillus*, and *Phascolosoma scolops* played a most important part in the destruction of corals. Recently, Kiene and Hutchings (1994) demonstrated that boring rates by polychaetes and sipunculans were relatively low and varied between sites. In this study, we did not try to quantify the

amount of erosion by individual taxa. However, it was obvious that sipunculans caused substantial erosion to individual coral heads at islands in the Andaman Sea. In other samples it was evident that sponges, polychaetes and mudlobsters constituted the most important rock-borers.

Cryptic fauna in relation to gradients of turbidity

Very turbid water was found in Ao Bang Tao. In that bay quantities of silt-clay, brought into suspension by offshore tin mining, affected benthos and coastal water (Hylleberg *et al.*, 1985a,b). However, there was no obvious effect of the suspended matter on species composition or abundance of sipunculans (Table 1).

The only piece of evidence which possibly could relate abundance of cryptic fauna to offshore mining is the distribution of the polychaete family Sabellidae. Sabellids in northern and southern Ao Bang Tao comprised only 0.2% and 1.7%, respectively, of the individuals (421) presented by this family. The third lowest count of sabellids occurred at the reef in Ao Nam Bor located in mangrove water near the limit of turbidity tolerated by *Porites lutea*. At this locality 2.8% of total sabellid collection was found compared to an average of $9.5 \pm 4.9\%$ for the other localities of this study (Fig. 1). Sabellids are filter-feeders and high loads of suspended matter obviously interfere with their feeding capabilities.

The distribution of thalassinids (Chatananthawej, 1986) may also reflect the gradient of turbidity, although this factor at Phuket Island normally is coupled with a protected habitat. Turbidity created by off shore tin mining is a man-made phenomenon. Mining took place in Ao Bang Tao during the calm north-east monsoon in an otherwise exposed environment. The thalassinid *Upogebia carinicauda* (Stimpson) lives in long tunnels connected to the surface of the hump coral through a series of holes. I speculate that the substantial bioerosion created by this species may weaken the coral to such an extent that *Upogebia* only can become abundant in protected habitats. Among the 55 individuals collected, 56% lived in Ao Nam Bor, the most protected locality of this study.

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