BASTERIA, 69: 157-166

Coral associations and space competitors of *Pedum spondyloideum* (Gmelin, 1791) (Bivalvia, Pteriomorphia, Pectinidae) from the northeast coast of Sulawesi, Indonesia

P. SCAPS, V. DENIS

Laboratoire de Biologie Animale, Université des Sciences et Technologies de Lille, F 59 655 Villeneuve d'Ascq, France; patrick.scaps@univ-lille1.fr

S. BERHIMPON & F. KALIGIS

Sam Ratulangi University, Faculty of Fisheries and Marine Science, Kampus UNSRAT Bahu, Manado 95 115, Indonesia

On the northeast coast of Sulawesi, Indonesia, several species of scleractinian corals are used as hosts by the nestling and facultatively boring pectinid bivalve *Pedum spondyloideum*, including the previously unrecorded hosts *Acropora robusta, Coeloseris mayeri, Montipora confusa, Porites monticulosa* and *P. evermanni*. *Porites* is the favourite host genus and the maximum density (7 specimens) occurs in both *Porites lutea* and *P. lobata*. *Pedum* is restricted to shallow water (2-16 m depth) and there is no relationship between the number of individuals associated with scleractinian host corals and the depth. Local distribution indicates that *Pedum* is most common in sheltered areas; some exposed sites are completely devoid of individuals. Competitors (nestling and boring organisms) are only observed in massive colonies of the coral genus *Porites* (*P. lutea* and *P. lobata*).

Key words: Bivalvia, *Pedum*, Scleractinia, Indonesia, NE Sulawesi, bioerosion.

INTRODUCTION

The nestling and facultatively boring pectinid bivalve *Pedum spondyloideum* (Gmelin, 1791) is an obligate associate of living scleractinian corals. It is byssally attached and lives embedded in the coral skeleton; it is usually completely surrounded by live tissue on the coral surface, but not inside the dwelling (Yonge, 1967; Waller, 1972; DeVantier & Endean, 1988; Kleemann, 1990; Savazzi, 1999). Data about associations of *Pedum* (Bruguière, 1792) with scleractinian host corals are very scarce. Except for the reports of Kleemann (1990, 1995, 2001) from the northern Red Sea and Lizard Island in the Great Barrier Reef region (Australia), very little is known about these associations in the Indo-Pacific and especially in the global centre of marine biodiversity. The main goal of this field study was to identify the associations of *Pedum* and host corals in Pulisan region on the northeast coast of Sulawesi, Indonesia, that occupies a key position at the heart of the southeast Asian biodiversity centre or 'Coral Triangle' and to evaluate the current abundance of this species in different reef systems and habitats.

MATERIALS AND METHODS

The area selected for the field study is the Pulisan region on the northeast coast of Sulawesi, Indonesia (fig. 1). The area lies near the centre of global marine biodiversity or "Coral Triangle" composed of Indonesia, Philippines, Malaysia and Papua New Guinea. This region harbours the biologically most diverse coral reefs in the world. Observations were carried out in the field by SCUBA-diving during the summer of 2004 (08-17 August) and 21 sites were surveyed for *Pedum* coral associations. For sampling locations and dates see table 1. During this study, the seawater temperature was 27-28°C. The salinity ranged from 35 to 36 psu. No difference was noticed between the surface and the bottom temperature and salinity. The transparency of the water, measured with a Secchi disk, was 13-18 m. Most of the sites were fringing reefs, with a developed reef crest and a fairly steep reef slope after which a flat gentle slope of sandy habitat dominates. A direct dive was made to the base of the reef, to or beyond the deepest visible coral. Dives consisted on a slow ascent along the reef in a zigzag path to the shallowest points. The distribution and population density of *Pedum* was estimated from notes in the field and from in situ underwater photography. Based on the aim to document the range of host corals, genera and species, photographs were taken of new or rarely observed associations. Additional pictures were taken of known associations when the *Pedum* density was high for either the particular host or the locality. Many corals can be positively identified under water up to species level, but several species cannot be recognized with certainty without knowing skeleton details. In the latter case, representative samples were collected to enable a positive identification in the laboratory. Corals were bleached for 24-48 hours to remove living tissue. They were then rinsed in freshwater, dried and identified following Veron (2000), Veron & Pichon (1976, 1980, 1982), Veron & Wallace (1984), Veron et al. (1977) and Wallace (1999). These specimens were deposited in the collections of the University of Sam Ratulangi.

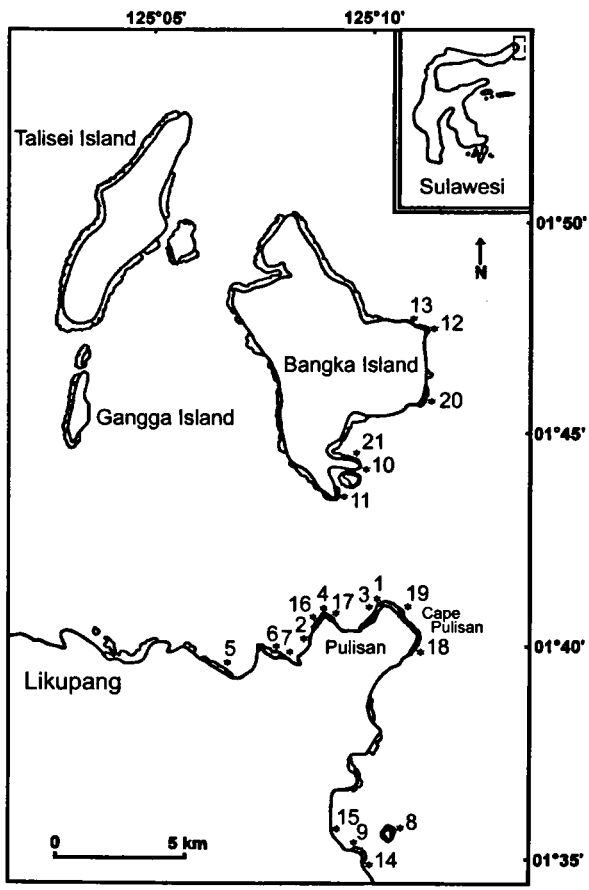

Fig. 1. A map of northeast Sulawesi showing sampling locations. For details see Table 1.

RESULTS

Associations with reef-building corals

At Pulisan, 11 associations of *Pedum* with scleractinian host corals were recorded (table 2). *Pedum* was observed in 8 genera of host corals (table 4) belonging to 5 families of 4 scleractinian suborders, viz. (1) Astrocoeniina, Acroporidae (*Acropora, Montipora*); (2) Fungiina, Agaricidae (*Coeloseris, Gardineroseris, Pachyseris*); (3) Faviina, Faviidae (*Leptastrea*) and Merulinidae (*Hydnophora*); and (4) Poritiina, Poritidae (*Porites*).

Some of these associations have been reported before from other localities in the Indo-Pacific (table 4), but it is the first time that associations with live corals of the genus *Coeloseris* and *Acropora* are recorded. One species of *Montipora* (*M. confusa*) and two species of *Porites* (*P. evermanni* and *P. monticulosa*) are also new records. A fringing reef located on the eastern side of Bangka Island (site 13) was particularly rich in new types of associations. It was at this site that we found one *Pedum* in *Acropora* (*Acropora*) *robusta* (fig. 2A) and in *Porites evermanni* (fig. 2B). Also a colony of *Porites monticulosa* (fig. 2C) hosted two *Pedum*. The association between *Pedum* and *Coeloseris mayeri* (fig. 2D) was observed near Cape Pulisan (site 1) and the association between *Pedum* and *Montipora confusa* (fig. 3E) was observed on three different sites located on the main Island (sites 2, 15, 19). *Pedum* occurred commonly in *Porites lutea* (fig. 3A) and *P. lobata* (fig. 3B), and was found occasionally in *Gardineroseris planulata* (sites 2, 7, 14, 17) (fig. 3C) and *Pachyseris speciosa* (sites 2, 3) (fig. 3D) and only once in both *Leptastrea purpurea* (site 4) and *Hydnophora microconos* (site 3) (table 2).

Abundance and depth distribution

Several specimens of *Pedum* were found in *Pachyseris speciosa* (2 individuals), *Gardineroseris planulata* (3 individuals), *Porites monticulosa* (2 individuals), *Porites lobata* and *Porites lutea*. For all the other associations only one *Pedum* was found. The number of *Pedum* in *Porites lutea* and *Porites lobata* varied between 1 and 7 (fig. 4) but in most of the cases *Pedum* occurred only once (51 and 61 % for *P. lutea* and *P. lobata*, respectively). The highest *Pedum* densities (7 specimens) were found at 8 m and 9 m for *Porites lutea* and *Porites lobata*, respectively. No relationship was found between the number of *Pedum* associated with scleractinian host corals and the depth.

The depth range of *Pedum* at Pulisan extended from 2 to 16 m. The depth records of *Pedum* in the various host corals were 3 m in *Acropora* (*Acropora*) *robusta*, 5-10 m (7.00 ± 2.64 m) in *Montipora confusa*, 7-9 m in *Pachyseris speciosa*, 3-16 m (9.20 ± 4.96 m) in *Gardineroseris planulata*, 3 m in *Hydnophora microconos*, 7 m in *Coeloseris mayeri*, 6 m in *Leptastrea purpurea*, 2-13 m (7.07 ± 2.58 m) in *Porites lutea*, 4-13 m (8.02 ± 1.98 m) in *Porites lobata*, 3 m in *Porites evermani*, 10 m in *Porites monticulosa*.

Local distribution

At Pulisan, *Pedum* appeared to be most common in the sheltered areas. More exposed sites were completely devoid of *Pedum* (sites 8, 10, 18, 20) or contained only a few individuals (site 12) (table 3). Soft corals dominated these exposed sites. In the sheltered areas *Pedum* was particularly common in the massive corals *Porites lutea* and *Porites lobata*. At some sites (sites 5, 9, 11, 21) *Pedum* was associated with only one species of scleractinian coral (*P. lutea* or *P. lobata*) whereas at a single dive on a small fringing reef near Pulisan village (site 2), *Pedum* was recorded from 5 different coral species (*Gardineroseris planulata,*

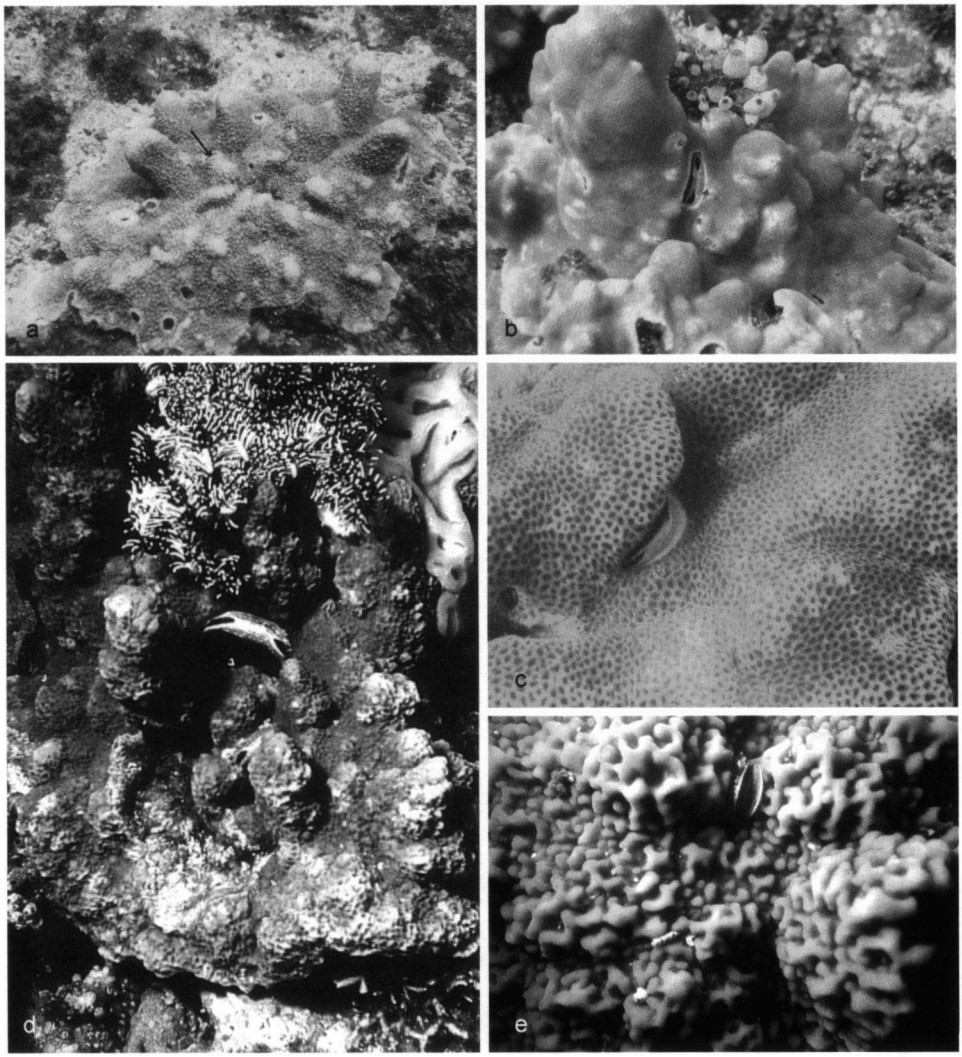

Fig. 2. Associations with *Pedum spondyloideum*. **a**, *Acropora robusta* inhabited by *Pedum* (arrow), *Dendropoma maxima* and *Spirobranchus giganteus*; **b**, *Pedum* imbedded in *Porites evermanni*; **c**, a *Pedum* in *Porites monticulosa*; **d**, massive *Coeloseris mayeri* inhabited by *Pedum*; **e**, a small *Pedum* in *Montipora confusa*.

Montipora confusa, Porites lutea, P. lobata and *P. speciosa*). The highest population density of *Pedum* was recorded on the main island west of Cape Pulisan (sites 2, 6, 16, 17). Sites located around (sites 1, 3, 4, 19) and south of Cape Pulisan (sites 9, 14, 15) were relatively poor in *Pedum* (table 3).

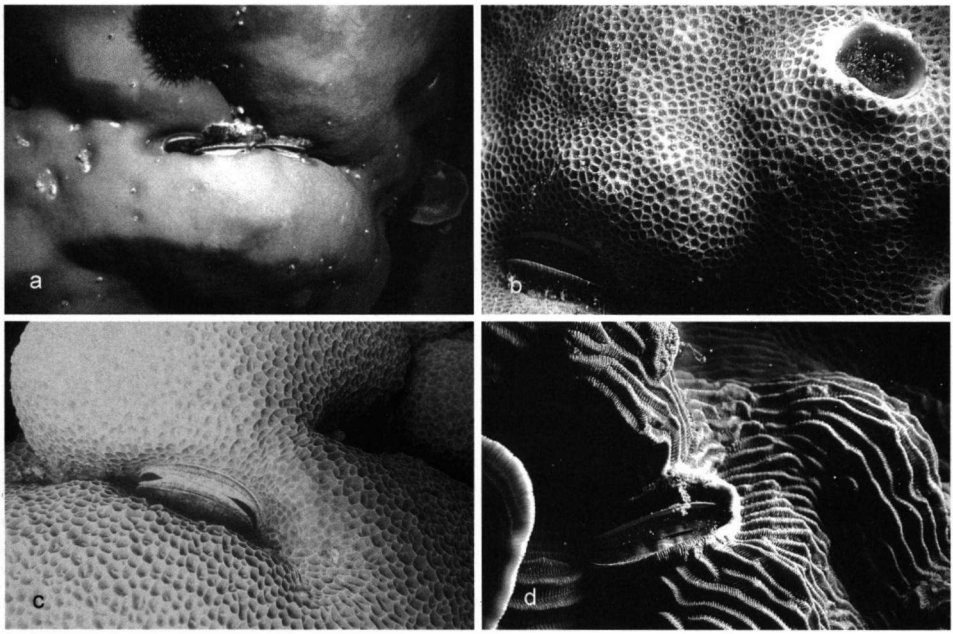

Fig. 3. Associations with *Pedum spondyloideum*. **a**, *Pedum* aggregation in *Porites lutea*; **b**, *Porites lobata* with *Pedum* and *Dendropoma maxima*; **c**, *Gardineroseris planulata* inhabited by *Pedum*; **d**, *Pachyseris speciosa* with *Pedum*.

Competitors

Apart from intraspecific competition for food and space, *Pedum* often has to cope with several competitors associated with the same host colony, dwelling in crevices or settling on dead parts of the coral (Kleemann, 2001). At Pulisan, competitors were only observed in massive corals of the genus *Porites* (*P. lutea* and *P. lobata*). *Pedum* occurred with other bivalves, e.g. nestling *Tridacna* spp. and boring *Lithophaga* spp., vermetid gastropods (*Dendropoma maxima*) (fig. 3B), serpulid annelids (*Spirobranchus giganteus*), cryptochirid and cirriped crustaceans (fig. 3A). Sometimes, these massive corals were also heavily infested by the corallivorous gastropod *Coralliophyla neritoidea* (Lamarck, 1816). 35 and 29% of *P. lutea* and *P. lobata* inhabited by *Pedum*, respectively, were infested by *C. neritoidea*.

DISCUSSION

In the Pulisan region, at the heart of the southeast Asian biodiversity centre, *Pedum* is found with 8 host coral genera and is mainly associated with massive corals of the genus *Porites* (87.5 %). Previous reports from other localities in the Indo-Pacific ocean also showed that *Pedum* is associated with *Porites* (table 4). *Pedum* was found associated with *Porites lutea* and *Porites lobata* at Phuket in Thailand and at Mellish Reef (Great Barrier Reef) in Australia, respectively (Nielsen, 1986; Kleemann, 1990; Scoffin & Bradshaw, 2000). At Lizard Island (Great Barrier Reef) *Pedum* was only found in *Porites rus*. On the contrary,

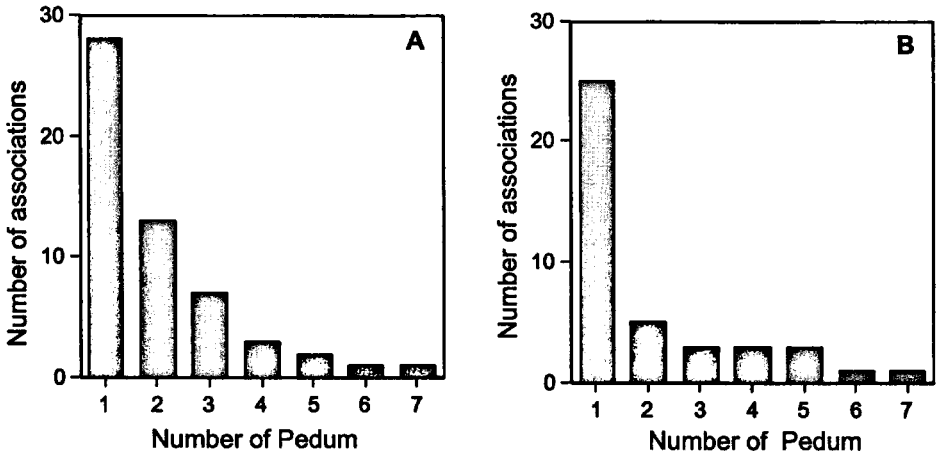

Fig. 4. Number of *Pedum* occurring in association with *Porites lutea* (A) and *Porites lobata* (B).

data from the Red Sea showed that *Pedum* occupies at least 14 host genera (table 4) and is associated more frequently and in higher densities with encrusting to semimassive and even branching *Montipora* species (Kleemann, 2000). The difference observed between the Pulisan region and the Red Sea cannot be due to the prevalence of corals of the genus *Porites* at Pulisan (23 species, SCAPS unpublished results) because the coral biodiversity is very high (more than 370 identified species, SCAPS unpublished data) and the genus *Montipora* is well represented (20 species, SCAPS unpublished data). This difference suggests that the associations may differ regionally. Except for some coral species that are restricted to the Red Sea (*Montipora meandrina* and *M. stilosa*) or to the West Pacific (*Montipora confusa, Porites evermanni*), most of the host species of *Pedum* have a large Indo-Pacific distribution. Nevertheless, few corals are used as host by *Pedum* in different areas (table 4), e.g. *Gardineroseris planulata* (northern Red Sea and northeastern Sulawesi), *Porites lutea* (Red Sea, Thailand and northeastern Sulawesi), *Leptastrea purpurea* (northern Red Sea and northeastern Sulawesi) and *Hydnophora microconos* (northern Red Sea and northeastern Sulawesi). As a consequence, the same coral host may harbour more than one bivalve species within the range of *Pedum*.

The depth distribution of *Pedum* at Pulisan ranges from 2 to 16 m, which is within the range for other localities: 0.5-25 m in the northern Red Sea (Kleemann, 1990); below 7 m in Eniwetok Atoll (Waller, 1972); 4 m on the northeast coast of Redika Island, south of Noumea, New Caledonia (Waller, 1972); 2-10 m below the reef crest on Holbourne Island Reef and Keeper Reef, central Great Barrier Reef (DeVantier & Endean, 1988). In Thailand, at Phuket (Nielsen, 1986) and at diverse locations in the Andaman Sea (SCAPS, personal observations) *Pedum* is restricted to the reef crest and slope. Its inability to withstand desiccation probably prevents it from inhabiting the intertidal area (Savazzi, 1999; Kleemann, 1990).

High population densities within single coral heads in *Porites* from Raboul, New Britain (Yonge, 1967) and from the Red Sea (Vine, 1986) are rare at Pulisan. Only 112 associations between *Pedum* and scleractinian host corals were observed and only 212 *Pedum* were numbered during this field study (24 hours of diving times). Moreover, corals containing more than 3 *Pedum* are rare at Pulisan (only 12% and 19% for *P. lutea* and *P. lobata*,

respectively) and they are mainly associated with big corals. At the Great Barrier Reef, low densities in *Porites* were also noted, the highest values being 10/0.46 m coral diameter and 24/1.06 m across (DeVantier & Endean, 1988). From the Philippines, Savazzi (1999) reported even lower densities, rarely more than 2-3 *Pedum/Porites* 1 m across.

At Pulisan, *Pedum* is particularly common in *Porites lutea* and *P. lobata* from the sheltered sites 2, 6, 16, 17, located at the west of Cape Pulisan. In the north entrance of the Molucca Sea the monsoons are powerful and constant. They blow chiefly from the north and south. The south monsoon prevails from June to November and the north monsoon blowing from north to northeast prevails from December through April. At the sites located west of Cape Pulisan, bay water passes relatively slowly being protected from the prevalent winds by Cape Pulisan. Moreover, due to the influence of land and the proximity of Pulisan village the nutrient content is considered to be higher than in more exposed sites. Consequently, these data agree with those of Kleemann (1990) who showed that, in the northern Red Sea, *Pedum* was also found in sheltered areas with high nutrient content. At Lizard island (Great Barrier Reef) the *Pedum-Porites* association was very common in the lagoon but rare at exposed sites (Kleemann, 1995). In addition, *Pedum* was only found in the lagoon of Eniwetok (Waller, 1972).

As was noticed by Kleemann (1990, 2001) for the northern Red Sea, we observed at Pulisan that *Pedum* found in a single or few specimens per coral colony, occurs alone or together with other nestling (*Tridacna* spp.) and/or boring endolithic associates (crustaceans, serpulids, and the mytilid bivalve *Lithophaga*). Nevertheless, in our study these competitors are restricted to massive *Porites* colonies (*P. lutea* and *P. lobata*), which are sometimes also heavily infestated by the corallivorous snail *Coralliophyla neritoidea*.

ACKNOWLEDGEMENTS

We wish to thank all the French volunteer SCUBA divers (R. Ben Jelloun, C. Bertrand, P. Courtois, G. Jovet, C. Paul, M. Pontaud, J.G. Tonneau and J. Vizinet) who assisted with diving. Thanks are also due to S. Kaunang, B. Poyoh and F. Runtukahu for their help in the field and laboratory work. We are particularly grateful to F. Breilly and D. Hebrard for assistance with field data collection and G. Allard for organizing the logistics. Professor Michel Pichon of the University of Perpignan assisted in identifying scleractinian species. The paper constitutes part of the Ms. Thesis submitted by V. Denis.

Date	Site	Name	Latitude North	Latitude East	Depth Max
13/08 AM	1	Machiko point	1°41'263"	125°9'895"	14 m
13/08 PM	2	Efrata	1°40'336"	125°8'336"	26 m
14/08 AM	3	Sanders	1°40'896"	125°9'645"	21 m
14/08 PM	4	Mokotamba Yuki	1°40'858"	125°8'821"	15 m
15/08 PM	5	Paradise jetty	1°39'782"	125°6'189"	17 m
16/08 AM	6	Mokotamba II	1°40'409"	125°7'690"	15 m
16/08 PM	7	Mokotamba III	1°40'145"	125°7'989"	11 m
17/08 AM	8	Win's point	1°35'746"	125°10'664"	26 m
17/08 PM	9	Jafan point	1°35'373"	125°9'522"	14 m
18/08 AM	10	Tanjung Sahaong, Bangka Island	1°44'187"	125°9'825"	35 m
18/08 PM	11	Sephia point, Bangka Island	1°43'522"	125°9'125"	18 m
20/08 AM	12	Tanjung Batugosoh, Bangka Island	1°47'381"	125°11'137"	14 m
20/08 PM	13	Lihaga, Bangka Island	1°47'612"	125°10'858"	22 m
21/08 AM	14	Tanjung batu butih	1°34'851"	125°9'896"	26 m
21/08 PM	15	Magic window	1°35'742"	125°8'984"	14 m
22/08 AM	16	Yuki	1°40'672"	125°8'519"	17 m
22//08 PM	17	Tanjung hell	1°40'784"	125°8'960"	10 m
23/08 AM	18	Batu pandita	1°39'933"	125°10'782"	34 m
24/08 AM	19	Ferry point	1°41'010"	125°10'746"	12 m
25/08 AM	20	Aimée point, Bangka Island	1°45'784"	125°11'174"	20 m
25/08 PM	21	Lihulu point, Bangka Island	1°44'507"	125°9'660"	10 m

Table 1. Sampling locations and dates.

Species	%
Acropora (Acropora) robusta	0.90
Montipora confusa	2.67
Coeloseris mayeri	0.90
Gardineroseris planulata	4.46
Pachyseris speciosa	1.78
Leptastrea purpurea	0.90
Hydnophora microconos	0.90
Porites evermanni	0.90
Porites monticulosa	0.90
Porites lobata	36.60
Porites lutea	49.10

Table 2. Occurrence percentages of *Pedum* in different scleractininan host corals.

Site	N ass	Nd ass	N ped
Site 1	4	3	8
Site 2	14	5	23
Site 3	3	3	4
Site 4	5	2	6
Site 5	1	1	1
Site 6	13	2	35
Site 7	6	3	9
Site 8	0	0	0
Site 9	4	1	10
Site 10	0	0	0
Site 11	10	1	21
Site 12	3	1	4
Site 13	5	4	5
Site 14	4	2	7
Site 15	3	3	3
Site 16	13	2	33
Site 17	12	3	30
Site 18	0	0	0
Site 19	3	2	3
Site 20	0	0	0
Site 21	9	1	10
Total	112	11	212

Table 3. Number of different and total associations and number of *Pedum* according to sampling locations. N ass = number of associations; Nd ass = number of different associations; Nped = number of Pedum specimens.

suborder	family, subfamily	genus	species	reference	locality
Astrocoeniina	Acroporidae	Acropora	*A. robusta*	**new record**	NE Sulawesi
		Montipora	*M. meandrina*	Kleemann (1990)	N Red Sea
			M. stilosa	Kleemann (1990)	N Red Sea
			M. floweri	Kleemann (1990)	N Red Sea
			M. tertia	Kleemann (1990)	N Red Sea
			M. hoffmeisteri	Kleemann (2001)	N Red Sea
			M. monasteriata	Kleemann (2001)	N Red Sea
			M. tuberculosa	Kleemann (2001)	N Red Sea
			M. venosa	Kleemann (2001)	N Red Sea
			M. confusa	**new record**	NE Sulawesi
		Astreopora	*A. myriophthalma*	Kleemann (2001)	Aqaba, Red Sea
Fungiina	Agaricidae	*Coeloseris*	*C. mayeri*	**new record**	NE Sulawesi
		Gardineroseris	*G. planulata*	Kleemann (1990)	N Red Sea
			G. planulata	**new record**	NE Sulawesi
		Pachyseris	*P. speciosa*	Kleemann (1990)	N Red Sea
			P. speciosa	**new record**	NE Sulawesi
		Pavona	*P. maldivensis*	Kleemann (1990)	N Red Sea
			P. cactus	Kleemann (2001)	N Red Sea
			P. varians	Kleemann (2001)	N Red Sea
		Leptoseris	*L. mycetoseroides*	Kleemann (1990)	Torres Strait, GBR
	Siderastreidae	*Coscinarea*	*C. monile*	Kleemann (1990)	N Red Sea
Faviina	Faviidae	*Cyphastrea*	*C. microphthalma*	Kleemann (1990)	N Red Sea
	Montastreinae		*C. microphthalma*	Zuschin & Piller (1997 b)	N Red Sea
		Echinopora	*E. gemmacea*	Kleemann (1990)	N Red Sea
		Leptastrea	*L. purpurea*	Kleemann (2001)	N Red Sea
			L. purpurea	**new record**	NE Sulawesi
	Faviidae,	*Favia*	*F. helianthoides*	Kleemann (2001)	N Red Sea
	Faviinae		*F. stelligera*	Waller (1972)	Eniwetok Atoll
			F. stelligera	Kleemann (1990)	N Red Sea
		Goniastrea	*G. retiformis*	Kleemann (1990)	N Red Sea
			G. edwardsi	Kleemann (2001)	N Red Sea
	Merulinidae	*Hydnophora*	*H. microconos*	Kleemann (2001)	N Red Sea
			H. microconos	**new record**	NE Sulawesi
Poritiina	Poritidae	*Porites*	*P. lutea*	Mastaller (1978)	Port Sudan, Red Sea
			P. lutea	Nielsen (1986); Scoffin and Bradshaw (2000)	Phuket, Thailand
			P. lutea	Kleemann (1990)	N Red Sea
			P. lutea	**new record**	NE Sulawesi
			P. lobata	Kleemann (1990)	Mellish Reef, GBR
			P. lobata	**new record**	NE Sulawesi
			P. evermanni	**new record**	NE Sulawesi
			P. monticulosa	**new record**	NE Sulawesi
		Porites	*P. rus* (*P. convexa*)	Yonge (1967)	Raboul, New Britain
			P. rus	Kleemann (1990)	N Red Sea
			P. rus	Kleemann (1995)	Lizard Island, GBR
Dendrophylliina	Dendrophylliidae	*Turbinaria*	*T. mesenterina*	Kleemann (1990)	N Red Sea

Table 4. Host corals of *Pedum spondyloideum* (Gmelin, 1791), an update of Kleemann (2001).

REFERENCES

DEVANTIER, L.M., & R. ENDEAN, 1988. The scallop *Pedum spondyloideum* mitigates the effects of *Acanthaster planci* predation on the host coral *Porites*: host defence facilitated by exaptation? – Marine Ecology Progress Series 47: 293-301.

KLEEMANN, K., 1990. Coral associations, bio corrosion, and space competition in *Pedum spondyloideum* (Gmelin) (Pectinacea, Bivalvia). – P.S.Z.N.: Marine Ecology 11: 77-94.

KLEEMANN, K., 1995. Associations of coral and drilling bivalves: Lizard Island (Great Barrier Reef, Australia) versus Safaga (N Red Sea). – Beiträge zur Paläontologie 20: 31-39.

KLEEMANN, K., 2001. The pectinid bivalve *Pedum spondyloideum* (Gmelin, 1791): amount of surface and volume occupied in host corals from the Red Sea. – P.S.Z.N.: Marine Ecology 22: 111-133.

MASTALLER, M., 1978. The marine molluscan assemblages of Port Sudan, Red Sea. – Zoologische Mededelingen 53: 117-144.

NIELSEN, C., 1986. Fauna associated with the coral *Porites* from Phuket, Thailand. Part 1: Bivalves with description of a new species of *Gastrochaena*. – Research Bulletin of the Phuket Marine Biological Center 42: 1-24.

SAVAZZI, E., 1999. Constructional morphology of the bivalve *Pedum*. In P.A. JOHNSTON & J.W. HAGGART, eds, Bivalves: an Eon of evolution. Paleontological studies honoring Norman D. Newell: 413-421. Calgary University Press, Alberta, Canada.

SCOFFIN, T.P., & C. BRADSHAW, 2000. The taphonomic significance of endoliths in dead –versus live –coral skeletons. – Palaios 15: 248-254.

VERON, J.E.N., 2000. Corals of the world: 1: i-xii, 1-463; 2: i-viii, 1-429; 3: i-viii, 1-490. Australian Institute of Marine Sciences, Townsville.

VERON, J.E.N., & M. PICHON, 1976. Scleractinia of eastern Australia. Part I. Families Thamnasteridae, Astrocoeniidae, Pocilloporidae. – Australian Institute of Marine Sciences Monograph Series 1: 1-86.

VERON, J.E.N., & M. PICHON, 1980. Scleractinia of eastern Australia. Part III. Families Agaricidae, Siderastreidae, Fungiidae, Oculinidae, Merulinidae, Mussidae, Pectiniidae, Caryophylliidae, Dendrophylliidae. – Australian Institute of Marine Sciences Monograph Series 4: 1-422.

VERON, J.E.N., & M. PICHON, 1982. Scleractinia of eastern Australia. Part IV. Family Poritidae. – Australian Institute of Marine Sciences Monograph Series 5: 1-195.

VERON, J.E.N., M. PICHON, & M. WIJSMAN-BEST, 1977. Scleractinia of eastern Australia. Part II. Families Faviidae, Trachyphylliidae. – Australian Institute of Marine Sciences Monograph Series 3: 1-233.

VERON, J.E.N., & C.C. WALLACE, 1984. Scleractinia of eastern Australia. Part V. Familly Acroporidae. – Australian Institute of Marine Sciences Monograph Series 6: 1-485.

VINE, P., 1986. Red Sea invertebrates: 1-224. London.

WALLACE, C.C., 1999. Staghorn corals of the world: a revision of the coral genus *Acropora* (Scleractinia; Astrocoeeniina; Acroporidae) worlwide, with emphasis on morphology, phylogeny and biogeography: 1-438. CSIRO Publishing, Collingwood.

WALLER, T.R., 1972. The Pectinidae (Mollusca: Bivalvia) of Eniwetok Atoll, Marshall Islands. – Veliger 14: 221-264.

YONGE, C.M., 1967. Observations on *Pedum spondyloideum* (Chemnitz) Gmelin, a scallop associated with reef-building corals. – Proceedings of the Malacological Society of London 37: 311-323.

ZUSCHIN, M., & W.E. PILLER, 1997. Bivalve distribution on coral carpets in the northern Bay of Safaga (Red Sea, Egypt). – Facies 37: 183-194.