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Associations between the Scallop *Pedum spondyloideum* (Bivalvia, Pteriomorphia, Pectinidae) and Hard Corals on the West Coast of Thailand

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Patrick Scaps (2011) Associations between the scallop *Pedum spondyloideum* (Bivalvia, Pteriomorphia, Pectinidae) and hard corals on the west coast of Thailand. *Zoological Studies* **50**(4): 466-474. Associations between the nestling and facultatively boring pectinid *Pedum spondyloideum* and scleractinian host corals are reported for the 1st time from the west coast of Thailand, Andaman Sea, eastern Indian Ocean. *Pedum* individuals used 14 hosts, including the previously unrecorded species of *Cyphastrea serailia*, *Favites abdita*, *Galaxea astreata*, *Montipora caliculata*, and *Pachyseris rugosa*. In addition, this is the 1st time that associations between *Pedum* and the calcareous hydrozoans, *Millepora dichotoma* and *Mil. exaesa*, were observed. http://zoolstud.sinica.edu.tw/Journals/50.4/466.pdf

Key words: *Pedum spondyloideum*, Scleractinian corals, Calcareous hydrozoans, Indian Ocean, Thailand.

Living scleractinian corals provide microhabitats for a large number of parasitic and commensal associates, which use the tissue and skeletons of the colonies as substrata (Frank et al. 1995, Floros et al. 2005). Coral associates are defined as sessile invertebrates that live on or within the coral skeleton (Risk et al. 2001), and apertures of the latter open through the living coral tissue (Scott 1987). Many taxa are involved, including sponges, polychaetes, bivalves, tunicates, and hydroids (reviewed in Scott 1987). Most of these coral associates stress the coral to some degree, and some of them, particularly some sponges, polychaetes, and bivalves, can do considerable harm, at least to the skeleton (Sammarco and Risk 1990, Smith and Harriott 1998, Floros et al. 2005).

The nestling and facultatively boring pectinid bivalve *Pedum spondyloideum* (Gmelin 1791) is an obligate associate of living scleractinian corals in the Indo-Pacific. It attaches byssally 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 and Endean 1988, Kleemann 1990, Savazzi 1999). This coral-bivalve relationship may be mutualistic, with the coral providing the bivalve with support and protection, and the bivalve enhancing water circulation for coral feeding (Scaps and Denis 2007). Furthermore, DeVantier and Endean (1988) showed that *Pedum* clams reduced the effects of heavy levels of predation by the starfish *Acanthaster planci* on their hosts on the Great Barrier Reef by repelling foraging starfish on contact by repeated expulsions of jets of water. On the other hand, *Pedum* clams may cause structural weakness to the host, since their presence, both alive and dead, results in a cavity inside the coral skeleton.

Associations between *Pedum* clams and host corals are relatively well known from the Red

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Sea (Kleemann (1990 2001), western Pacific (Scaps et al. 2005 2008, Scaps and Denis 2007, Scaps 2009), and Great Barrier Reef (Kleemann 1995), but we have no information about these associations in the Indian Ocean. In consequence, the main goals of this field study were to identify associations of *Pedum* individuals and host corals on the Andaman coast of Thailand and compare associations between different areas in the Indo-Pacific.

MATERIALS AND METHODS

The area selected for the field study was the west coast of Thailand, northern Andaman Sea, from the Malaysian to the Myanmar borders (Fig. 1). The area is located in the eastern part of the Indian Ocean.

The expedition took place aboard the *MV Andaman Seafarer*, a 22.5-m, live-aboard dive vessel, operated by Seafarer Divers (Phuket, Thailand). On 5-13 Apr. 2010, the vessel traveled to the Phi Phi and Koh Lanta Is., Hin Daeng, Hin Muang, and the Koh Tarutao and Similan Is. Then on 21-25 Apr., the vessel traveled to the Surin Is. and again to the Similan Is. Observations were carried out in the field by scuba diving, and 31 sites were surveyed for *Pedum*-coral associations. In order to obtain as many associations between *Pedum* clams and hard corals as possible, an effort was made to survey sites within all exposure and reef types. Sites ranged from calcareous underwater cliffs (vertical walls) and caves (the Phi Phi island group) to pinnacles (Hin Daeng, Hin Muang, Richelieu Rock, Hin Paad Mile, Stonehenge, and Jabang Channel) and granite islands (the Similan Is.). On the east coast of the Similan Is., dive sites consisted of fringing reefs with a developed reef crest down to a gently sloping sandy reef base at 30-40 m in depth. On the west coast, dive sites consisted of large granite boulders covered by hard corals. For sampling locations and dates see table 1.

The presence of *Pedum* individuals in hard corals at each dive site was recorded down to or beyond the deepest visible coral by the so-called roving diver technique (Schmitt et al. 2002, Munro 2005). The distribution and population density of *Pedum* clams were 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 *Pedum* individual density was high for either the particular host or the locality. Many corals can be positively identified underwater up to species level, but several are impossible to confirm without seeing skeletal details. In that case, representative samples were collected for a laboratory examination for positive identification. Corals were bathed in bleach for 24-48 h to remove living tissue. They were then rinsed in fresh water, dried, and identified following Veron and Pichon (1976, 1980, 1982), Veron et al. (1977), Veron and Wallace (1984), and Veron (2000). Calcareous hydrozoans of the genus *Millepora* were identified according to Razak and Hoeksema (2003). The presence of corals at the study sites was compared to lists of hard coral species recorded by Ditlev (1975 1978) and Turak et al. (2005).

RESULTS

On Thailand's northernmost Andaman coast, 14 associations of *Pedum* clams with scleractinian host corals were observed in 11 genera (Table 2) belonging to 6 families (1) Acroporidae (*Montipora*); (2) Agariciidae (*Coeloseris*, *Gardineroseris*, *Pachyseris*, and *Pavona*), (3) Faviidae (*Cyphastrea*, *Favia*, and *Favites*); (4) Siderastreidae (*Psammocora*); (5) Oculinidae (*Galaxea*); and (6) Poritidae (*Porites*).

Several of these associations were reported before from other localities in the Indo-Pacific (Table 3). Nevertheless, this is the 1st time that associations with live corals of the genera *Galaxea* and *Favites* were recorded. Moreover, *Montipora caliculata*, *Cyphastrea serailia*, and *Pachyseris rugosa* were also new host records. I observed 2 new associations at site 3 located on the eastern side of Koh Haa I. 3. Two colonies of *Pachyseris rugosa* respectively hosted 1 and 5 *Pedum* individuals (Fig. 2), and 1 colony of *Favites abdita* hosted 2 *Pedum* individuals (Fig. 3). One colony of *Galaxea astreata* from site 8 hosted a single *Pedum* clam (Fig. 4). Two colonies of *Cyphastrea serailia* from site 11 respectively hosted 2 and 4 *Pedum* individuals (Fig. 5), and 2 colonies of *Montastrea caliculata* from site 5 respectively hosted 1 (Fig. 6) and 2 *Pedum* clams. Apart from these new associations, *Pedum* individuals commonly occurred in *Porites lutea* and *Por. lobata*, occasionally in *Por. rus*, *Gardineroseris planulata*, *Coeloseris mayeri* (Fig. 7), and

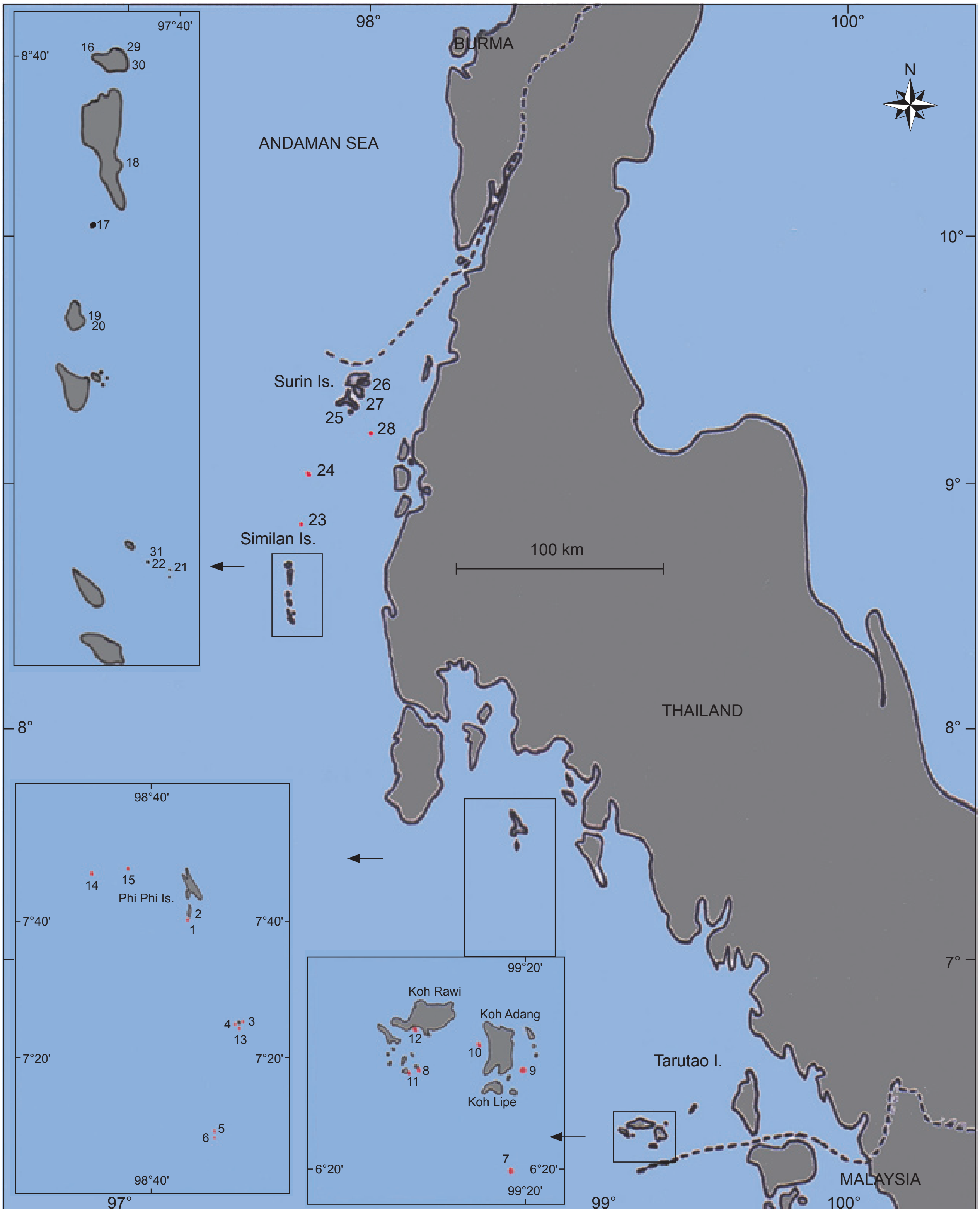


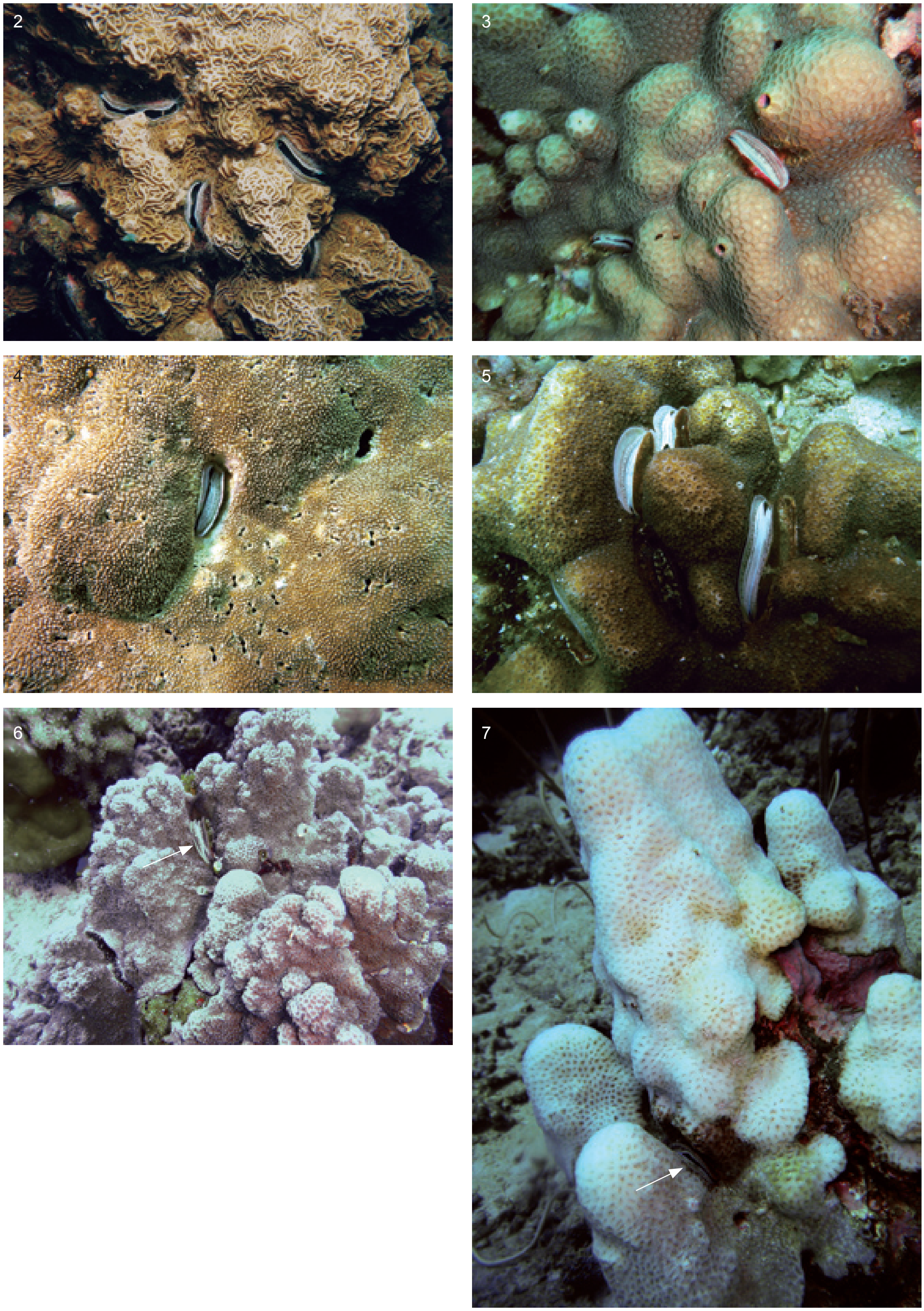
Fig. 1. Map of the northern Andaman Sea of Thailand showing sampling locations. For details see table 1.

Table 1. Sampling locations and dates

Site no.	Date	Site name	Latitude	Longitude
1	5 Apr. 2010	Koh Bida Nok	7°40'49"N	98°45'45"E
2	5 Apr. 2010	Shark Point, Phi Phi Le I.	7°41'01"N	97°46'02"E
3	5 Apr. 2010	Koh Haa (island no. 3)	7°25'49"N	98°53'49"E
4	6 Apr. 2010	Koh Ha Yai (The Cathedral)	7°25'49"N	98°53'39"E
5	6 Apr. 2010	Hin Muang (Purple Rock)	7°09'08"N	98°49'15"E
6	6 Apr. 2010	Hin Daeng (Red Rock)	7°09'01"N	98°49'29"E
7	7 Apr. 2010	Hin Paad Mile	6°19'51"N	99°19'09"E
8	7 Apr. 2010	Koh Palai	6°29'47"N	99°10'47"E
9	7 Apr. 2010	Stonehenge	6°29'05"N	99°20'06"E
10	8 Apr. 2010	Jabang Channel	6°30'54"N	99°16'17"E
11	8 Apr. 2010	Koh Sawang	6°29'31"N	99°10'39"E
12	8 Apr. 2010	Koh Rawi	6°32'29"N	99°09'42"E
13	9 Apr. 2010	Koh Haa (island no. 4)	7°25'45"N	98°53'48"E
14	10 Apr. 2010	Koh Doc Mai	7°47'50"N	98°31'52"E
15	10 Apr. 2010	Hin Musang (Shark Point)	7°47'54"N	98°37'37"E
16	11 Apr. 2010	Koh Bangu (Christmas Point)	8°40'59"N	97°38'37"E
17	11 Apr. 2010	Koh Similan (Elephant Head Rock)	8°37'24"N	97°38'37"E
18	11 Apr. 2010	Koh Similan (Beacon Reef)	8°38'35"N	97°39'11"E
19	12 Apr. 2010	Koh Payu (East of Eddn)	8°35'05"N	97°28'49"E
20	12 Apr. 2010	Koh Payu (Garden of Eden)	8°35'37"N	97°38'05"E
21	13 Apr. 2010	Hin Phae (Boulder City)	8°30'21"N	97°40'33"E
22	13 Apr. 2010	Hin Phae (Castle Rock)	8°30'22"N	97°40'19"E
23	21 Apr. 2010	Koh Bon (Manta Point)	8°40'31"N	97°47'45"E
24	21 Apr. 2010	Koh Tachai (Pinnacle)	9°03'26"N	97°48'53"E
25	22 Apr. 2010	West Rock, South Surin Is.	9°23'18"N	97°49'54"E
26	22 Apr. 2010	Turtle Ledge, South Surin Is.	9°23'10"N	97°52'59"E
27	22 Apr. 2010	Koh Torinla	9°22'08"N	97°52'59"E
28	23 Apr. 2010	Richelieu Rock	9°21'48"N	98°01'14"E
29	24 Apr. 2010	Koh Bangu (North Point)	8°41'00"N	97°38'36"E
30	24 Apr. 2010	Koh Bangu (Breakfast Bend)	8°40'58"N	97°38'59"E
31	25 Apr. 2010	Hin Phae (Shark Fin Reef)	8°30'36"N	97°39'48"E

Table 2. *Pedum spondyloideum* hosts on Thailand's northernmost Andaman coast

Species	Site no.
Scleractinian corals	
Acroporidae (1)	
Montipora caliculata (Dana, 1846)	5
Agariciidae (5)	
Coeloseris mayeri Vaughan, 1918	4, 30
Gardineroseris planulata Scheer and Pillai, 1974	2, 3, 5, 20, 23
Pachyseris rugosa (Lamarck, 1801)	3
Pavona clavus (Dana, 1846)	5, 18, 23, 24
Pavona duerdeni Vaughan, 1907	23
Faviidae (3)	
Cyphastrea serailia (Forskål, 1775)	11
Favia stelligera (Dana, 1846)	2
Favites abdita (Ellis and Solander, 1786)	3
Siderastreidae (1)	
Psammocora digitata Milne Edwards and Haime, 1851	3
Oculinidae (1)	
Galaxea astreata (Lamarck, 1816)	8
Poritidae (3)	
Porites lobata Dana, 1846	all sites
Porites lutea Milne Edwards and Haime, 1851	all sites
Porites rus (Forskål, 1775)	2, 3, 4, 13, 15, 26
Calcareous hydrozoans	
Milleporidae (2)	
Millepora dichotoma Forskål, 1775	27
Millepora exaesa Forskål, 1775	6, 26



Figs. 2-7. **2.** *Pachyseris rugosa* inhabited by *Pedum* clams. **3.** A *Pedum* clam imbedded in *Favites abdita*. **4.** *Pedum spondyloideum* and the boring openings of the bivalves *Lithophaga* spp. on the surface of a colony of *Galaxea astreata*. **5.** *Cyphastrea serailia* inhabited by a *Pedum* clam. **6.** A Pedum clam in *Montipora caliculata* (arrow). **7.** A *Pedum* clam in a completely bleached colony of *Coeloseris mayeri* (arrow).

Pavona clavus, and only once in *Favia stelligera*, *Psammocora digitata*, and *Pav. duerdeni* (Table 2).

I also observed for the 1st time the association between *Pedum* individuals and calcareous hydrozoans of the genus *Millepora*. A single *Pedum* clam was found in *Mil. dichotoma* (Fig. 8) from site 27. Two colonies of *Mil. exaesa* from sites 6 and 26 respectively hosted 1 and 2 *Pedum* individuals (Fig. 9).

Generally only a few *Pedum* individuals were found in scleractinian host corals, but sometimes high densities of individuals were found in massive *Por. lobata* and *Por. lutea*. The highest numbers of *Pedum* clams per colony were 20 and 17 individuals in *Por. lobata* and *Por. lutea*, respectively.

DISCUSSION

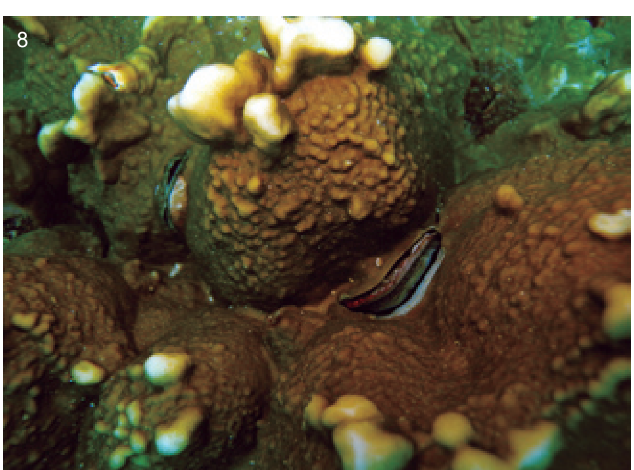
During this survey along the west coast of Thailand, 14 associations between *P. spondyloideum* and its scleractinian host corals were identified, among which 5 associations are new records. So, to date 55 species of scleractinian corals are known to be infested by *P. spondyloideum* in the Red Sea, the west Pacific and eastern Indian ocean (Table 3).

In the northernmost Andaman Sea, *P. spondyloideum* shows a strong preference for massive *Porites* corals (*Por. lobata* and *Por. lutea* and to a lesser degree *Por. rus*) with few records of other hosts. In a previous study on macroinvertebrates associated with *Porites* corals on the west coast of Thailand, Nielsen (1986) also reported that *Pedum* clams were associated with *Por. lutea*. Previous reports from other localities in the western Pacific indicated that *Pedum* clams are mostly restricted to massive *Porites* (Table 3). At Mellish Reef on the Great Barrier Reef, *Pedum* clams were associated with *Por. lobata* (Kleemann 1990, re Veron 1986 pp. 220-221), whereas at Lizard I., they were only found in *Por. rus* (Kleemann 1995). In the northern Red Sea, *Pedum* clams were found associated with *Por. lutea* but not with *Por. lobata*, although this species was present (Kleemann 1990 2001).

On the west coast of Thailand, *Pedum* clams are associated with only 1 species of *Montipora* (*Mon. caliculata*), whereas it is associated more frequently with encrusting to semi-massive and even branching *Montipora* species in the Red Sea (9 species) and the western Pacific (17 species) (Table 3). Most of the host species of *Pedum* individuals have a wide Indo-Pacific distribution.

During this study, I observed high population densities within single coral heads in *Porites*. The same observations were made from Raboul New Britain (Yonge 1967) and from the Red Sea (Vine 1986, Kleemann 1990 2001, Zuschin and Piller 1997). On the other hand, high population densities are rare in the West Pacific (Scaps et al. 2005 2007). On the Great Barrier Reef, low densities in *Porites* were also noted, the highest values being 10 individuals (ind.)/0.46-m coral diameter and 24 ind./1.06 m across (DeVantier and Endean 1988). From the Philippines, Savazzi (1999) reported even lower densities, rarely more than 2 or 3 *Pedum* clams per 1-m diameter of *Porites*.

So, there appears to be a disparity between the different coral species colonized relative to



Figs. 8-9. 8. *Millepora exaesa* inhabited by a *Pedum* clam. **9.** A *Pedum* clam in *Millepora dichotoma* (arrow).

Table 3. Scleractinian coral species colonized by *Pedum* in the Red Sea (Kleemann 1990 2001), West Pacific Ocean (Scaps et al. 2005 2008, Scaps and Denis 2007, Scaps 2009), and the East Indian Ocean (this study)

	Red Sea	West Pacific	Eastern Indian Ocean
Acroporidae (23)			
Acropora robusta (Dana, 1846)	-	+	-
Astreopora myriophthalma (Lamarck, 1816)	+	-	-
Montipora aequituberculata Bernard, 1897	-	+	-
Montipora caliculata (Dana, 1846)	abs	+[b]	+
Montipora capricornis Veron, 1985	abs	+	-
Montipora confusa Nemenzo, 1967	abs	+	abs
Montipora crassituberculata Bernard, 1897	abs	+	-
Montipora danae (Milne-Edwards and Haime, 1851)	-	+	-
Montipora digitata (Dana, 1846)	-	+	-
Montipora efflorescens Bernard, 1897	-	+	-
Montipora floweri Wells, 1954	+	-	-
Montipora hoffmeisteri Wells, 1954	+	-	-
Montipora hispida (Dana, 1846)	abs	+	-
Montipora informis Bernard, 1897	+[c]	+	-
Montipora mactanensis Nemenzo, 1979	abs	+	abs
Montipora meandrina (Ehrenberg, 1834)	+	abs	abs
Montipora monasteriata (Forskål, 1775)	-	+	-
Montipora stilosa (Ehrenberg, 1834)	+	abs	abs
Montipora spongodes Bernard, 1897	abs	+	-
Montipora tertia[a]	+	abs	abs
Montipora tuberculosa (Lamarck, 1816)	+	-	-
Montipora turgescens Bernard, 1897	-	+	-
Montipora undata Bernard, 1897	abs	+	-
Montipora venosa (Ehrenberg, 1834)	+	+	-
Agaricidae (9)			
Coeloseris mayeri Vaughan, 1918	abs	+	+
Gardineroseris planulata Scheer and Pillai, 1974	+	+	+
Pachyseris rugosa (Lamarck, 1801)	-	-	+
Pachyseris speciosa (Dana, 1846)	+	+	-
Pavona cactus (Forskål, 1775)	+	-	-
Pavona clavus (Dana, 1846)	-	+	+
Pavona duerdeni Vaughan, 1907	-	+	+
Pavona maldivensis (Gardiner, 1905)	+	+	-
Pavona varians Verrill, 1864	+	-	-
Siderastreidae (2)			
Coscinarea monile (Forskål, 1775)	+	-	-
Psammocora digitata Milne Edwards and Haime, 1851	abs	+	+
Faviidae (9)			
Cyphastrea microphthalma (Lamarck, 1816)	+	+	-
Cyphastrea serailia (Forskål, 1775)	-	-	+
Echinopora gemmacea Lamarck, 1816	+	-	-
Favia helianthoides Wells, 1954	+	-	-
Favia stelligera (Dana, 1846)	+	+	+
Favites abdita (Ellis and Solander, 1786)	-	-	+
Goniastrea retiformis (Lamarck, 1816)	+	-	-
Goniastrea edwardsi Chevalier, 1971	+	-	-
Leptastrea purpurea (Dana, 1846)	+	+	-
Merulinidae (1)			
Hydnophora microconos (Lamarck, 1816)	+	+	-
Oculinidae (1)			
Galaxea astreata (Lamarck, 1816)	-	-	+
Poritidae (7)			
Porites annae Crossland, 1952	abs	+	-
Porites evermanni Vaughan, 1907	abs	+	-
Porites lichen Dana, 1846	-	+	abs
Porites lobata Dana, 1846	-	+	+
Porites lutea Milne Edwards and Haime, 1851	+	+	+
Porites monticulosa Dana, 1846	-	+	-
Porites rus (Forskål, 1775)	+	+	+
Dendrophylliidae (3)			
Turbinaria irregularis Bernard, 1896	-	+	abs
Turbinaria mesenterina (Lamarck, 1816)	+	-	-
Turbinaria stellulata (Lamarck, 1816)	-	+	-
Total (55)	25	36	14

+, association present; -, association not seen; abs, coral species absent. [a]Non-valid species. [b]Association not observed by Scaps et al. (2005 2008), Scaps and Denis (2007), or Scaps (2009) but illustrated by Veron (2000) from Flores, Indonesia (Fig. 1, p. 128). [c]Association not observed by Kleemann (1990 1991) but illustrated by Veron (2000) from the Sinai Peninsula, Egypt (Fig 3, p. 113).

geographic location. Nevertheless, the most frequently colonized corals have a massive form and occur in prominent positions. Massive forms are the most porous corals (Hughes 1987), and they often experience a lower rate of mortality than foliaceous and branching forms during natural disturbances (Rowley 2008) and usually have a longer life span. A colony of frequently colonized host coral, *Por. lutea*, was estimated to be over 500 yr old (Dai and Yang 1995); thus *Pedum* clams inhabiting such corals might have higher fitness. Moreover, *Pedum* clams favor corals with small corallites such as *Montipora* and *Porites*, and species such as *Por. lutea* and *Por. lobata* are extremely robust in terms of colony morphology. Such species have a high coenosteum-to-corallite ratio, which may facilitate infestation by providing a sufficient surface area. Similarly, the majority of coral species with small corallite sizes are significantly inhabited by serpulid worms of the *Spirobranchus giganteus* complex (Rowley 2008). Coral species frequently colonized by *Pedum* individuals such as *Pavona clavus* and species of *Porites*, *Montipora*, and *Cyphastrea* are competitively subordinate in terms of aggression (Sheppard 1979, Dai 1990). These facts indicate that planktonic larvae of *P. spondyloideum* may be susceptible to nematocysts of aggressive corals. Dai and Yang (1995) also found that coral species in Taiwan frequently colonized by serpulid worms of the *Spirobranchus giganteus* complex are competitively subordinate in terms of aggression, and that very few species with high aggressiveness such as *Mycedium elephantotus*, *Merulina ampliata*, and *Galaxea astreata* are successfully colonized by the worms. Nevertheless, in the northern Andaman Sea (this study), the aggressive coral *Gal. astreata* and calcareous hydrozoans of the genus *Millepora* were inhabited by *Pedum* individuals. These types of association were not observed by the author in the western Pacific (Scaps et al. 2005 2008, Scaps and Denis 2007, Scaps 2009) or by Kleemann in the Red Sea (Kleemann 1990 1991) or Great Barrier Reef (Kleemann 1995), although *Gal. astreata* is present in these areas, and calcareous hydrozoans of the genus *Millepora* occur throughout tropical seas as a regular component of coral reefs (Lewis 1989). According to Lewis (1989), a number of parasites and predators of scleractinian hermatypic corals also attack millepores. *Galaxea astreata* and hydrozoans are highly aggressive (Dai 1990); so, it is possible that *P. spondyloideum* occurring in the Andaman Sea is more immune to nematocyst discharge, as it is the only area where it was observed to inhabit these hard corals.

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REFERENCES

Dai CF. 1990. Interspecific competition in Taiwanese corals with special reference to interactions between alcyonaceans and scleractinians. Mar. Ecol. Progr. Ser. **60:** 291-297.

Dai CF, HP Yang. 1995. Distribution of *Spirobranchus giganteus corniculatus* (Hove) on the coral reefs of southern Taiwan. Zool. Stud. **34:** 117-125.

DeVantier LM, R Endean. 1988. The scallop *Pedum spondyloideum* mitigates the effects of *Acanthaster planci* predation on the host coral *Porites*: host defence facilitated by exaptation. Mar. Ecol. Progr. Ser. **47:** 293-301.

Ditlev H. 1975. Stony corals (Coelenterata: Scleractinia) from the west coast of Thailand. Phuket Mar. Biol. Center Res. Bull. **13:** 1-14.

Ditlev H. 1978. Zonation of corals (Scleractinia: Coelenterate) on intertidal reef flats at Ko Phuket, eastern Indian Ocean. Mar. Biol. **47:** 29-39.

Floros CD, MJ Samways, B Armstrong. 2005. Polychaete (*Spirobranchus giganteus*) loading on South African corals. Aquat. Conserv.: Mar. Freshw. Ecosyst. **15:** 289-298.

Frank U, I Brickner, B Rinkevich, Y Loya, RPM Bak, Y Achituv, M Ilan. 1995. Allogenic and xenogenic interactions in reef-building corals may induce tissue growth without calcification. Mar. Ecol. Progr. Ser. **124:** 181-188.

Hughes TP. 1987. Skeletal density and growth form of corals. Mar. Ecol. Progr. Ser. **35:** 259-266.

Kleemann K. 1990. Coral associations, bio corrosion, and space competition in *Pedum spondyloideum* (Gmelin) (Pectinacea, Bivalvia). PSZN: Mar. Ecol. **11:** 77-94.

Kleemann K. 1995. Associations of coral and drilling bivalves: Lizard Island (Great Barrier Reef, Australia) versus Safaga (N Red Sea). Beit. Paläontol. **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. PSZN: Mar. Ecol. **22:** 111-133.

Lewis JB. 1989. The ecology of *Millepora*. Coral Reefs **8:** 99-107.

Munro C. 2005. Diving systems. *In* A Eleftheriou, A. McIntyre, eds. Methods for the study of marine benthos. Oxford, UK: Blackwell Science, pp. 112-159.

Nielsen C. 1986. Fauna associated with the coral *Porites* from Phuket, Thailand. Part 1: Bivalves with description of a new species of *Gastrochaena*. Phuket Mar. Biol. Center

Res. Bull. **42:** 1-24.

Razak TB, BW Hoeksema. 2003. The hydrocoral genus *Millepora* (Hydrozoa: Capitata: Milleporidae) in Indonesia. Zool. Verh. **345:** 313-336.

Risk MJ, JM Heikoop, EN Edinger, MV Erdmann. 2001. The assessment 'toolbox': community-based reef evaluation methods coupled with geochemical techniques to identify sources of stress. Bull. Mar. Sci. **69:** 443-458.

Rowley S. 2008. A critical evaluation of the symbiotic association between tropical-dwelling polychaetes and their hermatypic coral hosts, with a focus on *Spirobranchus giganteus* (Pallas, 1766). Plymouth Stud. Sci. **1:** 335-353.

Sammarco PW, MJ Risk. 1990. Large-scale patterns in the internal bioerosion of *Porites*: cross continental shelf trends in the Great Barrier Reef. Mar. Ecol. Progr. Ser. **59:** 145-156.

Savazzi E. 1999. Constructional morphology of the bivalve *Pedum*. *In* PA Johnston, JW Haggart, eds. Bivalves: an eon of evolution. Paleontological studies honoring Norman D. Newell. Alberta, Canada: Calgary Univ. Press, pp. 413-421.

Scaps P. 2009. New associations between the scallop *Pedum spondyloideum* (Bivalvia, Pteriomorphia: Pectiniidae) and scleractinian corals from the northeastern coast of Borneo (Malaysia). Zool. Stud. **48:** 492.

Scaps P, V Denis. 2007. Associations between the scallop *Pedum spondyloideum* (Bivalvia, Pteriomorphia: Pectiniidae) and scleractinian corals from the Wakatobi Marine National Park (southeastern Sulawesi, Indonesia). Raffles Bull. Zool. **55:** 1-10.

Scaps P, V Denis, S Berhimpon. 2008. Comparison of the associations between the pectinid bivalve *Pedum spondyloideum* (Bivalvia, Pteriomorphia: Pectiniidae) and scleractinian hermatypic corals in the Red Sea and the West Pacific Ocean. Bull. Soc. Zool. Fr. **133:** 39-50.

Scaps P, V Denis, S Berhimpon, F Kaligis. 2005. Coral associations and space competitors of *Pedum spondyloideum* (Gmelin, 1791) (Bivalvia, Pteriomorphia: Pectiniidae) from the northeast coast of Sulawesi. Basteria **69:** 157-166.

Schmitt EF, RD Sluka, KM Sullivan-Sealey. 2002. Evaluating the use of roving diver and transect surveys to assess the coral reef fish assemblage of southeastern Hispaniola. Coral Reefs **21:** 216-223.

Scott PJB. 1987. Associations between coral and macro-faunal invertebrates in Jamaica, with a list of Caribbean and Atlantic coral associates. Bull. Mar. Sci. **40:** 271-286.

Sheppard CRC. 1979. Interspecific aggression between reef corals with reference to their distribution. Mar. Ecol. Progr. Ser. **1:** 237-247.

Smith SDA, VJ Harriott. 1998. Tube-building polychaete worms smother corals in the Solitary Island Marine Park, northern NSW, Australia. Coral Reefs **17:** 342pp.

Turak E, JEN Veron, K Sanpanich. 2005. Post-tsunami coral reef surveys of Thailand's north Andaman coast: coral reef status after 26 December 2004 tsunami. *In* GR Allen, GS Stone, eds. Rapid assessment survey of tsunami affected reefs of Thailand. Boston, MA: New England Aquarium, pp. 16-30, 79-92.

Veron JEN. 1986. Corals of Australia and the Indo-Pacific. North Ride, NSW, Australia and London, UK: Angus & Roberstson Publishers.

Veron JEN. 2000. Corals of the world. Townsville, Australia: Australian Institute of Marine Sciences.

Veron JEN, M Pichon. 1976. Scleractinia of eastern Australia. Part I. Families Thamnasteridae, Astrocoeniidae, Pocilloporidae. Aust. Inst. Mar. Sci. Monogr. Ser. **1:** 1-86.

Veron JEN, M Pichon. 1980. Scleractinia of eastern Australia. Part III. Families Agaricidae, Siderastreidae, Fungiidae, Oculinidae, Merulinidae, Mussidae, Pectiniidae, Caryophylliidae, Dendrophylliidae. Aust. Inst. Mar. Sci. Monogr. Ser. **4:** 1-422.

Veron JEN, M Pichon. 1982. Scleractinia of eastern Australia. Part IV. Family Poritidae. Aust. Inst. Mar. Sci. Monogr. Ser. **5:** 1-195.

Veron JEN, M Pichon, M Wijsman-Best. 1977. Scleractinia of eastern Australia. Part II. Families Faviidae, Trachyphylliidae. Aust. Inst. Mar. Sci. Monogr. Ser. **3:** 1-233.

Veron JEN, CC Wallace. 1984. Scleractinia of eastern Australia. Part V. Family Acroporidae. Aust. Inst. Mar. Sci. Monogr. Ser. **6:** 1-485.

Vine P. 1986. Red Sea invertebrates. London: Immel.

Waller TR. 1972. The Pectinidae (Mollusca: Bivalvia) of Eniwetok Atoll, Marshall Islands. Veliger **14:** 221-264.

Yonge CM. 1967. Observations on *Pedum spondyloideum* (Chemnitz) Gmelin, a scallop associated with reef-building corals. Proc. Malacol. Soc. Lond. **37:** 311-323.

Zuschin M, WE Piller. 1997. Bivalve distribution on coral carpets in the northern Bay of Safaga (Red Sea, Egypt). Facies. **37:** 183-194.