FIVE CARIDEAN SHRIMPS ASSOCIATED WITH SEA ANEMONES IN CENTRAL JAPAN[1,2)]

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With Text-figures 1–5 and Plates I-II

The senior author has been studying the littoral fauna of Uchiura coast, the inner part of Suruga Bay (35°02′N, 138°53′E), and for the last three years has examined the relationship between sea anemones and caridean shrimps chiefly based upon observations by personal SCUBA diving, as well as upon the laboratory rearing at the Marine Science Museum, Tokai University (Fig. 1). The junior author collected crustacean decapods at Kushimoto, southernmost point of the Kii Peninsula (33°28′N, 135°44′E), from 1970 to 1973 and has collected many decapods from various invertebrate hosts. Both authors pooled their data on the shrimps associated with sea anemones. The following five shrimps proved to be associated with sea anemones in both localities.

Family Hippolytidae
- *Thor amboinensis* (De Man)

Family Palaemonidae
- *Hamopontonia corallicola* Bruce
- *Periclimenes brevicarpalis* (Schenkel)
- *Periclimenes holthuisi* Bruce
- *Periclimenes ornatus* Bruce

The present paper contains brief taxonomic notes on these shrimps and ecological notes on the symbiotic relationships between the shrimps and their host anemones. The shrimps reach the northernmost point of their distributions and two of them, *H. corallicola* and *P. ornatus,* are new to the Japanese fauna. The former is a new symbiont with sea anemones. The precise relationships between the shrimps and sea anemones vary in different species. *H. corallicola, P. brevicarpalis* and *P. ornatus* depend obligately upon sea anemones and associate with their hosts for shelter and a

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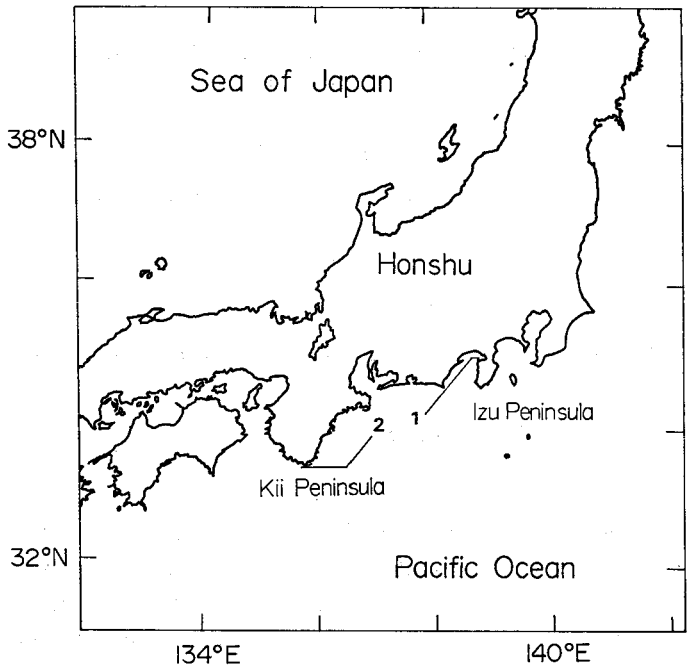


Fig. 1. Map showing the stations where the observations were made.
1, Uchiura coast (Suruga Bay); 2, Kushimoto.

part of their food. Their relationships are considered to be parasitic rather than commensal. *T. amboinensis* does not have a close relationship with sea anemones and can be reared for long time in isolation. *P. holthuisi* needs sea anemones or anemone-like corals but is thought to have a rather loose relationship with its respective hosts.

H. corallicola and *P. ornatus* probably pass through their whole life in central Japan and the other three species may be carried from southern waters by the Kuroshio Current.

Materials and Methods

Field observations of sea anemones and the associated shrimps have carried out at Suruga Bay on the Uchiura coast, during eight months from May 1974 to January 1975 by the senior author and his colleagues. Before and after this period they researched many times in the coast and confirmed the presence of the shrimp-anemone associations. Based upon the preliminary research prior to May 1974, two stations were established. One of them was located near the town of Kuryo, inner side of the so-called "Uchiura Bay". Two rope lines 100 m long were set parallel to each other from the tidal line at intervals of 2 m. Along either side of these two rope-lines, associated shrimps were examined twice or more in each month, and some of them were collected for laboratory research. On the other hand another station of about 100 m^2 was selected near the entrance of "Uchiura Bay", which was a center of a luxuriant

growth of sea anemones. In the latter station the shrimps were usually counted and a great number of specimens were collected and preserved on 12th November 1974. An area between these two stations was several times researched and the shrimps collected from there were used for laboratory rearing and for taxonomical studies. Field or laboratory observations on these shrimps were also made at Kushimoto, where the shrimps were collected occasionally and some of them were also preserved for taxonomical studies and the remaining ones were reared in an aquarium of the Kushimoto Marine Park.

Underwater observations were recorded on a plastic notebook and they were partly supplemented by underwater photographs. The shrimps were examined alive by binocular microscope and were photographed in natural colour. After fixation in 10 % formalin, they were measured and examined in detail.

Systematics of associated shrimps

Thor amboinensis (De Man)

(Figs. 1a and 2a)

Japanese name: Isoginchaku moebi (Hirata et al, 1973)

Hippolyte amboinensis De Man, 1888, p. 535.
Thor amboinensis Holthuis, 1947, pp. 14, 50 (synonymy); Chace, 1972, p. 130, figs. 55, 56; Hirata, Nakasone, Shokita, 1973, p. 57, with colour fig.; Bruce, 1975, p. 27, fig. 14 (colour); Miyake, 1975, two colour figs. on pp. 20 and 102.

Remarks: This hippolytid shrimp is readily distinguished from the other four palaemonids by the short rostrum, not reaching end of eye, slender second pereiopod with carpus subdivided into six joints and the unique colour pattern, "a dark olive brown body with numerous large round white opalescent patches" (Bruce, 1975).

Size: The specimens (1 ♂, 2♀♀) are examined. The male is 1.5 mm and two females are 1.9 and 2.5 mm in postorbital carapace length.

Distribution: It shows the circumtropical distribution (Chace, 1972). In Japan: Ishigaki-jima Island (Miyake and Hayashi, 1966); Okinawa (Hirata et al, 1973), Yoronto Island, Amami Islands (Hayashi, private observation), Izu Peninsula and southern part of Kii Peninsula (Miyake, 1975).

Hamopontonia corallicola Bruce

(Figs. 1b and 2b, Pl. 1)

New Japanese name: Hime isoginchakuebi

Hamopontonia corallicola Bruce, 1970, p. 41, figs. 1–4.

Remarks: The genus *Hamopontonia* is characterized by a forked telson and contains a single species, *H. corallicola*. The forked telson is a unique character, not only in

the subfamily Pontoniinae of Palaemonidae, but also in the section Caridea.

The present specimens examined (2 ♂♂, 2 ovig. ♀♀, 2 ♀♀) agree well with the original description of this species, except for a lack of the outer spine of the first antennular peduncle in two specimens and for three or four pairs of dorsal spines on the telson in all specimens. *H. corallicola* is distinguished from the following three species of *Periclimenes* by the absence of the hepatic spine and of teeth on the lower margin of the rostrum as well as the forked telson.

The colouration of ovigerous females is well described by Bruce (1970). In males the body is largely transparent with a large, transverse white patch on the gastric region. The abdomen is largely transparent. The pereiopods are similar to those of females.

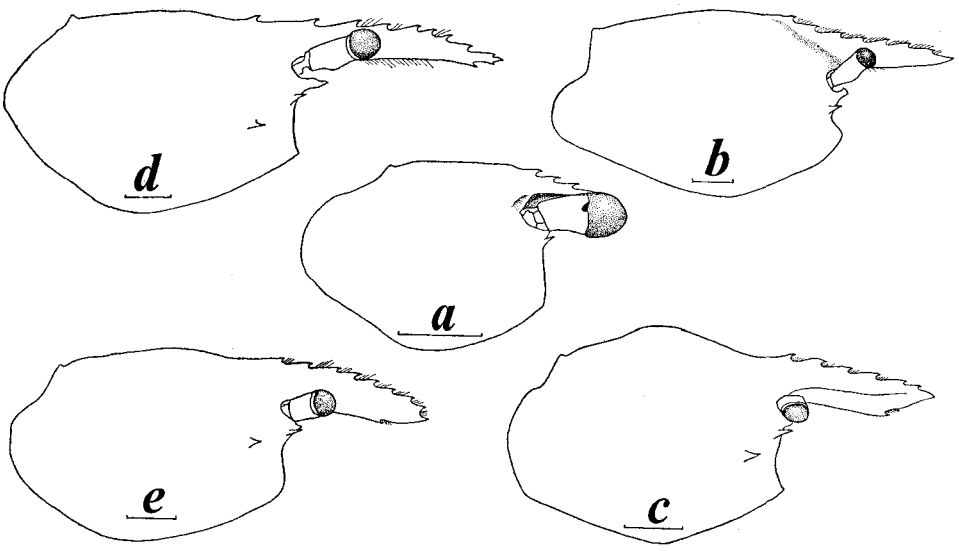


Fig. 2. Carapace of five shrimps associated with sea anemones; *a*, female of *Thor amboinensis* (De Man), *b*, ovigerous female of *Hamopontonia corallicola* Bruce, *c*, female of *Periclimenes brevicarpalis* (Schenkel), *d*, female of *Periclimenes holthuisi* Bruce, *e*, ovigerous female of *Periclimenes ornatus* Bruce. Scale for *a*, *b*, *e* represent 1.0 mm and those for *c*, *d* represent 1.5 mm.

Size: The ovigerous females vary from 4.2 to 5.1 mm and the largest male is 3.0 mm in carapace length.

Distribution: The species has been recorded only from the type locality, Hong Kong (Bruce, 1970).

Periclimenes brevicarpalis (Schenkel)

(Figs. 1c and 2c, Pl. 2 fig. 1)

Japanese name: Isoginchaku ebi (Hirata et al, 1973)

Ancylocaris brevicarpalis Schenkel, 1902, p. 563, pl. 13 fig. 21.
Preiclimenes (*Ancylocaris*) *brevicarpalis* Kubo, 1940, p. 46, figs. 13, 14.

Periclimenes (*Harpilius*) *brevicarpalis* Holthuis, 1952, pp. 10, 69, fig. 27 (synonymy); Suzuki, Kobayashi, Abe and Fukuda, 1972, p. 9.
Periclimenes brevicarpalis Hirata, Nakasone, Shokita, 1973, p. 56 with colour fig.

Remarks: This species is the most famous symbiont with sea anemones and characterized by the simple dactyli of the last three pereiopods, two pairs of dorsal spines placed near distal part of the telson and the gastric region largely swollen in the ovigerous females. The colour pattern is well described by Kemp (1922) and beautifully photographed by Hirata et al (1973). It is diagnostic that "in the latter half of the telson of each uropod there was a brilliant eyespot" (Kemp, 1922).

Size: Five specimens examined (4 ovig. ♀♀, 1 ♀); the ovigerous females vary from 5.2 to 7.0 mm in carapace length.

Distribution: This species has been recorded throughout the Indo-West Pacific region (Miyake and Fujino, 1968). In Japan: Ishigaki-jima Island (Kubo, 1940); Okinawa (Hirata et al, 1973); Izu Peninsula (Suzuki et al, 1972).

Periclimenes holthuisi Bruce

(Figs. 1d and 2d)

Japanese name: Akahoshi kakureebi (Miyake, 1975)

Periclimenes (*Periclimenes*) *aesopius* Holthuis, 1952, pp. 8, 34, figs. 5, 6 (not *Anchistus aesopia* Bate).
Periclimenes holthuisi Bruce, 1969, p. 258; Monod, 1969, p. 216, figs. 69–73; Bruce, 1972, p. 300; Miyake, 1975, colour fig. on p. 103.

Remarks: This species is characterized by the humped third abdominal somite, the elongated suborbital angle and the bifurcated dactyli of the last three pereiopods. The colour pattern is described by Bruce (1969 and 1972) and Monod (1969), and photographed in colour by Miyake (1975).

Size: Six specimens examined (3 ♂♂, 3 ♀♀) vary from 2.7 to 7.0 mm in carapace length.

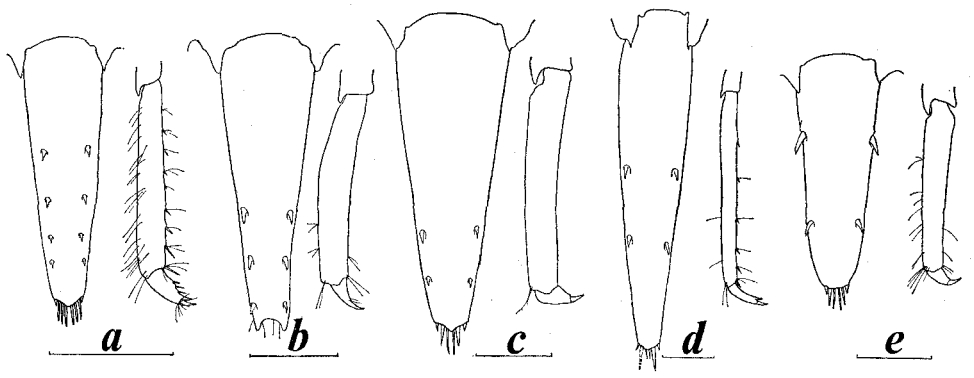


Fig. 3. Telson and two distal segments of the third pereiopod of the same individuals shown in the Fig. 1; *a*, *Thor amboinensis* (De Man), *b*, *Hamopontonia corallicola* Bruce, *c*, *Periclimenes brevicarpalis* (Schenkel), *d*, *Periclimenes holthuisi* Bruce, *e*, *Periclimenes ornatus* Bruce. Scales represent 1.0 mm.

Distribution: Maldive, Ceylon, Moluccas, Hong Kong, South China Sea, Japan, New Caledonia, Queensland (Bruce, 1969), Zanzibar harbour (Bruce, 1972). In Japan: Ishigaki-jima Island (Fukuda, private observation), Amakusa Islands, Nagasaki and Miura Peninsula (Miyake, 1975).

Periclimenes ornatus Bruce

(Figs. 1e and 2e, Pl. 2 fig. 2)

New Japanese name: Kazari isoginchakuebi

Periclimenes ornatus Bruce, 1969, p. 266.

Remarks: This species is related to *P. brevicarpalis* and *P. inornatus,* both of which were collected from sea anemones, in having the simple dactyli of the last three pereiopods. *P. ornatus* is distinguished from *P. brevicarpalis* by the dorsal spines on the telson situated equidistantly and from *P. inornatus* by the longer fingers of the second pereiopod and the colour pattern as mentioned by Bruce (1969 and personal communication).

The animal is entirely transparent, with two red, narrow longitudinal and one white longitudinal lines on either side of the body. Appendages including uropods are dotted by purple and white spots. The colour pattern does not show apparent sexual differences.

Size: Nine specimens examined (4 ♂♂, 1 ovig. ♀, 3 ♀♀, 1 sp.) are 2.8–5.2 mm in carapace length.

Distribution: The species is reported only from Hong Kong (Bruce, 1969).

Relationship between shrimps and sea anemones

Host sea anemones: According to Dr. Uchida, the following four sea anemones, from which the associated shrimps were collected, are observed on the Uchiura coast, *Parasicyonis actinostroides* (Wassilieff), *P. maxima* (Wassilieff), *Radianthus maculata* (Klunzinger) and *Dofleinia armata* (Wassilieff). Six large sea anemones have been found in the seas near Kushimoto (Uchida et al, 1975) and three of them, the two species of *Parasicyonis* and *Stoichactis haddoni* (Saville-Kent), are observed to be the natural hosts of the shrimps.

Except for *Dofleinia armata,* the other four sea anemones fix their pedal disk on rocks or dead corals at the depths varying from 1.5 to 20 m. *Dofleinia armata,* on the other hand, is embedded in muddy sand bottom at the depths of 20–40 m. On the Uchiura coast, *Parasicyonis actinostroides* is the most dominant species and the two species of *Parasicyonis* are codominant in Kushimoto area, too. *P. actinostroides* occurs in more shallow waters than does *P. maxima.*

Occurrence of shrimps: The occurrence of the associated shrimps on the Uchiura coast from May 1974 to January 1975 is shown in the Fig. 4. *H. corallicola* is first

observed in association with *Parasicyonis actinostroides* in early May. Subsequently *P. holthuisi* appears in late May. *P. brevicarpalis* is first discovered on *P. actinostroides* in early July, and *T. amboinensis* and *P. ornatus* are first found on the same anemone in early August. In 1976 *P. ornatus* already appears in April and May.

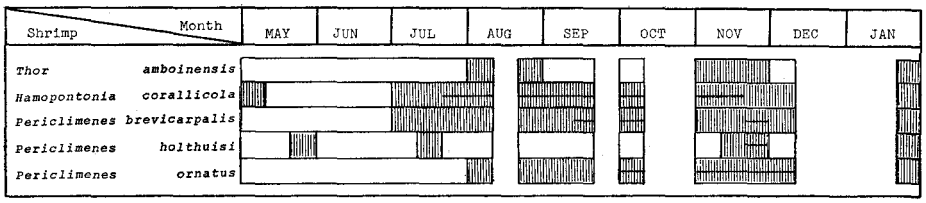


Fig. 4. Occurrence of five shrimps associated with sea anemones in Suruga Bay during May 1974-January 1975. The period stadied is encircled by thin line. The shaded area is the period, in which some specimens were obtained or observed. The bar shows the presence of the ovigerous female.

During the research period from May 1974 to January 1975, the ovigerous females appear continuously from late July to middle November in *H. corallicola* and from early October to early December in *P. ornatus,* whenever the research is carried out. The ovigerous females of *P. brevicarpalis* appear in middle September, early October and middle November. *P. holthuisi* is rare and its ovigerous female is observed in late November only and those of *T. amboinensis* are not found in this area. After this period, the ovigerous females of *H. corallicola* are found in late June and late January, and those of *P. ornatus* are also collected in late June and late October. There is no additional data on the ovigerous seasons of *T. amboinensis* and *P. holthuisi.*

The specimens observed in Sation 2 on 12th November 1974 were all captured in order to examine the species composition of the associated shrimps. The host anemones occured in this station are composed of a single species, *Parasicyonis actinostroides* and counted 1404 in total in 100 m^2 researching area. The species composition of the captured shrimps is shown in the Table 1. The pontoniine shrimp, *P. ornatus,* forms more than three-quarters of the total catch, and *P. holthuisi* was not collected at all.

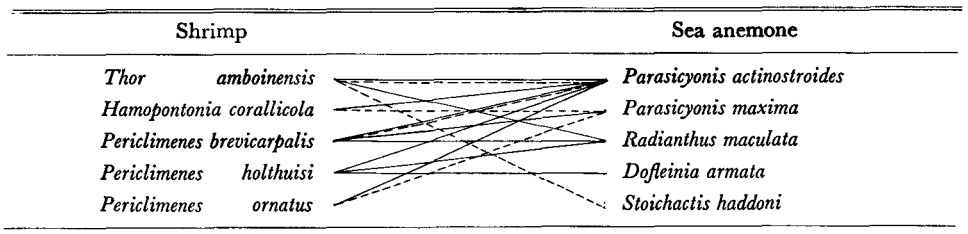
Table 1. The species composition of the shrimps associated with sea anemones obtained from station 2 on the Uchiura coast, Suruga Bay

Species	No. of individuals	Percentage (%)
Thor amboinensis	9	10.2
Hamopontonia corallicola	4	4.5
Periclimenes brevicarpalis	8	9.1
Periclimenes holthuisi	0	0
Periclimenes ornatus	67	76.2
Total	88	100.0

Partnership between shrimps and sea anemones: The partnership between the shrimps and the sea anemones observed in Uchiura coast and seas near Kushimoto is shown in the Table 2.

A host sea anemone houses usually only one specimen in the case of *P. holthuisi*. Two specimens are mostly collected from a single host in *H. corallicola* and two or more specimens are observed in *P. brevicarpalis, P. ornatus* and *T. amboinensis*. If two specimens are collected from a single host, usually they are a male-female pair in *H. corallicola* and *P. brevicarpalis*. The latter species is sometimes collected together with either the former species or *P. ornatus* on an individual of *Parasicyonis actinostroides* and in another case *H. corallicola* and *P. ornatus* are observed together with each other on one host.

Table 2. The partnerships between the shrimps and the sea anemones under natural conditions on the Uchiura coast (solid line) and at Kushimoto (dotted line)



Laboratory rearing: The laboratory rearing of the shrimps and the sea anemones reveals some facts concerning the interspecific relationships between them. At the Tokai University *P. holthuisi* recently separated from *Dofleinia armata* in the sea and *P. ornatus* from *Parasicyonis actinostroides* are both eaten by *D. armata,* which has been reared in a small aquarium for long period, as soon as the shrimps just touch a tentacle of the anemone. On the other hand, *P. holthuisi* just obtained from *D. armata* is not seized by the tentacles of similarly reared *Parasicyonis maxima,* while *P. brevicarpalis* from *Parasicyonis actinostroides* immediately land on oral disk of another individual of that species that has been rearing for long term. An isolated *Parasicyonis actinostroides* is capable to simultaneously accommodate the four species of the shrimps, *H. corallicola, P. brevicarpalis, P. ornatus* and *T. amboinensis,* which are successively added to the aquarium. These four shrimps live separately on oral disk or trunk of this anemone and were seen not to attack to one another during observations.

In Kushimoto a single specimen of *P. holthuisi,* whose host was uncertain under natural condition, can live in the following four different sea anemones, *Stoichactis haddoni, Cryptodendrum adhesivum, Heterodactyla hemprichii* and *Megalactis griffithsi,* which were occasionally collected from the coast of Kushimoto and reared together with the shrimp in the same aquarium. *Stoichactis haddoni* seems to be the most suitable host for this shrimp, because it is usually found in association with this anemone. *P. ornatus,* which was collected from either of the two species of *Parasicyonis* under seas, is immediately able to establish the partnership with *Cryptodendrum adhesivum* reared in isolation in aquarium.

Discussion

It is not necessary to discuss these five associated shrimps taxonomically. Including the present data, the shrimp-anemone associations from the Indo-West Pacific region are summarized in the Table 3. *Periclimenes inornatus* Kemp has not been found from Japan during the present study. It is closely related to *P. ornatus* in its general morphology and ecology. As mentioned by Bruce (1971) *P. ornatus* is distinguished from *P. inornatus* by the colour pattern and by the shape of the chelae of the second pereiopod. Except for *H. corallicola,* of which the present report is the second record of the species, the remaining three species are known throughout the vast Indo-West Pacific region.

There is not any definite specific relationship between the shrimps and sea anemones (Table 3). *T. amboinensis* was reported in association with other coelenterates than sea anemones; such as the scleractinian corals, *Pocillopora, Stylophora* (Patton, 1966) and *Acropora* (Hayashi, private observation) and the stinging polyp, *Stephanoscyphus racemosus* (Miyake, 1975). When this hippolytid shrimp is associated with sea anemones, it is usually found below the flattened oral disk or on a trunk of the cylindrical type of sea anemones, and seldom seen on the oral disk. Moreover it rather easily separates from the host anemones, when touched or disturbed by divers. This shrimp can be reared for long period free from sea anemones in an aquarium. Hirata et al (1973) mentioned 2–50 individuals were collected from a single host.

H. corallicola was originally reported from the scleractinian coral, *Goniopora stokesi,* and *P. holthuisi* occures on another coral, *Euphyllia fimbriata* in Ishigaki-jima Island (Fukuda, personal communication). Although these two shrimps are observed on the tentacles of the scleractinian corals, they can not be considered similar to the case of *T. amboinensis.* The general appearance of these two corals is very different from that of *Pocillopora* and *Acropora* and looks somewhat like sea anemones, as they have a long coenosarc or tentacles in each polyp and extend far enough to conceal the shrimps in them during the daytime. *P. holthuisi* was collected from the scyphozoan medusae, *Cassiopea andromeda,* at Zanzibar harbour (Bruce, 1972). This jellyfish also closely resembles sea anemones in general appearance.

On the Uchiura coast, *P. holthuisi* is usually observed on the tentacles or oral disk of the host anemone. When the divers get near the host anemone, this shrimp removes for short distance from the host and then swings his body and large second pereiopods there. Holthuis and Eibl-Eibesfeldt (1964) reported this swaying motions of the Atlantic anemone shrimp, *Periclimenes anthophilus* and very recently also observed similar phenomenon in *P. brevicarpalis* and *T. amboinensis,* too (Bruce, 1976). If the divers attempt to catch *P. holthuisi,* it returns to the anemone in order to hide itself between tentacles of the host, and finally departs from the host again, but always remains near the host. *P. holthuisi* can live on six different sea anemones in an aquarium in Kushimoto and is collected from three anemones under natural condition of Suruga Bay.

P. brevicarpalis and *P. ornatus,* as well as *H. corallicola* never move from their

Table 3. The shrimp-sea anemone associations from the Indo-West Pacific region

Associated shrimp	Host Sea-anemone	Author	Locality
Thor amboinensis	*Parasicyonis actinostroides*	Present study	Honshu, Japan
	Radianthus maculata	Present study	Honshu, Japan
	Stoichactis haddoni	Present study	Honshu, Japan
	Stoichactis kenti	Miyake & Hayashi, 1966	Ishigakijima I.
		Hirata, Nakasone & Shokita, 1973	Okinawa
Hamopontonia corallicola	*Parasicyonis actinostroides*	Present study	Honshu, Japan
	Parasicyonis maxima	Present study	Honshu, Japan
Periclimenes brevicarpalis	Actiniaria	Johnson, 1960	Singapore
	Parasicyonis actinostroides	Suzuki, Kobayashi, Abe & Fukuda, 1972	Honshu, Japan
		Present study	Honshu, Japan
	Parasicyonis maxima	Present study	Honshu, Japan
	Radianthus ritteri	Bruce, 1971	Seychelles
	Radianthus maculata	Present study	Honshu, Japan
	Stoichactis giganteum	Coutière, 1898	Jibuti
		Nobili, 1906	Jubuti
		Gravely, 1927	Gulf of Manaar
		Nayer, 1947	Gulf of Manaar
	Stoichactis haddoni	Saville-Kent, 1893	G.B.R., Australia
	Stoichactis kenti	Stephenson, Stephenson, Tandy & Spender, 1931	G.B.R., Australia
		Kubo, 1940	Ishigakijima I.
		Miyake & Fujino, 1968	Palau Is.
	Stoichactis sp.	Kemp, 1916	Andaman Is.
		Borradaile, 1917	Torres Strait
		Kemp, 1922	Andaman Is.
		McCulloch & McNeil, 1923	G.B.R., Australia
		Barnard, 1950	Delagoa Bay
	Thalassianthus hypnoides	Stephenson, Stephenson, Tandy & Spender, 1931	G.B.R., Australia
Periclimenes holthuisi	Actiniaria	Bruce, 1969	Hong Kong
	Dofleinia armata	Present study	Honshu, Japan
	Parasicyonis actinostroides	Present study	Honshu, Japan
	Radianthus maculata	Present study	Honshu, Japan
Periclimenes inornatus	*Radianthus ritteri*	Bruce, 1971	Comoro Is. Seychelles
		Bruce, 1976a	Seychelles
	Stoichactis sp.	Kemp, 1922	Andaman Is.
Periclimenes ornatus	Actiniaria	Bruce, 1969	Hong Kong
	Parasicyonis actinostroides	Present study	Honshu, Japan
	Parasicyonis maxima	Present study	Honshu, Japan

hosts, even with persistent disturbances. If the host sea anemone retracts entirely, the shrimps are always missing. It is observed in the field that these three species tear off tentacles of the host by their chelae, probably for food. This fact is confirmed by a laboratory rearing. The stomach of *H. corallicola* and *P. ornatus* contains many nematocysts of sea anemones and their symbiotic algae, *Zooxanthellae* (Fig. 5). While *P. brevicarpalis* picks up youngs of a rhynchocinetid shrimp, which are food for the host in a laboratory. It probably shows the shrimp snatches the prey of sea anemones. The relationships between these three shrimps and the host sea anemones are

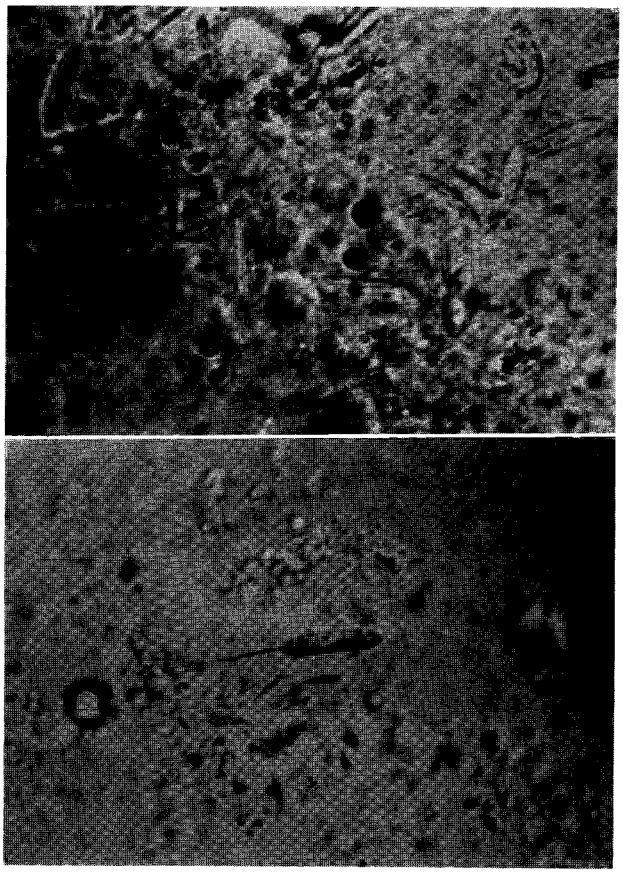


Fig. 5. Stomach contents of *Hamopontonia corallicola* Bruce associated with *Parasicyonis actinostroides* (Wassilieff) in an aquarium, showing nematocysts and symbiotic algae, *Zooxanthella*, of the host.

thought to be parasitic rather than commensal, although the heavy damage, which is known in the host sea urchins parasited by the small crab, *Zebrida adamsii* (Suzuki and Takeda, 1974), can not be observed.

These facts indicate that *H. corallicola, P. brevicarpalis* and *P. ornatus* depend obligately upon sea anemones. They always live on the host, using it as shelter and getting from it a part of their food. *P. holthuisi* is rather loose association with the re-

spective sea anemone but it seems not to live without sea anemones or anemone like corals. The function of its striking colour pattern accompanying the swaying movements is not still obscure. As discussed by Bruce (1976), it may be linked to the cleaning behavior (Limbaugh, Pederson and Chace, 1961; Mahnken, 1972), but actual cleaning by *P. holthuisi* could not be observed in natural nor aquarium conditions. *T. amboinensis* associates with sea anemones for shelter, but their relationship is rather loose.

P. ornatus and *H. corallicola* have been only known from the West Pacific and their hosts are mostly the two species of *Parasicyonis*. *P. brevicarpalis* has been reported in association with the species of *Stoichactis* in the tropical waters, which are the distributional center for this shrimp. Although it was collected from *Radianthus ritteri* in Seychelles, no anemones of the genus *Stoichactis* were observed at the collecting stations (Bruce, 1971). The fact is probably the same in central Japan. A single species, *Stoichactis haddoni,* occurs in central Japan but it is very rare even in Kushimoto. Therefore the two common species of *Parasicyonis* are used as the host by the shrimps there.

P. ornatus seems to be the most common anemone-associated shrimp in Suruga Bay. It appears first in early August and has the ovigerous season from early October to early December, 1974. In 1976 it already appears in early April and the ovigerious females are collected in mid-June. There is no decrease of population during the period of observations. *H. corallicola* has been observed from early May to late January. Its ovigerous season is much longer than those of the other species. The ovigerious females were collected from late July to mid-November. *P. brevicarpalis* appears in early summer and its population gradually increases in number and in specimen size. Some of them establish pairs and then the ovigerous females occur from mid-September to late November. In December the large specimens disappear and the pair formation is broken. In *T. amboinensis* and *P. holthuisi* little data on the population structure is available.

P. brevicarpalis has its ovigerous season in autumn in central Japan. It is uncertain, however, whether its young specimens can tolerate the lowest temperature (about 13°C) of the midwinter period, due to the lack of observations. Holthui (1952) reported the young specimens of this species were found among floating weeds on the high seas. Like many other tropical elements, this shrimp and probably the other two tropical shrimps, *P. holthuisi* and *T. amboinensis,* seem to be carried the Pacific coast of central Japan from southern waters by the warm Kuroshio Current during their planktonic or young stages. *H. corallicora* and *P. ornatus,* on the other hand, are rather different from the above-mentioned species in the progress of their acclimatization to central Japan and their distributional inclinations. Both species are very common on sea anemones in Suruga Bay and have no period of the population decrease during observations. They appear in spring and their ovigerous females are observed from late July to mid-November in the former species and from early October to early December in the latter species. The appearence of the ovigerous females, however, seems to vary in years. In *H. corallicola* the ovigerous females

collected on June 23 are 5.23–6.5 mm, while the ovigerous female on January 23 is smaller, only 4.0 mm in carapace length. In *P. ornatus* the ovigerous females are 4.0–5.25 mm in carapace length and no apparent size differences between the ovigerous females were observed in spring and autumn. Yasuda (1956) and Kosaka (1976) reported that some Japanese caridean shrimps have the long-term and short-term generations in the Seto Inland Sea and Sendai Bay. Judging from the occurrences of the ovigerous females and population structure, *H. corallicola* and probably *P. ornatus* are thought to be well settled in central Japan and may also have long-term and short-term generations there.

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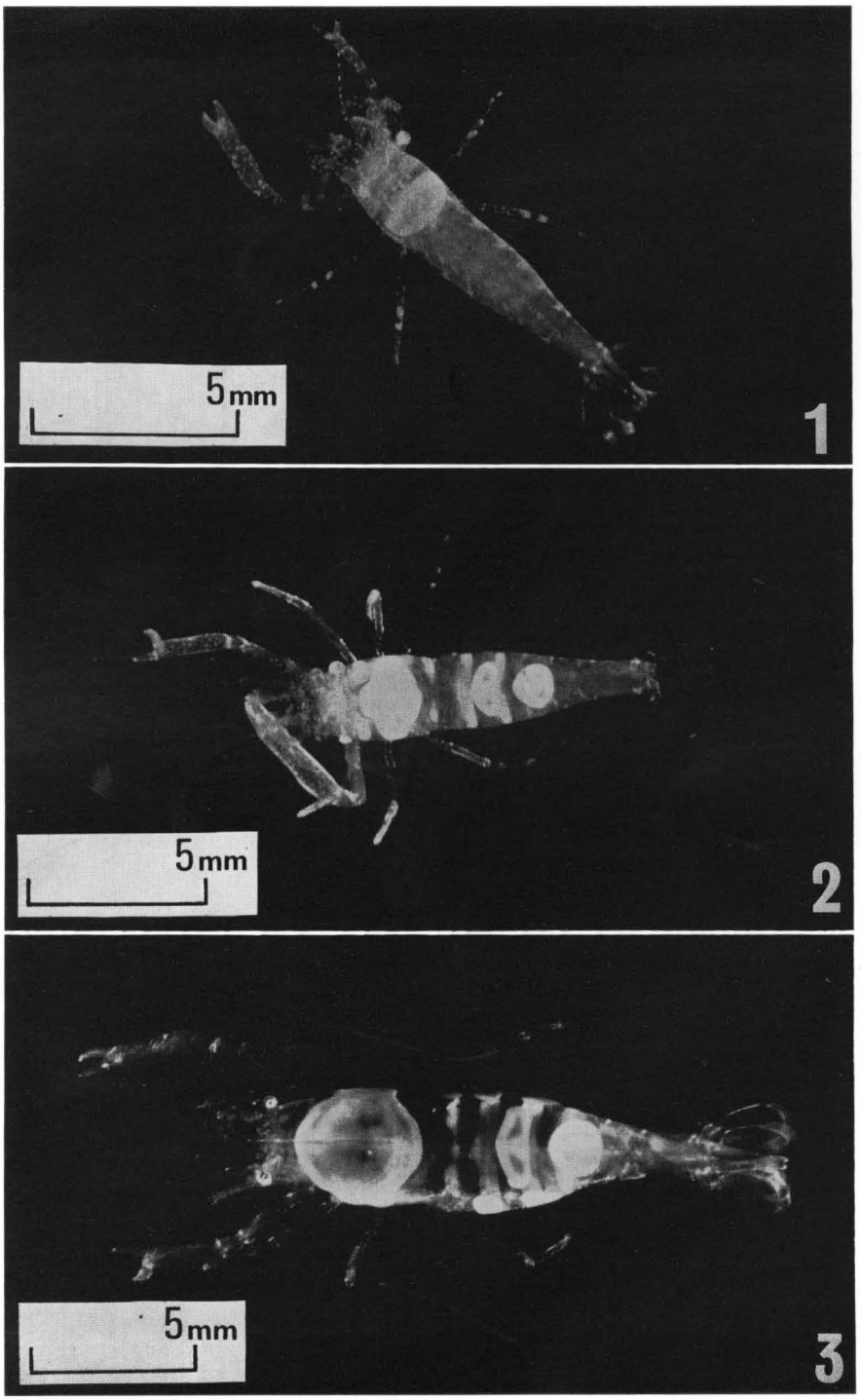
EXPLANATIONS OF PLATES

Plate I. Anemone-associated shrimp, *Hamopontonia corallicola* Bruce, showing colour variation, 1, juvenile, 2, mature male, 3, ovigerous female.

Plate II. Shrimps associated with sea anemone, *Parasicyonis actinostroides* (Wassilieff), in an aquarium. 1, a pair of *Periclimenes brevicarpalis* (Schenkel); left, mature male, right, ovigerous female. 2, female of *Periclimenes ornatus* Bruce.



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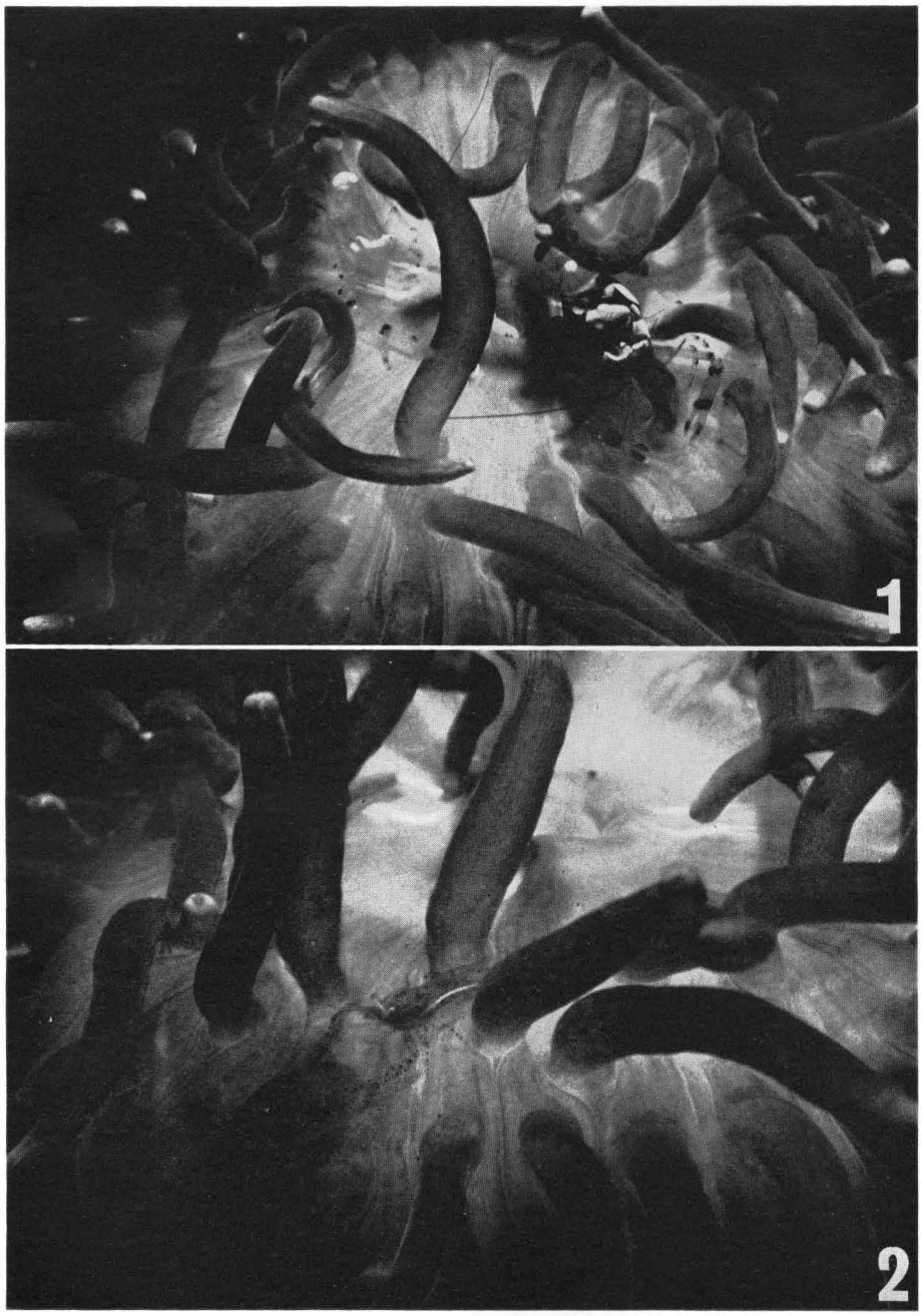

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