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ON THE ECOLOGY OF *HARROVIA ALBOLINEATA* ADAMS & WHITE, 1848 (CRUSTACEA: DECAPODA: BRACHYURA: EUMEDONIDAE), A CRAB SYMBIOTIC WITH CRINOIDS

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ABSTRACT. - The ecology of the crinoid symbiont, *Harrovia albolineata* (Crustacea: Decapoda: Brachyura: Eumedonidae) is discussed. This species is almost always found singly per host with two crinoid species in Singapore - *Comaster gracilis* (Hartlaub) and *C. multifidus* (Müller) (Comasteridae). The crabs do not appear to parasitise their hosts. The relationship is more likely to be a mutualistic one, with the crab defending the crinoid host against possible predators.

The biology of crabs of the subfamily Eumedoninae Dana, 1852, which are obligate symbionts on echinoderms, have been the focus of some attention in recent years (Castro, 1971, 1978, 1986, 1988, 1989; Suzuki & Takeda, 1974; Sakai, 1976; Sastry, 1977, 1981; Ng & Rodriguez, 1986; Van Dover *et al.*, 1986; Števčić & Ng, 1987; Lim & Ng, 1988; Števčić *et al.*, 1988). Most of this work however, has centred on their taxonomy. There can be little doubt that the subfamily should be excluded from the Parthenopidae MacLeay, 1838 sensu Balss (1957) where it has been placed by many authors. There is some uncertainty however, as to whether it should be classified as a superfamily (Guinot, 1985), family (Števčić *et al.*, 1988) or subfamily within the Pilumnidae (Lim & Ng, 1988). In this paper, the authors have followed Števčić *et al.*'s (1988) classification since their work represents the most recent and complete attempt at revising the group.

As part of a study of the echinoderm fauna of Singapore, the second author (see Lim, 1986; Lim & Chou, 1988) collected specimens of the eumedonid crab *Harrovia albolineata* Adams & White, 1848 from shallow-water crinoids. In this note, some aspects of the ecology of the crab is discussed.

Harrovia albolineata was described from a single young specimen collected north of Borneo and listed by White (1847). This name however, was a *nomen nudum.* It was subsequently illustrated under the same name by Adams & White (1848). They also made the species the type of a new genus, *Harrovia,* which some subsequent authors suggested to be a synonym of *Ceratocarcinus* Adams & White, 1848. Serène *et al.* (1958) (see also Števčić *et al.*, 1988) regarded both genera as distinct. Serène *et al.* (1958) described the

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species in great detail, providing figures and comparisons for a large series of specimens obtained from Vietnam. Unfortunately, very little ecological information was available for their specimens since all were obtained by dredging.

The smallest specimen collected at present from Singapore, a juvenile, is comparable in size to the type male, and there are no significant morphological differences between them. The other specimens collected agree very well with the description and figures of the species given by Serène *et al.* (1958), and their conspecificity is not in doubt. *Harrovia albolineata* is very close to *Harrovia elegans* De Man, 1887, and the characters that have been used thus far to separate the two species are far from reliable (see also Castro, 1989). The taxonomy of these two species as well as the other eumedonids will be dealt with in greater detail by the first author in a separate paper (under preparation) on the Eumedonidae contained in the Zoological Reference Collection (ZRC), Department of Zoology, National University of Singapore.

A total of 10 specimens of *Harrovia albolineata* were collected from Singapore (Table 1). Six genera and 15 species of crinoids were collected from Singapore coral reefs, representing four families - Comasteridae, Colobometridae, Himerometridae and Mariametridae (Lim, 1986; Lim & Chou, 1988). The crabs occurred only on two species of crinoids - *Comaster gracilis* (Hartlaub, 1890) and *Comaster multifidus* (Müller, 1841) (Comatulida, Comasterida, Comasteridae). The species identifications follow Clark (1931). Recent indications are that the characters used thus far to separate *C. gracilis* from *C. multifidus* are not reliable, and specimens previously referred to as *C. gracilis* may well prove to be *C. multifidus* (A. R. Birtles, pers. comm.). Until a revision becomes available, both names are used in the sense of Clark (1931). *Harrovia albolineata* thus seems to have a certain degree of host-specificity. Both *Comaster* species are very common in Singapore and were most frequently found in more protected shallow waters. Jones & Sankarankutty (1960) reported *H. albolineata* from *Lamprometra* sp., whilst Lanchester (1900) reported it from *Actinometra multiradiata*. Only one *Lamprometra* species was obtained from Singapore in the present study - *L. palmata* (Müller, 1841). No crabs were obtained from this species although it was relatively common (Lim, 1986). *Actinometra* was not collected, and there is a possibility that Lanchester's identification may have been erroneous, especially since the genus belongs to a group of crinoids which are free-swimming and not almost sessile like the other species mentioned so far, and thus might not be suitable hosts for the crabs (see below). The species identified and figured by Jones & Sankarankutty (1960) appears to be closer to *H. elegans* than to *H. albolineata*, and should probably be referred to that species (see also Castro, 1989).

Each crinoid seems to support only one specimen of *H. albolineata*, male or female. In the only instance when two specimens were collected, one proved to be a large female and the other a small juvenile. Jones & Sankarankutty (1968) also recorded only one specimen per crinoid. As in the present instance, they were usually found on the aboral surface. This brings up several intriguing questions. We have obtained solitary ovigerous females, whose larvae we have reared in the laboratory (Lim & Ng, 1988). This implies that for mating to occur, either the male or female (or both) must move from or between crinoids.

We have removed *Harrovia* from their crinoid host and observed their responses on flat substrates. They can move slowly between points, albeit with difficulty because of their hooked ambulatory dactyli. On rougher substrates, however, they are capable of relatively smooth and fast movement. Garth (1964) and Imanaka *et al.* (1984) recorded

Table 1.
Distribution and ecological data of *Harrovia albolineata* collected in Singapore

Location	Collection Date	*Comaster* Species	No. of individuals/ sex	Depth (m)	Diameter of crinoid	Other Associates
1. Pulau Hantu	12/8/86	*gracilis*	1 female	–	25cm	myzostomes
2. Pulau Semakau	22/8/86	*gracilis*	1 female	9.45m	–	myzostomes
3. Pulau Semakau	22/8/86	*multifidus*	1 male	–	–	myzostomes
4. Pulau Jong	26/8/86	*gracilis*	1 male	6.77m	17cm	myzostomes
5. Pulau Semakau	14/10/86	*gracilis*	1 female, 1 juv	–	13cm	myzostomes, copepods, gastropod
6. Pulau Satumu	16/10/86	*gracilis*	1 female	3.66m	15cm	myzostomes, 2 *Synalpheus* shrimps.
7. Pulau Satumu	16/10/86	*gracilis*	1 female	3.96m	16cm	myzostomes
8. Pulau Semakau	15/6/87	*gracilis*	1 female	–	–	–
9. Pulau Semakau	8/87	*gracilis*	1 female	–	–	–
10. Pulau Semakau	8/87	*gracilis*	1 female	–	–	–

Pulau = island
"-": no information

specimens of *Harrovia elegans* which were not associated with crinoids. Whilst Garth's record was most possibly due merely to displacement of the crabs from neighbouring crinoids during collections, Imanaka *et al.*'s record stated that their specimen was obtained on a "... coral rock". They however, did not indicate whether crinoids were in the adjacent area.

In all likelihood, *Harrovia albolineata* moves between crinoids, especially for mating. This is in sharp contrast to the known biology of some other eumedonines which occur in mated pairs on their host - *Echinoecus pentagonus* A. Milne-Edwards, 1879, on various species of sea urchins (Castro, 1971, 1978, 1986, 1988); and *Zebrida adamsi* White, 1847, on sea urchins (Suzuki & Takeda, 1974). Considering the small size of crinoids, it is possible that *Harrovia albolineata* somehow limits itself to one crab per crinoid in order not to deplete the space and food resources derived from its host. This ecological segregation has precedence in the parasitic crabs of the family Pinnotheridae, in which solitary animals are normally found in their bivalve hosts, the males moving between shellfish during the mating period. The crinoids *Comaster gracilis* and *C. multifidus* are both known to aggregate, with several individuals being found beneath a single coral (Lim, 1986). This would allow for movement of the crab between hosts during mating. Castro (pers. comm.) had noted that for *Echinoecus pentagonus*, males moved between their hosts when the sea urchins aggregated.

If this hypothesis is true, it presents several other interesting problems. How does the crab prevent conspecifics (or congeners) from settling on their host? Is it the male or female which moves? How does the male (or female) know when to move? Or more unlikely, does mating occur on one of the host crinoids, or on/under the rocks between the crinoids?

Even more intriguing is the kind of relationship *Harrovia* shares with its host crinoid. None of the crinoids examined (including those which harboured *Harrovia)* showed any signs of damage or predation. Dissections of the gut of several fresh specimens of *Harrovia* failed to reveal any trace of crinoid tissue. Galil (1987) reported that the hard coral symbiont crabs of the genus *Trapezia* feed on the mucus produced by its host coral. It is possible *Harrovia* behaves in a similar way, feeding on the mucus produced by the crinoids. *Harrovia* however, does not appear to have the specialised structures present on the dactylus of the ambulatory legs of *Trapezia* which are used to gather mucus (Galil, 1987). *Harrovia albolineata* seem to occur with other associates on their crinoid hosts (Table 1) which include myzostomes (Polychaeta), copepods and a gastropod *(Balcis?).* Two specimens of *C. gracilis* were more heavily "infested" - one harbouring a single *Harrovia albolineata,* myzostomes, copepods and a gastropod; while another hosted two *Harrovia albolineata* and two *Synalpheus* sp. shrimps. It is also unlikely that *Harrovia* feeds on the other symbionts (including parasites) on the crinoids. The long chelipeds, and rather bulky and short fingers of the chelae are not suited for this mode of nutrition, and comparisons of the fauna obtained from crinoids with and without *Harrovia* do not support this idea at the moment. No traces of these organisms were also found in the gut contents of dissected *Harrovia.* Adult crabs may also feed on the algae and soft-bodied organisms on the coral or rock surfaces, not obtaining its nutrition directly from the crinoid.

Harrovia, with its long and relatively powerful chelipeds, may possibly help to defend the crinoid against potential predators, although crinoids have few known natural enemies. In the aquaria, the crabs are quite aggressive, stretching out their chelipeds, fingers agape, when the crinoids are disturbed. A similar role has been reported for *Trapezia* in defending its host coral against the predatory Crown-of-Thorns starfish, *Acanthaster planci* (see Pearson & Endean, 1969; Weber & Woodhead, 1970; Glynn, 1983, 1987; Castro, 1976, 1988). It would thus appear that the relationship between *Harrovia* and the crinoid may be mutualistic rather than parasitic.

In a recent paper on crinoid ecology by Zmarzly (1984), no eumedonid crabs were reported from specimens in Enewetak, Marshall Islands, although *Comaster gracilis* was among the six species studied. Interestingly, she recorded numerous specimens of two species of prawns instead - *Palaemonella pottsi* (Borradaile) (Pontoniinae, Palaemonidae) and *Synalpheus stimpsoni* (De Man) (Alpheidae).

All the crinoid and eumedonid specimens examined during the present study have been deposited in the ZRC.

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