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Pair Formation in a Coral Inhabiting Hermit Crab

Wendell K. Patton and D. Ross Robertson

Summary. The hermit crab, Pagurita harmsi, is a sedentary filter-feeder, previously known as an inhabitant of polychaete tubes on the surface of living corals. It is now reported living directly within colonies of the massive coral, Astreopora myriopthalma, growing in 8–10 m of water at Heron Island, Great Barrier Reef, Australia. Small hermit crabs (2–3 mm body length) were found within normal, tissue-containing corallites of the host, while larger individuals occupied the outer portion of tubular pits that extended as much as 98 mm down into the coral skeleton. P. harmsi tended to occur in pairs of adjacent male and female individuals, which may reduce predation risks during mating. Available evidence favours the hypothesis that hermit crabs are quite long-lived, invade normal host corallites and remain there while the coral gradually grows outward producing an elongate pit.

Methods

P. harmsi was studied during July and August 1971 within colonies of Astreopora growing in 8–10 m of water over the western edge of the reef at Heron Island, Great Barrier Reef, Australia. Coral heads were surveyed in situ using SCUBA and their contained hermit crabs censused by sampling with a 0.25 m x 0.25 m quadrat. Several colonies were pried loose and returned to the laboratory. For these corals, the distance between each crab and its nearest and second nearest neighbor was determined. The crab was then removed from the coral by dissection with hammer and chisel and its length, sex and the depth of the pit that it was inhabiting determined. Body length was measured from front of carapace to tip of telson. Male crabs were recognized by the absence of abdominal pleopods (Gordon 1935). The smallest egg-bearing female had a body length of 9 mm and all specimens smaller than this were classified as juveniles, although, in view of their generally smaller size, males 7 or 8 mm long could well have been sexually mature. Parametric statistics were employed for data sets that were normally distributed (g1 and g2, Sokal and Rohlf 1969).

Results

Twenty-six of the 56 Astreopora colonies surveyed by SCUBA were found to contain P. harmsi, yielding a highly clumped distribution of crabs among the available corals. (For crabs found per quadrat on the various colonies, the variance/mean ratio was 41.2.) Overall, there was a significant correlation (Spearman r = 0.347, N = 56) between coral size and total number of crabs per coral although both heavily infected small colonies and uninfected large ones were found in the study area. Calculations based on sampling from the 26 inhabited corals yielded a mean of 37.8 crabs per coral (range 2-231) and an average density of 3.2 crabs per 100 cm2 of coral surface.

Table 1 gives data on the inhabitants of a single A. myriopthalma colony. In addition to the 68 P. harmsi found within the living coral, there were two empty holes (one a worm tube and the other a small pit that was probably formed by a crab). Most crab-inhabited pits had a thin lining of the encrusting coralline alga Lithothamnion sp. No old pits that had been overgrown by coral were seen inside the colony, indicating that once a pit is formed, it is then occupied more or less continually. For undamaged crabs that could be measured, there were significant correlations between the length of the body and the depth of the pit that they were inhabiting (Spearman r = 0.913 for 56 crabs of all sizes, Spearman r = 0.387 for 18 males, r = 0.755 for 19 females, r = 0.863 for 19 juveniles). Although females were significantly longer than males (r = 2.864, N = 37), there were no significant differences between the widths or depths of their inhabited
pits. Twenty-two of the 24 females listed in Table 1 were bearing eggs. Four crabs, including an ovigerous female, had an attached isoped parasite.

There was a strong tendency for hermit crabs to occur in pairs on the coral surface. For the 68 crabs listed in Table 1, 81% had a reflexive distribution, that is, were the nearest neighbour of their own nearest neighbour, compared with an expected 62% in the absence of pairing tendencies (Clarke and Evans 1955). Of the 42 adults shown in Table 1, 30 occurred in heterosexual pairs and in one case a male was sandwiched between two females. Four adults were paired with juveniles, while only five were more than 20 mm from their nearest neighbour and hence recorded as being unpaired. Eight of the juveniles were adjacent to other juveniles and probably represented incipient heterosexual pairs. Unpaired juveniles were common, however, and as a group, juveniles were significantly further ($t=3.200, N=68$) from their nearest neighbours than were adults. For the 28 paired adults for which complete data were available, there was a significant correlation ($r=0.633$) between the body lengths of the male and female pair members.

**Discussion**

Since young specimens of *Paguritta harmsi* were found within normal corallites of *Astreopora myriothalma*, it can be assumed that continued occupancy results in death of the polyp and the formation of a gradually deepening pit as the surrounding coral continues to grow outward. Active extension of the tube backwards into the coral skeleton by crab digging seems highly unlikely, since although the rear appendages are modified for pressing against the sides of the pit, they show no sign of abrasion or of modification for burrowing.

The fact that juveniles are significantly more distant from each other than are adults indicates that young *P. harmsi* may inhabit particular *Astreopora* corallites on a temporary basis. Subsequent movements over the coral surface and interactions between individuals will result in eventual pair formation.

The continuing occupancy of crab-formed pits could be the results of two quite different processes. (1) When a pit becomes vacant another crab takes it over, the saturation of the available pits resulting from an abundant supply of potential recruits. Such is the case with the xanthid crab, *Domecia acanthophora*, which induces skeletal deformations in the elkhorn coral *Acropora palmata*, but readily occupies vacant pits and crevices formed by previous crabs (Patton 1967). If the growth of a hermit crab is limited by the size of its pit and pit growth is a slow process, then movement into a hole vacated by a larger crab will be favoured. Although the observed close correlation between hermit crab length and pit depth does seem to argue against this hypothesis, such an association could perhaps arise if the crabs grow rapidly once in a larger pit. (2) An alternate hypothesis is that most or all crabs form their own pits from normal corallites. Pair formation by juveniles would explain the correlation that exists between the body lengths of paired individuals. The absence of empty pits within the coral skeleton would then result from established crabs having a longevity equal to that of their host coral. Two colonies of *A. myriothalma* collected from 7 m depth at Eniwetok revealed average skeletal growth of 7.5 and 13 mm/year (Budde-meier et al. 1974). If similar growth rates apply in the cooler waters at Heron Island and each crab does indeed form its own pit, then the male *P. harmsi* in the 98 mm pit (Table 1) would be between 7 and 13 years old.

Although long-term pair formation has not been demonstrated previously for a hermit crab, it is well known in other "commensal" marine animals. In the case of fish associated with sea anemones and branching corals, pairing is thought to have evolved in response to the discrete and isolated nature of the habitat and the intense predation pressure facing an organism leaving its shelter (Fricke 1974; Lassig 1976). Since the habitations of *P. harmsi* are permanently fixed in the substrate, it is probable that pairing of pits and crabs has been selected for because it has reduced the predation occurring when crabs leave their burrows to achieve mating.

The use of worm tubes on the coral surface as shelter for *Paguritta harmsi* noted by Schuhmacher (1977) allows the colonization of corals that have small corallites or slow growth rates but does not permit much choice of habitat. The direct invasion of *Astreopora* corallites allows pair formation and an adjustment of crab densities that may reduce competition for resources.

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