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An Association Between the Anemone, *Cribrinopsis fernaldi*, and Shrimps of the Families Hippolytidae and Pandalidae

by

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Abstract

A previously undocumented association between the pink sea anemone Cribrinopsis fernaldi and several species of Caridean shrimp was observed from a submersible at depths of 75-150 m in Kodiak, Alaska. Shrimp were aggregated in a radial pattern around anemones, beneath or just beyond the tentacle canopy. Species collected with a suction sampler included Eualus suckleyi, Spirontocaris sp., Lebbeus grandimanus, L. groenlandicus and Pandalus tridens, but not Pandalus borealis, although it was probably also present. Numbers of shrimp per anemone increased with depth from 61 to 115 m, and more shrimp were observed on silty-sand than on sandy-gravel substrates. While associations between actinians and Hippolytid shrimp are common in tropical waters, this association is unusual because of its northern geographic location and the involvement of Pandalid shrimp.

Key Words: Shrimp, anemones, symbiosis.
Running Title: Shrimp-anemone association.

Introduction

Many species of decapod crustaceans exhibit commensal associations with other organisms (Ross, 1983). Perhaps the most well known associations are those between Caridean shrimps (of the families Palaemonidae and Hippolytidae) and sea anemones. Bruce (1976) and Ross (1983) provide extensive reviews of these and other crustacean symbioses. Virtually all of the observations of commensalism involving shrimps and actinians have occurred in tropical waters of the Western Caribbean or Indo-Pacific. Only one decapod-anemone association has been reported from the eastern North Pacific ocean. The Hippolytid Lebbeus grandimanus occurs in association with the pink anemone Cribrinopsis fernaldi, but is occasionally found on anemones of the genus Urticina (Tealia) (Butler, 1980; for an excellent photograph see Barr, 1980). In this report we document association between C. fernaldi and several species of the families Hippolytidae and Pandalidae, in Alaskan waters.

Materials and Methods

Initial observations of shrimp aggregations were made in Chiniak Bay, Kodiak Island, Alaska (57E43'N, 152E20'W) from the 2-person submersible Delta (Delta Oceanographic, Torrance, CA) during April 18-30, 1991. At that time, we first observed and photographed aggregations of numerous shrimp around the bases of the pink anemone, Cribrinopsis fernaldi. On 8 and 12 April, 1992, we counted shrimp associated with pink anemones during two dives on a sandy-gravel slope in Chiniak Bay (Site 1). Starting at 120 m depth, the sub traveled upslope and stopped whenever an anemone came within view of the observer, who counted all shrimp visibly associated with the anemone.

Shrimp associated with pink anemones were collected during two more dives; one at Site 1, and another dive to 137 m depth on a silty-sand substrate in Chiniak Bay (Site 2), using a venturi-driven suction sampler mounted on the Delta. To avoid startling the shrimp, the 5-cm diameter hose was held above the anemone prior to starting the pump, and then pressed down over the anemone and nearby sediments until the anemone completely contracted. Anemones which were already contracted did not have shrimp associated with them, so were not sampled. Eight to ten anemones were sampled in this manner during each dive, and all shrimp were collected in one or two fine mesh plankton nets connected to the suction sampler. We could not keep samples from individual anemones separate without returning to the surface repeatedly, so did not attempt to do so. On the surface, shrimp were fixed in 10% buffered formalin for return to the lab, where they were identified, counted, and stored in 70% ethanol.

Results

Radially oriented shrimp aggregations, some including over 100 shrimp, were observed around individual pink anemones (Fig. 1). Although solitary shrimp were occasionally observed in association with the giant anemone (Metridium giganteum), they were never aggregated around it. The majority of aggregated shrimp were observed in contact with the sediment immediately beneath or close to the extended tentacles and arranged in a radial pattern around the anemone, with heads pointing outward. Based on visual observations, distance of shrimp from the anemone seemed to be correlated with shrimp size, as larger shrimp were farther away, and smaller ones closer to the anemone base. Shrimp tended to be more numerous on the downcurrent side of anemones, and were occasionally observed on their side, with the dorsal surface facing into the current. Shrimp were also observed with their telsons up against the stalk of the anemone, in an almost vertical position. Some specimens of L. grandimanus were observed walking on the tentacles and oral surface of C. fernaldi, and a few were observed on the oral surface of M. giganteum as well. We also commonly observed shrimp aggregating in depressions of the seafloor sediment and around other objects such as drift kelp, but the orientation of shrimp in these aggregations appeared to be random, and not radial.

Shrimp number and type varied with depth and substrate. On the sandy-gravel substrate at Site 1, the mean number of shrimp seen in association with pink anemones increased with depth (Fig. 2) from 0.25@anemone^{-1} at 61 m, to 6.6@anemone^{-1} at 116 m (Table 2), probably reflecting a general increase in shrimp density with depth. Water temperatures ranged from 5.3EC to 5.0EC over the same depth range.

Shrimp taxa which were collected from aggregations associated with pink anemones (Table 1) included four Hippolytids (Eualus suckleyi, Spirontocaris sp., Lebbeus grandimanus, L. groenlandicus) and one Pandalid (Pandalus tridens). The most abundant species was E. suckleyi. Shrimp appeared to be indifferent to the presence of the submersible and its lights, only moving away when approached to within several cm. However, shrimp were easily alarmed by vibrations from the suction pump motor and hose tip, and many of the larger shrimp (possibly P. tridens, P. goniurus, or P. borealis, all of which are known to inhabit the sampling area), were able to escape, so these samples do not reflect their presence or abundance. The shrimp/anemone ratio ($\bar{x}$ = 8.75) was higher in samples collected from silty-sand (Site 2) than from sandy/gravel (Site 1) substrates ($\bar{x}$ = 4.0), but the number of aggregated species was greater at the latter site (5 vs. 3). Shrimp density observed from the submersible (including shrimp not associated with anemones) also appeared to be greater on silty-sand than on sandy-gravel substrates, but this was not estimated quantitatively. There was no significant difference in mean carapace length of Eualus suckleyi ($F_{17,49}$=0.293, P=0.59) or Spirontocaris sp. ($F_{6,19}$=1.198, P=0.28)(Table 1) between the two collection sites.

Discussion

Both the pink anemone, Cribrinopsis fernaldi, and the giant anemone, Metridium giganteum, are abundant in Chiniak Bay, often occurring adjacent to each other. Yet shrimp were observed aggregating only around the pink anemone, indicating that shrimp can easily distinguish these two species. Structurally, the two species of anemone are quite different. The stalk of C. fernaldi is short and thick, 5-10 cm in height and width, and is crowned by 60-80 thick tentacles of 5-10 cm length, which extend outward, forming a canopy under which many shrimp were situated. It usually occurs as solitary individuals anchored to rocks or shells in sandy sediments. In contrast, M. giganteum usually has a much longer stalk (up to 50 cm) crowned by a thin, feathery, highly branched mass of >200 minute tentacles, and occurs on both sandy and rocky substrates, often in clusters.

Most observations of symbiotic associations between decapods and actinians have occurred in tropical waters. Stanton (1977) reported 6 species of shrimp, including <u>Periclimenes</u> <u>pedersoni</u>, <u>P</u>. <u>yucatanicus</u>, and <u>P</u>. <u>rathbunae</u> (all Palaemonids), <u>Thor</u> <u>amboinensis</u> (a Hippolytid), and several species of crabs, including <u>Mithrax</u> sp. and <u>Stenorhynchus</u> <u>seticornis</u> (both Majids), cohabiting with the anemone <u>Lebrunia</u> <u>danae</u> on Jamaican coral reefs. Many of the species which cohabit with <u>L</u>. <u>danae</u> also cohabit with the anemone <u>Bartholomea</u> <u>annulata</u>, as do the snapping shrimps <u>Alpheus</u> <u>armatus</u> (Herrnkind et al, 1976), and <u>A</u>. <u>immaculatus</u> (Knowlton and Keller, 1983). <u>P</u>. <u>yucatanicus</u> have also been reported to cohabit with <u>Condylactis</u> <u>gigantea</u> (Limbaugh et al., 1961) and rarely with <u>Rhodactis</u> <u>sanctithomae</u> (Williams and Williams, 1982). The shrimp <u>Lysmata</u> <u>grabhami</u> has been reported in association with the anemone <u>Stoichactis</u> <u>helianthis</u> at Antigua (Chace, 1972) and with an unspecified anemone in the Indian Ocean (Bruce, 1974). Manning (1970) described a new species of Majid crab, <u>Mithrax</u> <u>commensalis</u>, which was found only in association with anemones of the genus <u>Stoichactis</u>, from Dominica in the eastern Caribbean.

Observations of shrimp-anemone associations in temperate or boreal waters, or involving Pandalid shrimp, are sparse and anecdotal. Howard (1982) reported that <u>P</u>. <u>borealis</u> formed clusters of up to 20 shrimp around the base of the deeplet, <u>Bolocera</u> <u>tuediae</u>, remarkably similar to our observations. Other associations similar to the one we describe have been observed in the Northwest Atlantic between unidentifed shrimp species and <u>Bolocera</u> <u>tuediae</u>, <u>Cerianthus</u> <u>borealis</u>, and <u>Actinoscyphia</u> <u>saginata</u> (P. Auster, Univ. of Connecticut, Groton CI, pers. commun., October 1993). Shepard et al. (1985) observed pandalids adjacent to tubes of <u>Cerianthus</u> sp. Moffitt and Parrish (1992) made submersible observations of the pandalids <u>Heterocarpus</u> <u>laevigatus</u> and <u>H</u>. <u>ensifer</u> in Hawaiian waters, and reported that the latter species often concentrated around high relief features over otherwise flat, sandy, substrates, but such features included rocks as well as anemones, and no host specificity was indicated.

Many of the tropical shrimp species reported in association with anemones are "cleaner" shrimps (particularly <u>P</u>. <u>pedersoni</u>, <u>P</u>. <u>yucatanicus</u>, and <u>L</u>. <u>grabhami</u>), belonging to the families Palaemonidae and Hippolytidae. Stanton (1977) noted that most of the shrimps he observed occupied the "over" or "on-frond" micro-habitat, as opposed to being "under-frond". For these shrimp, there is an obvious advantage in occupying highly visible habitats where they can be noticed by fish in need of cleaning. While most of the species we observed in association with pink anemones were also Hippolytids, most occupied understory habitats, and none have been reported exhibiting cleaning activity, including <u>Lebbeus</u> spp., which commonly occupy the "on-frond" habitat.

A common feature of shrimp-anemone associations is the anatomy of the host anemones, which usually have large, fleshy tentacles, as opposed to the fine, feathery tentacles of <u>M</u>. <u>giganteum</u>. Stanton (1977) reported a significant correlation between anemone frond area and the number of associated decapod species. The presence of actinians on crab carapaces may help protect their decapod hosts from predation (Ross, 1983). Shrimp occupying the "under-frond" habitat probably derive some protection from demersal feeding predators, such as Pacific cod (<u>Gadus</u> <u>macrocephalus</u>) in the Northeast Pacific. Thus, anemones which have short stalks and fleshy tentacles close to the substrate, such as <u>C</u>. <u>fernaldi</u>, may provide better shelter, and harbor more individuals, than anemones like <u>M</u>. <u>giganteum</u> which have finer tentacles further from the substrate. Fleshy tentacles may bear larger or more numerous cnidocytes, and are more substantial as well, so can easily support shrimp walking about on them, whereas the fine tentacles of <u>M</u>. <u>giganteum</u> may provide less support for symbionts. Whether <u>C</u>. <u>fernaldi</u> derives any benefit from its association with shrimp is unknown, although Smith (1977) demonstrated that <u>A</u>. <u>armatus</u> was capable of protecting its host (<u>B</u>. <u>annulata</u>) from attacks by predatory polychaetes which partially consumed and killed the anemones in the absence of shrimp.

We were unable to collect the largest shrimps observed, which may have been <u>Pandalus</u> <u>tridens</u>, <u>P</u>. <u>goniurus</u>, or <u>P</u>. <u>borealis</u>. On the other hand, the few <u>P</u>. <u>tridens</u> we did capture may have been "just passing by" rather than actively associating with the anemone when they were collected. Further detailed observations are warranted to clarify this relationship, and to determine whether other species of <u>Pandalus</u> were indeed present. Butler (1980) reported the apparent preference of <u>P</u>. <u>tridens</u> for rocky substrates, which may explain the absence of this species from samples taken in the featureless silty-sand environment of outer Chiniak Bay (Table 1). In such environments, there is less potential cover for shrimp, which may explain the greater number of shrimp collected from anemones there. In contrast, sandy-gravel habitat was more fractal, with broken, rocky structure providing more potential cover.

Our observations indicate that shrimp of the genera <u>Eualus</u>, <u>Lebbeus</u>, <u>Pandalus</u>, and <u>Spirontocaris</u> are facultative symbionts with the pink anemome <u>C</u>. <u>fernaldi</u>. Whether this relationship is commensal or mutual, and whether shrimp would aggregate around similarly shaped inanimate objects, remains to be determined. All of these shrimp species, as well as the pink anemome, are apparently able to survive and prosper independently. Shrimp of these genera are frequently encountered among commercial catches of Pandalid shrimp in both the Northeast Pacific and the Northwest Atlantic oceans (Butler, 1980). Our observations indicate that individuals of these genera may occur in very close proximity, and that anemone-centered aggregations may contribute substantially to patchiness of shrimp distribution.

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Table 1. Numbers and species of shrimps collected via submersible from aggregations surrounding the pink anemone Cribrinopsis fernaldi. CL = Carapace length.

Species	Site 1 (sandy-gravel) 112 m	Site 2 (silty-sand) 119 m	CL (mm) Mean (SD)
Anemones sampled	10	8	
Eualus suckleyi	27	50	6.6 (1.3)
Spirontocaris sp	6	19	5.1 (0.9)
Pandalus tridens	3	0	12.1 (4.2)
Lebbeus groenlandicus	2	0	7.3 (1.5)
Lebbeus grandimanus	2	1	6.4 (0.6)
Mean # shrimp/anemone	4.0	8.75	

Table 2. Numbers of shrimp counted per anemone, by depth, during two dives on a sandy-gravel slope in Chiniak bay, Kodiak AK.

Date	**Dive**	**Depth**	**Counts**							**Mean**
5/8/92	2771	61.0	0	0	0	1				0.25
5/8/92	2771	76.2	0	1						0.50
5/12/92	2781	91.4	4	3	2	6				3.75
5/12/92	2781	94.5	2	0	1	3				1.50
5/12/92	2781	97.5	5							5.00
5/8/92	2771	100.6	9	3	2	3	0	4		3.50
5/12/92	2781	105.2	3	3	5	0	4	5		3.33
5/8/92	2771	115.2	3	9	5	9				6.50
5/8/92	2771	115.8	6	5	7	6	8	8	6	6.57

Fig. 1. Hippolytid and Pandalid shrimps aggregated around the pink anemone *Cribrinopsis fernaldi*, at a depth of 119 m in Kodiak, Alaska. Approximately 100 shrimp are present. Note the radial distribution pattern, with heads pointing outwards and tails in, and that larger shrimp appear to be farther from the anemone. Photograph by Brad Stevens.

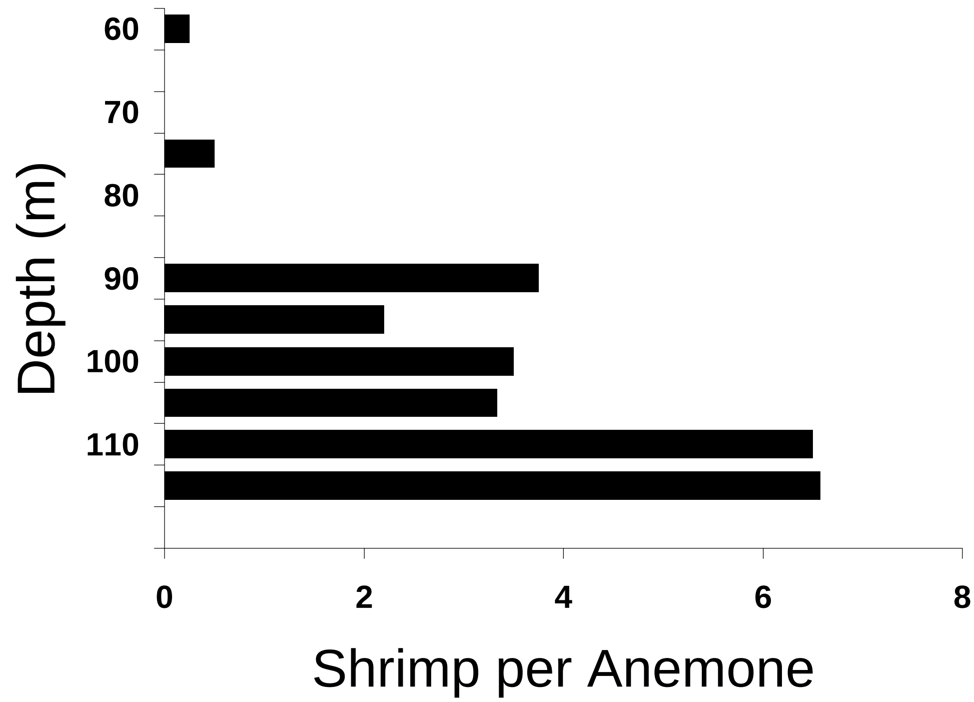

Fig. 2. Mean number of shrimp aggregated around individual anemones vs. depth (in 5 m intervals) on a sandy-gravel slope. See Table 2 for raw data.