# Decapod crustaceans associating with the sea urchin *Diadema antillarum* in the Virgin Islands

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## Abstract

The association of decapod crustaceans with the long-spined urchin *Diadema antillarum* was studied at 18 sites in the Virgin Islands during 2002-2003. At least eight species of decapods, including three previously unreported species, associated facultatively with *D. antillarum*. The decapods probably benefit by increased protection from the urchin's long spines whereas the urchin is probably unaffected. Of 1,800 *D. antillarum* examined, 115 (6.4%) hosted one or more decapods with an average of 0.09 individuals per urchin. Of 164 individual decapods observed, the grapsid crab *Percnon gibbesi* was the most common species (48.8% of all individuals), followed by unidentified hermit crabs (Paguridae; 30.5%), the arrow crab *Stenorhynchus seticornis* (11.0%), the banded coral shrimp *Stenopus hispidus* (5.5%), the spiny lobster *Panulirus argus* (2.4%), the porcelain crab *Petrolisthes galathinus* (0.6%), and an unidentified spider crab (possibly *Mithraculus* sp.; 0.6%). In addition, a green clinging crab *Mithrax sculptus* moved from an urchin *Tripneustes ventricosus* to a *D. antillarum*. The frequency of decapods associating with *D. antillarum* in the Virgin Islands was about five times lower than on some islands in the southeastern Caribbean Sea. The environmental factors responsible for geographic variation remain unknown. Because long-term temporal trends in the association of decapods with urchins may be linked to large-scale population dynamics of *D. antillarum,* the populations of both urchins and their decapod associates should be monitored.

Key words: crustacean-echinoderm associations, Caribbean Sea, crustacea, decapods, *Diadema antillarum,* Virgin Islands

## Introduction

Decapod crustaceans form symbiotic relationships with a variety of echinoderm hosts (e.g., Ross, 1983; Williams, 1984; Hendler *et al.,* 1995). Such relationships may include predation/parasitism (one species obtains nutrition from another), mutualism/protocooperation (both species benefit; obligatory or facultative), and commensalism/association (one species benefits; obligatory or facultative) (e.g., Douglas, 1994; Sapp, 1994; Ahmadjian and Paracer, 2000). However, the ecological relationships of most decapod-echinoderm symbioses remain poorly studied.

In the Caribbean Sea, the spines of the long-spined urchin *Diadema antillarum* (Philippi, 1845) provide refuge for a variety of associated organisms, including an anemone, a flatworm, the young of many fish species, a copepod, a mysid shrimp, and a variety of decapods (Randall *et al.,* 1964; Chace, 1969; Clifton *et al.,* 1970; Davis, 1971; Castro, 1974; Gooding, 1974; Serafy, 1979; Criales, 1984; Stock and Gooding, 1986; Hayes *et al.,* 1998a, b; 2006). The frequency of decapods associating with *D. antillarum* is poorly documented and has been studied only at scattered localities in the southeastern Caribbean Sea (Hayes *et al.,* 1998a, b; 2006). In 1983, an unknown pathogen

swept across the Caribbean from west to east, wiping out > 93% of *D. antillarum* in some areas (Lessios *et al.,* 1984; Lessios, 1988). The impacts of the epidemic on decapods associating with *D. antillarum,* especially the closely associated grapsid crab *Percnon gibbesi* (Milne-Edwards, 1837; Schmalfuss, 1976; Colin, 1978), remain unknown. Given the potential effects of future urchin epidemics, the populations of both urchins and their decapod associates should be monitored (Hayes *et al.,* 2006). Here I report data on the frequency of decapods associating with *D. antillarum* in the Virgin Islands.

## Study Areas and Methods

From January 2002 to July 2003, I surveyed the association of decapods with *D. antillarum* at 18 sites in the Virgin Islands, including eight on St. Thomas, seven on St. John, one on Tortola and two on St. Croix (Table I). All of these sites were in bays fairly protected from heavy surf or on the windward side of an island. The substrate of most sites consisted of sandy or muddy bottoms with interspersed rocks and fringing coral reefs. Two sites (Cas Cay and Patricia Cay, St. Thomas) were within channels of a large mangrove lagoon. One site (Caneel Bay, St. John) included concrete pilings of a dock. The marine environments of the Virgin Islands are described in further detail by Wells (1988) and Division of Fish and Wildlife (2005).

With the use of a stick, each urchin was gently probed underneath to facilitate examination. An association was considered to occur when a decapod was encountered within 2.5 cm of the spines of an urchin. Each decapod observed (tiny species may have been overlooked) was identified in the field based on Colin (1978), Sefton and Webster (1986), and Humann (1992), or photographed and subsequently identified by a taxonomist (no specimens were collected), and the number of individuals of each species at each urchin was recorded on an underwater writing slate. All urchins were accessed with standard snorkeling equipment in shallow water < 5 m deep. The percent frequency of urchin hosts occupied by decapods and the mean number of decapods per urchin host were calculated for each decapod species and for all associated decapods combined.

## Results

Of 1,800 *D. antillarum* examined during this study, 115 (6.4%) hosted one or more decapods with an average of 0.09 individuals per urchin. The frequency of *D. antillarum* occupied by decapods varied greatly among sites, ranging from 0% at two sites with large samples (Steven Cay, $n = 200$ urchins; Annaberg Point, $n = 100$) to 41.1% at Estate Northside ($n = 90$), 45% in the vicinity of concrete pilings at Caneel Bay ($n = 20$), and 57.1% at Protestant Cay ($n = 7$; see Table I).

The grapsid crab *Percnon gibbesi* was the most common associate of *D. antillarum,* comprising 48.8% of the 164 individuals observed. It associated with 3.7% of the urchins with an average of 0.04 individuals per urchin. It was most abundant at Estate Northside (Table I), where up to four associated with a single urchin, with an average of 0.52 individuals per urchin.

Unidentified hermit crabs (Paguridae) of an unknown number of species (none collected) accounted for 30.5% of the decapods observed. They associated with 1.2% of the urchins with an average of 0.03 individuals per urchin. They were most abundant at Protestant Cay, with an average of 0.43 individuals per urchin although the sample size was very small ($n = 7$ urchins; Table I), and at Lameshur Bay, where up to 21 associated with a single urchin with an average of 0.24 individuals per urchin ($n = 100$; Table I).

The arrow crab *Stenorhynchus seticornis* (Herbst, 1788) comprised 11.0% of the decapods observed, associating with 0.9% of the urchins with an average of 0.01 individuals per urchin. It was most abundant at Caneel Bay (Table I), where up to two associated with a single urchin with an average of 0.4 individuals per urchin.

The banded coral shrimp *Stenopus hispidus* Olivier, 1811 comprised 5.5% of the decapods observed, associating with 0.4% of the urchins with an average of 0.005 individuals per urchin. Two associated with a single urchin at Brewer's Bay and Sugar Bay. Up to 0.05 individuals per urchin occurred at Caneel Bay where it was most common (Table I).

The Caribbean spiny lobster *Panulirus argus* Latreille, 1804 comprised 2.4% of the decapods observed, associating with 0.2% of the urchins with an average of 0.002 individuals per urchin. Three adults

and one immature were observed, with no more than one associated with a single urchin. One adult was photographed beside the urchin and another was photographed directly underneath the spines; the position of the third adult was not recorded.

The porcelain crab *Petrolisthes galathinus* (Bosc, 1802) comprised 0.6% of the decapods observed and associated with 0.06 of the urchins. Only one individual was observed and photographed under the spines of an urchin at Cinnamon Bay.

An unidentified, grayish species of crab, possibly from the majid genus *Mithraculus,* was seen (but not collected) associating with an urchin at Protestant Cay and at Secret Harbor (Table I).

On two occasions a decapod was seen associating with another species of urchin. At Caneel Bay, a *S. seticornis* associated with a slate-pencil urchin *Eucidaris tribuloides* (Lamarck, 1816). The only previous report of this association is from Tobago in the southeastern Caribbean Sea (Hayes *et al.* 1998b). At Protestant Cay, a green clinging crab *Mithrax sculptus* (Lamarck, 1818) associated with a West Indian sea egg *Tripneustes ventricosus* (Lamarck, 1816) but quickly moved about 5 cm to an unoccupied *D. antillarum* when disturbed.

## Discussion

The nature of the relationship between decapods and *D. antillarum* is poorly studied. None of the decapod species associates exclusively with *D. antillarum.* The grapsid crab *Percnon gibbesi* is perhaps more closely associated with *D. antillarum* than any other decapod observed in this study (e.g., Schmalfuss, 1976; Colin, 1978), yet it is often found apart from urchins in the Caribbean Sea (e.g., Williams, 1984; Hayes *et al.,* 1998a) and apparently does not associate with urchins in the Mediterranean where it has recently become established (Cannicci *et al.,* 2006; Thessalou-Legaki *et al.,* 2006; Yokes and Galil, 2006). The decapod-urchin relationship is clearly facultative rather than obligatory.

The decapods probably benefit from the relationship by seeking shelter among the long spines of *D. antillarum,* which most likely provide an efficient defensive shield from most potential predators. At least one species, the arrow crab *S. seticornis,* prefers associating with *D. antillarum* more than with other species of urchins, probably because its spines are longer than those of the other urchin

**Table I.** Frequency of urchins (*Diadema antillarum*) occupied by decapods at 18 study sites in the Virgin Islands. Hc, unidentified hermit crab; Pa, *Panulirus argus;* Pgi, *Percnon gibbesi;* Ss, *Stenorhynchus seticornis;* Sh, *Stenopus hispidus;* Pga, *Petrolisthes galathinus;* Un, unidentified decapod species. a, month-day-year. b, channels within a sheltered mangrove lagoon. c. on concrete pilings or within 5 m. d. *Mithrax sculptus* moved from an urchin *Tripneustes ventricosus* to a previously unoccupied *Diadema antillarum.*

| | | | | Percent of Urchins Occupied by Species | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Island / Site | | Date[a] | Urchins | Hc | Pa | Pgi | Ss | Sh | Pga | Un |
| St. Thomas | | | | | | | | | | |
| | Brewer's Bay | 06-17-03 | 200 | 0.5 | 1.0 | – | – | 2.0 | – | – |
| | Cas Cay[b] | 01-26-03 | 38 | – | – | – | – | – | – | – |
| | Dog Island | 05-28-03 | 100 | 2.0 | – | 6.0 | – | – | – | – |
| | Patricia Cay[b] | 01-17-03 | 5 | – | – | – | – | – | – | – |
| | St. John Bay | 06-16-03 | 100 | 1.0 | – | – | – | – | – | – |
| | Salt Cay | 03-20-03 | 50 | 4.0 | – | 14.0 | – | – | – | – |
| | Secret Harbor | 01-12-03 | 212 | – | – | 1.4 | 1.9 | – | – | 0.5 |
| | Sugar Bay | 11-11-02 | 33 | – | 3.0 | 3.0 | – | 3.0 | – | – |
| St. John | | | | | | | | | | |
| | Annaberg Point | 06-10-03 | 100 | – | – | – | – | – | – | – |
| | Caneel Bay[c] | 01-18-03 | 20 | 5.0 | – | – | 35.0 | 5.0 | – | – |
| | Cinnamon Bay | 06-18-03 | 50 | 6.0 | – | 14.0 | – | – | 2.0 | – |
| | Frank Bay | 06-18-03 | 200 | 3.0 | – | 1.0 | – | – | – | – |
| | Hansen Bay | 06-10-03 | 100 | – | – | 0.5 | – | – | – | – |
| | Lameshur Bay | 07-23-03 | 100 | 3.0 | 1.0 | 1.0 | – | 1.0 | – | – |
| | Steven Cay | 05-30-03 | 200 | – | – | – | – | – | – | – |
| Tortola | | | | | | | | | | |
| | Brewer's Bay | 07-06-03 | 100 | – | – | 1.0 | 4.0 | – | – | – |
| St. Croix | | | | | | | | | | |
| | Estate Northside | 01-07-02 | 90 | 3.3 | – | 41.1 | – | – | – | – |
| | Protestant Cay[d] | 01-04-02 | 7 | 28.6 | – | 14.3 | 28.6 | – | – | – |

species studied (Joseph *et al.,* 1998). In some decapods, especially the adult spiny lobsters *P. argus,* which are larger than the other species, the association may be incidental rather than intentional. However, juvenile *P. argus* associating with *D. antillarum* routinely follow the urchins across seagrass beds and quickly return to them when removed and released several m away (Davis, 1971).

Because each decapod species does not always associate with *D. antillarum,* and the decapods apparently derive a defensive benefit from the association whereas the urchin is probably unaffected, the relationship is probably best regarded as a facultative association rather than an obligatory commensalism (e.g., Bruce, 1976). However, the test and spine fragments of small *D. antillarum* have been reported in the gut of the spiny lobster *P. argus* (Randall *et al.,* 1964), suggesting that the association of adult *P. argus* with the urchin may represent a predatory rather than a defensive relationship.

This study revealed a minimum of eight species of decapods associating with the urchin *D. antillarum* in the Virgin Islands. Surprisingly none of these species was reported by Randall *et al.* (1964) to associate with *D. antillarum* at St. John, US Virgin Islands. However, Randall *et al.* (1964) reported two undescribed species of palaemonid shrimps (of the genera *Stegopontonia* and *Periclimenes*) associating with *D. antillarum,* neither of which were observed in this study. The spiny lobster *P. argus* was noted associating with *D. antillarum* in the Virgin Islands both by Davis (1971) and this study. There appear to be no previously published reports of *M. scultpus, P. galathinus* or *S. hispidus* associating with urchins in the Caribbean (Williams, 1984; Hendler *et al.,* 1995).

The frequency of decapods associating with *D. antillarum* in the Virgin Islands (6.4% of urchins, 0.09 individuals per urchin) was about five times lower than on islands in the southeastern Caribbean Sea (Grenadines, Grenada, Barbados, and Tobago), where Hayes *et al.* (2006) reported 30.1% of urchins ($n$ = 991) hosted by decapods with an average of 0.49 individuals per urchin. In both regions the most abundant species were *P. gibbesi,* hermit crabs, and *S. seticornis,* respectively.

Geographic variation in the frequency of association is pronounced in both the Virgin Islands and in the southeastern Caribbean, yet the environmental factors responsible for such variation, which may include either or both abiotic and biotic factors, remain unknown. Decapod associates were relatively common on urchins inhabiting concrete pilings at Caneel Bay and appeared to be absent from channels fringing a mangrove lagoon at Cas Cay and Patricia Cay. Decapods were absent at some localities with large samples yet present in similar areas elsewhere.

Regional and local differences in the frequency of decapods associating with *D. antillarum* in the Caribbean Sea may be related to differences in the population growth rate of *D. antillarum* following the 1983 mass mortality event, but unfortunately few comparative data are available. Population growth rates of *D. antillarum* appear to be much faster in some areas of the Caribbean, such as in St. Croix (Miller *et al.,* 2003) and Barbados (Hunte and Younglao, 1988), than in other parts of its range (e.g., Panama; Lessios, 2005). Because long-term temporal trends in the association of decapods with urchins may be linked to the large-scale population dynamics of *D. antillarum* (Hayes *et al.,* 2006), the populations of both urchins and their decapod associates should be monitored to document patterns of geographic and temporal variation, and to elucidate the underlying processes.

## Acknowledgements

I thank the United States Fish and Wildlife Service and the University of the West Indies for grants indirectly funding this study, S. De Grave and B. Werding for identifying a photograph of *Petrolisthes galathinus,* E. Williams and three anonymous reviewers for commenting on an earlier draft of the manuscript, and my family along with a few friends for patiently tolerating my collection of data and occasional wounds from urchin spines.

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Received: July 2007
Accepted: September 2007