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SHORT COMMUNICATIONS

INVERTEBRATES ASSOCIATED WITH THE THINSTRIPE HERMIT *CLIBANARIUS VITTATUS* (BOSC) (CRUSTACEA: DECAPODA: DIOGENIDAE) FROM THE BARRIER ISLANDS OF MISSISSIPPI

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ABSTRACT Hermit crabs, the gastropod shells that they inhabit, and associated epifauna constitute a motile microhabitat. Twenty-three macroscopic, epifaunal invertebrates were associated with the diogenid crab *Clibanarius vittatus* in Mississippi coastal waters. Epibiotic growth may discourage predation of the crab, reduce competition for the shells, or provide an advantage in agonistic shell interaction. In addition, the shell provides a hard substrate for settling and attachment of epifauna in an area that is largely devoid of hard substrate. Reduced sedimentation and prevention of shell burial, improved food availability, transport, and protection from predation may also be advantageous to the epizoans.

Introduction

Hermit crabs and associated fauna have been discussed in the literature (Jensen and Bender 1973; Stachowitsch 1980), much of which concerns the association of anemones and hydroids with hermit crabs (Ross 1960, 1971; Jensen 1970; Jensen and Bender 1973; McLean and Mariscal 1973; and Wright 1973). Other known or possible symbionts rarely have been cataloged (Jensen and Bender 1973, Fotheringham 1976, Stachowitsch 1980). This study presents a faunistic survey of macroscopic invertebrates associated with the diogenid crab *Clibanarius vittatus* (Bosc) in the coastal waters of Mississippi. This report parallels Fotheringham's (1976) findings and reports a number of additional species. However, 14 species symbiotic with *C. vittatus* are reported here for the first time. Fotheringham (1976) reports 11 species from Texas specimens also found here.

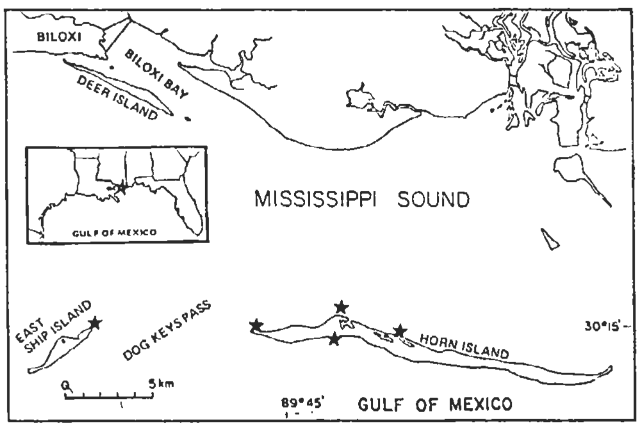

Figure 1. Location of collection sites.

Site description

Specimens were collected from five littoral sand beach sites on two barrier islands, Horn and Ship, approximately 10 and 15 km south of the mainland coast of Mississippi, respectively, in the Gulf of Mexico (Fig. 1). The gradually sloping, low wave-energy beaches of well-sorted quartz sand experience diurnal tides with a mean tidal range of 0.55 m. Near-shore submerged grass flats and submergent/emergent tree stumps of a flooded maritime forest provide areas where crabs aggregate. Tidal lagoons that are dominated by *Spartina* marsh and deeper water channels and passes are adjacent to collection sites.

Methods

A total of 1,818 specimens of *C. vittatus* was collected in a more or less random fashion in < 1 m of water within the littoral zone. Specimens were collected between 1 June and 15 July 1981. Each specimen was visually examined and the presence of live organisms on or within the visible portions of the shell noted. Individuals of each symbiont were retained and preserved in 10% formalin for identification.

RESULTS

Of the crabs that were examined, 70% harbored associated epifauna that represented seven phyla and 23 invertebrate species (Table 1). Acorn barnacles (*Balanus* spp., 44.5%) and slipper shells (*Crepidula* spp., 22.3%) were the most abundant symbionts encountered. All other symbionts occurred on less than 10% of the total crabs examined.

Porifera

The boring sponges *Cliona celata* and *C. truitti* were endolithic in 11 (0.6%) of the shells.

Cnidaria

The star coral *Astrangia poculata (= astreiformis, = danae)* infested 45 (2.5%) of the shells. A single specimen of the tricolor anemone *Calliactis tricolor* was collected. Only one crab was found with a thriving colony of the hydroid *Hydractinia echinata*, although several shells showed evidence of previous colonization.

Platyhelminthes

A single specimen of the oyster leech *Stylochus ellipticus* was observed (others might have been found if the shells had been broken).

Polychaeta

The polynoid polychaete *Lepidonotus sublevis* and the nereid polychaete *Nereis* (syn. *Neanthes*) *succinea* were commonly encountered, infesting 103 (5.7%) and 109 (6.0%) of the shells, respectively. *Lepidonotus sublevis* was usually found in the siphonal canal of whelks of the genus *Busycon* and the umbilicus of the moon snail *Polinices duplicatus*; up to three specimens of *L. sublevis* were found associated with some large crabs. Specimens of *N. succinea*, however, were found in small bore holes within the shell, in the tubes of serpulid worms, and crawling freely within or on the shells. Calcareous tubes of the serpulid worms *Hydroides* spp. were present on many shells, but no living polychaetes were found. Only three specimens of the polychaete *Polydora websteri* were noted; however, polycheates that were retracted into their burrows may have been overlooked.

Mollusca

Slipper shells (*Crepidula* spp.) were abundant, occurring on 406 (22.3%) of the shells, and were frequently found in large numbers; several crabs had 25+ individual *Crepidula* per shell. *Crepidula plana* was the most abundant species, although many specimens of *C. maculosa* and a few specimens of *C. fornicata* were also noted. Several other small gastropods were noted on the exterior of some crab-inhabited shells. Specimens of *Cantharus cancellarius* (2, 0.1%), *Anachis simplicata* (5, 0.2%), and *Boonea impressa* (23, 1.3%) were also observed. In addition, 93 (5.1%) of the shells carried the southern oyster drill, *Thais haemastoma*. Small oysters were present on 180 (9.9%) of the shells, with as many as 30+ specimens on a single shell. *Ostrea equestris* and *Crassostrea virginica* were both present as adults in the study area.

Crustacea

Acorn barnacles *Balanus improvisis* and *B. amphitrite* were the most prevalent associate, infesting 810 (44.5%) of the shells. Several small crabs were present. The porcelain crab *Porcellana sayana* was the most prevalent and occurred with 112 (6.2%) of the hermit crabs; up to four individuals occurred with a single crab. This species is known to inhabit the shells of other diogenid species, notably *Petrochircus diogenes* (Hedgepeth, 1953). In addition, juvenile portunid and xanthid crabs were also noted. One adult xanthid, *Hexapanopeus angustifrons*, was identified. Two amphipods, *Talorchestia* sp. and *Hyale* sp., and the isopod *Syphaeroma quadridentatum* were observed, but only in small numbers: 2 (0.1%), 6 (0.2%), and 8 (0.4%), respectively.

Bryozoa

Colonies of the encrusting bryzoan *Membranipora* sp. were common; 98 (5.2%) of the shells harbored live colonies, while 278 (15.7%) of the shells showed evidence of previous colonies. *Membranipora* is a common fouling organism of this area (Gunter and Geyer, 1955).

DISCUSSION

Hermit crabs exhibit distinct shell preferences based on the availability of shells in a given locale (Reese 1962). The shell-use pattern of *C. vittatus* in Mississippi Sound is included (Table 2). Since the shell substrate itself may affect the associated epifauna, the shell substrate of each symbiont is also noted (Table 1).

TABLE 1

Prevalence of epifauna associated with *Clibanarius vittatus*, with reference to the gastropod shell species inhabited by the crab and the number of crabs infested by each symbiont. Dashed line indicates no specimens collected. Total *Clibanarius* examined = 1,818.

Taxon	Symbionts	Gastropod Shell* T	P	B	O	Total # of *Clibanarius* Infested	Percent of Total
Porifera	*Cliona* spp.	7	1	3	-	11	0.60
Cnidaria	*Astrangia poculata* (Ellis & Solander)	45	-	-	-	45	2.47
	Calliactis tricolor (Lesueur)	1	-	-	-	1	0.06
	Hydractinia echinata Fleming**	1	-	-	-	1	0.06
Plathyhelminthes	*Stylochus ellipticus* (Girard)**	1	-	-	-	1	0.06
Annelida, Polychaeta	*Nereis succinea* (Frey & Leuckart)**	81	13	15	-	109	5.99
	Lepidonotus sublevis Verrill**	62	34	7	-	103	5.66
	Polydora websteri Hartman**	3	-	-	-	3	0.16
Mollusca	*Crepidula* spp.**	184	93	126	4	407	22.38
	Oysters	122	25	32	1	180	9.89
	Thais haemastoma (Lamarch)**	59	11	23	-	93	5.10
	Boonea (= *Odestomia*) *impressa* (Say)	9	6	8	-	23	1.26
	Anachis simplicata (Stearns)**	1	2	2	-	5	0.20
	Cantharus cancellarius (Conrad)	1	-	1	-	2	0.10
Arthropoda, Crustacea	*Balanus* spp.**	564	143	100	3	810	44.50
	Porcellana sayana (Leach)**	74	10	27	1	112	6.15
	Juvenile crabs (xanthid & portunid)**	11	2	3	-	16	0.88
	Sphaeroma quadridentatum Say	5	1	2	-	8	0.44
	Hyale sp.	2	-	-	6	8	0.44
	Talorchestia sp.	-	-	-	2	2	0.10
	Hexapanopeus angustifrons (Benedict & Rathbun)	-	-	-	1	1	0.06
Bryozoa	*Membranipora tenuis* Desor						
	Live colonies	68	16	14	-	98	5.38
	Dead colonies	198	30	50	-	278	19.89

*T = *Thais haemastoma*, P = *Polinices duplicatus*, B = *Busycon* spp., O = Other

**Species noted by Fotheringham

TABLE 2

Shell-use pattern of the Mississippi population of *Clibanarius vittatus*.

Gastropod Shell Species	Total No.	% of Total
Thais haemastoma (Lamarch)	1219	67.05
Polinices duplicatus (Say)	400	22.00
Busycon contrarium (Conrad)	178	9.79
Cantharus cancellarius	10	0.55
Busycon spiratum (Lamarck)	7	0.39
Fasciolaria lilium Fischer	3	0.17
Strombus alatus Gmelin	1	0.06

The hermit crab's motile community is a dynamic phenomenon that can be viewed as functional unit, although exact relationships between the crab and its shell cohabitants are difficult to assess. A few symbionts such as *Hydractinia* are known to be associated only with hermit crabs and can be termed obligatory symbionts. Generally speaking, interactions between facultative (nonobligatory) symbionts can be viewed as enhancing or reducing survivability of either organism.

Several significant advantages to the crab have been proposed:

(1) The epibiotic growth may help to conceal the animal from predators. (2) Some epibiotic species such as *Hydractinia* and *Calliactis* (Wright 1973) may actually discourage predation (Ross 1971), or reduce competition for shells. (3) Those epizoans that secrete $CaCO_3$ structures (such as barnacles and oysters) may also serve to discourage predators by increasing shell strength (Stachowitsch 1980). (4) Epibiotic growth may make the shell appear larger and thus is advantageous in agonistic interaction (Hazlett 1970).

Several advantages also exist for the epizoans:

(1) The presence of a hard surface exists for attachment (Stachowitsch 1980). Such suitable substrate may explain the presence of *Cliona, Hydractinia, Astrangia, Polydora, Ostrea, Crassostrea, Crepidula, Balanus,* and *Membranipora*. Hard substrates are sparse along the Mississippi coast; most surface sediments are mud, sand, or a mixture thereof. Gastropod shells, therefore, represent small islands of suitable habitat to organisms that would otherwise find few acceptable settlement areas. Certainly the abundance of *Balanus* (44.5%), *Crepidula* (22.4%), *Ostrea* (9.8%), and *Membranipora* colonies (5.3% live and 19.8% dead) indicates the importance of hard substrate.

(2) Reduced sedimentation and prevention of shell burial is advantageous (Conover 1975). The constant foraging activity of the crab keeps its symbionts free of sediment and detritus which might interfere with respiration or feeding.

(3) Improved food availability to the epibionts is increased by a crab's respiratory currents as well as its passage through the water and feeding activities. An improved current for filter feeders is generated by the crab's normal respiratory activity and active movements. Organisms thus benefited include: *Cliona, Hydractinia, Astrangia, Calliactis, Ostrea, Crassostrea, Crepidula, Balanus, Porcellana,* and *Membranipora*. Additionally, small worms (*Lepidonotus, Nereis* [syn. *Neanthes*], *Polydora*), crabs (*Porcellana*) and juvenile xanthid and portunid crabs probably benefit from both particulate material stirred up by the crab as it passes and particles liberated as the crab tears and masticates its own food. The relationship may be even more direct. Brightwell (1951) noted that *Neanthes* positioned itself amidst the mouthparts of the hermit crab *Pagurus* (syn. *Eupagurus*) *bernhardus* (L.) while both were feeding.

(4) Transport is another distinct advantage. Phoresy (the passive transport of one organism by another) was proposed by Cake (1983) as the reason for the presence of *Thais haemastoma* on hermit crabs (*C. vittatus*) and blue crabs (*Callinectes sapidus*) in the same locale. Phoresy may account for the presence of *Cantharus, Anachis,* and *Boonea*. Dispersal into new feeding areas would certainly be facilitated by accompanying the active hermit crabs.

(5) Protection from predation is also a major advantage for association. The siphonal notch, the umbilicus, ridges, spires, projections, and interior whorls provide a number of hiding places for these small invertebrates. Mississippi coastal substrate generally lacks structural diversity, and shells thus provide structural alternatives for hiding the epibiont. *Lepidonotus, Nereis,* and *Crepidula* were usually found in the shell cavity along with *Porcellana* and other juvenile crabs. *Lepidonotus* was also frequently found in the umbilicus of *Polinices* shells.

The presence of the amphipod *Talorchestia* within the hermit crab's "shell" is probably accidental. The amphipod was collected from crabs that were actively feeding in the same area that contained large numbers of these semiterrestrial amphipods. During the disturbance of specimen collection, the amphipod may have been collected inadvertently. However, the amphipod, *Hyale* sp., and the isopod, *Sphearoma*, are characteristic of epibiotic and fouling communities in Mississippi.

Associated invertebrates may also suffer disadvantages from the relationship. *Clibanarius* often forages in the upper littoral zone and can withstand stranding at low tide. Stranding subjects the symbionts to desiccation and thermal and osmotic stresses. Even slight exposure stresses organisms such as *Hydractinia* and *Calliactis*, and such temporary strandings may account for the virtual absence of these epibionts that are common on sympatric hermit crab species that do not forage above the low tide line in Mississippi Sound. This intertidal existence also subjects associates on the outer shell to abrasion as the crab is rolled by wave action. Furthermore, *C. vittatus* as an adult is an estuarine organism. Symbionts which cannot tolerate the wide fluctuations in salinity, temperature, and turbidity that are associated with estuarine habitats will not survive.

These discussion items are based on observation, and suggest that experimental studies to determine the exact relationships between crabs and associates are needed.

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