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Interspecific and Intraspecific Aggression in Two Species of Urchins: *Echinometra viridis* and *Diadema antillarum*

Abstract

Two species of urchins, Echinometra viridis and Diadema antillarum, were placed in paired encounter situations and observed for aggression. The greatest degree of aggression was noted in the intraspecific encounters with Echinometra in a crevice. Diadema was found to exhibit little intraspecific aggression, and interspecific aggression levels were intermediate. It is suggested that this aggression is due to spatial competition for the crevices which are a protection against turbulence and predation.

Introduction

Both intra- and interspecific aggression have been documented in echinoderms. The Echinometra lucunter urchin displays intraspecific aggression (Grunbaum, etal, 1978). It inhabits individual burrows in shallow surge regions of coral reefs, and defends its hole against conspecific intruders.

Interspecific aggression has been observed in two species of rocky intertidal starfish, Pisaster ochraceus and Leptasterias hexactis. This apparently is related to competition for food; the smaller P. ochraceus directs aggression towards the larger L. hexactis, resulting in a

reduced feeding rate for L. hexactis (Menge and Menge, 1974).

Space is commonly considered a limiting resource in coral reef environments (Sebens, 1982; Goreau, et al, 1979). For Echinometra lucunter the shelter of a burrow is of primary importance as protection from the turbulence (Grünbaum, et al, 1978). Competition for space, then, can be a basis for agonistic behavior in a coral reef system.

Two of the most common urchin species at Discovery Bay, Jamaica are Diadema antillarum and Echinometra viridis. Both of these species inhabit shallow, turbulent areas of the reef, sometimes sympatrically. Diadema is a purplish-black urchin with a test diameter usually 3-7cm and spines 6-16cm. These long spines are brittle and break easily. Diadema therefore needs protection from the surge. During the day, many stay in crevices under coral or other rocky structures. Many others, particularly in turbulent weather, form aggregations of up to thirty individuals in more open areas (Pearse and Arch, 1969). Magnus (1965) attributes this to competition for space. The aggregations may help shield the individuals from the surge. Diadema moves from these crevices and aggregations at night and forages actively.

Echinometra is a red urchin with a test diameter of 2-5cm and purple-tipped spines from 1.5-3.5cm. It usually inhabits crevices in coral rock, and rarely ventures more than a few centimeters from its home. The hole is thus vital to an Echinometra; almost never are they found in the open.

These crevices seem to be a limiting resource at Discovery Bay. This study predicts that inter and intraspecific aggression will occur if confrontations are engineered. More specifically, since crevices are presumed to be an important limiting resource, Echinometra residing in crevices should display more aggression than those out in the open. Since Echinometra are more sedentary than Diadema, and thus have a particular home crevice, it is predicted that Echinometra will display more intraspecific agonism than will Diadema. In addition, Diadema have a tendency to aggregate (Pease and Arch, 1969). One would therefore expect that more aggression would occur when an Echinometra is placed near a Diadema's crevice than when a Diadema is placed near a conspecific's crevice, and that there will be greater aggression when a Diadema is placed at an Echinometra hole than when a Diadema is put by a Diadema hole.

It is further hypothesized that an Echinometra residing in a crevice will be more aggressive towards a Diadema than an intruding Echinometra will be towards a Diadema in a crevice, because in the first case, the Echinometra is defending its own hole. The intraspecific aggression of Echinometra in a crevice should be greater than the aggression exhibited by Echinometra in a crevice against a Diadema. Diadema, because of its longer spines, usually cannot fit into the same size crevices as Echinometra.

Finally, as suggested by Grünbaum et al (1978), it is predicted that the resident Echinometra will have an advantage in intraspecific confrontations, and that this advantage will be greater for crevice residents than for residents in the open.

Study Site

This study was conducted at Discovery Bay Marine Laboratory, Discovery Bay, Jamaica, West Indies. Three areas of the bay were used. Columbus Park, a shallow surge zone filled with Acropora cervicornis rubble, dusky damselfish territories, and colonies of Zoanthus sociatus, houses a large population of Echinometra viridis and a smaller population of Diadema antillarum. This is the only site used in which the two species co-occur.

The mangrove cove is a small protected area which receives a considerable amount of detritus in turbulent weather. It provides a complex substrate with many crevices for its population of Echinometra viridis.

The west back reef is a shallow wave-swept area with crevices under coral rock, in which Diadema antillarum take refuge. The Diadema also form aggregations in the sand near these coral outcroppings.

Methods

Sixty-one encounters were set up between pairs of urchins. Each consisted of placing an intruder urchin next to a resident urchin, either at the entrance of the resident's crevice or in the open. Five types of encounters were observed (Table I.).

Table I. Encounters

Resident	Intruder	N
Echinometra (crevice)	Echinometra	16
Echinometra (open)	Echinometra	15
Echinometra (crevice)	Diadema	10
Diadema (crevice)	Echinometra	10
Diadema (crevice)	Diadema	10

Aggression, as determined by spine and tube foot waving and pushing, chasing, or biting with the Aristotle's lantern, was recorded. The winner of each encounter, defined as the urchin ultimately holding the resident's place, was recorded when a winner existed. Each encounter was observed until the two urchins settled into stationary positions, up to a maximum of fifteen minutes. This timespan and the distance between the two urchins was also recorded. Finally, the spine length and test diameter of each urchin were measured.

G-tests were performed to compare the frequency of aggression in the various types of encounters. A G-test was also used to compare the resident advantage for Echinometra in a crevice to Echinometra in the open.

Results

Aggression was observed in at least one trial of each type of encounter. This was usually in the form of spine and podia waving and pushing and less frequently involved chasing. Biting was observed in one instance in an intraspecific Echinometra encounter in the open. The intruder turned on to its side, protruded its Aristotle's lantern, and presumably was biting the resident's spines, although this was not observed.

The results of each type of encounter are presented in Table II.

Table II. Results of Encounters

Type	N	#aggression	#non-aggression	#resident win	#intruder win	#larger win	#smaller win
Echinometra-Echinometra crevice	16	14	2	10	1	4	3
Echinometra-Echinometra open	15	8	7	2	2	3	0
Diadema-Echinometra crevice	10	6	4	6	0	2	4
Echinometra-Diadema crevice	10	6	4	2	4	2	4
Diadema-Diadema crevice	10	1	9	1	0	1	0

Ties were observed in seven cases; either both urchins moved away or they were still together at the end of the fifteen minute period.

The resident urchin won 71.4% of the aggressive encounters in the intraspecific trials with Echinometra in a crevice. The intruder won only 7.1% of these aggressive encounters.

No correlations found between the size of the urchins and the winner. No pattern was seen to the length of time until both urchins stopped moving, or to the distance they moved.

Echinometra (crevice) displayed significantly more intraspecific aggression than did the Echinometra (open), with a p-value less than .05. Echinometra (crevice) was significantly more aggressive towards conspecifics than

was Diadema (crevice), $p < .001$. Both the Echinometra intruding upon Diadema (crevice) and the Diadema upon Echinometra (crevice) displayed significantly more aggression than did Diadema in the intraspecific trials, $p < .025$. The levels of aggression for these interspecific encounters, however, were equal. Intraspecific aggression in Echinometra (crevice) was not significantly greater than interspecific aggression with resident Echinometra (crevice) and Diadema ($p < .5$). The resident Echinometra in the crevice intraspecific encounters was not found to be more likely to win than in the open encounters ($p < .1$).

Discussion

Agonistic behavior clearly occurs between these sea urchins in artificially induced encounter situations. If this aggression is related to spatial competition, it should be greater when there is a space to be competed for. Echinometra viridis stay in their crevices most of the time, for protection from the surge and probably also as a protection from predation. The crevice of Echinometra, then, is a vital resource, which when threatened, should be defended. An Echinometra without a crevice should be seeking one, and may attempt to displace a conspecific in order to gain one. One could therefore

expect the high level of aggression found in these intraspecific encounters (Table II).

Alternatively, if there is no choice space such as a crevice to be had, agonistic behavior due to spatial competition would be futile as well as energy costly. The intermediate levels of aggression seen in the intraspecific encounters carried out with Echinometra in the open may be attributed to competition for food. Echinometra feed mostly on floating algae and Thalassia pieces, so a nearby conspecific may interfere with the amount of food it can capture.

The higher level of aggression found in the crevice encounters suggests that competition for space is a major factor in this intraspecific agonism.

Diadema and Harum often stay under coral rock overhangs during the day. These spaces are apparently limited, but Diadema also form large aggregations on the sand, probably as protection from both turbulence and predation (Pearse and Arch, 1969). Therefore Diadema have a viable alternative to crevices. Furthermore, since they tend to aggregate, intraspecific aggression would be counterproductive. Indeed, intraspecific aggression was shown to be significantly greater for Echinometra (crevice) than for Diadema (crevice).

No difference was found between the level of aggression when an Echinometra was placed at a Diadema crevice and when a Diadema was placed by an Echinometra crevice. Since Diadema is so much larger than Echinometra, it cannot use the same size crevices as Echinometra. Competition for crevices, then, probably is not the determining factor in this interspecific aggression.

Both of these cases, however, had significantly greater levels of aggression than the Diadema intraspecific interactions. This can be attributed to Diadema's tendency to form large groups; Diadema cannot afford to display aggression towards conspecifics. It does not aggregate with Echinometra, so interspecific aggression can be exercised, perhaps as a spacing mechanism.

Because of Diadema's longer spines and inability to fit into Echinometra crevices, it was predicted that Echinometra intraspecific aggression would be greater than the interspecific aggression displayed when a Diadema is the intruder upon an Echinometra crevice. This difference was not significant. A larger sample size could lead to a larger difference in agonism levels. Alternatively, the Echinometra may not be sufficiently discerning

to always recognize whether an intruder actually poses a threat. Further tests could be performed using models to determine what the stimulus for aggression is.

Residents were shown to have a greater chance of winning in the Echinometra (crevice) intraspecific encounters. This advantage should only occur for the resident of a crevice. This urchin presumably is familiar with its own crevice and can use the sides of the crevice as leverage for pushing the intruder. Residents in crevices were found to have a greater advantage than residents in the open in Echinometra intraspecific encounters. This difference was significant only to the .1 level, however. Further study and a larger sample size could help confirm or disprove this hypothesis.

Intraspecific behavior may be important in maintaining the distribution of Echinometra viridis. It seems clear that Echinometra does exhibit aggression due to spatial competition, under artificial conditions. Observational studies should be performed to determine if aggression occurs among these urchins in nature.

A good study with a critical analysis of some interesting results.

References

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