PATTERNS OF DISTRIBUTION OF THREE BRITTLESTAR SPECIES (ECHINODERMATA: OPHIUROIDEA) ON CORAL REEFS

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Abstract: Three common species of brittlestars occur under coral rubble in Discovery Bay, Jamaica. We studied the patterns of intraspecific and interspecific distribution of these species. We found that there is a relationship between rubble size and brittlestar abundance. We also found that brittlestars are distributed randomly with respect to conspecifics and interspecifics. This may attest to the success of brittlestars in minimizing both intraspecific and interspecific competition.

Key words: co-occurrence, coral, Ophiocoma echinata, Ophioderma appressum, Ophiocoma pumila, *Poisson, rubble*

INTRODUCTION

Brittlestars are ubiquitous on coral reefs, with more than 1,800 species worldwide. They tend to be cryptic in their habits, avoiding light and seeking refuge in dark crevices during the day (Kaplan 1982). In Discovery Bay, Jamaica, 14 species can be found occurring under rubble (Sides 1981). Our study focuses on the three most common species: *Ophiocoma echinata, Ophioderma appressum,* and *Ophiocoma pumila.* Paine and Platt (1999) studied the coexistence of these species under rubble in the back reef of Discovery Bay. They found that *O. echinata* was found less frequently with other species than with conspecifics, while *O. appressum* was found more frequently with other species. However, their study did not distinguish whether patterns of coexistence were due to tendencies to avoid conspecifics, tendencies to co-occur with other species, or a combination of both.

To better understand distribution patterns of brittlestars under rubble, we studied the intraspecific distribution of the three common species in the back reef at Discovery Bay to determine whether they are clumped, overdispersed, or randomly distributed with respect to conspecifics. We also analyzed patterns of co-occurrence between the three brittlestar species. In this way, we expected to determine if intraspecific and/or interspecific interactions drive the patterns we observed.

METHODS

On 25 - 26 February 2004, we overturned 76 pieces of coral rubble in the back reef of Discovery Bay, Jamaica, in water depths of 1.5 - 2 m. Each haphazardly selected rubble fragment was within a size range that could be overturned by a single snorkeler. We recorded the dimensions of each fragment and the abundance of each species of brittlestar present.

We calculated expected Poisson distributions for each of the three species and compared that with the observed distributions to determine whether brittlestar occurrence is a random event (meaning that the presence of one brittlestar does not affect the probability of another being present). We used contingency tables to determine whether patterns of co-occurrence between the three species deviated from random.

RESULTS

Of the 76 rubble pieces that we turned over, 65 sheltered brittlestars. A maximum of seven brittlestars was found underneath one rubble fragment. Size of rubble fragments ranged from 100 - 1140 cm^2.

The distribution of brittlestars did not differ significantly from a Poisson distribution for any of the three species (*O. echinata:* $\chi^2 = 1.75$, df = 2, P = 0.41; *O. appressum:* $\chi^2 = 2.25$, df = 1, P = 0.14; *O. pumila:* $\chi^2 = 1.32$, df = 1, P = 0.25; Fig. 1). Various subsets of rubble fragments of narrower size ranges, in which the area-abundance relationship was not significant, also did not differ significantly from a Poisson distribution. Thus, the relationship between rubble size and brittlestar abundance did not influence our comparison to the Poisson distribution. Patterns of co-occurrence also appeared to be random (*O. echinata* and *O. appressum:* $\chi^2 = 3.00$, df = 1, P = 0.08 , *O. appressum* and *O. pumila*: $\chi^2 = 2.62$, df = 1, P = 0.11, *O. pumila* and *O. echinata*: $\chi^2 = 1.35$, df = 1, P = 0.24; Table 1). We found a positive lin-

Table 1. Observed frequencies of *O. echinata*, *O. appressum*, and *O. pumila*. Values in parentheses are expected frequencies under the null hypothesis of no association between species.

		O. echinata	
O. appressum		Present	Absent
	Present	20 (17)	3 (6)
	Absent	36 (39)	17 (14)

		O. appressum	
O. pumila		Present	Absent
	Present	4 (6)	16 (14)
	Absent	19 (17)	37 (39)

		O. pumila	
O. echinata		Present	Absent
	Present	12 (15)	44 (41)
	Absent	8 (5)	12 (15)

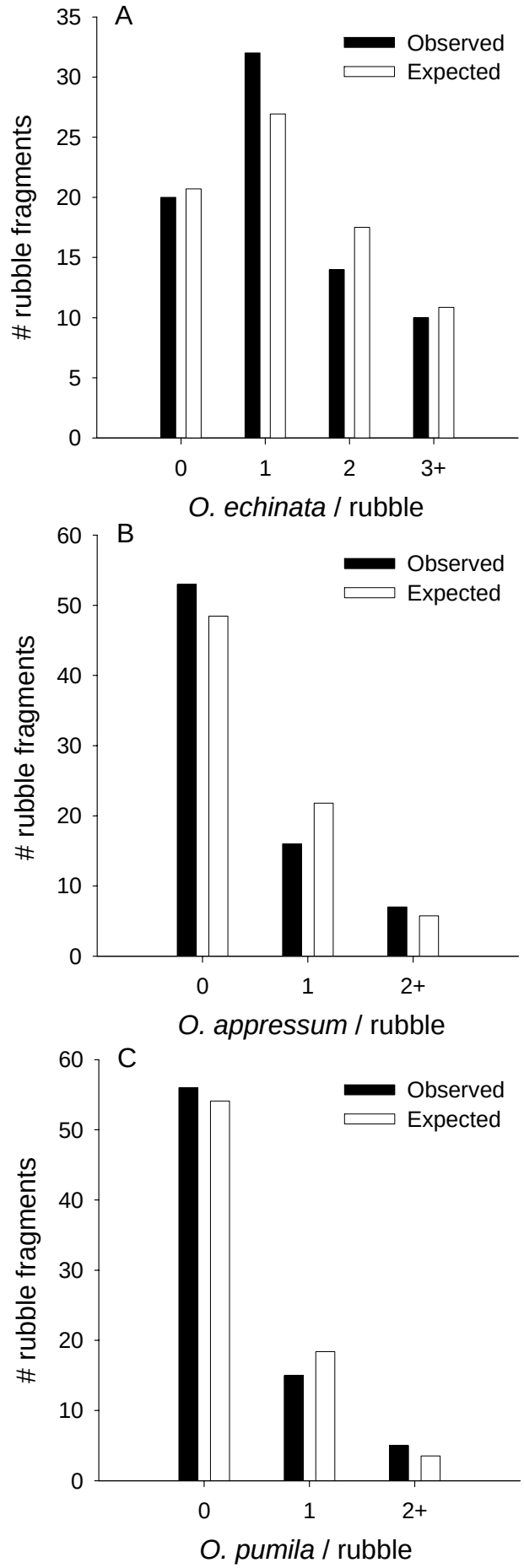

Figure 1. Observed and expected distributions of brittlestars under rubble fragments. Expected values calculated from a Poisson distribution. (A) *O. echinata*: mean = 1.3. (B) *O. appressum*: mean = 0.4. (C) *O.pumila*: mean = 0.3.

ear relationship between size of rubble and abundance for *O. echinata* and *O. appressum*, but not for *O. pumila* ($r^2 = 0.12$, P = 0.002; $r^2 = 0.11$, P = 0.004; $r^2 = 0.0014$, P = 0.75, respectively; Fig. 2). Total brittlestar abundance also increased linearly with rubble size ($r^2 = 0.18$, P = 0.0001).

DISCUSSION

The pattern of brittlestar abundance matches the Poisson distribution, and thus, appears to be driven by random processes. That is, the presence of one brittlestar does not influence the probability of the presence of another. Contrary to the results of Paine and Platt (1999), we found that no two species tended to co-occur less or more frequently than by chance. This suggests that there is no competitive exclusion or facilitation between these three brittlestar species.

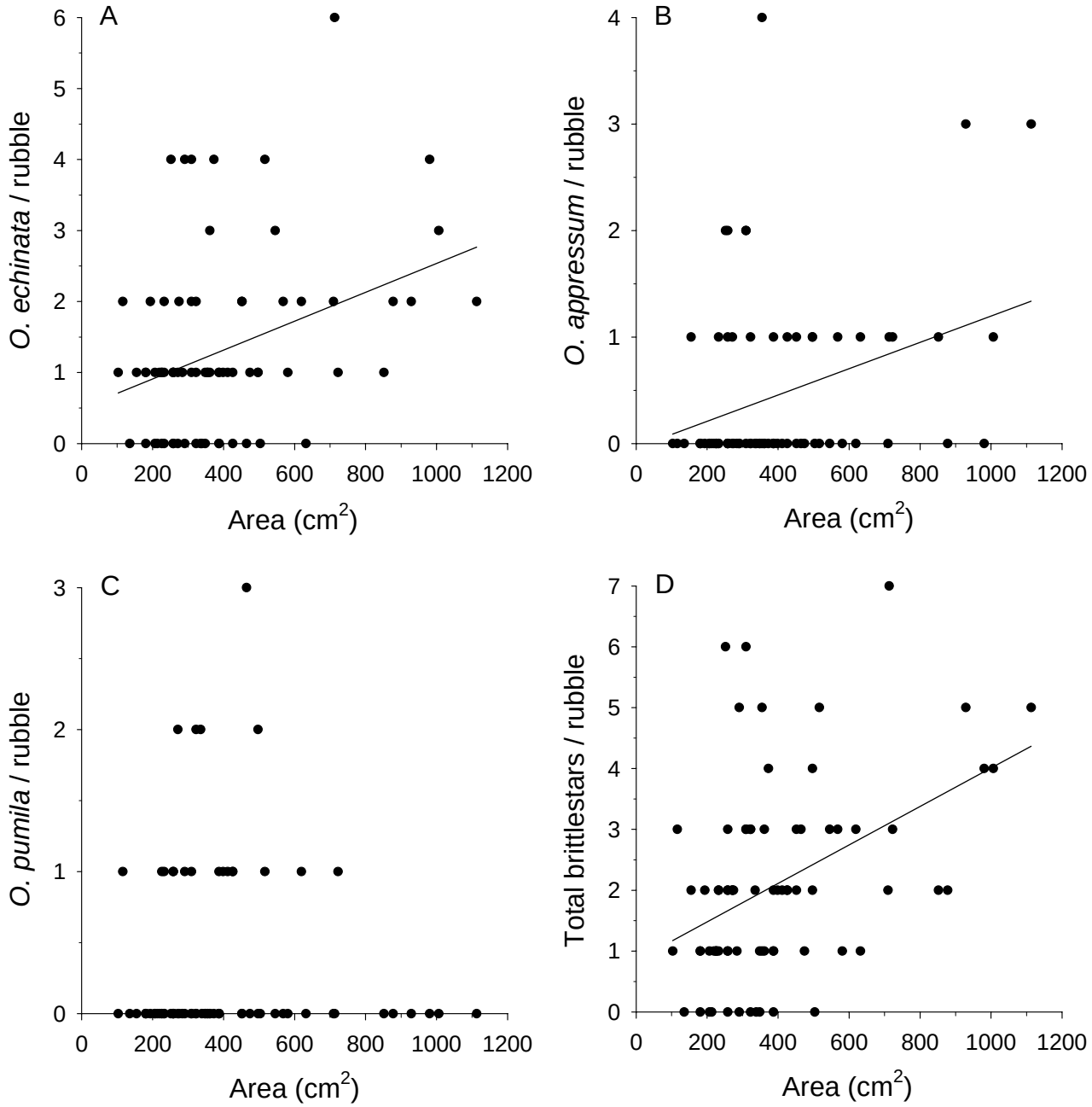

Figure 2. The relationship between brittlestars per rubble fragment and area of rubble fragment. (A) *O. echinata*: y = 0.50 + 0.13x. (B) *O. appressum*: y = -0.04 + 0.008x. (C) *O. pumila*: no significant relationship. (D) Total: y = 0.85 + 0.02x.

The relationship between rubble size and brittlestar abundance in *O. echinata* and *O. appressum* suggests that either larger fragments are capable of housing more individuals (with space being limiting), are encountered more often by colonizing individuals, or are preferred more. However, we can eliminate the first possibility of space limitation because the pattern of brittlestar distribution matches the Poisson distribution. They are not over-dispersed as one would expect if space were limiting. We can also reject the second possibility of unequal encountering rates, since we would expect to see this relationship in all three species, but it is not the case for *O. pumila.* Therefore, it seems that preference for larger rubble fragments is the most reasonable explanation for the relationship between rubble size and abundance. Larger fragments may provide better refuge from predators because they allow brittlestars to retreat farther from exposure at the edge. However, *O. pumila* seems to utilize different spaces within rubble fragments than *O. echinata* and *O. appressum*. We observed *O. pumila* pressing themselves into small crevices, unlike the other two species which tended to occupy the space underneath the rubble. Thus, *O. pumila* may obtain refuge in a different manner.

Patterns of brittlestar dispersal appear largely driven by random processes. However, preference for larger rubble fragments may also play an important role. Future studies examining the role of habitat preference and predation in brittlestars may improve our understanding of patterns in brittlestar distribution.

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