Threespot damselfish housekeeping: Behavioral differences in the expulsion of snails in two coral reef habitats

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Abstract: Threespot damselfish, *Stegastes planifrons,* defend territories in which they maintain a garden of macroalgae. Based upon an initial observation of a damselfish removing a snail from its territory, we hypothesized that the threespot damselfish removes herbivorous snails from territories to prevent these competitors from consuming algae. We also hypothesized that in areas where snails are more abundant, they represent, and are recognized as, more of a threat to algal productivity. We observed the response of *S. planifrons* to experimentally introduced snails and rocks in their territories in the back reef and in the mangrove area at Discovery Bay Marine Laboratory. As predicted, a higher proportion of snails was removed than rocks in the back reef, supporting our first hypothesis. A higher proportion of snails was removed in the back reef than in the mangroves, matching the pattern of snail abundance, and supporting our second hypothesis. We suggest that snail removal could either be a learned response where snail density is higher or may only be energetically possible when pressure from conspecific intrusion is low.

Key Words: algal garden, grazer, herbivory, intruder, territoriality, territory quality

Introduction

Threespot damselfish, *Stegastes planifrons,* maintain macroalgal gardens within territories which they defend against intruders (Klumpp et al. 1987). Klumpp et al. (1988) showed that, despite aggressive defense by damselfish, some of the macroalgae is consumed by intruders, including snails. We observed a threespot damselfish removing a snail from its territory on the West back reef at Discovery Bay Marine Laboratory, Jamaica. We hypothesized that the fish remove herbivorous snails from their territories because snails detract from territory quality by consuming algae. Previous study has shown that damselfish use visual cues to recognize different fish species and thereupon determine the degree of defensive response (Conte 2000). We assumed that these cues would also allow damselfish to recognize snails as competitors. We therefore predicted that the damselfish would remove a greater proportion of experimentally introduced snails than of an innocuous control, i.e. experimentally introduced coral rock. We further hypothesized that where snails are more abundant, they represent, and are recognized as, more of a threat to algal productivity. We predicted that damselfish in habitats with high snail abundance would remove a greater proportion of snails from their territories than damselfish in habitats where snails are scarce.

Methods

We observed the response of threespot damselfish to experimentally introduced snails and rocks in their territories on 25-26 February 2001 in the back reef and in the mangrove area at Discovery Bay Marine Laboratory, Jamaica. The rocks were of similar size and shape to the snails, presumably representing innocuous controls. We determined the core area of the fish's territory by eliciting a defensive response to an encroaching observer, and placed either one snail or one rock in that spot. Individual fish were only sampled once. We observed the fish from a distance of approximately 2.5 m and recorded the time until the snail or rock was removed by the fish. Observations were terminated after 2.5 min if the object had not been removed by that time. We ran 26 snail and 26 rock trials in the back reef, and 22 snail and 21 rock trials in the mangroves. Three macroalgae height measurements were taken

haphazardly around the core of 31 back reef damselfish territories and 23 mangrove territories. The abundances of snails in the back reef and mangroves were assessed by counting all snails found in 4 min of searching on either side of a haphazardly placed 5 m transect. Ten transects were sampled per site. Snail abundance was square-root transformed and removal time was log transformed to meet the assumptions of normality. Snail and rock removal was analyzed by a contingency table G-test, macroalgae height by a student's t-test, snail abundance by Welch's ANOVA, and the time until object removal by one- and two-way ANOVA.

Results

Damselfish in the back reef removed significantly more snails than rocks from their territories (G-test = 12.32, df = 1, P = 0.0004; Fig. 1). Similar numbers of snails and rocks were removed by damselfish in the mangroves (G-test = 0.26, df = 1, P = 0.61; Fig. 1). Damselfish in the back reef removed a significantly higher proportion of the experimentally introduced snails, 84.6%, than the damselfish in the mangroves, 40.9% (G-test = 10.31, df = 1, P = 0.001; Fig 1). The damselfish in the back reef and mangroves removed a similar proportion of rocks, 38.5% and 33.3% respectively (G-test = 0.13, df = 1, P = 0.72; Fig. 1). The mean height of macroalgae in the damselfish territories at the back reef, 4.9 ± 0.36 cm, was significantly greater than that in the mangrove territories, 1.7 ± 0.38 cm, (T-test = 6.08, df = 52, P = 0.0001). Snails were significantly more

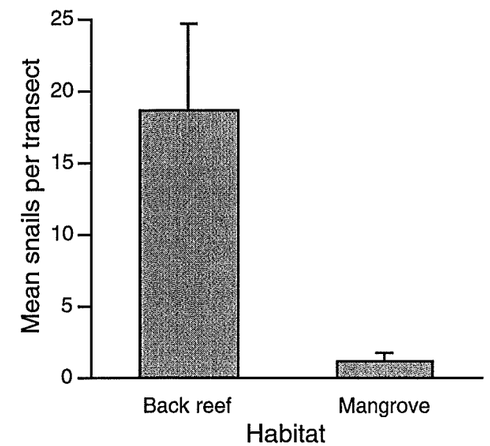

Fig. 2. Mean number of snails (± 1 SE) per 5m transect in two reef habitats at Discovery Bay Marine Laboratory, Jamaica (n = 10).

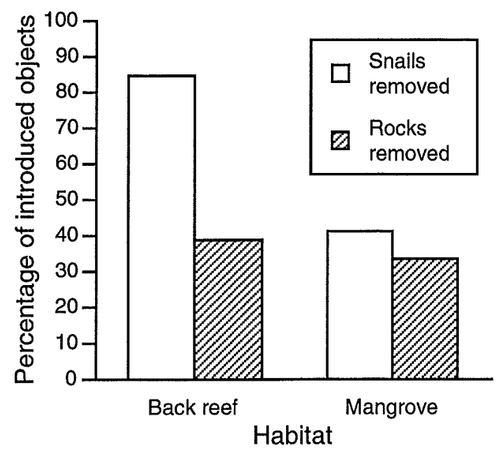

Fig. 1. Percentage of snails and rocks removed from territories by Threespot Damselfish in two reef habitats at Discovery Bay Marine Laboratory, Jamaica. (Backreef n = 52, mangrove n = 43).

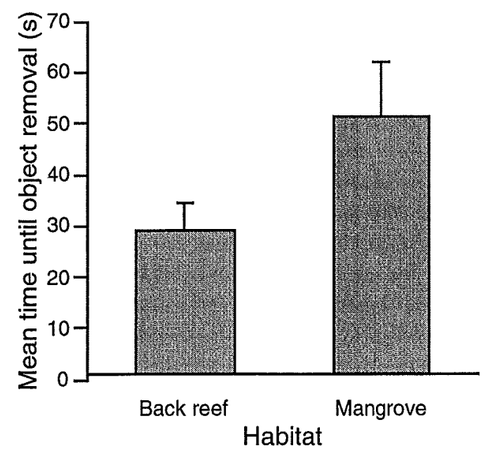

Fig. 3. Mean time (± 1 SE) until threespot damselfish removed the experimentally introduced object--either a snail or rock--in two reef habitats at Discovery Bay Marine Laboratory, Jamaica (Back reef n = 32, Mangrove n = 16).

abundant in the back reef than in the mangroves (Welch's ANOVA, F = 14.59, df = 1, 18, P = 0.003; Fig. 2). Damselfish in the back reef removed objects in significantly less time than fish in the mangroves, (ANOVA, F = 5.54, df = 1, 46, P = 0.023; Fig. 3), although in neither habitat did fish move one object type faster than the other (2-way ANOVA, F = 1.88, df = 3, 44, P = 0.15).

Discussion

As predicted, threespot damselfish in the back reef removed a greater proportion of snails than rocks, suggesting that damselfish distinguish snails from other objects as threats to the macroalgae gardens. Also, damselfish removed a greater proportion of snails in the back reef than in the mangroves, matching the pattern of snail abundance. This finding supports our hypothesis that snails represent, and are recognized as, more of a threat to algal productivity where they are most abundant.

We propose two alternative hypotheses for the development of the snail removal behavior, more common among the back reef damselfish than those in the mangroves. Removing snails from a territory could be a learned response. In this case, one might expect individuals transplanted from the mangroves to the back reef to gradually learn to remove more snails from their territory after exposure to high snail abundance and herbivory of their algal gardens. Alternatively, this behavior may be affected by damselfish density. Damselfish density is higher in the mangrove area than in the back reef (Erickson et al. 2001), and thus snail expulsion may be inhibited by a greater demand for territory defense from neighboring conspecifics. Our data show that damselfish in the mangroves do not respond to introduced objects as quickly as back reef fish, suggesting that the higher defensive pressures require mangrove fish to wait until there is an opportunity to move objects from their territories (Fig. 3). In areas of high damselfish density, energy may be more efficiently spent defending a territory from fish than from snails, as fish present a much greater threat to algal gardens. In this scenario, individuals would spend a greater proportion of time in agonistic interactions in the mangroves than in the back reef. Investigation of the above hypotheses would elucidate the behavioral differentiation between the two reef populations.

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