POTENTIAL BENEFITS OF JUVENILE COLORATION IN DAMSELFISH

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Abstract: Adult damselfish aggressively defend general-purpose territories on coral reefs against both conspecific and heterospecific fish. In contrast to the drab coloration of adults, juvenile damselfish are brightly colored. To explore the potential benefits of juvenile coloration, we examined the conspecific and heterospecific interactions of adults across two damselfish species: Threespot (*Stegastes planifrons*) and Beaugregory (*Stegastes leucostictus*). Adult damselfish may recognize the bright coloration of juvenile conspecifics and identify them as individuals which should not be attacked. Therefore, we hypothesized adult damselfish will be less likely to attack conspicuously colored juvenile damselfish. Furthermore, damselfish may also attack small, colorful fish less than other heterospecific fish visitors because their bright colors resemble juvenile coloration. We observed the number and type of encounters between adult damselfish and other fish. Adult damselfish attacked juvenile conspecifics less frequently than heterospecifics, and small, colorful heterospecifics less than other categories of heterospecifics. This result suggests that small size and bright coloration reduce the frequency of attacks, and that the specific coloration pattern of juveniles may further reduce the frequency of attacks by conspecific adults.

Key Words: Threespot Damselfish, Beaugregory, juvenile coloration, conspecific, heterospecific

INTRODUCTION

Because coral reefs provide habitat for many species of fish with overlapping resources, reef fish have different strategies, including territory establishment, to exploit limited resources and to compete successfully with other fish. Damselfish (Family:Pomacentridae) are known to establish individual territories (Humann 1991), which provide shelter from predators, nest sites for eggs, and food resources in the form of algal gardens (Robertson et al. 1981). Damselfish are pugnacious defenders of these territories, protecting them from both intruding conspecific and heterospecific fish.

Juveniles of these territorial damselfish exhibit bright coloration, which differs dramatically from the uniformly drab coloration of adults. The benefit of this conspecific dichromatism, and more specifically, conspicuous juvenile coloration, is not completely understood. The bright coloration may make juveniles recognizable to adult conspecifics as individuals which should not be attacked (Deloach 1999, Conte 2000). However, given the spatial overlap of adults and juveniles, this benefit of lessened aggression towards juveniles is not self-evident. Our hypothesis, based on Deloach's observations on juvenile coloration, states that conspicuous coloration allows adults to recognize their juveniles, and acts to reduce aggression against juveniles. If our first assumption is correct, and adults attack their juveniles less, we would further hypothesize that adults may also attack small, colorful fish

less than other heterospecific fish visitors since these fish resemble their juveniles. To explore potential benefits of juvenile coloration and bright coloration in general, we examined conspecific and heterospecific interactions of adult Beaugregory (*Stegastes leucostictus)* and Threespot (*Stegastes planifrons)* damselfish in Discovery Bay, Jamaica.

METHODS

We observed 11 adult Beaugregory and 5 adult Threespot Damselfish territories on 22 - 24 February 2006, in the back reef near the Discovery Bay Marine Lab. We chose adult damselfish territories where juveniles were also present. In each territory, we monitored a focal adult for 20 minutes, recording the number of encounters the focal adult had with other fish and the category of each fish encountered. We categorized encountered fish as: (1) adult conspecific, (2) juvenile conspecific, (3) small, colorful heterospecific, (4) large, colorful heterospecific, (5) small, drab heterospecific, or (6) large, drab heterospecific; where small heterospecifc fish were smaller and large heterospecific fish were larger than the focal adult damselfish. We defined each encounter as either an "ignore" (when the adult damselfish did not appear to respond to the presence of the encountered fish) or an "attack" (when the adult damselfish attempted to drive an intruding fish out of its territory).

We tested the effect individual focal damselfish behavior and encountered fishes' morphological category had on the frequency adult damselfish attacked intruding fish using a two-way ANOVA. We compared the compared the means following the ANOVA using a Tukey-Kramer analysis (JMP5.0.1).

RESULTS

Adult damselfish responded differently to the various morphological classes of intruding fish ($F_{5,71}$ = 20.0, P < 0.0001). The effect of individual focal damselfish behavior was not significant, $F_{15,71}$ = 1.26, P = 0.25). Adult damselfish attacked juvenile conspecifics less frequently per encounter than all other categories (Fig. 1). Small, colorful heterospecifics and adult conspecifics were attacked in about one out of every two encounters, and all other categories of heterospecific fish were attacked with high frequency (>70% of the time; Fig. 1).

DISCUSSION

Bright coloration seems to reduce the frequency of attacks by the adult damselfish, as we found adult damselfish attack juvenile damselfish less frequently than all other categories of intruding fish. They also attack small, colorful heterospecifics less than other categories of heterospecifics. However, the difference in the frequency of attacks on juveniles and on

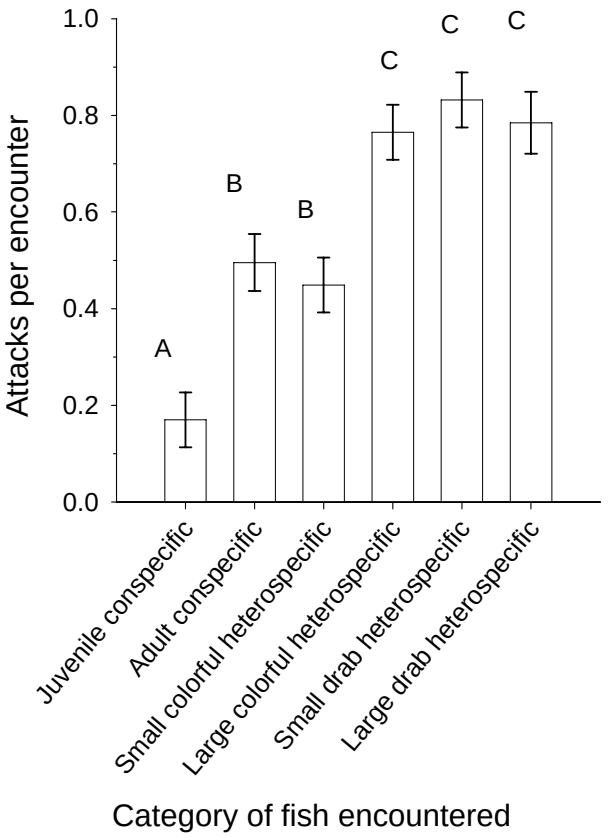

Figure 1: Attacks per encounter by adult damselfish on different categories of fish in Discovery Bay, Jamaica (mean $\pm$ 1 SE). Frequencies of attacks that are significantly different at $\alpha = 0.05$ are represented by different letters (A, B, C; based on Tukey HSD test). Data were collected on 16 individual damselfish. The effect of individual focal damselfish behavior was not significant.

small, colorful heterospecifics suggests that there are additional mechanisms that adult damselfish use to identify conspecific young. Adults may be able to recognize specific color patterns, body shape, or chemical cues of conspecific juveniles. They may attack all conspecific juveniles less in order to avoid attacking their own offspring.

There is also evidence that adults are able to distinguish between species of some fish. For example, we observed squirrelfish utilizing crevices within adult Threespot Damselfish territories without any attack by Damselfish while other colorful fish (blue head wrasse and parrotfish) were attacked. The damselfish apparently distinguished the large, colorful squirrelfish (which do not share a food niche with the damselfish) from other colorful fish--including parrotfish (which share a food niche) and Bluehead wrasse (which prey on damselfish eggs). If damselfish have evolved the ability to recognize non-competitors from competitors and predators, it is possible that they are also able to distinguish the distinctive features of juvenile conspecifics from similar bright color patterns of other small fish species. Given the overlap in food resources between adult and juvenile damselfish, the question of why adult damselfish should attack their juveniles less remains unresolved. However, it is reasonable to assume that adults simply may not consider their juveniles to be competitors.

Previous studies in Discovery Bay examining how size and color of intruding fish affect territory defense of damselfish also found that juvenile coloration decreased adult aggression (Conte 2000). However, in this study, tests using model fish showed different results (decreased aggression towards all colorful fish) than our results. Therefore, we suggest further studies examine the specific mechanisms of recognition in adult damselfish using live fish manipulations, and model fish with different coloration and patterns. Future tests could determine what specific juvenile features adult damselfish are able to recognize, as well as the relative importance of these features in identifying conspecific juveniles as non-competitors.

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