

THE USE OF MIXED-SPECIES FORAGING GROUPS BY THE STOPLIGHT PARROTFISH, *SPARISOMA VIRIDE*

Jonathan J. Ruel and David B. Zug, Jr.

ABSTRACT (JJR)

The stoplight parrotfish, *Sparisoma viride*, is one of many species that associates with mixed species foraging groups on Caribbean coral reefs. Possible reasons for participation in these groups include increased predator vigilance, decreased search time for food patches and increased ability to forage inside damselfish territories. We predicted that in an area with low predation pressure, both adult and juvenile stoplight parrotfish would join groups for the benefits of decreased search time and increased foraging in territories, and that juveniles would benefit more in terms of gaining access to the territories than adults, resulting in a greater overall use of group foraging. However, our results suggest that adults and juveniles use the mixed species groups to a similar degree, but for different reasons. The adults gain better access to damselfish territory while the juveniles benefit from increased foraging rate outside the territories.

Key Words: *Sparisoma viride*, stoplight parrotfish, mixed species groups, foraging, damselfish territory.

INTRODUCTION (DBZ)

Mixed species fish groups consist of core species which lead the groups and spend most of their time in groups, and associate species, which follow the core species and join groups less frequently (Itzkavitz, 1977). Members of mixed species groups benefit from improved foraging efficiency access to defended food resources and predator detection (Foster, 1985). In some habitats, including our study site at Discovery Bay, Jamaica, predatory fish are scarce, so we focused on foraging as the major incentive for fish to join a group.

We examined the use of groups in foraging by the stoplight parrotfish. *Sparisoma viride*, which is found throughout the Caribbean in shallow reef environments (Humann, 1989). The stoplight parrotfish is an associate species, joining mixed species groups as they swim through open areas (Itzkavitz, 1977). It forages

by scraping algae from rocks and corals. The lifecycle of the stoplight parrotfish is characterized by three life stages, juvenile (≈ 3 -5 inches in length), adult (≈ 6 -10 inches), and supermale (≈ 12 -18 inches). Each life stage is recognizable by a distant color pattern (Humann, 1989).

One benefit of group foraging may be increased foraging efficiency due to decreased search time for food patches (Itzkavitz, 1977). When an individual joins a group, it can take advantage of food resources found by other group members. We predicted that both juvenile and adult stoplight parrotfish would have higher foraging rates in groups than when solitary.

Another benefit of group foraging is access to food resources defended by damselfish. Algae in territories defended by damselfish are preferred by herbivorous fish (Reinthal and Fearis, 1986), presumably because the food quality is better due to less foraging. If an individual is able to forage in a damselfish terri-

tory, it will gain access to the preferred food resources. A group can forage more easily than an individual because the damselfish is unable to fend off several fish at the same time (Foster, 1985). When foraging in a damselfish territory, individual fish may have access to the resources, but it may be limited by fewer lites due to attacks by the damselfish. Thus, we predicted lower foraging rates for solitary fish inside of a damselfish territory.

The ability of a solitary individual to forage in a damselfish territory may be related to body size. We hypothesize that a larger individual may be able to overwhelm a damselfish and gain access to the territory. Thus, we predicted that of solitary individuals, adults would have higher foraging rates than juveniles. We predicted that juveniles will benefit more than adults by joining a group.

In addition, we hypothesize differences in foraging rates between morning and afternoon for an individual in any combination of the parameters already discussed due to a buildup in levels of photosynthetic in algae throughout the day (Polunin and Klumpp, 1989).

METHODS (JJR)

This study was conducted in the back reef area of the west side of the fringing barrier reef in Discovery Bay, Jamaica, about 60 meters offshore from the marine laboratory. The area varies in depth from 0.5m to 2.0m and contains large amounts of coral rubble presumably washed back from the crest.

Two snorkeling observers recorded 141 encounters with stoplight parrotfish during March 2-4, 1994. Morning encounters were between 09:15 and 10:16 while afternoon encounters were between 14:30 and 15:55.

Each site was observed for 30 seconds and the number of nips at the substrate during that time was recording as the "foraging rate". The fish was classified as either juvenile or adult using photographs in Humann (1989) as reference. No supermales were encountered. The fish was then classified as solitary or in a group depending on the presence of other fish feeding in the area and whether or not the stoplight appeared to move with them. If the fish was chased by any species of territorial damselfish or obviously inside a territory, it was recorded as such.

Frequencies of individuals solitary and in groups and inside and outside of damselfish territories were compared with Chi-square and G-test analysis. Foraging rates were compared with Wilcoxon two-sample analysis.

RESULTS (DBZ)

We observed 141 stoplight parrotfish. Foraging rates did not differ significantly between morning and afternoon within age class, within solitary and group behavior categories or within location relative to a damselfish territory (Wilcoxon two sample analysis across all parameters, $p > 0.18$). Thus the morning and afternoon data were pooled for further analyses.

A juvenile was just as likely to forage in a damselfish territory whether solitary or in a

group ($X^2 = 0.46$, $df = 1$, $p < 0.5$; Table 1A). However, an adult was more likely to forage in a damselfish territory when in a group than when solitary ($G = 20.12$, $df = 1$, $p < 0.001$; Table 1B). In groups, juveniles and adults were equally likely to be in a damselfish territory ($G = 0.134$, $p > 0.5$; Table 2A). However when solitary, juveniles were about three times more likely to be in a damselfish territory ($G = 4.730$, $p < 0.05$).

Foraging rates of juveniles inside of damselfish territories were similar for individuals alone and in groups (Table 2A). Outside of damselfish territories, juveniles, foraged at rates on the average 2.5 times greater when in groups than when solitary (Table 2A). Whereas for adults outside of a damselfish territory, there was no difference between the foraging rates of individuals solitary and in groups.

Table 1: Number of individuals observed for juveniles (A) and adults (B) proportion of individuals observed inside to outside of damselfish territories.

A. Juveniles		
	Solitary Individuals	Individuals in Groups
Inside Damselfish Territory	18	12
Outside Damselfish Territory	39	35
Σ	57	47
Proportion Inside/Outside	0.46	0.34
B. Adults		
	Solitary Individuals	Individuals in Groups
Inside Damselfish Territory	2	5
Outside Damselfish Territory	20	10
Σ	22	15
Proportion Inside/Outside	0.1	0.50

Juveniles, both solitary and in groups, showed no difference between foraging rates inside or outside of damselfish territories (Table 2A). However, adults in groups outside of damselfish territories foraged at a rate on average four times greater than those inside a territory (Table 2B).

The foraging rates of solitary adults and juveniles foraging outside of a damselfish territory did not differ ($z = -1.32$, $p = 0.180$). There was no difference between foraging rates of adults and juveniles in groups measured inside or outside of a damselfish territory ($z = -1.289$, $p = 0.197$ and $z = 0.595$, $p = 0.552$, respectively).

Comparing the relative numbers of juveniles solitary and in groups to those of adults, we found overall similar use of mixed species groups ($X^2 = 0.11$, $df = 1$, $p < 0.9$; Table 1A, B).

Table 2: Mean foraging rates (bites/30 seconds) of *Sparisoma viride* for juveniles (A) and adults (B) and Wilcoxon test statistics for comparisons between rate solitary and in group and rate's inside and outside of damselfish territories. See Table 1 for sample sizes.

A. Juveniles			
	Solitary Individuals	Individuals in Groups	Wilcoxon Test Statistics
Inside Damselfish Territory	1.11	2.83	$Z = -1.667$, $p = 0.095$
Outside Damselfish Territory	1.56	4.34	$Z = -3.298$, $p = 0.001^*$
Wilcoxon Test Statistics	$Z = 1.158$ $p = 0.247$	$Z = 1.29$ $p = 0.259$	
B. Adults			
	Solitary Individuals	Individuals in Groups	Wilcoxon Test Statistics
Inside Damselfish Territory	0 +	0.8	----
Outside Damselfish Territory	3.65	3.9	$Z = -0.984$, $p = 0.325$
Wilcoxon Test Statistics	----	$Z = 2.041$ $p = 0.041^*$	

*statistically significant, +sample size too small for comparison

DISCUSSION (JJR)

It appears that the fish do not take advantage of the diurnal build-up of photosynthate in the algae, or perhaps the algae being grazed do not experience this build-up phenomenon. Alternatively, the result could be an artifact of our sampling because we missed an overall trend by sampling in only a fraction of both the morning and afternoon. Perhaps it would also be useful to try another measure of foraging activity (e.g. # of observed foraging fish per hour).

While juveniles did not appear to use group foraging to gain better access to damselfish territories, adults did. When solitary, juveniles were more likely to be inside a territory than adults. Perhaps because they are larger and more brightly colored adults are more easily detected and removed from the territory by

damselfish.

We did not find enough solitary adults inside territories to compare their foraging rates to solitary juveniles inside territories. After reviewing the conclusion in the previous paragraph, we might reverse our original prediction and expect the adults to forage at a lower rate than juveniles when solitary inside territories. As expected, foraging rates of adults and juveniles did not differ significantly in any of the other cases.

Although foraging rate data for the solitary adults were inconclusive, adults in groups showed the predicted decline in foraging rate when entering a damselfish territory. The juveniles did not show this trend and it again appears that adults have a more difficult time foraging in damselfish territories.

If joining a group decreases search time

for food patches, one would expect a greater foraging rate in groups. This was supported by the foraging rates of juveniles (outside territories, Table 2A). Adults did not seem to benefit from groups in this way (Table 2B). Perhaps with increasing age, fish learn to find patches more efficiently when solitary, maybe having learned from the groups when young. It is also possible that the higher foraging rate juveniles experience when in groups is due to factors other than patch search time.

Our general prediction was that juveniles use groups more than adults because while they benefit equally from decreased search time, juveniles gain more from the access to damselfish territories. It seems, however, that the two ontogenetic stages use groups with similar frequency, but for different reasons. The juveniles benefit from an increase in foraging rate outside of damselfish territories while the adults gain better access to protected algae inside the territories.

Our data may have been biased by pool-

ing all fish observed and discerning between the majority, which were foraging, and a few which may have been involved in other activities (e.g. travel and hiding). Further study should include detailed time budget analysis and an investigation of the variation in patch search time across ontogenetic stage, when solitary and in groups.

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