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An observational study of surgeonfish feeding behavior.

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Abstract

An observational study was done on the West Back reef at Discovery Bay, Jamaica on the feeding behavior of three species of surgeonfish; the Ocean Surgeon, Doctorfish and Blue Tang. Comparisons were made between attack rates on the fish and feeding aggregate composition with respect to fish found feeding on Algal turf vs. Thalassia beds. Comparisons were also made between the three species. Results seem to show some signs of food resource partitioning by the three species which could suggest the presence of some type of dominance interactions between species.

Introduction

Three species of surgeonfish are common members of the coral reef community at Discovery Bay, Jamaica. The Blue Tang (Acanthurus coeruleus), Doctorfish (A. chirurgus) and Ocean Surgeon (A. bahianus) are all predominantly herbivorous, and browse primarily on filamentous algae and the epiphytic growth on Thalassia. Often surgeonfish feed in the defended territories of damselfish (Pomacentrus), and an individual fish's feeding bouts are often ended by damselfish attacks. Surgeonfish in this area are commonly found in feeding aggregations, both with congeners and in mixed genera groups which often contain parrotfish, goatfish, and wrasses. Schooling has been suggested to be important both as a method of gaining access to the defended resources of the damselfish (Foster 1985), and as a way of avoiding predation (Brock and Rittenburgh 1960, Hobson 1968, Erhlich and Erhlich 1973). Juvenile Blue Tangs have also been found to be territorial, defending their territories from both conspecifics and congeners (Foster 1985).

I observed that individual surgeonfish feeding on Thalassia seemed to spend a larger proportion of their time actually consuming food than did those browsing on algae. To try to figure out why this might be so I observed the feeding behavior of the three species on Thalassia beds and algal turfs, and then tested a number of null hypotheses. First, there should be no difference in the number of attacks on surgeonfishes in the two areas, or the degree to which the surgeonfish reacts to these attacks. Also, they

should be no difference in the size or composition of the feeding aggregations participated in by surgeonfish found in Thalassia beds or algal turfs.

I also observed a few aggressive interactions between feeding surgeonfish of both the same and different species; these were most often initiated by juvenile Blue Tangs. Dominance relations have been found between many species of ⁱⁿ surgeonfish, reflected both in agonistic behavior between species and habitat partitioning by different species (Robertson and Gaines 1986), but all three of these species are considered equally susceptible to damselfish attack (Foster 1985). I developed a set of null hypotheses to compare different aspects of each species' behavior and food choices. These were that there would be no difference in ^{the number of} attacks by damselfish and surgeonfish on the different species, ^{and} no difference in the food chosen or the type of aggregation ^{in which} the individual surgeonfish was found for the three species.

Methods

All observations on feeding surgeonfish were carried out at the West Back Reef at Discovery Bay, Jamaica during the period February 28 to March 7, 1980. I concentrated my study on the fringe of this reef, an area made up of both rocky and living coral reefs in about 1 to 2 m of water. This area is characterized by small clusters of corals and rocky outcrops, often covered with dense algal mats. These clusters are separated by open patches of sandy substrate and are bordered to the North by the much larger, denser reefs that constitute the fore reef, and to the South by wide expanses of Thalassia. Many species of pomacentrids defend territories in this area; especially common are the Threespot damselfish (Pomacentrus planifrons) and the Dusky Damselfish (Pomacentrus fuscus).

The observational method that I employed was to begin swimming West, starting at the part of the fringe of the West Back Reef directly North of the Marine Laboratory. I watched for a fish to take at least 10 bites from a particular substrate, and then watched to see what type of activity marked the end of each feeding bout. These activities were grouped into: Attack by damselfish, Attack by surgeonfish, or no attack. The species and size of the feeding surgeonfish was recorded, along with the composition of any feeding aggregates with respect to total number and genera of other fish involved. The size of the surgeonfish were estimated using the gridded pages of a Nalgene underwater notebook; the length of the body from the mouth to the end of the body (excluding tail) was recorded in units of these

~6.5 cm squares. For testing, fish were grouped into categories of 2 - 2.6 cm (3-4 squares), 2.7 - 4.6 cm (>4-7 squares), and > 4.7 cm (>7 squares). Feeding aggregates were characterized as either a group of congeners, mixed genera, or a solitary individual. If the surgeonfish was attacked, the species of the attacker was recorded, along with the degree of reaction exhibited by the surgeonfish. Reaction category ① was a minor disruption of feeding activity after which the surgeonfish resumed feeding quickly in an area no more than 20cm. from where it had been feeding. A ② reaction was when a fish moved >20 cm < 0.5m from its original position but still resumed feeding, and a ③ reaction was when the fish moved more than 0.5m or did not resume feeding in the first 30 seconds after the attack.

The substrate upon which the surgeonfish was feeding was recorded as Thalassia, Algae on a rocky (includes coral) substrate, or algae on open, sandy substrate. No more than 4 observations were taken on an individual fish, and no more than 10 observations were taken on individuals from one feeding aggregate.

To determine whether surgeonfish spent more time feeding when foraging on Thalassia than when foraging on algae, 4 10 minute observations were done on surgeonfish feeding on each. The 10 minute period started when a fish was found that had taken at least 10 bites on either Thalassia or algae. The number of minutes the fish spent feeding during the 10 minute period was recorded. If a fish switched feeding substrates during the time period, the trial was terminated. ¹ Students t-tests was performed on these sets of data.

To test the first group of null hypotheses, a number of Chi-square and G-tests were performed. A Chi-square test was done to compare the ratio of attacks by damselfish, attacks by surgeonfish and no attacks on the focal surgeonfish in the Thalassia vs. the Algae. 2 G-tests were performed comparing the degree of attack by damselfish and by surgeonfish on surgeonfish feeding on the two substrates. A G-test was done comparing the number of feeding observations of the 3 species of surgeonfish with respect to the feeding choices of Thalassia, algae on rocky substrate, and algae on sandy substrate. Chi-square tests were done comparing the type of feeding, aggregate and size of aggregation between the fish feeding on algae or Thalassia.

To test the second set of null hypotheses, Chi-square tests were done to compare the number of attacks vs. no attacks across the three species, and to compare the number of damselfish attacks between different types of feeding aggregations. A G-test was done to compare the types of aggregations participated in by the three surgeonfish species.

Results

The number of minutes in a 10 minute period spent feeding by surgeonfish was found to be significantly higher for fish feeding on Thalassia than for fish feeding on algae (Student's t-test, $p = < .01$, $df = 6$). The mean time per 10 minute period on Thalassia was 6.90 minutes with a standard deviation of .34 minutes, and for fish feeding on algae was 3.41 minutes with a standard deviation of 1.54 minutes.

A total of 132 surgeonfish feeding bouts were observed; 87 of these were of Ocean Surgeons, 26 of Doctorfish, and 19 of Blue Tangs. The majority of observations were made on Ocean Surgeons between 2 and 4.6 cm long (See Fig. 1). No difference was found in the ratio of attacks on surgeonfish by damselfish, by surgeonfish, and end of feeding bout without attacks between feeding bouts on Thalassia vs. on algae (chi-square test, $\chi^2 = 1.51$, $p > .1$). In Thalassia beds, 54% of feeding bouts ended in damselfish attack, 8% ended in surgeonfish attack, and 38% ended in no attack. Feeding bouts in algae ended in damselfish attack 48% of the time, in surgeonfish attack 15%, and no attack 37% of the time (See Table 1.). There was also no difference in the degrees of either damselfish or surgeonfish attacks in the two feeding areas (both G tests, $G = 1.08$, $p > .1$ and $G = 1.40$, $p > .1$ respectively).

No difference was found between the type of feeding aggregation that surgeonfish were found in when feeding on algae vs. Thalassia (Chi-Square test, $\chi^2 = 1.56$, $p > .5$) (See Table 2). No difference was found between the size of the feeding aggregation that surgeonfish were

found in when feeding on algae vs. Thalassia (Chi-square test $\chi^2 = 1.22$, $p > .5$) (See Table 3.)

A significant difference was found in the ratio of where each of the 3 species of surgeonfish were found feeding (G test, $G = 13.9$, $p < .01$ df = 4). (See Table 4). Blue Tangs were found to feed on algae on rocks 86% of the time, Ocean Surgeons 54% of the time, and Doctorfish were found to feed on algae on rocks 21% of the time.

No difference was found in the number of combined attacks by both damselfish and surgeonfish vs. no attacks for the three surgeonfish species (Chi-square test, $\chi^2 = 3.055$, $p > .1$) (See Table .). A significant difference was found in the feeding aggregation patterns found for the three surgeonfish species (G test, $G = 9.54$ $p < .05$ df = 4) (See Table 6). A significant difference was also found in the number of attacks^{by damselfish} vs. no attacks for fish feeding in each of the types of feeding aggregations. (Chi-square test, $\chi^2 = 6.52$, $p < .05$, 2df). Fish in mixed species schools tended to be less likely to be attacked than did those in schools with congeners only, or solitary individuals (See Table 7.)

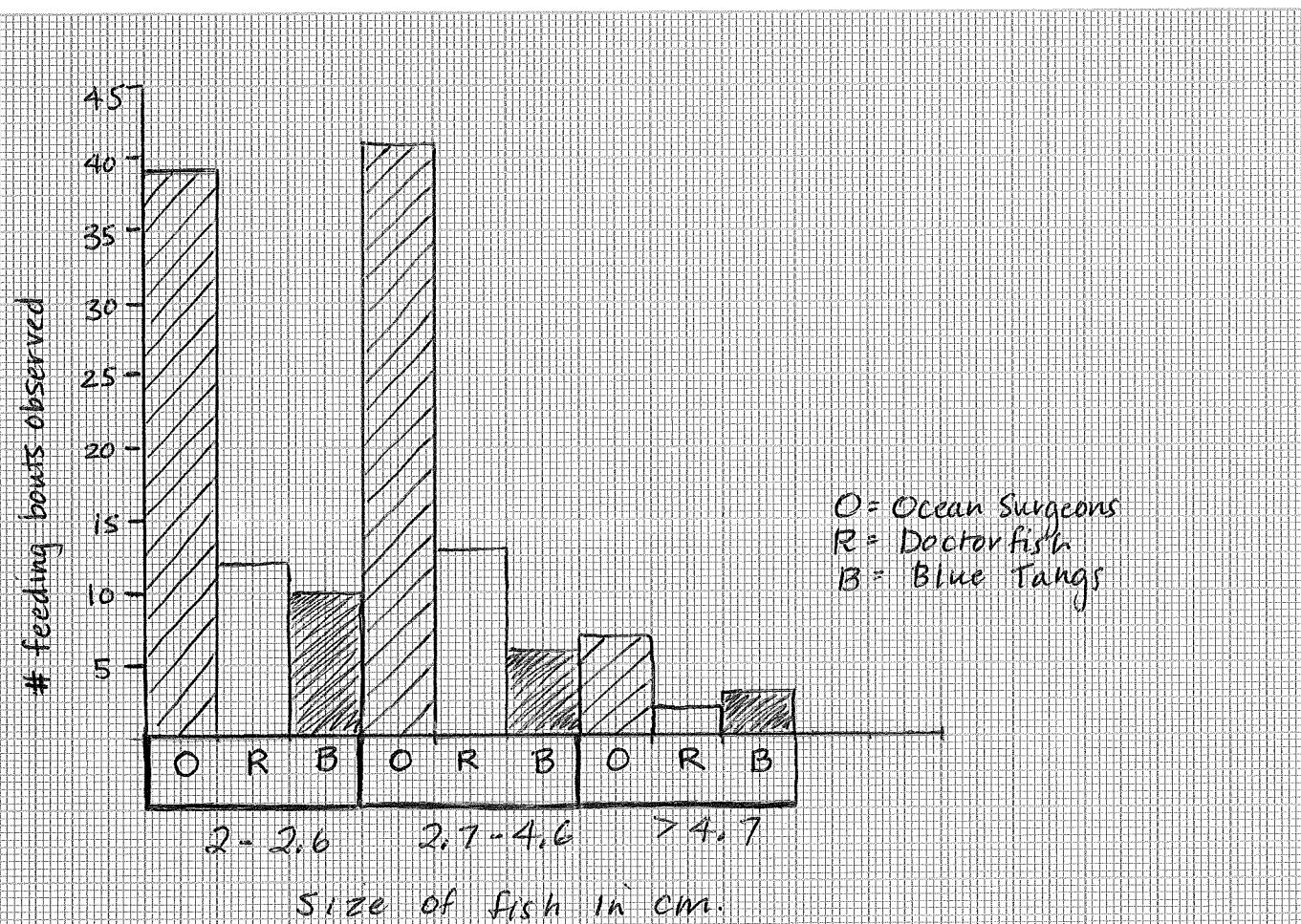


Fig. 1 Size distribution of the three species of surgeonfish observed feeding. Totals equal 87 Ocean Surgeons, 26 Doctorfish, and 19 Blue Tangs.

TABLE I. Number and degree of attacks of damselfish and surgeonfish on surgeonfish, and number of feeding bouts ending without attack on Thalassia vs. Algae.

Attack	<u>Thalassia</u>		<u>Algae</u>
	1	2	3
Damselfish			
degree 1	2	3	
2	16	17	
3	10	18	
Attack			
Surgeonfish			
degree 1	3	5	
2	1	6	
3	0	1	
No Attack	20	29	

[TABLE 2] Feeding aggregation surgeonfish found in when eating either Thalassia or algae.

	<u>Thalassia</u>	Algae
Alone	9	19
Congeneric	10	14
Mixed	25	36

[TABLE 3] School sizes found in Thalassia and algae, and attacks and non attacks found for each size.

Group size	<u>Thalassia</u>				Algae				% = percent attacked is of total observ. for that category
	Total	Attack	Not	%	Total	Attack	Not	%	
1	9	5	4	55	18	8	10	44	
2-5	10	7	3	70	20	15	5	75	
6-10	14	8	6	57	14	8	6	57	
> 10	13	7	6	54	18	10	8	55	

[TABLE 4] Feeding locations of each of three sp. of surgeonfish

species	<u>Thalassia</u>	Algae on rocks or coral	Algae on sandy substrate
Ocean Surgeon	28	44	10
Doctorfish	19	6	3
Blue Tang	1	18	2

[TABLE 5.] # of attacks vs no attack by species

	Attack	No Attack
Ocean Surgeon	53	29
Doctorfish	13	15
Blue Tang	13	7

TABLE 6.

Schooling patterns of 3 surgeonfish species.

Aggregation
Alone Congeneric Mixed.Species

Species	Alone	Congeneric	Mixed
Ocean Surgeon	15	18	40
Doctorfish	5	3	17
Blue Tang	8	1	6

TABLE 7.

Attacks vs. no attacks on surgeonfish in different types of feeding aggregations.

Alone | Congeneric | Mixed

Attacks by damselfish	18	20	35
No Attack	9	3	26

Discussion

The results of this study supported my observation that an individual surgeonfish foraging on Thalassia spent more time eating than did an individual foraging on algae. There were, however, no significant trends in the attack rates by damselfish or surgeonfish on the feeding surgeonfish. This is probably due to a difference in the length of each foraging bout being longer in the Thalassia than in the algae; the activity that ends the bout may be the same, but in algae they are probably ended after shorter periods of time due to both an increase in attacks by damselfish and an increase in terminations of feeding bouts

In order to travel to another patch of this more widely dispersed food source. Future studies could test this by comparing feeding bout durations in the two areas.

Differences might occur in the intensity of attacks delivered by damselfish to surgeonfish feeding in different areas because algae, which would usually be found in the center of a territory, is a much more valuable resource to a damselfish than is Thalassia, which is probably found closer to a territory edge. For this reason I tested the reactions to attacks by surgeonfish feeding on algae and Thalassia in ^{or near} damselfish territories. Possibly any difference is lost here because most of the surgeonfish were feeding on sparse algal turf that was not central to a territory. Surgeonfish were aggressively chased away from dense algal turf before they had a chance to feed, so these types of interactions are not reflected in my data.

Surgeonfish might be more likely to be more aggressive with each other when feeding on algae, both because some individuals, for example Juvenile Blue Tangs, tend to protect territories in rocky areas, and also because algae can be found in small patches that would promote more crowding than would expanses of Thalassia. The extremely small sample size (16) could be a factor in this case - further studies with larger sample sizes could uncover this trend. In the future, it might also be interesting to divide the surgeonfish by species to do this type of study.

The similarities between the numbers of feeding individuals found in congeneric groups in both substrates and mixed groups in both substrates could suggest that there is no advantage for a surgeonfish to be with either conspecifics or mixed groups while feeding on Thalassia when compared to algae, or vice versa. This could mean that any competitive interference interactions are not affected by the change in substrates, or that any advantage of being in either group is unrelated to food choice. Possibly further testing could show a significant difference in the proportion of solitary feeding fish; it seems that single fish would be found more often on algae because territorial fish would probably set up territories on algae as the rocky areas would provide more protection than Thalassia, and also because algae has been shown to be a more preferred food source (Robertson & Gaines 1986).

I expected to find larger group sizes for individuals feeding on algae because surgeonfish seem to use the schooling

Strategy to overwhelm the territorial defenses of the damselfish. It is possible that in this area, the population of schooling fish is not high enough for effectively large schools to form on a consistent basis. This idea seems to be supported in that most fish that were seen feeding on algae did not gain access to the thick algal mats in the highly defended areas of territories. Also, group sizes in Thalassia could be as large as those in algae to compensate for the increased predation pressure in the seemingly more dangerous Thalassia.

None of the three species of surgeonfish were found very often to be eating algae on sandy substrates; this could show that the sparse algae here is not a desirable food when compared to the usually more lush algal growth on rocks, or to the Thalassia. The trend that Doctorfish tend to feed more often on Thalassia, while both other species feed more often on algae on rocks could reflect differences in feeding preferences by the three species, or that possibly some type of dominance hierarchy exists between two or more species. As suggested before, the Blue Tang may establish territories that they defend against the other two species. Possibly the Blue Tang's defenses are less effective against the Ocean Surgeon than against the Doctorfish, or maybe the Ocean Surgeon is also dominant over the Doctorfish, further excluding them from the algal turf. To test this dominance idea, observations could be made on the feeding locations of Ocean Surgeons and Doctorfish after the removal of Blue tangs. Blue Tangs could also tend to avoid

Thalassia beds more than the other two because they are not able to camouflage themselves as well as the the Doctor and Ocean Surgeon. ^{as can the Doctor and ocean surgeon} Blue Tangs can get lighter over lighter substrates, ^{but their bluish tint} still makes them more obvious, at least to me.

The absence of a difference in attack rates for the 3 species by combined damselfish and surgeonfish attackers supports the statement by Foster (1985) that these species are not differentially attacked by damselfish. Possibly if more data ^{were} collected, a difference could be found between the attack rates by each species of surgeonfish on both conspecifics and each congener. This type of data could again reveal some type of dominance hierarchy.

The differences in ~~feeding~~ feeding aggregation patterns for the 3 species shows the tendency for Blue Tangs to be found alone, which probably reflects the presence of some territorial individuals. Usually Ocean Surgeons or Doctorfish seen alone, especially the smaller ones, seemed to be looking for a group to join, while this was not true for the Blue Tangs. Blue Tangs were usually found eating in groups only when the group came to them. Most Ocean Surgeons and Doctorfish were found in mixed genera aggregations; this could reflect a preference for mixed species schools, or a much higher abundance of mixed ~~mixed~~ schools with respect to congeneric schools. Mixed aggregations were generally of a highly temporary nature; compositions of these aggregations changed rapidly as groups left or joined. Groups of congeners,

especially those of small surgeonfish, seemed much less likely to split up.

The trend that surgeonfish in mixed species schools are less likely to be attacked by damselfish than are fish in congeneric schools is very interesting because it suggests that being in a mixed genera school provides some kind of protection for the individual surgeonfish from the damselfish attacks. Possibly some other species of fish, for example parrotfish, are receiving a higher percentage of attacks than are the surgeons. This trend could also reflect a tendency for mixed species schools to be larger in number than congeneric schools, which theoretically should afford more protection for individuals in these aggregations.

Two areas particularly worthy of further study are

- ① The possibility of a dominance hierarchy within the three fish species. ② The possibility of decreased attack rates by damselfish on ~~the~~ surgeonfish in mixed species vs. congeneric schools.

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