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SITE FIDELITY AND FOOD RESOURCES OF THE FOUREYE BUTTERFLYFISH

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Abstract: Butterflyfish are often associated with specific home ranges, though the costs and benefits of living in these home ranges are unclear. We studied site fidelity of the foureye butterflyfish, *Chaetodon capistratus*, in the back reef at Discovery Bay, Jamaica and examined how feeding behavior and vulnerability to attacks by aggressive damselfish changed with distance traveled. We monitored 10 fish over the course of three days. Foureye butterflyfish occurred as pairs or as individuals in non-overlapping home ranges with radii less than three meters. With increased distance traveled, *C. capistratus* suffered increased attacks from damselfish, but benefited from increased foraging attempts.

Key Words: Chaetodon capistratus, *clumped distribution, damselfish, foraging*

INTRODUCTION

Coral-reef fish are often associated with specific home ranges on reefs and are relatively sedentary compared with other vertebrates (Sale 1991). In previous studies a fish's home range has been defined as the area in which a fish spends 95% of its time (Parsons 2003). The foureye butterflyfish, *Chaetodon capistratus*, is thought to live in a specific home range with one monogamous mating partner for long periods of time, possibly for its entire life. Foureye butterflyfish are most often found alone, but they can also be found less commonly in pairs, and rarely in larger groups of up to 12 individuals (Deloach 1999). The foureye butterflyfish forages on almost every bottom substrate, but eats mostly anthozoan polyps (Deloach 1999).

We studied site fidelity, the tendency for an individual to remain in one specific area throughout its life, in the foureye butterflyfish in the back reef at Discovery Bay, Jamaica. We hypothesized that foureye butterflyfish would be site faithful and could be found in the same area repeatedly over a three-day period. We examined some of the costs and benefits of site fidelity in the foureye butterflyfish to better understand why coral reef fish might be faithful to specific sites; specifically, we observed feeding behavior and frequency of damselfish aggression

towards butterflyfish. We hypothesized that for foureye butterflyfish, as total distance moved increases, the number of attacks from damselfish would increase, and foraging efficiency would decrease.

METHODS

Our study was conducted from 24 - 26 February 2005 in the back reef of Discovery Bay, Jamaica (Fig. 1). Snorkeling, we located a total of 10 foureye butterflyfish in 6 different locations (Table 1). When a focal fish was located on a patch of reef, the site was marked and revisited every subsequent morning (0800-1000) and afternoon (1400-1600) throughout our study. Only seven fishes were located during the first observation period (Fishes 6, 9, and 10 were located during the second observation period, Table 1). During each visit, fish were recorded as present or absent. If the foureye butterflyfish was visible from the marked reef patch, within approximately 3 m of the marked location, it was recorded as present; if not seen over the two hour period of observation, it was recorded as absent. We define home range as the 3 m radius area that consistently contained the focal foureye butterflyfish. We compared the arcsine transformed proportions of times fish were present to times fish were absent to assess site fidelity in the foureye butterflyfish (JMP 5.0.1).

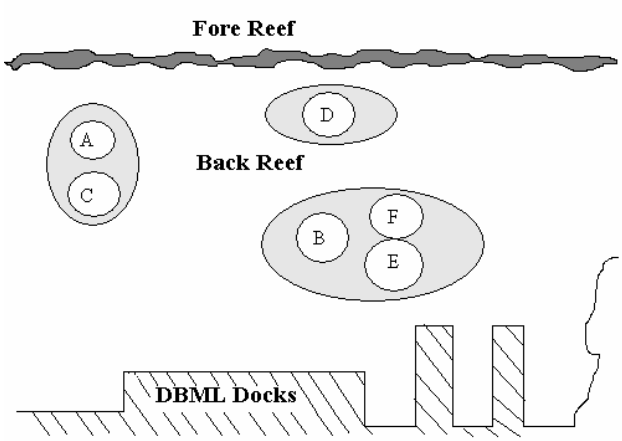

Figure 1. Locations of foureye butterflyfish (n = 10) in the back reef at Discovery Bay. Small circles with letters (A-E) represent non-overlapping 3 m radius home ranges of individuals or pairs that were followed for 10-minute observational periods and monitored over three days. Large shaded ovals represent 'clumps' of foureye butterflyfish observed within the reef.

We conducted 18 ten-minute observation periods of the 10 focal foureye butterflyfish. We recorded maximum distance traveled from marked home range center, number of feeding bites, and number of attacks by damselfish (attacks were any act of damselfish aggression which elicited a response in the observed foureye butterflyfish). We performed a linear regression on the number of feeding attempts and number of attacks by distance traveled to assess the effects of travel distance on feeding efficiency and damselfish attacks (JMP 5.0.1).

RESULTS

Fish were most often found in the locations where they were first sighted ($F = 8.41$, $df = 18$, $P = 0.001$; Table 1). Foureye butterflyfish always occurred alone or in pairs. Fishes 1 and 2 were the only fish that were never found paired with conspecifics (Table 1; they are the only fish found at locations A and B respectively). Our defined home range size seems to accurately reflect fish behavior since at each visit focal fish were never sighted beyond this range and most fish were found re-

peatedly within the marked areas where we first observed them. These home ranges were non-overlapping, but appeared to be aggregated in clumps, approximately 15-25 m in diameter, within the back reef (Fig. 1).

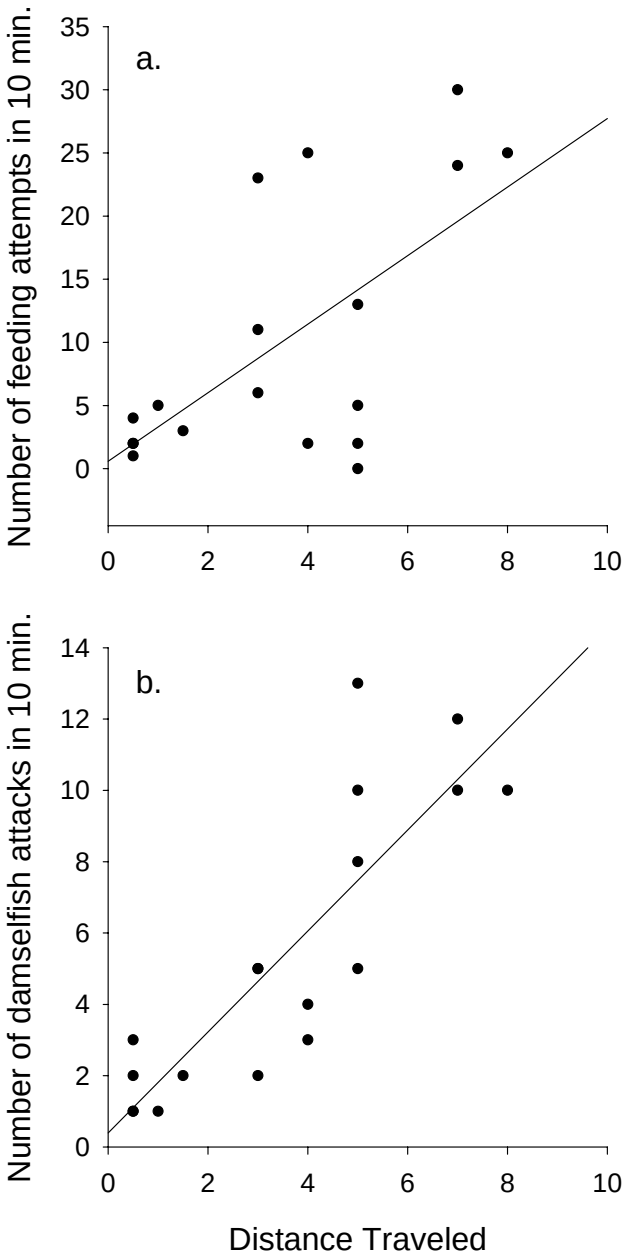

Figure 2. Feeding efficiency and damselfish attacks vs the maximum distance traveled away from the home range. a) Number of feeding attempts vs distance traveled by foureye butterflyfish in 18 ten-minute observation periods ($F = 43.03$, $df = 17$, $P < 0.0001$). b) Number of damselfish attacks increases with distance travelled for foureye butterflyfish ($F = 11.14$, $df = 17$, $P = 0.004$).

Within 10-minute observation periods, butterflyfish traveled distances ranging from 0.5 to 8.0 m. As distance traveled increased, the number of feeding attempts and the number of damselfish attacks increased (Fig. 2). When butterflyfish traveled greater than 1 m, they foraged on coral, algal, and sand substrates with no apparent preference for any specific substrate. When foureye butterflyfish traveled less than 1 m, they were often inactive within a rock recess, emerging only to feed on a nearby damselfish algal territory when the damselfish was occupied chasing another fish.

DISCUSSION

Most foureye butterflyfish were site faithful to home ranges within the back reef at Discovery Bay. However, fish were not always within marked sites, and in most cases one member of a pair was more site faithful than its pair-mate (Table 1). We propose five possible reasons for the absence of fish at marked sites: 1) Inaccurate home range size definition. Home ranges of some foureye butterflyfish may be larger than the 3 m radius circles that we defined for our study; Chapman and Kramer found that the banded butterflyfish have a home range of about 100 m (1998). 2) Initially observing a focal fish while outside of its home range. Foureye butterflyfish in Discovery Bay may travel outside of home ranges. This is supported by fish in our study that traveled greater than 6 m, thus out of their home ranges as we defined them. Locations may have been marked

when fish were traveling outside of their home range, and fish presence at the marked spot upon revisiting would be unlikely. 3) Chance observations at times when focal fish were foraging outside the home range. Marked locations may have been fish home ranges, but fish were foraging outside of this range at one or more of our visits. 4) Some foureye butterflyfish in Discovery Bay may not be site faithful. If this is true, it would imply that site fidelity by the foureye butterflyfish is facultative and not obligate. 5) Pairs may facilitate a distribution of tasks. One fish may 'stay home' and another may explore for better resources. Such behavior would lead to the unequal site fidelity in a pair which we observed in our study.

Consistent with our hypothesis, damselfish attacks increased with increasing foureye butterflyfish travel distance. This suggests that as foureye butterflyfish travel greater distances within or outside of their home ranges, they will expend more energy averting damselfish aggression. However, feeding bites increased with time traveled, suggesting that as a foureye butterflyfish travels further within or outside of its home range, its feeding efficiency increases even as damselfish attacks increase.

Continual use of home ranges could allow foureye butterflyfish to become familiar with the physical structure and damselfish territory locations within home ranges; this could lead to higher foraging success within home ranges than outside of home ranges (Marnane 2000). We observed this type of behavior in individuals that traveled short distances and emerged from rock recesses to feed when a nearby damselfish left its territory to defend against other foragers. However, the increase in foraging efficiency with travel distance suggests that food resources are not the only benefit to home ranges. It is

Table 1. Foureye butterflyfish presence and absence at 10 locations in Discovery Bay. Distinct locations are indicated by letters; two fish found at one location are considered a mating pair, indicated by subscript 2; solitary fishes are indicated by subscript 1.

Fish	Location	Times Present		Times Absent	
		Number	Percent	Number	Percent
1	A_1	4	80	1	20
2	B_1	4	80	1	20
3	C_1	5	100	0	0
4	C_2	5	100	0	0
5	D_1	4	80	1	20
6	D_2	3	75	1	25
7	E_1	1	20	4	80
8	E_2	2	50	2	50
9	F_1	1	25	3	75
10	F_2	3	75	1	25
Mean	-	3.2	68.5	1.4	31.5

possible that since the back reef at Discovery Bay has relatively low coral populations and relatively high algal cover (informal observations), algal mats are not a limiting resource for foureye butterflyfish. If this is true, they could easily forage on algae while avoiding damselfish territories. This limits the value of having familiarity with within-home-range damselfish territories. Since foureye butterflyfish have been shown to feed preferentially on coral polyps (Deloach 1999), they may be traveling greater distances to find this relatively rare food resource on the reef.

Familiarity with a home range may facilitate predator avoidance (Deloach 1999). We observed schools of night-feeding grunts that consistently aggregated in the same areas of our study sites, suggesting that these fish may convene in the same location for protection when they are not actively feeding (Partridge 1982). This may be a benefit that foureye butterflyfish derive from maintaining a home range, although we didn't directly observe any predation within or outside home ranges. Future studies should observe how predation changes as distance from home range increases.

Since many observed fish were in pairs, and foureye butterflyfish are believed to be monogamous, familiarity with home ranges may also facilitate mate location. Since foureye butterflyfish have been shown to forage outside home ranges, if a mating pair were separated while foraging, they would be able to relocate their counterpart by returning to a home range.

While the use of home ranges seems to be common in foureye butterflyfish in Discovery Bay, our results suggest that feeding efficiency is unlikely to be the only reason for this behavior. Longer term studies could examine the usefulness of home ranges in mating success and predator avoidance to better understand the benefits of having a home range.

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