DIEL PATTERNS OF CORAL REEF FISH COMPOSITION AND ABUNDANCE IN FOUR HABITATS

ELIZABETH V. WILSON, STEPHEN T. WELLER, R. QUINN THOMAS, SARA M. HELLMUTH, PETER N. CHALMERS AND JULIA M. BUTZLER

Abstract: In this study, we explore the role of spatial and temporal resource partitioning as potential factors contributing to the maintenance of diversity of fish on a coral reef. We surveyed the fish community of Discovery Bay, Jamaica in four different habitats during two different times of day. We calculated species richness and evenness to compare the day and night fish communities. We also used richness and evenness to compare the day and night fish communities within each habitat, and to compare the fish communities within each habitat during each sampling period. We observed a total of 60 fish species, and a total of 1002 individuals. We found that both species richness and evenness varied with time of day and habitat. This study shows that coral reef fish partition themselves both spatially and temporally, possibly contributing to the high diversities of fish observed on coral reefs.

Key words: abundance, back reef, coral reef fish, day, night, patch reef, richness, sand, turtle grass

INTRODUCTION

The coral reef fish community is recognized as being highly speciose (Horn 1989, Harmelin-Vivien 2002). Many theories have been proposed to explain the general pattern of high species diversity, such as intermediate levels of disturbance, a highly diverse regional species pool and resource partitioning (Begon et al. 1990). Resource partitioning encourages high diversity by allowing many species to occupy the same geographic area through the separation of resources; because species are utilizing different resources, direct competition is prevented (Begon et al. 1990).

Resource partitioning can occur both spatially and temporally. A species can avoid interacting with another species with which it competes by avoiding overlap in space (e.g., feeding grounds) and/or time (e.g., feeding time). In this study, we explore the role of spatial and temporal resource partitioning as potential factors contributing to the maintenance of diversity of fish on a coral reef. We hypothesize that the species composition, richness and evenness will differ temporally (between day and night) and spatially (between habitat: sandy bottom, turtle grass beds, patches reefs, and the back reef).

METHODS

On 26 February 2004, we surveyed the fish community of Discovery Bay, Jamaica. Eight pairs of observers each conducted 10-min surveys in four habitat types (back reef, patch reef, turtle grass bed and sand patch) both in the day (0830 - 0930) and night (2030 - 2130). Observers recorded fish species composition and abundance observed during each time interval. The data collected by each observer pair were combined to estimate overall abundance and richness in each habitat at both night and day.

We calculated species evenness for each treatment using

$$J' = (H' / H' max) = -\Sigma(p_i * log (p_i)) / log (k),$$

where p_i is the proportion of observations in category i, and k is the total number of species observed (Zar 1984). We then used Chi square tests to compare overall species richness found in the day versus the night, to compare species richness within each habitat between both sampling periods, and to determine if species richness within each sampling period varied between habitats.

RESULTS

We observed a total of 60 fish species, with 29 species found only during the day, 15 found only during the night, and 16 found in both day and night samples (Figure 1, Appendix 1). A total of 1002 individuals were observed, 85% during the day and 15% during the night. Species richness was lower at night than in the day; however, when examined at a finer scale (e.g., habitat), this difference was only significant for patch reefs (Table 1, Fig. 2). The number of species found in patch reefs during the day was three times greater than the number found at night. Species richness also differed significantly among habitats during the day, but not at night (Table 1). Overall, evenness tended to be higher at night; when examined at a finer scale, we found that sand patches had the highest evenness at both day and night (Table 2, Fig. 3).

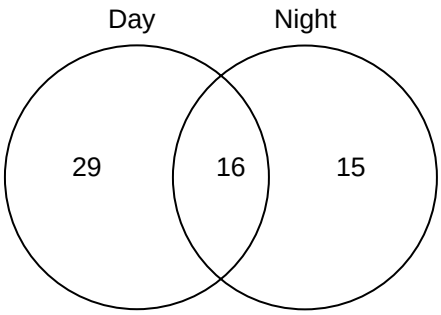

Figure 1. Number of fish species found in the day, night, and in both censuses in four habitats of the back reef of Discovery Bay, Jamaica.

Table 1. Chi-square statistics for diel and habitat comparisons of species richness. Significant differences are marked with an asterisk (*).

Treatment	χ^2	df	P
Overall (day vs. night)	2.58	1	0.11
Day patch reef vs. night patch reef	6.72	1	0.01*
Day back reef vs. night back reef	0.40	1	0.53
Day turtle grass vs. night turtle grass	0.93	1	0.34
Day sand vs. night sand	0.22	1	0.64
Between habitats (within day)	11.23	3	0.01*
Between habitats (within night)	4.24	3	0.24

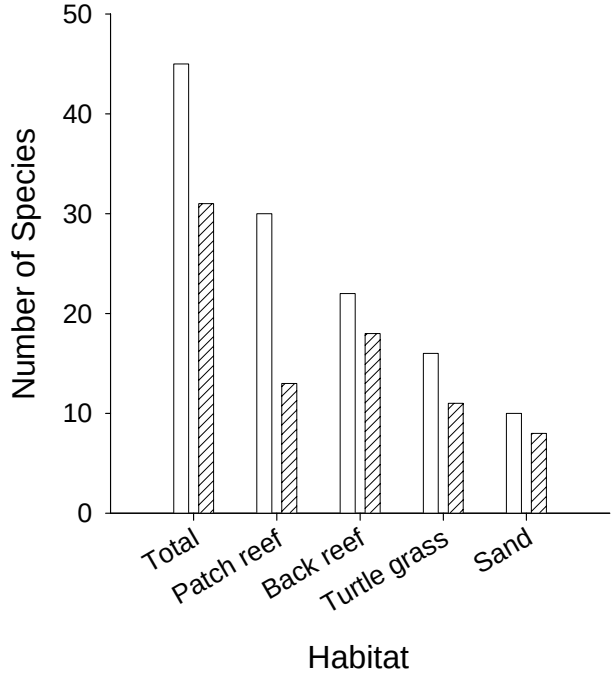

Figure 2. Species richness for each habitat type during the day (open bars) and night (hatched bars). Night and day richness differed significantly in patch reefs. Richness was significantly different among habitats during the day but not at night.

Table 2. Evenness values for diel and habitat comparisons.

	Day	Night
Sand bed	0.6164	0.8277
Turtle grass bed	0.7569	0.8637
Patch reef	0.7231	0.6806
Back reef	0.9145	0.9138
Total	0.6705	0.8468

DISCUSSION

Species richness tended to be higher during the day than at night, suggesting that there may be either more niches available to fish, or there are more resources available during the day. However, this pattern was only significant in the patch reef habitats. Previous studies have suggested that during the day, fish are more prevalent in areas that provide a refuge from predators such as patch reefs (Nagy et al. 2000). It is possible that many different species are concentrated on patch reefs during the day to avoid predation, subsequently dispersing at night to areas of less cover.

Species evenness was greater at night than during the day, indicating that there are fewer dominant species at night. The bluehead wrasse, french grunt, threespot damselfish, hardhead silversides and striped parrotfish were dominant during the day, each comprising at least 10% of the total species seen during the day, whereas these same species were very rare at night (Appendix 1). These particular fish feed on very different resources (e.g., the striped parrotfish feeds on algae and the bluehead wrasse feeds on invertebrates) thereby possibly allowing them to co-occur at higher abundances than if they all fed on the same resource. In contrast, most species found at night were primarily feeding on demersal zooplankton, prohibiting any one species to dominate.

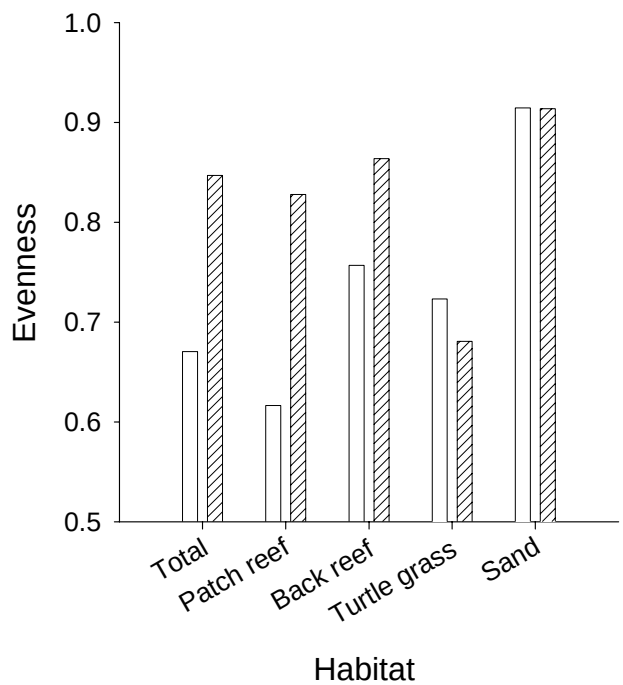

Figure 3. Evenness for each habitat type during the day (white bars) and night (hatched bars).

This study shows coral reef fish partitioning themselves both spatially and temporally, possibly contributing to the high diversities of fish observed on coral reefs. Further studies could test whether fish during the day are exploiting a higher diversity of feeding niches than those found at night, which might explain the higher species richness observed during the day.

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Appendix 1. # individuals of fish species observed at each location and time on 26 February 2004, Discovery Bay, Jamaica.

	Day				Night			
Species	Back	Patch	Sand	Turtle	Back	Patch	Sand	Turtle
Balloonfish	1	1		1	4	1	2	1
Banded jawfish			1					
Bar jack			2					
Barracuda				1				
Barred cardinalfish					2		3	
Barred hamlet				1				
Beaugregory	5	7	8	14	1			
Bicolor damselfish	20	3						
Bigeye								20
Blackbar soldierfish		1						
Blackear wrasse				2				
Blue tang	6	7			1			
Bluehead wrasse	75	10		30				
Bridled goby		5	9	3			5	
Clown wrasse		2						
Cocoa damselfish		1	4					
Doctorfish	11	3		4				
Dusky cardinalfish						2		
Dusky damselfish	25	2		1	2	1		
Dwarf herring					11			
Eyed flounder		1		1				
Fairy basslet		1						
Flamefish					2			
Foureye butterflyfish		1		1				
French grunt	11	65		40				
Glasseye snapper								1
Goldentail moray eel	1	1	3					
Hardhead silverside	100	1050	40	300	1040	1550	1350	740
Indigo hamlet	2	1						

Appendix 1. Continued from previous page.

	Day				Night			
Species	Back	Patch	Sand	Turtle	Back	Patch	Sand	Turtle
Longjaw squirrelfish	1				2	4		1
Longspine squirrelfish					4		2	
Mottled mojara			5					
Night sergeant					3			
Ocean surgeon	6	5		3	1	1		
Palehead blenny	1							
Porcupine fish					2		1	1
Purplemouth moray eel					1	1		
Redband parrotfish	2			1		1		
Reef squirrelfish	2	1			2	1		
Sergeant major	4							
Sharpnose puffer								1
Sharptail eel	1							
Slippery dick	10			1				
Spotfin butterflyfish		1						
Spotted goatfish		5		11				
Spotted scorpionfish	1							
Squirrelfish	8	6			14	11	2	6
Stoplight parrotfish	25	7				1		
Striped parrotfish	49	122		56				1
Threespot damselfish	36	51	3	20		2		
Trumpetfish					1			
Twospot cardinalfish					2	1		
Yellow stingray							4	1
Yellowfin mojarra			2					4
Yellowhead wrasse		1						
Yellowtail damselfish		4						
Yellowtail parrotfish							8	1
Yellow-tail hamlet		3						