FACTORS AFFECTING TROPICAL FISH COMMUNITIES ON PATCH REEFS

ELEANOR E. CAMPBELL, ELIZABETH V. WILSON AND STEPHEN T. WELLER

Abstract: Tropical reefs are known to support diverse and abundant populations of fish. These fish are divided into resident and transient communities that differ in their use of reefs and are affected by competition, substrate complexity, and food availability. We examined the effects of *Diadema antillarum*, reef complexity, and macroalgal cover on resident, transient, and total fish communities on patch reefs. Transient fish abundance and species richness decreased with increasing *D. antillarum* abundance while resident fish abundance increased with increasing substrate complexity. Macroalgal cover was not related to community composition.

Key words: Diadema antillarum, *macroalgal cover, reef complexity, resident species, topographic chain method, transient species*

INTRODUCTION

Tropical patch reefs support abundant and diverse communities of both resident and transient fishes. Resident species primarily reside in a specific area of the reef to take advantage of local resources, while other species roam across reefs, most likely expending more energy to find the best resources available. These fish communities are affected by a suite of biotic and abiotic factors, in particular competition for resources, substrate complexity, and food availability.

The reefs in Discovery Bay, Jamaica, are not pristine; the depletion of large predatory fishes by overfishing in particular has led to an abundant population of long-spined black urchins, *Diadema antillarum*. These urchins consume a large amount of macroalgae at night (Sammarco 1982), and hide in holes and crevices during the daytime. *D. antillarum* is therefore a strong competitor with most fishes for both space and food on patch reefs, and thus its presence or abundance may affect both resident and transient fish communities. We predicted that increased *D. antillarum* abundance would decrease abundance and richness in overall resident and transient fish communities. One common reef fish, the threespot damselfish may be an exception because they are capable of evicting urchins from their territories (Williams 1979). We predicted that increased threespot damselfish abundance would be correlated with decreased urchin abundance.

We also hypothesized that substrate complexity would affect only the resident fish community, such that resident abundance and richness would increase with complexity. We expected no changes in transient species because they are less reliant on the physical structure of reefs. Macroalgae may be an important resource for herbivorous fish as well as for carnivores which eat small invertebrates in algae. We expect to see an increase in the species abundance and richness for both transient and resident fish species in areas of high macroalgal cover. We also expect to see decreased macroalgal cover with increasing *D. antillarum* density because *D. antillarum* is known to be a voracious herbivore.

METHODS

We sampled patch reefs in the back reef area north of the Discovery Bay Marine Laboratory, Jamaica on the afternoons of 25 - 26 February 2004. We chose reefs that were predominantly boulder coral (*Montastrea*), roughly 3 m in length, 1.5 m deep, and surrounded by turtle grass or sand. We counted the number of *D. an-*

tillarum on each reef and counted the number and types of fish species that lived on or crossed over the reef area during a 20 minute sample period. We also noted whether each fish species was transient or resident (Appendix 1). We calculated a reef topographic complexity index at the widest point across each reef: complexity = (1 - length / 3D length) using the chain method of Aronson and Precht (1995). We estimated the percentage of macroalgal cover for each patch observed.

RESULTS

As *D. antillarum* abundance increased on patch reefs both the abundance (n = 8, r = 0.96, P = 0.0002) and richness (n = 8, r = 0.79, P = 0.02) of transient fishes decreased significantly (Fig. 1 and Fig. 2, respectively). Urchin abundance did not affect the abundance (n = 8, r = 0.57, P = 0.14) or richness (n = 8, r = 0.39, P = 0.34) of the resident community. Threespot damselfish abundance had no effect on abundance of *D. antillarum* (n = 8, r = 0.25, P = 0.55).

The abundance of resident fishes (n = 7, r = 0.91, P = 0.004) increased with increasing reef complexity, while the abundance of transient fishes was not affected (n = 7, r = 0.48 P = 0.28; Fig. 3). The richness of the resident (n = 7, r = 0.13, P = 0.44) and transient (n = 7, r = 0.48, P = 0.78) fish communities did not change with in-

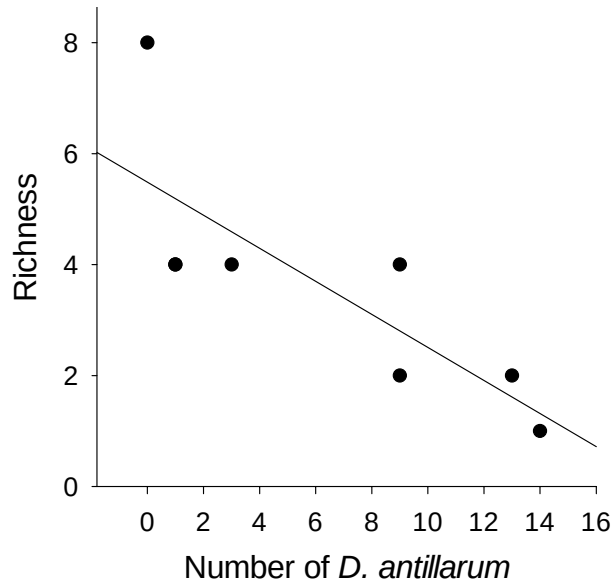

Figure 2. Effects of *D. antillarum* on richness of transient fish communities on patch reefs.

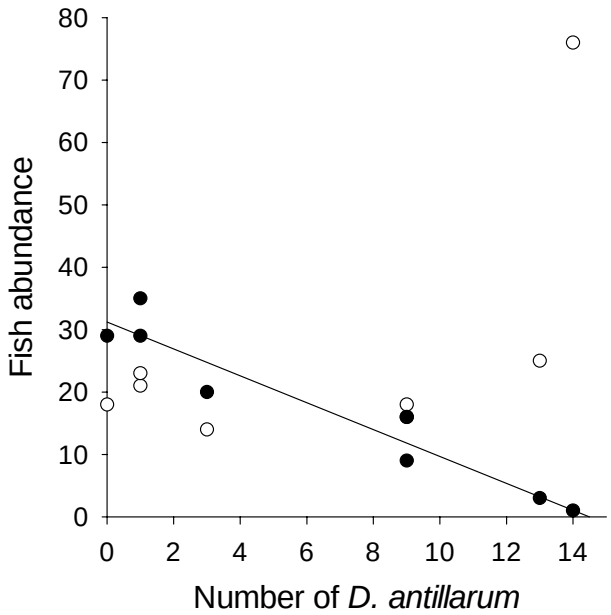

Figure 1. Effects of *D. antillarum* on abundances of resident and transient fish on patch reefs. Open circles = resident fish; line, filled circles = transient fish. Only the significant trend is shown.

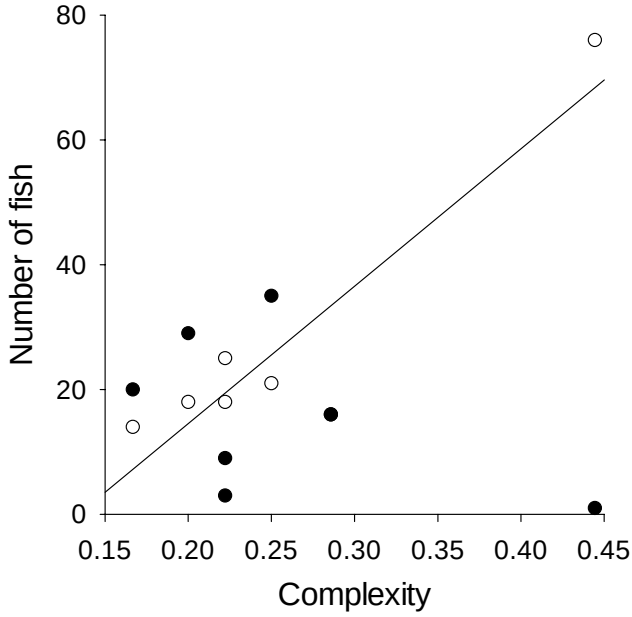

Figure 3. Effects of substrate complexity on abundances of resident and transient fish on patch reefs. Solid line, open circles = resident fish; filled circles = transient fish. Only the significant trend is shown.

creasing reef complexity.

The percent macroalgal cover on patch reefs was not affected by the abundance of *D. antillarum* ($n = 8$, $r = 0.17$, $P = 0.67$). The percent macroalgal cover did not affect the abundance or richness of residents or transients ($n = 8$, all $P \geq 0.26$).

Discussion

Both *D. antillarum* and substrate complexity affect the fish community on patch reefs: *D. antillarum* caused a decrease in transient species abundance and richness, and reef complexity increased resident species abundance. Overall, macroalgal cover did not influence any aspects of the fish communities, nor was macroalgal cover affected by *D. antillarum* density. Because we did not categorize types of algae on patch reefs, we were unable to evaluate the effects of different algal species on fish community. Presumably, fish communities will vary according to the availability of their preferred algal food source. *D. antillarum* may selectively feed on a few algal species and therefore do not affect total macroalgal cover.

Due to the high mobility of transient species, close proximity of patch reefs, and variability in the number of *D. antillarum* on patch reefs, transient fish can choose the best reefs for foraging. They may avoid patches with *D. antillarum* because the urchins lower abundance or quality of available food. On the other hand, residents are not affected by *D. antillarum*, suggesting that the urchin does not limit their food or habitat availability. Surprisingly *D. antillarum* abundance is not affected by threespot damselfish abundance; they seem to coexist on patch reefs without substantial interactions.

Transient fish typically swim from one reef to another, rather than using the reef for refuge, and so may not be a determining factor in reef choice. Resident fish are more reliant on their home reefs to provide cover, and are most abundant on reefs with the highest complexity. The richness of resident fish was unrelated to complexity, suggesting that the same species occur on most patch reefs. Complexity therefore affects total abundances of residents, but not species composition.

While abundance of competitors and reef complexity did affect the resident and transient fish communities on patch reefs, there may be additional factors which contribute to the diversity and abundance of fishes in these habitats. Reefs experience a high level of temporal and spatial variation which may influence these fish communities. Additionally, interspecific interactions undoubtedly influence fish populations. Further studies could investigate other variables that affect these diverse fish communities.

Literature Cited

Aronson, R. B. and W. F. Precht. 1995. Landscape patterns of coral reef diversity: a test of the intermediate disturbance hypothesis. Journal of Experimental Marine Biology, 192: 1 - 14.

Sammarco, P. W. 1982. Effects of grazing by *Diadema antillarum* (Echinodermata: Echinoidea) on algal diversity and community structure. Journal of Experimental Marine Biology, 65: 83 - 105.

Williams, A. H. 1979. Interference behavior and ecology of threespot damselfish (*Eupomacentrus planifrons*). Oecologia, 38: 223 - 30.

Appendix 1. Resident and transient species observed on patch reefs in the back reef north of Discovery Bay Marine Lab, Jamaica.

Resident species	Age	Total observed
Foureye butterflyfish	adult	3
	juvenile	0
Blue tang	adult	0
	juvenile	1
French grunt	adult	0
	juvenile	65
Beaugregory	adult	1
	juvenile	6
Bicolor damselfish	adult	0
	juvenile	3
Sergeant major	adult	1
	juvenile	0
Threespot damselfish	adult	56
	intermediate	27
	juvenile	10
Barred hamlet	adult	0
	juvenile	1
Indigo hamlet	adult	1
	juvenile	0
Hybrid indigo/ barred hamlet	adult	1
	juvenile	0
Harlequin bass	adult	0
	juvenile	1
Dusky squirrelfish	adult	1
	juvenile	0
Longjaw squirrelfish	adult	1
	juvenile	0
Longspine squirrelfish	adult	1
	juvenile	0

Resident species	Age	Total observed
Squirrelfish	adult	1
	juvenile	0
Bridled goby	adult	14
	juvenile	0
Gold spot goby	adult	1
	juvenile	0
Blennies	adult	13
	juvenile	0
Porcupine fish	adult	1
	juvenile	0
Goldentail moray	adult	1
	juvenile	0

Appendix 1 (Continued).

Transient species	Age	Total observed
Doctorfish	adult	0
	juvenile	1
Ocean surgeonfish	adult	1
	juvenile	11
Redband parrotfish	adult	1
	juvenile	0
Striped parrotfish	adult	18
	juvenile	85
Stoplight parrotfish	adult	7
	juvenile	2
Bluehead wrasse	adult	2
	juvenile	2
Slippery dick	adult	1
	juvenile	3
Spotted goatfish	adult	7
	juvenile	0