SHARKNOSE GOBY AND PEDERSON SHRIMP PROVIDE DISTINCT CLEANING SERVICES TO CLIENT FISH

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Abstract: Several species of fish and shrimp act as cleaners for fish in tropical reef systems. Cleaners remove harmful ectoparasites from clients and in turn gain safe and reliable access to food resources. This mutualism has been extensively studied, but differences in the services provided by cleaner species remain unclear. We examined the cleaning behaviors of Pederson shrimp and Sharknose gobies at Bloody Bay, Little Cayman Island. We predicted that morphological and behavioral differences between shrimp and gobies would result in specialized cleaning behaviors that provide different services to clients. As expected, Pederson shrimp and gobies cleaned different areas of clients.

Key Words: Little Cayman, cleaner fish, cleaner shrimp, Periclimenes pedersoni, Gobiosoma genie

INTRODUCTION

In the mutualism between cleaners and their clients, the cleaners gain access to food while clients benefit from removal of harmful parasites (Trivers 1971). This mutualism is well known (Wiksten 1995); however, few studies compare specific cleaning behaviors between shrimp and fish.

Pederson shrimp (*Periclimenes pedersoni*) and Sharknose gobies (*Gobiosoma genie*) provide similar services to client fish in coral reefs at Little Cayman Island. Both clean the same spectrum of client species, occupy similar habitats around coral heads and sponges, and often clean the same client simultaneously (Wiksten 1995; personal observations). However, shrimp and gobies are very different morphologically. Shrimp are dexterous and slow-moving, while gobies have larger mouths and are more mobile. We hypothesized that these differences determine different cleaning behaviors. We predicted that cleaner shrimp and gobies would specialize on certain areas of clients. We also expected the morphological differences between fish and shrimp would influence the time taken to clean their clients.

METHODS

From 6 March to 8 March 2008 we observed cleaning behavior by gobies and Pederson shrimp at the Cumber's Cave diving location in Bloody Bay, Little Cayman Island. Using SCUBA we conducted six 60-minute dives in pairs at a depth of ca. 10 m, and surveyed 50 m to each

of the east and west, from the permanent buoy marker at Cumber's cave dive site. We opportunistically located active cleaning stations and monitored cleaning behaviors at each for 10 minutes, or until the client fish swam away.

We measured the duration of each cleaning event from the time of discovery. While this underestimates time spent cleaning, it is unbiased with respect to cleaner type. We noted client and cleaner species, and each area where the cleaner came in contact with the client (head, eye, side, back, gills, mouth, and fins). From these data we calculated an index of 'total area covered' by counting the number of areas covered by cleaners and averaging by station. We excluded cleaning observations that appeared to have been terminated due to diver presence.

RESULTS

We observed a total of 42 cleaning events at 23 cleaning stations in Cumber's Cave. Nineteen events occurred at 11 Sharknose Goby stations, 11 events occurred at 7 Pederson Shrimp stations, and 12 events occurred at 5 stations with both gobies and shrimp ("gobies/shrimp stations"). We tallied 34 gobies at goby-specific stations, and 35 shrimp at shrimp-specific stations.

Shrimp and gobies cleaned different areas of client fish (Table 1). Shrimp cleaned eyes and gills more than gobies, while gobies cleaned the sides of client fish more than shrimp. As the number of cleaners increased, so did the total number of areas covered by the cleaner (regression: $F = 6.27$, $df = 1,28$, $P = 0.018$). However, the number of areas covered by the cleaner did not differ between shrimp and gobies (one-way ANOVA: $F = 0.43$, $df = 1,15$, $P = 0.52$). Shrimp cleaning thoroughness (number of areas cleaned) did not differ between shrimp specific stations and gobies/shrimp stations (2 tailed t-test; $t = 0.618$, $df = 17$, $p = 0.054$). At stations with both species of cleaners present, gobies covered more areas on a client than did gobies at goby-specific stations (2 tailed t-test; $t = 3.03$, $df = 26$, $p = 0.005$).

Cleaning event durations ranged from 5 s to 600 s (mean ± SE = 142 ± 21 s). Shrimp and gobies at their respective stations cleaned each client for approximately the same amount of time (74 ± 36 and; 86 ± 26 s client^{-1}, respectively), but when clients visited stations occupied by gobies and shrimp, they stayed significantly longer (one-way ANOVA; $F = 5.13$, $df = 2, 19$, $P = 0.017$; 223 s client^{-1} ± 39). Interestingly, there was no relationship between the time spent at the cleaning station and the overall number of fish or gobies

actively cleaning (one-way ANOVA; $F = 0.064$, $df = 1,45$, $P = 0.80$).

TABLE 1: The percentage of cleaning events by each type of cleaning station (rows) that resulted in cleaning specific areas of the client (columns). X^2, R^2, and p-values shown for each of the different chi-squared tests. Data collected 6-8 March 2008 at 10 m depth, 50 m East and West of the Cumber's Caves dive site permanent mooring ball.

	Head	**Eye**	**Side**	**Back**	**Gills**	**Mouth**	**Fins**
Gobies/ shrimp	100%	60%	100%	100%	100%	60%	100%
Gobies	55%	9%	82%	64%	45%	18%	72%
Shrimp	57%	57%	29%	43%	86%	71%	57%
X^2	3.42	6.15	8.52	4.22	6.07	5.65	2.79
R^2	0.168	0.226	0.335	0.193	0.261	0.189	0.149
p	0.181	**0.046**	**0.014**	0.121	**0.048**	0.059	0.247

DISCUSSION

As predicted, there were subtle differences between the behaviors of Pederson shrimp and Sharknose gobies at cleaning stations. Although cleaners at these stations spent the same amount of time cleaning, shrimp appeared to clean gills and eyes preferentially, while gobies were more likely to clean the side of the client. Different morphologies of shrimp and gobies may maximize foraging efficiency in these different areas; perhaps the longer and more agile appendages of shrimp allow easier reach into gill crevices and a more delicate cleaning of the eyes, whereas the larger mouths and quicker movement of gobies allow them to clean larger areas, such as the side. In addition to providing distinct services to clients by cleaning different areas, fish and shrimp may be accessing different resources in different areas of client fish. The provision of different services to clients may indicate niche partitioning, which is one possible mechanism to explain how these species co-occur.

We also found a high incidence (23%) of stations containing both shrimp and goby cleaners. Goby and shrimp stations did not differ in time spent cleaning a client, but clients spent more time at stations containing both shrimp and fish. Gobies cleaned significantly more areas at goby/shrimp stations than at goby stations, but shrimp cleaned similar numbers of areas, whether at shrimp stations or goby/shrimp stations. Shrimp may be more specialized cleaners than gobies, because even in the longer cleaning events that occurred at goby/shrimp stations, shrimp focused on the same areas, while gobies cleaned additional areas, not covered at goby stations.

Gobies and shrimp clearly provide different services to cllents. To explore the implications of these

differences, each type of cleaner could be experimentally removed, and the consequences for fish health, growth and survival evaluated.

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