NICHE PARTITIONING AND RELATED OBSERVATIONS ON CLEANING STATIONS IN DISCOVERY BAY, JAMAICA

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ABSTRACT:

This study quantitatively and qualitatively describes the activities of several different species of hosts and their cleaners at fish cleaning stations in Discovery Bay, Jamaica. The cleaner species Thalassoma bifasciatum and Gobiosoma genie partition the portions cleaned on their common host, Clepticus parrai, to a statistically significant degree. In addition, these species seem to coexist at the stations by partitioning host species (other than Clepticus parrai). We do not infer competition in the past from the niche partitioning, although we cannot exclude it. Finally, we make observations on the postures of hosts during cleaning, and on other interesting aspects of the cleaning station community.

INTRODUCTION

Cleaning symbioses between fish species, in which one species of fish picks ectoparasites off of others, have been reported to occur in perhaps the majority of both freshwater and marine fishes (Losey 1974) -- and Discovery Bay in Jamaica appears to offer no exception. Cleaning stations, at which host species line up to be cleaned, often signalling their intention with a characteristic "invitation" posture, are a not uncommon sight for divers.

We decided to conduct an observational study of the cleaning stations in Discovery Bay because the locally available literature (both published literature and Dartmouth literature) contained little specific information about the particular host-species symbioses we observed during preliminary dives.

During the initial data-collection dives, we found a station at which three cleaner species co-existed with no sign of aggressive interaction, despite sharing a common host species. Bluehead wrasses (Thalassoma bifasciatum), spanish hogfish (Bodianus Rufus), and shark-nose gobies (Gobiosoma genie) all participated in cleaning Creole wrasse (Clepticus parrai) individuals -- sometimes even simultaneously. Closer examination lent us the impression that niche partitioning lay at the bottom of this coexistence; bluehead wrasses seemed to clean predominantly the fins; spanish hogfish seemed

to clean predominantly the body (ie, scales); while the gobies were seen only to enter the mouths of the creoles (in order to clean the gills). Further observations indicated that in addition to the creole wrasse, each cleaner species cleaned other species unique to it, and thus that niche partitioning might also be accomplished by the partitioning of host species. Thus, In addition to making a number of qualitative observations on these cleaning symbioses, we decided to test quantitatively the hypothesis of niche partitioning by cleaners -- either via spatial partitioning on common hosts and/or via host species partitioning.

METHODS

Observations & Recordings

The study was conducted over an 8-day period (2/28/85 - 3/7/85) at the fringing reef in Discovery Bay in Jamaica, West Indies. All observations were made in the vicinity of Mooring 1, with a total data collection time of 9 hrs. 41 min., in 14 dives with SCUBA.

We found and observed five cleaning stations, recording aspects of species composition (species cleaning, being cleaned, or seemingly only in the vicinity), and of cleaning behavior (invitation poses of hosts, and portion of host cleaned — mouth/head area, body, or fins). We also noted any other host or cleaner activities or interactions that could have had implications for the cleaning symbiosis. For complete site descriptions, refer to Figure 1 (next page).

The bulk of our data and conclusions come from observations of the main station. We feel the time we spent there was justified by the continuous diurnal activity observed there, as well as its relatively large volume of cleaning activity. All observations at other stations were consistent with main station observations, and thus confirmed our feeling that the main station is generally typical of the cleaning stations in the ~~bay.~~ reef.

FIGURE 1. Site descriptions.

STATION	SITE LOCATION + DESCRIPTION	DEPTH	# DAYS OBS. ON	# DIVES OBS. FOR	SPECIES COMPOSITION	DAMSELFISH TERRITORY?
#1 MAIN STATION	Near mooring buoy. Divided into a larger station and a substation-- approximately 1 meter apart. Substrate composition of M. Annularis, Porites, Millepora, A. Cervicornus, and various brain corals. Promontory height: main station - 4ft.; substation - 3ft.	45'	8	11	cleaners = BHW, goby, spanish hogfish (adult + juv.). hosts: creole wrasse, blue chromis, dusky, yellowtail, 4 bicolored damselfish, yellowhead wrasse adult, stoplight, redtail and striped parrots, rock hind, sharpnose puffer, barjacks. *V.S.: squirrelfish, indigo hamlet, barred hamlet, yellowhead wrass juvs.	YES
#2 FAR WEST STATION	8-10 minute swim west of the mooring buoy. Promontory of M. Annularis of approximately 5ft. in height.	30'	2	2	cleaners: BHW hosts: creole wrasse, striped, redtail, and stoplight parrots, yellowhead wrasse, yellowtail damselfish. V.S: sharpnose puffer.	YES
#3 CORAL RUBBLE STATION	2 minute swim west of the mooring buoy. M. Annularis rubble (no promontory).	35'	2	2	cleaners: BHW, goby hosts: creole wrasse, rock hind, blue chromis, striped, redtail, and stoplight parrots. V.S.: indigo hamlet, sharpnose puffer, bandtail puffer	NO
#4 MIXED ZONE STATION	2 minute swim South of the mooring buoy. Promontory of M. Annularis of approximately 4ft. in height.	25'	1	1	cleaners: BHW hosts: creole wrasse, blue chromis, redtail, striped parrots, dusky damselfish, V.S.: indigo hamlet	YES
#5 CRATE STATION	1 minute swim west of the mooring buoy, located by an old crate. Small promontory of M. Annularis and Labyrinthiformes of approximately 2ft. in height.	45'	2	2	cleaners: BHW, goby hosts: creole wrasses V.S.: yellowhead wrasse juve.	YES

*V.S. = Vicinity Species (species observed in the area although neither cleaning nor being cleaned)

Statistical Analysis

We tested our hypothesis of niche partitioning between cleaner species via spatial partitioning on common hosts, with a Chi-squared analysis. The analysis compared cleaning on fins vs. mouth & head parts of the major shared host, by the 2 most common cleaners. Our data base for other shared hosts and for the third cleaner species was insufficient to merit similar Chi-squared analyses, or any other statistical analysis for that matter.

RESULTS

(Note: In structuring this report, we have found it best to use some qualitative observations to interpret the significance of quantitative results within the Results section, while reserving others for use in the Discussion.)

→ Cleaner species The cleaner species predominantly observed in this study was the bluehead wrasse (BHW). All cleaners were in phases other than the terminal male phase (viz., "yellow", "striped", and "barred" adults, and juveniles; see Itzkowitz). The BHW occurred in numbers between 6 and 12 at all 5 of the stations. Sharknose gobies were the next most commonly observed, ranging in numbers between 1 and 4 at 3 of the 5 stations. Finally, we observed 2 Spanish hogfish ~~(Bo~~ cleaning along with the other species,

at our main station. The hogfish disappeared before we were able to get rigorous quantitative data on them, so we could not include them in our analysis for spatial partitioning.

→ Host species The five stations we observed serviced primarily Creole wrasses. They were the only hosts observed at all stations on all days. In addition, in any given observation period for any given station, the number of Creoles cleaned far exceeded that of any other hosts. In general, the Creoles swam in large and diffuse schools of at least 200 fish, in a wide area above and around the station. Fish would descend in small groups or individually to the cleaning station, where as many as 40 were observed posing at one time.

Nevertheless, other host species were consistently observed, most notably several species of parrotfish, and yet another wrasse, the yellowhead wrasse (*Halichoeres garnoti*). A complete listing of the host species observed, and a rough indication of the frequency (# days seen) and the typicalness (# stations seen at) of host species' appearances, follows.

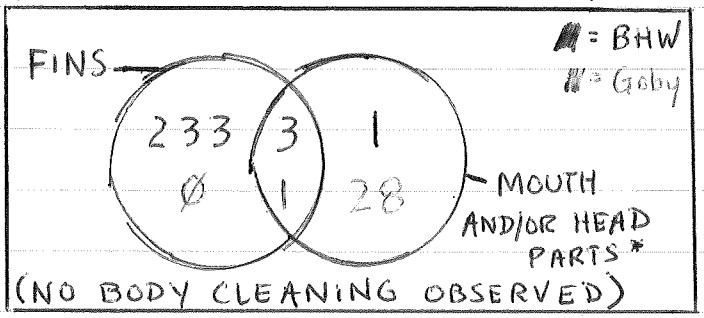
Figure 2. MASTER HOST SPECIES LIST *

Host	# Days Seen Cleaned	# Stations Seen at
Creole Wrasse	8	5
Striped Parrotfish	6	4
Stoplight Parrotfish	4	3
Redtail Parrotfish	4	3
Yellowhead Wrasse	4	3
Blue Chromis	4	3
Rock Hind	2	2
Resident Damselfish	2	2
Sharpnose Puffer	2	2
Bar Jacks		
Doctorfish		

* Host species observed, listed in order of predominance, as assessed not only by figures given, but also by qualitative impressions of relative numbers of individuals of species cleaned.

→ Spatial Partitioning The portions of the Creole wrasse cleaned by BHWs and gobies, are represented in the following Venn diagram:

Figure 3.
Recorded Observations of Portion of Host Cleaned



* Body parts in this category consist of any parts anterior of the preopercle, including most notably the mouth (inside and out), the eye, the cheek, and the underlip.

A Chi-squared analysis of the relative frequencies depicted in the Venn diagram indicated — as is obvious — that there is a significant difference in the types of Creole wrasse body parts cleaned by gobies, as compared to those cleaned by bluehead wrasses ($p \ll .001$). The magnitude of these relative frequencies is such as to support our conjecture of spatial niche partitioning: gobies clean the mouth/head area, BHWs clean the fins, of Creole wrasses.

Interestingly enough, gobies did not exhibit this same pattern of host portion cleaned, on the species unique to it. Specifically, when cleaning a rock hind, a goby would move over all areas of the rock hind's body. In addition, gobies cleaned the body portions of the blue chromis, while BHWs cleaned predominantly the fins, as they did on the Creole wrasse.*

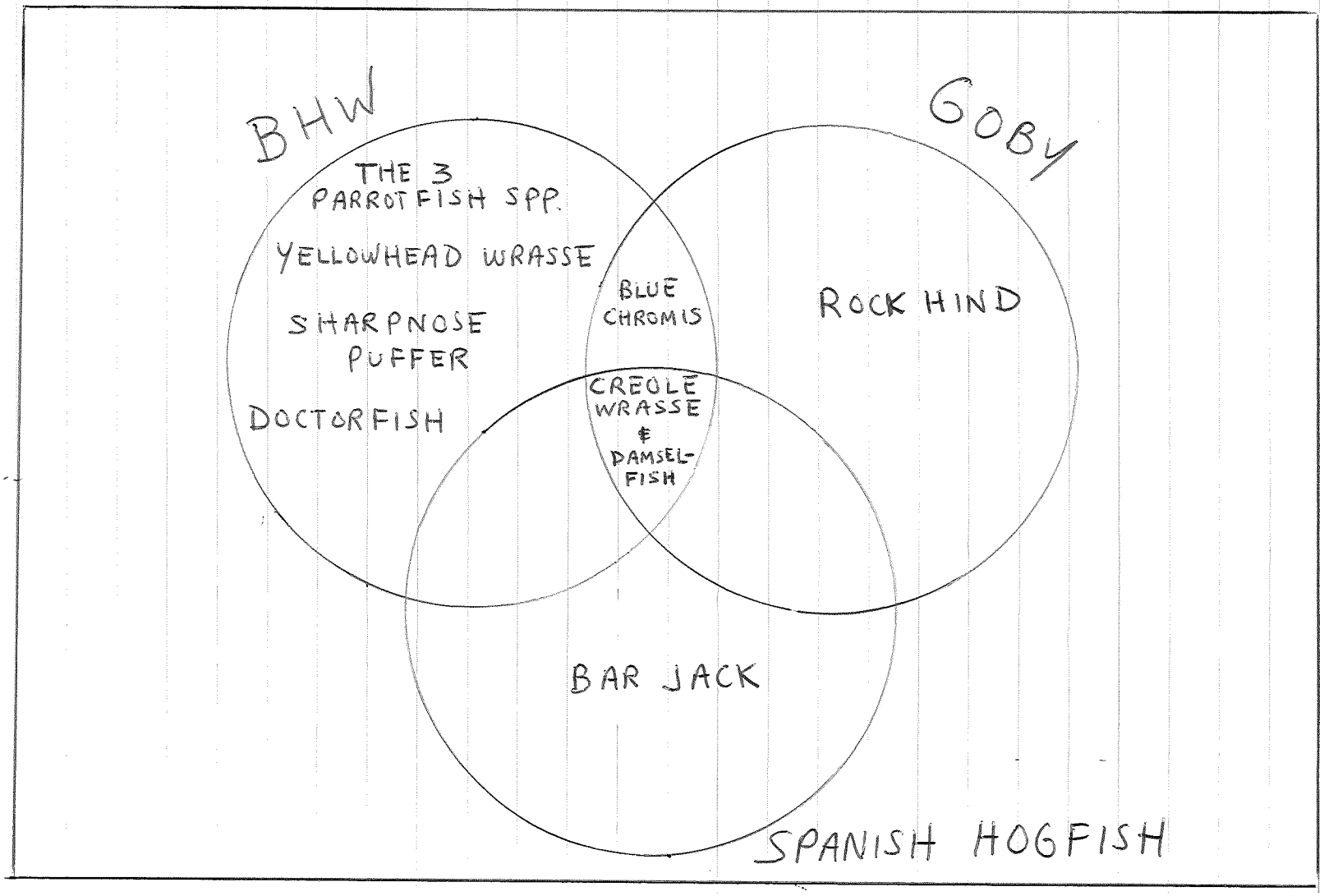
→ Species Partitioning Again, a Venn diagram proves useful in illustrating our results: the distribution of host species among cleaners follows on the next page (Figure 4).

Due to the small numbers of observations of some host species, we feel our results with respect to the unique species must remain qualitative; in other words, it's possible that they in fact are shared by other cleaners, and we just happened not to see any instances of this overlap. It is less likely, both logically and with respect to our figures, that host species represented in the figure as shared are in fact unique to a particular cleaner.

* (Data base on this shared host [blue chromis] too small to merit statistical analysis.)

FIGURE 4. VENN DIAGRAM OF SPECIES PARTITIONING

- HOST SPECIES OF THE VARIOUS CLEANER SPECIES



partitioning does not require that host species be unique.

In the end, though, we feel our observations do support the hypothesis of species partitioning — i.e., that at least some of the species depicted as unique are indeed so — due to a number of observations in which these unique species were pointedly ignored by other cleaners. Particularly, we observed gobies cleaning a rock hind on only 5 occasions, in the regions of the promontory directly over the gobies' home corals. On an equal number of occasions, a rock hind was observed in the midst of BHWs, and to pass through them unapproached. Similarly, we observed Spanish hogfish cleaning a bar jack on 8 different occasions. We saw a total of 7 bar jacks passing through the main station after the hogfish had disappeared; all were ignored by the remaining BHWs.

Cleaning Posture of Hosts The Creole wrasse was the only host species which consistently presented an "invitation to clean", as defined as an orientation which differs markedly from normal swimming or feeding orientation*. The Creole's invitation pose in fact took various forms, evidently depending-at least in part- on the part of its body it intended to be cleaned. Most frequently, the Creole up-ended itself, such that it pointed downwards, at an angle of from 45° to 90°. In these cases it was generally cleaned on various of its dorsal, caudal, anal, and pelvic fins.

Pectoral fin cleaning was generally the result of a second pose, in which the Creole lay on its side

* (our definition)

and waved its pectoral fins.

The third and final pose exhibited by the Creole is like the first except that ~~it~~ the Creole also extends its lips — up to about a half a centimeter out, for the larger individuals. This enables the gobies to travel inside to clean the gills. However, we noted lip extension even where the Creoles were presenting only to the BHWs. Thus it would seem that the degree of specialization in the Creole's various invitation poses is not as great as it could be, considering the spatial partitioning we have demonstrated.

The only other host species observed to pose for the cleaners were the parrotfish species — and these posed only occasionally. They had only one form of invitation, in which they oriented themselves vertically and presented themselves ventrally to the BHWs, just as with the Creole wrasses. However, the parrotfishes posed head-up, whereas the Creoles posed head-down.

DISCUSSION

The results of this study support our hypothesis that resource partitioning on the Creole wrasse occurs among 2 species of cleaners: the bluehead wrasse and sharknose goby. This partitioning is twofold, operating both through spatial partitioning on common hosts — which we were able to quantify — and through host species partitioning, which we observed qualitatively. The spatial partitioning correlates with the existence of not one but 3 different invitations to clean, for the Creole wrasse.

The traditional explanation for niche partitioning is competition in the past. This hypothesis is not easily testable and we have no data either to support or to refute it. Fortunately, it is not necessary to rely on past competition as ~~an~~ the explanation, since at least one testable alternate explanation exists.

This may also be termed niche partitioning

~~This is that~~ Specifically, different parasites may occur at each of the body portions partitioned by the different cleaner species. It is possible that gobies have specialized to feed on parasites which are present only in the gill and surrounding areas, while BHWs have specialized on parasites which attack only the fins. (We found no literature on this subject.) One might test this hypothesis by catching Creole wrasses, and examining to see whether different body portions do in fact contain different parasites. Gut content analyses for BHWs and gobies could be used in corroboration.

We see 2 other alternative explanations to competition in the past, equally abstract and therefore also untestable and unsatisfactory. Nevertheless, as alternatives which are no more faulty than the traditional view, they deserve mention.

For one, it's possible that the 2 cleaner species never had the tendency to clean the same areas of the same host species in the first place, and thus never came into competition. According to this explanation, present-day niche partitioning would simply represent the persistence of the original disjunction. In addition to its untestability, we see another drawback to this theory. Now, it is true that we can't assert that the 2 cleaners

exhibit the same tendency to clean the same areas of their common host. We can assert, however, that the 2 cleaners clean the same areas when different hosts are considered together. Gobies cleaned the body and fins — never the mouth/head region — of fish not cleaned by BHWs (i.e., rock hinds). Similarly, BHWs were seen to clean the mouths (on the outside) of other host species on 6 occasions. In our minds, the overlap of host portion cleaned by the different cleaner species, when their respective hosts are considered together, discounts the possibility that they never tended to clean the same portion on their common host, the Creole wrasse.

good argument

Secondly, one might postulate that, since adult BHWs are too large to enter the mouths of Creole wrasses, there was selection against the species as a whole to clean the Creole's gills. We don't place much credence in this possibility either, because one sees dietary differences between the juveniles and adults of many tropical reef communities (Helfman).

We were surprised to observe that the BHWs are much more active and persistent in their cleaning behavior than are the gobies. (Note the small number of goby cleaning acts which we were able to observe [Figure 3].) Because gobies are obligate cleaners and BHWs are facultative cleaners, we had expected the goby to be a much more active cleaner than the BHW. However, gobies remain closely within the proximity of one mound-shaped coral, often resting for relatively long periods between cleanings. In contrast, BHWs swim

over a wider area, darting from host to host throughout the cleaning area. Thus the goby's energy expenditures and consequent needs may be relatively low enough to account for its marked relative inactivity.

Another interesting observation was the presence of damselfish at 4 out of the 5 cleaning stations. One explanation for this is that the predominant species at the stations, BHWs and Creole wrasses, are both carnivores, and thus do not excite the damselfish's territorial aggression (damselfish are herbivores). However, BHWs do attract parrotfish, a major competitor of the damselfish. In light of this, and considering the large numbers of fish in general at the stations, the damselfishes' apparent tolerance is probably best explained as representing a swamping effect.

The damselfish may also obtain some benefit from the presence of a cleaning station encompassing their territories, as they were observed to be cleaned on 5 occasions.

Here we will end our discussion of our observations of cleaning stations. Though we made many more than we report here, the bulk of these do not lend themselves to meaningful speculation. The observation which most interests us and which we find most meaningful is that of spatial partitioning of common host species; we found no mention of this in the literature. We found the study of cleaning stations enjoyable as well as productive and can recommend it to future study groups.

References

(Note: John: Please forgive the incomplete nature of these references. Our papers were packed away before we could get full bibliographical information)

Helfman, Gene S. "Patterns of Community Structure in Fishes: a Summary Overview."

Itzkowitz, Murray. "Feeding Strategies of a Facultative Cleaner Fish". Journal of Zoology 187.

Losey, George S., Jr. "The Symbiotic Behavior of Fishes," in The Behavior of Fish and Other Aquatic Animals, David Motofsky, ed. Academic Press 1978.

First-rate study, and superb write-up.