HONDURAS DISSERTATION/THESIS PROJECT

HO27 The behaviour and ecological role of coral reef cleaning interactions

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Mutualistic relationships between species are an integral part of the complex web of interactions in natural communities and in many cases they are essential to the maintenance of ecosystem health and function. On coral reefs, cleaning interactions are classic interspecific mutualisms between cleaners (i.e. gobies, wrasse, and shrimp) and a community of client fish that span the taxonomic spectrum – think of them as the car washes of the ocean! The interactions between cleaners and client fish positively impact fish diversity and health as ectoparasite loads on the reef are reduced. Cleaner species occupy discreet microhabitats that serve as cleaning stations that are intentionally sought by clients; at these cleaning stations, the client fish pose motionless and are vulnerable to predation while cleaners inspect and remove parasites from gills, mouth, and scales. The physical contact from cleaner shrimp, known as tactile stimulation, has also been shown to reduce stress in client fish.

Cleaning interactions are risky for both parties and they often involve multiple species that differ in their sensitivity to diver presence. This, coupled with the fact that these interactions are essential for maintaining ecosystem function, means that cleaning stations represent an ideal model for testing hypotheses about community-wide impacts of human presence on the behaviour of reef organisms. One recent study by Operation Wallacea scientists (Titus et al 2015, PLoS One) explored the impacts that anthropogenic activities have on the behaviours of coral reef organisms, using cleaning symbioses involving Pederson cleaner shrimp (*Ancylomenes pedersoni*) as a model. This study compared remotely deployed video cameras to active diver observations on a reef where SCUBA diving has taken place regularly for decades and another reef where no SCUBA diving had ever taken place. Their data clearly demonstrated a suppression of cleaning behaviour when divers were present in the water, although this impact was significantly less where reefs have experienced a high intensity of SCUBA diving. This suggests reef fish communities can partially habituate to diver presence, but that full habituation is likely to be unobtainable on Caribbean coral reefs. Similar studies are needed for other reef cleaners (e.g. cleaner fish), and at additional sites to build on this study.

Another recent study by our scientists (Titus et al 2015, Marine Biology) explored temporal patterns in the cleaning activity of Pederson's cleaner shrimp, and showed that their cleaning interactions did not change throughout the day. This is in contrast to research on cleaner gobies that has shown a peak in cleaning activity around dawn. A third recent study published recently (Titus et al 2019, Scientific Reports) explored the curious behaviour of cheating, whereby cleaners will pretend to clean a client but will instead take a bite of flesh from them. Cleaner shrimp in other parts of the tropics have been shown to modify the quality of their cleaning services (i.e. by cheating more or less) based on the species of client, but our findings suggest Caribbean cleaner shrimp maintain a constant cleaning quality regardless of client.

Each of these studies have used remote underwater video observations rather than direct diver observations, which encourages more natural behaviour compared to the potential issues surrounding passive diver presence. Students joining this project will also use video observations, but

the specific focus of the project could take multiple directions. Operation Wallacea scientists have a series of pre-defined research goals that students may choose to pursue, or alternatively students might like to work with these scientists to develop their own ideas. Projects could include a combination of remote video footage and direct diver observations to further explore the impact of human presence on cleaning behaviour. Alternatively, projects could focus on one particular methodology to investigate ecological patterns of behaviour, for example client pool structuring, temporal variations in cleaning behaviour, and relationships between cleaning activity and size/structure of cleaning stations. Students may choose to focus on individual cleaner species (e.g. Pederson shrimp, or, cleaning gobies of the genus *Elacatinus*), or at multiple cleaners in order to explore how resources are partitioned between species occupying such similar niches. All projects will require a SCUBA diving element, while those making use of video observations will also require significant time analysing footage between dives.

Recommended Reading

Becker JH, Grutter AS (2004) Cleaner shrimp do clean. Coral Reefs 23: 515–520

Bshary R, Grutter AS, Willener AST, Leimar O (2008) Pairs of cooperating cleaner fish provide better service quality than singletons. Nature 455: 964–966

Cheney KL, Côté IM (2005) Mutualism or parasitism? The variable outcome of cleaning symbioses. Biology Letters 1: 162–165

Côté IM (2000) Evolution and ecology of cleaning symbioses in the sea. Oceanography and Marine Biology 38: 311–355

Grutter AS (1995) Relationship between cleaning rates and ectoparasite loads in coral reef fishes. Marine Ecology Progress Series 118: 51–58

Huebner LK, Chadwick NE (2012) Patterns of cleaning behaviour on coral reef fish by the anemone-shrimp *Ancylomenes pedersoni*. Journal of the Marine Biological Association of the UK 92(7): 1557–1562

Januchowski-Hartley FA, Graham NAJ, Feary DA, Morove T, Cinner JE (2011) Fear of fishers: human predation explains behavioral changes in coral reef fishes. PLoS One 6(8): e22761

Sih A (2013) Understanding variation in behavioural responses to human-induced rapid environmental change: a conceptual overview. Animal Behaviour 85: 1077-1088

Titus BM, Daly M, Exton DA (2015) Do reef fish habituate to diver presence? Evidence from two contrasting historical levels of SCUBA intensity in the Bay Islands, Honduras. PLoS One 10(3): e0119645

Titus BM, Daly M, Exton DA (2015) Temporal patterns of Pederson shrimp (*Ancylomenes pedersoni* Chace 1958) cleaning interactions on Caribbean coral reefs. Marine Biology 162: 1651-1664

Titus BM, Daly M, Vondriska C, Hamilton I, Exton DA (2019) Lack of strategic service provisioning by Pederson's cleaner shrimp (*Ancylomenes pedersoni*) highlights independent evolution of cleaning behaviors between ocean basins. Scientific Reports 9: 1–99