Field experiments to determine the ability of gnathiid isopods to detect and locate Caribbean reef fish hosts using chemosensory cues in John Brewers Bay, St Thomas, US Virgin Island from June to August, 2019

Website: https://www.bco-dmo.org/dataset/887304
Data Type: Other Field Results
Version: 1
Version Date: 2023-01-25

Project
» Beyond Cleaning and Symbiosis: Ecology of 'Ticks of the Sea' on Coral Reefs (Gnathiid isopod ecology)

Contributors	Affiliation	Role
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Abstract
Gnathiid isopods are common crustacean parasites that inhabit all oceans from shorelines to depths of over 3000 m and use chemical cues to find their marine fish hosts. While gnathiids are host-generalists, hosts vary in their susceptibility to infestation. However, the mechanisms that mediate differential susceptibility are unknown. Here we used field experiments to investigate if the chemical attractiveness of hosts explains differences in the susceptibility of Caribbean reef fishes to infestation by a common Caribbean gnathiid isopod, Gnathia marleyi. We showed that while G. marleyi can detect and locate hosts using only chemical cues, they do not exhibit a preference for chemical cues produced by more susceptible fish species. We conclude that species-specific chemical cues are not the main mechanism driving differences in host susceptibility to gnathiid isopod infestation and that visual or post-attachment factors such as ease of obtaining a blood meal are likely mediators.

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Coverage

Spatial Extent: **Lat**:18.333 **Lon**:-64.967
Temporal Extent: 2019-06-03 - 2019-08-14

Methods & Sampling

Host species: Host fishes selected for testing were French grunt (*Haemulon flavolineatum*: Haemulidae), lane snapper (*Lutjanus synagris*: Lutjanidae), longspine squirrelfish (*Holocentrus rufus*: Holocentridae), and longfin damselfish (*Stegastes diencaeus*: Pomacentridae). French grunt and lane snapper are carnivorous, nocturnal fish that forage in seagrass and sandy areas at night and school on reefs during the day. Both species are highly and similarly susceptible to gnathiids. French grunts are locally abundant and are known to be able to attract gnathiids with only chemical cues and therefore were used as a standard for the experiments (see below). Longspine squirrelfish are nocturnal invertivores that forage at night and shelter in or near refuges on reefs during the day. Finally, longfin damselfish are diurnal herbivores that are highly territorial. Longspine squirrelfish and longfin damselfish represent moderate and low susceptibility to gnathiids, respectively.

Field collection: Juvenile *Gnathia marleyi* and adult host fishes were collected from John Brewers Bay, St. Thomas, United States Virgin Islands (18°20’ N, 64°58’ W) from May to August 2019 and January to March 2020. Gnathiids were collected using zooplankton light traps similar to those de- scribed by Artim and Sikkel (2016). They were held at the University of the Virgin Islands’ MacLean Marine Science Center in small colonies in 150-milliliter (ml) containers filled with filtered seawater. All host fishes were caught by free-divers using cast nets and were held in a 2800-liter tank with continuously flowing seawater, at 28 degrees C. Fish were held for no longer than 24 hours and all were returned to the original capture site.

Field experiments: To determine the ability of gnathiid isopods to detect and locate hosts using chemosensory cues and whether they used these cues to distinguish between host species, traps similar to those described in Sikkel et al. (2011) and Santos and Sikkel (2019) were used. These traps were constructed using a PVC tube (20 centimeters × 5 centimeters) with two removable, inward-facing funnels. The hole in the bottom of the funnel was sealed and four 1 centimeter diameter holes were drilled in the side of the funnels, allowing chemical cues to be released without the gnathiids being able to see the fish from outside the trap. Traps were placed haphazardly on the reef in pair-wise choice arrays. Pairings included: 1) French grunt versus empty (Control); 2) French grunt versus lane snapper (high vs high susceptibility); 3) French grunt versus longspine squirrelfish (high vs medium susceptibility); and 4) French grunt versus longfin damselfish (high vs low susceptibility). Fishes of similar size were paired for trials. The traps were placed more than 1 meter apart 1 hour before sunset and collected 1 hour after sunrise. This ensured that traps were deployed at times of peak gnathiid activity. Water from the traps was then filtered through 55-micrometer (µm) plankton mesh and fish were checked to assure no gnathiids were still feeding. The number of gnathiids in each trap was counted and all gnathiids were categorized by stage. In total, 66 pairs of traps were deployed (Control: n = 10; lane snapper: n = 15; longspine squirrelfish: n = 20; longfin damselfish: n = 21).

Data Processing Description

Statistical analysis: All statistical analyses were performed using RStudio (Version 1.2.1335). For field experiments, gnathiid counts within traps did not conform to and could not be transformed to a normal distribution, so a Kruskal-Wallis test was used to compare the differences between treatment levels. The differences within each treatment were calculated by subtracting the number of gnathiids found in a French grunt trap from the number of gnathiids found in its paired trap. A Dunn’s Multiple Comparison Test was then used to determine any differences between treatments (e.g. Control versus lane snapper, lane snapper versus longspine squirrelfish, etc.). Independently, Mann-Whitney U tests were used within each treatment to detect any differences between French grunt and its paired treatment (e.g. French grunt versus lane snapper, French grunt versus longspine squirrelfish, etc.). Data were also analyzed using permutation resampling (see Online Resource 1).

Video data was collected using a DLSR camera. Video data was analyzed manually. Statistical analyses were conducted in RStudio (Version 1.2.1335).

BCO-DMO Processing Description:
- Missing data identifier ‘NA’ replaced with 'nd' (BCO-DMO's default missing data identifier)
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added a conventional header with dataset name, PI names, version date
- Added columns for latitude and longitude based on sampling site location
- Converted dates to ISO date format (YYYY-MM-DDThh:mmZ)

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Data Files

File
field_data.csv (Comma Separated Values (.csv), 4.06 KB) MD5:75c19ebbed344c6346e496d354e7507d Primary data file for dataset ID 887304

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Supplemental Files

File
Permutation resampling resource filename: 887304_Summary_Permutation_Resampling_Vondriska.pdf (Portable Document Format (.pdf), 9.83 KB) MD5:2f647a1b88ee4adfb30145ef989550bb Summary of permutation resampling of field experiment results

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Related Publications

Artim, J. M., & Sikkel, P. C. (2016). Comparison of sampling methodologies and estimation of population parameters for a temporary fish ectoparasite. International Journal for Parasitology: Parasites and Wildlife, 5(2), 145–157. https://doi.org/10.1016/j.ijppaw.2016.05.003
Methods

RStudio Team (2017) RStudio: Integrated Development for R. Version 1.0.153. RStudio, Inc., Boston, MA. http://www.rstudio.com/ http://www.rstudio.com/.
Software

Santos, T. R. N., & Sikkel, P. C. (2017). Habitat associations of fish-parasitic gnathiid isopods in a shallow reef system in the central Philippines. Marine Biodiversity, 49(1), 83–96. https://doi.org/10.1007/s12526-017-0756-6
Methods

Sikkel, P. C., Sears, W. T., Weldon, B., & Tuttle, B. C. (2011). An experimental field test of host-finding mechanisms in a Caribbean gnathiid isopod. Marine Biology, 158(5), 1075–1083. https://doi.org/10.1007/s00227-011-1631-9
Methods

Vondriska, C., Dixson, D. L., Packard, A. J., & Sikkel, P. C. (2020). Differentially susceptible host fishes exhibit similar chemo-attractiveness to a common coral reef Ectoparasite. Symbiosis, 81(3), 247–253. https://doi.org/10.1007/s13199-020-00700-0
IsRelatedTo

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Parameters

Parameter	Description	Units
Date	Date of trial	unitless
Latitude	Latitude of sample site North (South is negative)	decimal degrees
Longitude	Longitude of sample site East (West is negative)	decimal degrees
Treatment	Host placed in comparison trap (Control = empty trap; Ls = Lutjanus synagris; Hr = Holocentrus rufus; Sd = Stegastes diencaeus)	unitless
Hf_Total	Total number of gnathiids found in trap containing a Haemulon flavolinieatum	unitless
Treatment_Total	Total number of gnathiids found in comparison Treatment trap	unitless
Difference	Difference between Hf Total and Treatment Total	unitless
Hf_Z1	Number of unfed stage 1 gnathiids found in the Haemulon flavolineatum trap	unitless
Hf_Z2	Number of unfed stage 2 gnathiids found in the Haemulon flavolineatum trap	unitless
Hf_Z3	Number of unfed stage 3 gnathiids found in the Haemulon flavolineatum trap	unitless
Hf_P1	Number of fed stage 1 gnathiids found in the Haemulon flavolineatum trap	unitless
Hf_P2	Number of fed stage 2 gnathiids found in the Haemulon flavolineatum trap	unitless
Hf_P3	Number of fed stage 3 gnathiids found in the Haemulon flavolineatum trap	unitless
Treatment_Z1	Number of unfed stage 1 gnathiids found in the Treatment trap	unitless
Treatment_Z2	Number of unfed stage 2 gnathiids found in the Treatment trap	unitless
Treatment_Z3	Number of unfed stage 3 gnathiids found in the Treatment trap	unitless
Treatment_P1	Number of fed stage 1 gnathiids found in the Treatment trap	unitless
Treatment_P2	Number of fed stage 2 gnathiids found in the Treatment trap	unitless
Treatment_P3	Number of fed stage 3 gnathiids found in the Treatment trap	unitless

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Instruments

Dataset-specific Instrument Name	DLSR camera
Generic Instrument Name	Camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Host-attraction trap
Generic Instrument Name	Fish Cage
Dataset-specific Description	Host-attraction traps: PVC tubing with a reversed funnel on each side. An individual host is placed within the trap to test chemical attraction for gnathiids.
Generic Instrument Description	Used to catch fish.

Dataset-specific Instrument Name	Lighted plankton trap
Generic Instrument Name	Plankton Net
Dataset-specific Description	Lighted plankton traps: PVC tubing with a reversed funnel. A light is shined out the funnel to attract plankton (including gnathiids) into the trap.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	
Generic Instrument Name	Self-Contained Underwater Breathing Apparatus
Generic Instrument Description	The self-contained underwater breathing apparatus or scuba diving system is the result of technological developments and innovations that began almost 300 years ago. Scuba diving is the most extensively used system for breathing underwater by recreational divers throughout the world and in various forms is also widely used to perform underwater work for military, scientific, and commercial purposes. Reference: http://oceanexplorer.noaa.gov/technology/diving/diving.html

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Project Information

Beyond Cleaning and Symbiosis: Ecology of 'Ticks of the Sea' on Coral Reefs (Gnathiid isopod ecology)

Coverage: Eastern Caribbean, Philippines, Australia

NSF Award Abstract:
Most research on the complex biological interactions that inhabit coral reefs has focused on larger organisms that are easily observed by divers. However, marine scientists are increasingly aware of the importance of the tiny organisms that make up the "smaller majority." This includes parasites, organisms that feed on other organisms without killing them, which may make up as many as 80% of the species on coral reefs. Among the most important parasitic organisms on coral reefs are gnathiid isopods, so-called 'ticks of the sea', that share many similarities with blood-feeding ticks and other arthropods on land. Like ticks and mosquitoes, gnathiids transmit malaria-like blood parasites. In high numbers, they can remove enough blood to kill adult fish, but even a single gnathiid can kill a juvenile fish. Thus, gnathiids may have a significant effect on coral reef communities through their effects on coral reef fishes. This project will use an integrative interdisciplinary approach involving field and laboratory observations and experiments, and molecular tools. In addition to contributing to our understanding of life in our oceans, this research will provide continued support for U.S. Doctoral and Masters students and will create valuable research opportunities for undergraduates from multiple institutions. The project will further build on the investigators existing relationships with resource managers, local divers, fishers, and boat operators, as well as K-12 schools and environmental education programs, and will contribute to local economies. A major goal of our outreach efforts will include an exhibit featuring our research at Coral World Ocean Park on St. Thomas, participation in Virgin Islands radio programs, and hosting high school students from South Carolina Governor's School.

The overall goal this investigation is to understand the ecology of fish-parasite interactions on coral reef and associated ecosystems. This project focuses on fish-parasitic gnathiid isopods, the most common ectoparasites of coral reef fishes that are best known for their role in cleaning symbiosis, as the major food item of cleaner fishes. However, their abundance, host range, role as micropredator, disease vector, and

potential prey item for other species, as well as their strong association with the benthos suggests the potential for much stronger community impacts. The goals for this project are to: 1) characterize the factors influencing local gnathiid isopod density by examining the role of fish-hosts, benthic cover, gnathiid predators including cleaners, and gnathiid conspecific attraction; 2) determine and quantify variation in host exploitation and the effects of gnathiid density on larval fish-host recruitment. To accomplish the first objective, the investigators will trap gnathiids from the substrate at sites in the Caribbean, Australia, and the Philippines. Variables associated with benthic habitat as well as local fish communities will be quantified and compared with local gnathiid abundance. Laboratory experiments will be conducted to determine the effects of different host species on gnathiid growth and reproduction and to determine the role of conspecific attraction in the formation of aggregations. Predators of gnathiids will be identified through examination of gut contents and through laboratory feeding studies. To accomplish the second objective, patterns of host-exploitation will be determined by DNA barcoding of blood meals from wild-caught gnathiids and results compared with the availability of different host species. To determine the effects of gnathiids on early life history stages of coral reef fishes, gnathiid abundance will be manipulated on small artificial patch reefs onto which newly-settled reef fishes will be transplanted.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1536794

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