Data package from a drifting in situ chamber (DISC) including larval tracking images and environmental data from deployments in Southwater Caye, Belize between June and August of 2016

Website: https://www.bco-dmo.org/dataset/739221
Data Type: Other Field Results
Version: 1
Version Date: 2018-06-25

Project
» Collaborative Research: The Role of Larval Orientation Behavior in Determining Population Connectivity (Elacatinus Dispersal II)

Contributors	Affiliation	Role
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Abstract
These data were collected with a drifting in situ chamber (DISC). The DISC instrument was developed by Claire Paris at the Rosenstiel School of Marine and Atmospheric Sciences (RSMAS) of the University of Miami to observe the movement behavior and orientation of pelagic larvae at sea. The DISC version used for this project was equipped with a 8-inch diameter behavioral chamber, a video camera looking up into the chamber, 3 analog and one digital compass, and environmental sensors for temperature, light, and magnetic field, a drogue, and a surface float with a GPS. A single larva was deployed at a time in the chamber. Two DISC instruments were released at sea at the same time, similar to ocean drifters. They were visually tracked for a set period of time (20-30 minutes) from a small boat and retrieved for the next set of larval deployment. The DISC was deployed in Southwater Caye, Belize (16°43′08″N 88°08′56″W).

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Coverage

Spatial Extent: **N**:16.83897 **E**:-88.06593 **S**:16.78007 **W**:-88.0817
Temporal Extent: 2016-06-03 - 2016-08-16

Dataset Description

Data package files (179 deployment folders):
Only deployments where larvae can be tracked are included in these files. Not all deployments could be successfully analyzed because the larva was either not visible or did not survive the deployment. If you have issues downloading these compressed tar files, please contact info@bco-dmo.org.

DISC_deployments_part1.tar.gz (26GB) discA deployments 45 to 137
DISC_deployments_part2.tar.gz (29GB) discA deployments 141 to 181
DISC_deployments_part3.tar.gz (24GB) discA deployments 183 to 258
DISC_deployments_part4.tar.gz (28GB) discA deployments 268 to 362
DISC_deployments_part5.tar.gz (33GB) discB deployments 46 to 147
DISC_deployments_part6.tar.gz -(31GB) discB deployments 149 to 212
DISC_deployments_part7.tar.gz - (29GB) discB deployments 214 to 286
DISC_deployments_part8.tar.gz - (27GB) discB deployments 288 to 363

Data package structure:

Each folder corresponds to the deployment of a single larva. In other words, each set of data in a deployment folder corresponds to the environment of the larva that was deployed at that time. The data from a single folder were synchronized to match the time stamp of the larval images.

Please refer to the file DISC_files_README.txt (also available as Microsoft Office format DISC_files_README.docx) for documentation of the files within the data package structure.

Related Datasets (data collection during same DISC deployments):
* DISC: Temperature and Light https://www.bco-dmo.org/dataset/739220
* DISC: Depth, Temperature, and Salinity https://www.bco-dmo.org/dataset/739541
* DISC: Deployment, environmental, and larval behavior information https://www.bco-dmo.org/dataset/739595

Methods & Sampling

The DISC is a free-floating, cylindrical behavioral observation chamber composed of clear acrylic and is used to monitor the behavior of marine larvae in situ. During each trial, an individual fish larva is placed inside of the central arena (20 cm diameter, 10 cm height) which is transparent to odor, light, and sound. The bottom of the arena is made of clear plexiglass, while the top is made of a fine mesh, and the walls are made of a black opaque film. Larvae can swim freely inside of the arena, and their behavior is recorded using a camera system which is supplemented by information on the rotation of the DISC and by records of the environment (temperature, light intensity, salinity, GPS).

A reference context was first defined. This was the ecological context in which we imagined a larva would be exposed to the most information. For this set of experiments, larvae were deployed in the DISC to a depth of 18 meters, within a kilometer from the reef, and during the ebb tide. The depth was chosen to reduce light scattering / intensity and based on observations of the vertical distribution of similar goby species. The distance was chosen to expose the larvae to higher sound levels and more concentrated chemosensory stimulants. The ebb tide was chosen to create a link between flow direction and chemosensory information, as we suspected that the ebb current would come from the direction of the reef.

To test the importance of the different environmental variables, three additional ecological contexts were defined by varying one of the defining features of the reference context at a time. That is, one group (shallow context) of larvae was deployed at 9 meters, within a kilometer from the reef, and during the ebb tide. One group (far context) was deployed at 18 meters, further than a kilometer from the reef, and during the ebb tide. The final group (flood context) was deployed at 18 meters, within a kilometer from the reef, and during the flood tide. For group-level analysis, significantly-directional individuals in a common ecological context were pooled. They were then assessed for significant consistency in their mean angles using a second-order Rayleigh's test. Additionally, the precision of orientation (rho-value) was compared between ecological contexts, as was the mean larval turning angle (i.e., the angle produced by three successive points on a larva's trajectory). Finally, the percentage of orienting individuals in each context was compared using a logistic model. In addition to looking at differences in circular statistics among contexts, we also assessed whether there was evidence of several common orientation hypotheses, both within and across contexts. Specifically, we looked for evidence of a sun compass, orientation with the current direction, orientation with the wind direction, and orientation variation with temperature and light.

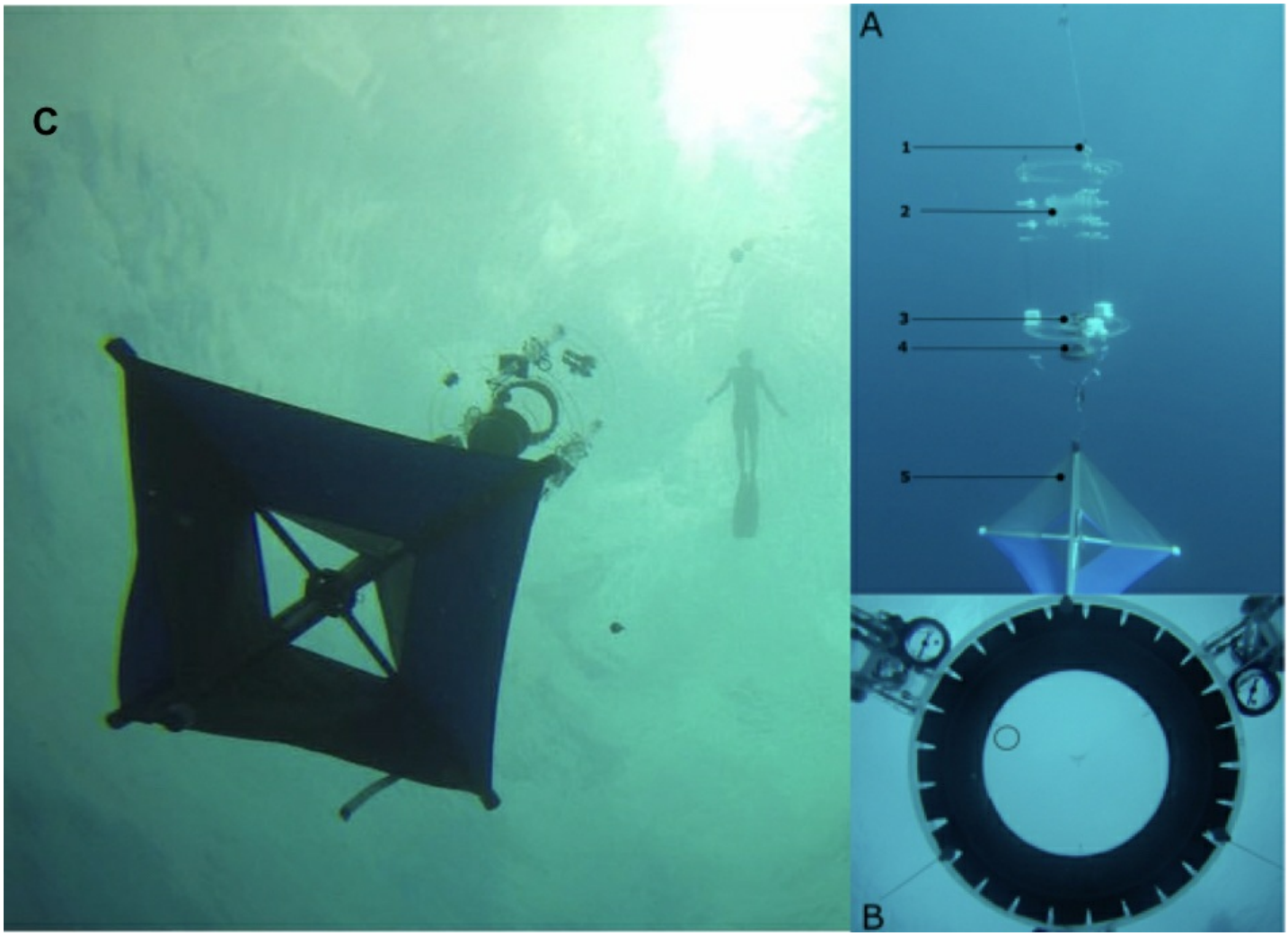

Figure 1. Drifting In Situ Chamber (DISC).

A. Schematic of DISC components. A thin kite-line (A1) tethers the DISC to a surface float equipped with a GPS and to a subsurface float that decouples the movement of the DISC in the water mass in which it is embedded from potential stokes drift. The clear acrylic DISC frame holds a behavioral arena (A2, 20.32 cm diameter, 10 cm height) - transparent to sound, light, and chemical cues – where individual larvae are deployed. A video camera (A3), placed 35 cm under the chamber, records the larval movement continuously during each 15-minute trial, which includes 5 minutes of acclimation time and 10 minutes of observation time. Environmental sensors (A4) attached to the DISC's frame record light levels, temperature, salinity, depth, earth's magnetic field strength, 3-D acceleration, and compass heading. The compass serves to track the DISC's rotation and is used to translate the movement of the larva from the chamber's frame of reference to a cardinal frame of reference. A drogue (A5) is attached to the DISC's bottom frame, keeping the DISC locked in the instantaneous current at the depth of the instrument. For deep deployments, the DISC was initially deployed to 9 m and lowered to 18 m with a dive reel placed above the DISC's tethering bridles. To optimize the number of observations, two DISCs were deployed simultaneously.

B. Example of image collected by the DISC's camera; the location of the larva is indicated by the black circle. A series of these images are used to manually track the location of the larva inside the chamber throughout the deployment.

C. Deployment of the DISC at 18 m offshore the Belize Barrier Reef.

Data Processing Description

Using a custom software, trends in orientation behavior were examined at both the individual-level and group-level. For individuals, the position of the larva was recorded in each image captured during the experiment. A Rayleigh's test was used to assess whether recorded positions of the larva were significantly oriented in a certain direction (Circular package in R, Lund and Agostinelli 2011). The individual's mean orientation angle and rho-value (a measure of variance in a circular distribution) were calculated for trials in which the larva was indeed significantly directional. Using a compass to record the rotation of the DISC throughout the deployment allowed for assessment of the data in a cardinal frame of reference rather than the camera's frame of reference, and all trials where orientation was more

precise before this correction (with a 5% tolerance) were discarded as artifactual behavior in response to the DISC.

All processing was done with the “discr” package in R (see https://github.com/jiho/discr). The exact version of discr used to create the data package version served here can be downloaded as a zip file (DISC_software_tag_v1.zip) and was released as tag "v1" at BCO-DMO's github for curatorial purposes (see https://github.com/BCODMO/DISC/releases/tag/v1).

BCO-DMO data manager processing notes:
* converted documentation of files within data structure from a Microsoft Word (.docx) format to non-proprietary rich text format (DISC_files_README.rtf). .rtf format can be used with Microsoft Word or other word processing software.
* Packaged data into two .zip files, one per deployment (A|B)
* Forked submitter's code repository https://github.com/beatrixparis/DISC to BCO-DMO's github account for curatorial purposes and tagged it to associate with this data version. See https://github.com/BCODMO/DISC/releases/tag/v1.

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Parameters

Parameters for this dataset have not yet been identified

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Deployments

DISC_Deployments_Belize

Website	https://www.bco-dmo.org/deployment/740951
Platform	Belize_reefs
Start Date	2016-06-03
End Date	2016-08-18

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Project Information

Collaborative Research: The Role of Larval Orientation Behavior in Determining Population Connectivity (Elacatinus Dispersal II)

Coverage: Belizean Barrier Reef System

Description from NSF award abstract:
Understanding how far young fish move away from their parents is a major goal of marine ecology because this dispersal can make connections between distinct populations and thus influence population size and dynamics. Understanding the drivers of population dynamics is, in turn, essential for effective fisheries management. Marine ecologists have used two different approaches to understand how fish populations are connected: genetic methods that measure connectivity and oceanographic models that predict connectivity. There is, however, a mismatch between the predictions of oceanographic models and the observations of genetic methods. It is thought that this mismatch is caused by the behavior of the young, or larval, fish. The objective of this research is to study the orientation capabilities of larval fish in the wild throughout development and under a variety of environmental conditions to see if the gap between observations and predictions of population connectivity can be resolved. The project will have broader impacts in three key areas: integration of research and teaching by training young scientists at multiple levels; broadening participation of undergraduates from underrepresented groups; and wide dissemination of results through development of a website with information and resources in English and Spanish.

The overall objective of the research is to investigate the role of larval orientation behavior throughout ontogeny in determining population connectivity. This will be done using the neon goby, Elacatinus lori, as a model system in Belize. The choice of study system is motivated by the fact that direct genetic methods have already been used to describe the complete dispersal kernel for this species, and these observations indicate that dispersal is less extensive than predicted by a high-resolution biophysical model; E. lori can be reared in the lab from hatching to settlement providing

a reliable source of larvae of all ages for proposed experiments; and a new, proven behavioral observation platform, the Drifting In Situ Chamber (DISC), allows measurements of larval orientation behavior in open water. The project has three specific objectives: to understand ontogenetic changes in larval orientation capabilities by correlating larval orientation behavior with developmental sensory anatomy; to analyze variation in the precision of larval orientation in different environmental contexts through ontogeny; and to test alternative hypotheses for the goal of larval orientation behavior, i.e., to determine where larvae are heading as they develop.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459156

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