Experimental results on the direction of escape for five species of calanoid copepod and multiple developmental stages in response to artificial hydrodynamic stimuli (PreyEscape project)

Website: https://www.bco-dmo.org/dataset/686922
Data Type: experimental
Version:
Version Date: 2017-04-04

Project
» The Drive to Survive: Copepods vs Ichthyoplankton (PreyEscape)

Contributors	Affiliation	Role
Lenz, Petra H.	University of Hawai'i at Mānoa (PBRC)	Principal Investigator
Hartline, Daniel K.	University of Hawai'i at Mānoa (PBRC)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Coverage

Spatial Extent: **Lat**:21.3 **Lon**:-157.8197

Dataset Description

This dataset includes the direction of escape for five species of calanoid copepod nauplii and copepodites in response to an abrupt hydromechanical stimulus (moving sphere, suction).

These data were published in:
Buskey, E.J., Strickler, J.R., Bradley, C.J., Hartline, D.K. and Lenz, P.H., 2017. Escapes in copepods: comparison between myelinate and amyelinate species. Journal of Experimental Biology, 220(5), pp.754-758. doi:10.1242/jeb.14830

Related Reference:
Takagi, D. & Hartline, D.K. (2017). Directional hydrodynamic sensing by free-swimming organisms. Bulletin of Mathematical Biology, in press doi: 10.1007/s11538-017-0368-0

Methods & Sampling

Copepods' approaches to and escapes from the source of a fluid disturbance were recorded on high-speed digital video (500 fps) in 3D. The optical set-up used is a scaled down version of a system described in Strickler (1998). The system, which uses beam splitters and prisms, generates in a single recorded image of two views, the front (x, z) and the side (y, z). These 3-D views were recorded high-speed digital video cameras (in Texas

by a Photron FastCam Super 10K series, in Hawaii by a Kodak Motioncorder SR-3000) at 500 frames per second.

For the behavioral experiments, sets of individuals were transferred into the experimental chamber (1.25 x 1.25 x 4.5 cm) at densities of 7 to 15 ind mL-1 for nauplii, and 1.5 to 3 ind mL-1 for copepodites. When one or more individuals were within the camera view the hydromechanical stimulus was triggered and a video sequence that included footage from before and after the trigger was recorded.

The hydromechanical stimulus: a 3-mm diameter inert plastic sphere was attached to a stiff rod mounted to a piezoelectric pusher (DSM LPA 100 Dynamic Structures) and positioned in the upper quarter of the optical vessel. A pulse trigger controlled the pusher, which displaced the sphere downward by 35 microns in 0.5 ms, returning it to its initial position 60 ms later.

Reference:
Strickler JR. 1998. Observing free-swimming copepods mating. Phil. Trans. R. Soc. Lond. B 353: 671-680.

Data Processing Description

For the data analysis, more than 800 escape sequences in response to the stimulus were reviewed and the copepods' body-axis orientation just prior to the stimulus trigger was recorded, as was the direction of its subsequent escape jump. Initial orientation and escape direction were categorized using a simple classification system: towards the sphere or away from it, according to the angle relative to the horizontal plane. In a few cases, the copepod's swim/escape direction was perpendicular to the stimulus (± 5º from horizontal), and these were excluded from the analysis (fewer than 5 % of observations). Results for each group (myelinate vs. amyelinate) were combined and tested using the Fisher Exact test (two-tailed) to compare swimming behavior of the two groups. Nauplii and copepodites were tested separately. Specific comparisons included: 1) swim direction prior to stimulus; 2) whether the escape direction was in the direction of the original swim ("original swim direction" vs. "reverse direction") and 3) whether escapes were directed towards or away from the stimulus ("towards sphere" vs. "away from sphere").

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

[table of contents | back to top]

Data Files

File	
copepod_escape_direction.csv	(Comma Separated Values (.csv), 1.37 KB) MD5:5a9805f1af94e84a579c70c8b28a880b
Primary data file for dataset ID 686922	

[table of contents | back to top]

Parameters

Parameter	Description	Units
stage	copepod developmental stage	unitless
myelin_flag	whether species possess (yes) or lack (no) myelin sheath on nerve cells	unitless
species	copepod species	unitless
orig_swim_dir	original swim direction which is either towards or away from stimulus; total is the sum of "towards" and "away"	unitless
escape_toward_count	number of observations of escapes directed towards stimulus	escapes
escape_away_count	number of observations of escapes directed away from stimulus	escapes
num_observ	total number of escapes observed	escapes

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Photron FastCam 10K series or Kodak Motioncorder SR-3000
Generic Instrument Name	Camera
Dataset-specific Description	Used to record swimming behavior of copepods
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

[table of contents | back to top]

Deployments

CopepodEscape_2017

Website	https://www.bco-dmo.org/deployment/687833
Platform	Lenz_lab
Start Date	2017-01-01
End Date	2017-12-31
Description	Copepod predation study

[table of contents | back to top]

Project Information

The Drive to Survive: Copepods vs Ichthyoplankton (PreyEscape)

Coverage: Pacific

Description from NSF award abstract:
This study will experimentally elucidate the dynamics of predator evasion by different species and life stages of copepod responding to a model larval fish predator. The PIs will use standard and high-speed videographic and cutting-edge holographic techniques. Predator-prey interactions within planktonic communities are key to understanding how energy is transferred within complex marine food webs. Of particular interest are those between the highly numerous copepods and one of their more important predators, the ichthyoplankton (the planktonic larval stages of fishes). The larvae of most fishes are planktivorous and heavily dependent on copepods for food. In general, evasion success increases with age in copepods and decreases with the age of the fish predator. How this plays out in detail is critical in determining predatory attack outcomes and the effect these have on predator and prey survival. To address this problem, different copepod developmental stages will be tested against several levels of predator competence, and the results examined for: 1) the success or failure of attacks for different combinations of predator and prey age class; 2) the kinematics (reaction latencies and trajectory orientation) for escape attempts, successful and unsuccessful, for different age classes of copepod; 3) the hydrodynamic cues generated by different ages and attack strategies of the predator and the sensitivity of different prey stages to these cues; and 4) the success or failure of the predatory approach and attack strategies at each prey stage. The data obtained will be used to inform key issues of zooplankton population dynamics. For the prey these include: predator-evasion capabilities and importance of detection ability, reaction speed, escape speed, escape orientation, and trajectory irregularity; for the predator they are: capabilities and importance of mouth gape size, stealthiness, hydrodynamic disturbance production, and lunge kinematics.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1235549
NSF Division of Ocean Sciences (NSF OCE)	OCE-0451376
NSF Division of Ocean Sciences (NSF OCE)	OCE-0452159

[table of contents | back to top]