Experimental results on the speed 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/686940
Data Type: experimental
Version:
Version Date: 2017-04-12

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

Contributors	Affiliation	Role
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Coverage

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

Dataset Description

This dataset includes the maximum speed of escape for five species of calanoid copepod and multiple developmental stages 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.148304

Sources of data: *Acartia tonsa* (immature stages; current study), *Acartia tonsa* (adult females; Buskey et al. 2002); *Bestiolina similis* (current study); *Eurytemora affinis* (Bradley et al. 2013); *Parvocalanus crassirostris* (Bradley et al. 2013); *Centropages hamatus* (Burdick et al. 2007)

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.

Data Processing Description

For the 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. A sub-set of these sequences was analyzed for maximum escape speeds. For this analysis, x,z and y,z coordinates of the copepod were measured to obtain the distance moved between frames and dividing this by the time interval between frames (2 ms). Maximum escape speeds were obtained from the literature for Parvocalanus crassirostris and Eurytemora affinis (Bradley et al. 2013), Acartia tonsa adults (Buskey et al. 2002) and Centropages hamatus (Burdick et al. 2007).

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- transposed species and myelin_flag rows to columns to create a flat file required to serve data on BCO-DMO
- replaced spaces with underscores
- added missing standard deviations for Acartia tonsa male and female to the data (version:2017-04-12)

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Data Files

File	
copepod_escape_speed.csv	(Comma Separated Values (.csv), 1.75 KB) MD5:a2bcb231a408fc6faf7d90e9eceaa16b
Primary data file for dataset ID 686940	

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Related Publications

Bradley, C. J., Strickler, J. R., Buskey, E. J., & Lenz, P. H. (2012). Swimming and escape behavior in two species of calanoid copepods from nauplius to adult. Journal of Plankton Research, 35(1), 49–65. doi:10.1093/plankt/fbs088
Methods

Burdick, D. S., Hartline, D. K., & Lenz, P. H. (2007). Escape strategies in co-occurring calanoid copepods. Limnology and Oceanography, 52(6), 2373–2385. doi:10.4319/lo.2007.52.6.2373
Methods

Buskey, E. J., Strickler, J. R., Bradley, C. J., Hartline, D. K., & Lenz, P. H. (2017). Escapes in copepods: comparison between myelinate and amyelinate species. The Journal of Experimental Biology, 220(5), 754–758. doi:10.1242/jeb.148304

Results

Buskey, E., Lenz, P., & Hartline, D. (2002). Escape behavior of planktonic copepods in response to hydrodynamic disturbances: high speed video analysis. Marine Ecology Progress Series, 235, 135–146. doi:10.3354/meps235135
Methods

Strickler, J. R. (1998). Observing free-swimming copepods mating. Philosophical Transactions of the Royal Society B: Biological Sciences, 353(1369), 671–680. doi:10.1098/rstb.1998.0233
Methods

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Parameters

Parameter	Description	Units
species	copepod species	unitless
myelin_flag	whether species possess (yes) or lack (no) myelin sheath on nerve cells	unitless
stage	copepod developmental stage: N = nauplius stages 1-6; C = copepodite stages 1-5; C6_Fem/Male = adult stage and sex	unitless
length_um	copepod body total length	microns
length_mm	copepod body total length	millimeters
speed	maximum escape speed	millimeters/second
speed_stdev	standard deviation for maximum speed	millimeters/second

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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.

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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

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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.

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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

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