Mean instantaneous larval and local flow velocities used to construct distributions of larval swimming velocities collected at Woods Hole Oceanographic Institution in 2011 (Larvae in turbulence project)

Website: https://www.bco-dmo.org/dataset/561140
Data Type: experimental
Version: 2015-06-08

Project
» Larval Response to Turbulence During Dispersal and Settlement (Larvae in turbulence)

Contributors	Affiliation	Role
Mullineaux, Lauren	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator
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Dataset Description

Mean vertical velocities (of both individual larvae and local flow) used to construct distributions of observed larval velocity, local flow velocity, and larval swimming velocities, as described in Wheeler et al. 2013. Velocities are recorded in three forcing regimes, 0 Hz, 0.75 Hz, and 1.75 Hz. PIV recordings by Wheeler in Summer 2012.

Relevant Reference:

Wheeler J.D., Helfrich K.R., Anderson E.J., McGann B., Staats P., Wargula A.E., Wilt K., Mullineaux L.S. (2013) Upward swimming of competent oyster larvae Crassostrea virginica persists in highly turbulent flow as detected by PIV flow subtraction. Mar Ecol Prog Ser 488, 171-185.

Data Processing Description

PIV velocity vectors extracted from raw images using DaVis image processing software, as described in Wheeler et al. 2013. PIV velocity vectors are isolated near larvae and used to subtract out local flow near larvae to identify larval velocities, as described in Wheeler et al. 2013.

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Data Files

File
flow_vel.csv(Comma Separated Values (.csv), 29.77 KB) MD5:824fe9dc7fa6ea6dc3e1a71af4886a44 Primary data file for dataset ID 561140

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Parameters

Parameter	Description	Units
forcing	forcing regime	Hz
larval_vert_vel	mean instantaneous larval vertical velocity	cm/s
larval_flow	mean instantaneous flow velocity around larvae	cm/s
larv_swim_vel	larval vertical swimming velocity (vertical flow velocity local to larva subtracted from larval vertical velocity)	cm/s
flow_vertvel_diff	average flow substracted from larval vertical velocity	cm/s

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Camera
Dataset-specific Description	high-speed monochrome camera (Photron Fastcam SA3) and a pulsed near-infrared laser (Oxford Lasers, Firefly 300 W, 1000 Hz, 808 nm)
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

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Deployments

lab_Mullineaux_2011

Website	https://www.bco-dmo.org/deployment/561100
Platform	WHOI
Start Date	2011-06-01
End Date	2012-08-31
Description	Larval oysters in turbulence experiments

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Project Information

Larval Response to Turbulence During Dispersal and Settlement (Larvae in turbulence)

Coverage: Laboratory studies at Woods Hole Oceanographic Institution

Description from NSF award abstract:
The planktonic larval stage of benthic marine invertebrates provides a mechanism for exchange of individuals between remote populations. Dispersal is affected by swimming behaviors, particularly those that alter the larva's vertical position in the water. Larvae of some species change their vertical positions in response to turbulence by ceasing to swim and sinking downward (diving). By doing so, they can alter their horizontal transport in currents and increase their supply to the seafloor. The main objectives of this study are to investigate behavioral responses of oyster (*Crassostrea virginica*) larvae to turbulence in the water column and at the seafloor, and to determine how these behaviors affect settlement. The investigators hypothesize that diving behavior enhances settlement into suitable habitat, even where mean bed shear stress is high. They expect that once larvae approach the bottom, they can take advantage of temporal and spatial refuges (such as turbulent lulls in the lee of roughness elements) to settle in otherwise harsh conditions. Investigating larval responses to turbulence is a challenge because it requires simultaneous measurement of time-variant flows and larval behaviors. The investigators will modify a conventional particle image velocimetry (PIV) approach so it can be used to track larval motions and fluid velocities simultaneously. PIV provides information on flow kinematics (e.g., rotation and strain rate) in the immediate vicinity of a larva, as well as bulk dissipation rates and measures of Taylor and integral length scales that likely influence larval acceleration. When these measurements are coupled with a larval trajectory, they provide a history of the fluid environment a larva experiences, and can be used to determine what characteristic of turbulence triggers the diving behavior. They also make it possible to calculate the bottom shear stress an individual larva experiences when it encounters the bottom and attempts to settle. The investigators will examine turbulence effects on larval behaviors in the water column using a grid-stirred tank. They will use a racetrack flume to test the hypothesis that larval settlement success depends on the frequency of lulls of sufficient duration for larval attachment.

Laboratory experiments will provide a mechanistic understanding of larval behavior that can be used in general theoretical models exploring how behavior influences dispersal and population connectivity. The quantified swimming responses of oysters are critical input for coupled bio-physical models of dispersal in the field. An understanding of larval behavior contributes to our ability to predict the effects of natural and anthropogenic perturbations (some of which are linked to global climate change) on benthic communities in coastal ecosystems where turbulence and habitat suitability vary spatially. This information is critical for informed decision making on shellfish management and design of marine reserves. The technique developed for simultaneous PIV and larval tracking will open new questions in larval ecology and be broadly applicable to studies of plankton interactions with turbulence.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0850419

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