Videos of polychaetes burrowing and swimming in La Jolla, CA during 2011 (Burrowing polychaete mechanics project)

Website: https://www.bco-dmo.org/dataset/555463
Version: 2015-04-07

Project
» Functional diversity of infaunal burrowers: Towards a mechanistic understanding of animal-sediment interactions (Burrowing polychaete mechanics)

Contributors	Affiliation	Role
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Dataset Description

Supplemental online videos for publications on biomechanics of burrowing by polychaete annelids.

Methods & Sampling

Dorgan, K.M., C.J. Law, and G.W. Rouse. 2013. Meandering worms: Mechanics of undulatory burrowing in muds. *Proceedings of the Royal Society B* 280: 20122948.

Specimens were collected by hand and sorted or sieved from sediments and preserved for DNA and morphology analysis. Armandia brevis (Moore, 1906) and Thoracophelia mucronata (Treadwell, 1914) were collected from Mission Bay, San Diego, California on June 9, 2011 and La Jolla Shores Beach, California on May 4, 2012, respectively.

http://dmoserv3.bco-dmo.org/data/rouse/polychaete_videos/Armandia_brevis_burrowing_in_gelatin_fragments_Rouse.mp4

This video shows *Armandia brevis* burrowing in gelatin fragments. See the paper "Meandering worms: mechanics of undulatory burrowing in muds" by Dorgan et al, published in Proceedings of the Royal Society B

http://dmoserv3.bco-dmo.org/data/rouse/polychaete_videos/Armandia_brevis_swimming_Rouse.mp4

This video shows *Armandia brevis* swimming. See the paper "Meandering worms: mechanics of undulatory burrowing in muds" by Dorgan et al, published in Proceedings of the Royal Society B

Law C, Dorgan KM, Rouse GW. 2014. Relating divergence in musculature within Opheliidae (Annelida) with different burrowing behaviors. J Morphol 275: 548-571.

http://dmoserv3.bco-dmo.org/data/rouse/polychaete_videos/Law_etal2013.mov

To observe the movements of the septum and injector organ corresponding with the peristaltic wave, live *Thoracophelia mucronata* were placed in tunnels in a thin layer of seawater gelatin between a microscope slide and cover slip. Tunnels were created by allow- ing the gelatin to set around straight pieces of fishing line, which were then pulled out of the set gelatin. Small worms with diameter close to that of the fishing line were positioned with the anterior at the entry of the tunnel and encouraged to move. Videos were recorded using a Canon T3i camera attached to a Leica DMR microscope with polarizing filters. Crossed polarizers were used to view muscle fibers, which are birefringent.

Francoeur, A.A., K.M. Dorgan. 2014. Burrowing behavior in mud and sand of morphologically divergent polychaete species (Annelida: Orbiniidae). *Biological Bulletin* 226: 131-145.

http://dmoserv3.bco-dmo.org/data/rouse/polychaete_videos/Francouer&Dorgan104.mp4

Videos of the orbiniid polychaetes, *Leitoscoloplos pugettensis, Naineris dendritica,* and *Orbinia johnsoni,* burrowing in gelatin, a clear analog for muddy sediments, and glass beads and cryolite, analogs for sandy sediments. All three species extend burrows by fracture in gelatin. *L. pugettensis,* naturally found in muddy sediments, exhibits periodic twisting in gelatin, whereas twisting in sand analogs is more erratic. *N. dendritica,* naturally found in sands, has a wider anterior that shows periodic fluctuations in width. For all three species, substantially more grain movement can be seen in glass beads than in cryolite. Additionally, *O. johnsoni,* naturally found on sandy beaches, exhibits frequent periodic body expansions, visible as anterior movement of dark internal mass, in cryolite that rarely occur in glass beads and were not observed in gelatin.

Data Processing Description

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard

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Data Files

File
polych_videos.csv (Comma Separated Values (.csv), 863 bytes) MD5:16fca1ebd8efdff6920f9b974d15b81a Primary data file for dataset ID 555463

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Parameters

Parameter	Description	Units
species	taxonomic genus and species name	unitless
reference_paper	citation	unitless
activity	activity of polychaetes in video	unitless
video_link	link to the video	unitless

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Instruments

Dataset-specific Instrument Name	camera
Generic Instrument Name	Camera
Dataset-specific Description	Canon T3i camera attached to microscope
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	microscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Leica DMR microscope
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Deployments

Rouse_2011

Website	https://www.bco-dmo.org/deployment/555360
Platform	SIO_Rouse
Start Date	2011-06-09
End Date	2012-05-04
Description	polychaete studies

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Project Information

Functional diversity of infaunal burrowers: Towards a mechanistic understanding of animal-sediment interactions (Burrowing polychaete mechanics)

Coverage: California

Description from NSF award abstract:
Benthic communities comprise diverse and abundant organisms with important ecological and biogeochemical roles. They convert organic carbon into biomass that is transferred to higher trophic levels, regenerate nutrients, and determine the fate of pollutants and organic carbon buried in sediments. In many coastal environments, anthropogenic stresses, including eutrophication and resulting hypoxia, trawling and disturbance from fisheries, and pollutants have negative and often dramatic affects on species diversity. Assessing the ecological and biogeochemical impacts of changes in species diversity is nearly impossible,

however, without understanding the functional roles of the species. In sedimentary environments, determining functionality is especially important for organisms closely associated sediments, such as infaunal deposit feeders that ingest sediments while living in and moving through them.

Burrowing behaviors and morphologies have been examined for individual species, but decades have passed since even broad burrowing behaviors were compared across diverse taxa. Moreover, such comparisons largely ignored the mechanical response of sediments, an omission similar to studying swimming without considering fluid mechanics. Since that time, there have been several major advances in the physics of animal-sediment interactions. Muddy sediments are elastic solids through which burrows are extended by fracture. In contrast, sands are granular materials whose mechanics are governed by gravitational forces acting on individual grains, rather than by adhesion and cohesion of the mucopolymeric matrix dominating mud mechanics. Use of gelatin as a clear analog for muds has enabled visualization of burrowing and analyses of forces and kinematics. This research will combine structural and anatomical studies and kinematic analyses of burrowing in gelatin and sand analogs with mechanical testing and numerical modeling of real sediments. Linkages would be made among anatomies, morphologies, and behaviors to burrowing function in sands versus muds. Polychaetous annelids, a diverse and abundant component of benthic communities, will be the focal taxon.

Functional groupings of burrowing infauna have been based on morphologies and trophic roles but advances in sediment mechanics suggest that similar morphologies may have different functions in sands versus muds (e.g., expansible structures extend cracks in muds but are anchors in sands). In addition, seemingly different morphologies may have analogous functions (e.g., the pharynx of Nereis virens and the muscular anterior of the cirratulid Cirriformia moorei both exert dorso-ventral stress to extend burrows by fracture). Linking functions to morphologies and behaviors of burrowers is important in understanding functional roles of infauna and resulting functional diversity of benthic communities. The diversity of burrowing mechanisms revealed in this study will enable generalizations about burrowing mechanics in different environments. Important characteristics of burrowing locomotion will be identified as those shared by diverse burrowers. How the different physical constraints of sand and mud specify burrowing mechanics and affect morphologies and behaviors of burrowers will be contrasted for closely related taxa from different environments.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1029160

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