1-27-2014

Functional Diversity of Subsurface Deposit Feeders

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Preview of Award 0851172 - Final Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	**4900**
Federal Grant or Other Identifying Number Assigned by Agency:	**0851172**
Project Title:	**Functional Diversity of Subsurface Deposit Feeders**
PD/PI Name:	**Peter A Jumars, 000238217** **Sara M Lindsay, 000258983**
Submitting Official:	**Peter A Jumars** **Principal Investigator**
Submission Date:	**1/27/2014**
Recipient Organization:	**University of Maine**
Project/Grant Period:	**6/1/2009 - 9/30/2013**
Reporting Period:	**6/1/2013 - 9/30/2013**
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions):	**Peter A Jumars**

Accomplishments

What are the major goals of the project?

The major goals of the project are to gain a comprehensive understanding of polychaete chemosensory behaviors below the sediment-water interface and to understand how burrowing displaces sediment grains.

What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities:	Our major activities were methods development of a method to locate worms burrowing beneath the sediment-water interface and to develop an observational capability for assessing local flow around polychaete nuchal organs and particle motion around burrowing polychaetes.
Specific Objectives:	Survey a diversity of subsurface deposit feeders to illuminate relationships between structure and function, especially concerrning chemsensing behaviors.
Significant Results:	We have documented statistically significant capability by nereidid worms to locate positions of chemical cues below the sediment-water interface. In a massive review of polychaete feeding, we have identified correlated syndromes of morphological features and feeding behaviors (Jumars et al. 2015).
Key Outcomes or Other Achievements:	We have documented artifacts produced by rigid aquaria walls due to jamming in sands (Du Clos et al. 2013). We developed a particle-imaging-velocimetric method to locate the horizontal position of burrowing worms in sands so that directional responses to subsurface chemical cues could be documented (Du Clos, in review). We developed a method using transparent, elastic-coated chambers that allows high-resolution video recording of nuchal organ deployement and burrowing. The method has shown us very distinct, taxon-specific "sniffing" behaviors.

What opportunities for training and professional development has the project provided?

Kevin Du Clos (2012) completed his M.S. in marine sciences at UMaine and is now a Ph.D. candidate in that program. Katelyn Hunt as a result of her experience in this project was hired as a marine science education intern with the Georgia Marine Extension Program, and is applying to graduate schools

How have the results been disseminated to communities of interest?

In addition to publications, these results have been presented at a meeting:

Hunt K, Du Clos K, Jumars P.A., Lindsay S.M. Assessing polychaete responses to subsurface chemical cues. Benthic Ecology Meeting, Savannah, GA, March 2013.
Du Clos KT., Lindsay S.M., Jumars, P.A. Particle-imaging velocimetry for surface visualization of subsurface *Nereis virens* burrowing. March, 2013 at Benthic Ecology Meeting, Savannah, GA.
We anticipate at least two additional manuscripts on our chemosensing results.

What do you plan to do during the next reporting period to accomplish the goals?

Uploaded Files

See supporting files:

None reported

Products

Journals

Journal 1 of 3

Wall effects in mud and sand: Behavior of Allita virens and Clymenella torquata near rigid walls.	
Journal:	Journal of Marine Resrearch
Issue:	3
Volume:	71
Publication Year:	2013
Page Numbers:	211
Authors:	Du Clos, K., S.M. Lindsay and P.A. Jumars
Publication Status:	Published
Peer Reviewed:	Yes
Acknowledgement of Federal Support:	Yes

Journal 2 of 3

Visualizing subsurface burrowing by the polychaete Alitta virens with particle image velocimetry	
Journal:	Limnology and Oceanography: Methods
Issue:	
Volume:	
Publication Year:	
Page Numbers:	
Authors:	Du Clos, K.T.
Publication Status:	Under Review

Peer Reviewed:	Yes
Acknowledgement of Federal Support:	Yes

Journal 3 of 3

Diet of worms Emended: An update of polychaete feeding guilds	
Journal:	Annual Review of Marine Science
Issue:	
Volume:	7
Publication Year:	2015
Page Numbers:	
Authors:	Jumars, P.A., K.M. Dorgan and S.M. Lindsay
Publication Status:	Other
Peer Reviewed:	Yes
Acknowledgement of Federal Support:	Yes

Thesis/Dissertations

Thesis/Dissertation 1 of 1

Polychaete burrowing behavior in sand and mud	
Institution:	University of Maine
Authors:	Du Clos, K. T.
Completion Year:	2012
Acknowledgement of Federal Support:	Yes

Technologies or Techniques

1.
We developed particle image velocimetry methods to remotely detect the horizontal positions of burrowing animals beneath the sediment-water interface.
We developed small-scale observational methods resistant to particle jamming problems present in ordinary "ant farms" with rigid walls.

Patents

Patent 1 of 1

Method and Apparatus for Investigating Mechanical Properties of Soft Materials	
Country:	USA
Application Date:	3/18/2011

Status:	GRANTED
Patent Number:	20120234102
Date Issued:	9/20/2012

Abstract:
A method and apparatus for investigating subsurface properties of sediment, soil, snow, food stuff and other soft materials incorporates a probe head, preferably in the form of a coil spring that functions as a screw thread, which moves into the soil, snow, sediment, food stuff or other soft material, isolates a column of the material and applies tension to that column while measuring the applied force with a force sensor.

Other Products

Other Product 1 of 1

Product Type:	Audio/Video
Description:	We are editing video recordings and plan to post versions that are useful for visualizing aspects of burrowing and chemosensing in polychaetes

Uploaded Files

See supporting files:

None reported

Participants

Research Experience for Undergraduates (REU) funding

REU Comments:

What individuals have worked on the project?

Name	Most Senior Project Role	Email Address	Nearest Person Month Worked
Kevin T. Du Clos	Graduate Student	kevin.duclos@maine.edu	3
Sara M Lindsay	Co-PD/PI	slindsay@maine.edu	2
Peter A Jumars	PD/PI	jumars@maine.edu	1
Katelyn Hunt	Non-student Research Assistant	katelyn_hunt@umit.maine.edu	2

Participant 1 of 4

Kevin T. Du Clos , kevin.duclos@maine.edu	
Nearest Persons Months Worked:	3
Funding Support:	K. Du Clos was supported for all three months on this grant as a half-time RA.

International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	
REU: Government Fiscal Year(s) Participant was Supported:	

Contribution: K. Du Clos carried out extensive experiments with burrowing and particle image velocimetry.

Participant 2 of 4

Sara M Lindsay , slindsay@maine.edu

Nearest Persons Months Worked:	2
Funding Support:	Two months of salary were provided during this final phase of the grant.
International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	
REU: Government Fiscal Year(s) Participant was Supported:	

Contribution: S. Lindsay has overseen the chemosensing portions of this work and has conducted many of the observations and experiments.

Participant 3 of 4

Peter A Jumars , jumars@maine.edu

Nearest Persons Months Worked:	1
Funding Support:	One month of summer salary was provided.
International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	

REU: Government Fiscal Year(s) Participant was Supported:

Contribution: P. Jumars coordinated the entire project and oversaw the experiments on burrowing behavior.

Participant 4 of 4

Katelyn Hunt , katelyn_hunt@umit.maine.edu	
Nearest Persons Months Worked:	2
Funding Support:	After her graduation from UMaine, she was paid two months to work on the project.
International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	
REU: Government Fiscal Year(s) Participant was Supported:	

Contribution: K. Hunt conducted many of the chemosensing experiments.

What other organizations have been involved as partners?

Nothing to Report

Have other collaborators or contacts been involved? NO

Impacts

What is the impact on the development of the principal discipline(s) of the project?

This work continues to develop understanding of the interactions between morphological structures and behaviors of burrowing organisms and mechanical properties of muds and sands. It has identified syndromes of associated morphologies and behaviors that characterize the tropohic roles of burrowing polychaetes.

What is the impact on other disciplines?

Ichnologists are following this work to aid in their interpretations of trace fossils. We anticipate that Jumars et al. (2015) will replace Fauchald and Jumars (1979) as their summary of choice.

What is the impact on the development of human resources?

The work emphasizes the importance of material properties on sediment-dwelling organisms and thus the value of a materials engineering background for understanding form and function.

What is the impact on physical resources that form infrastructure?

We expect the particle imaging velocimetry methods developed in this project for locating the positions of subsurface burrowers to be used by others and extended to field applications.

What is the impact on institutional resources that form infrastructure?

The project has developed a particle imaging velocimetry capability at the Darling Marine Center that others are using.

What is the impact on information resources that form infrastructure?

Nothing to Report

What is the impact on technology transfer?

Nothing to Report

What is the impact on society beyond science and technology?

Nothing to Report

Changes

Changes in approach and reasons for change

We originally planned to use particle imaging velocimetry to quantify particle motions caused by burrowing. We could not get enough depth of field to escape wall effects with this method. Thus we developed two other methods to address the original questions. We used particle imaging velocimetry to visualize effects of force chains that reached the sediment surface during burrowing -- far from any artifact-causing wall. For close observations we used transparent silicon elastomers to coat small chambers and reduce the jamming observed when rigid walls were used instead.

Actual or Anticipated problems or delays and actions or plans to resolve them

The methods development took much longer than anticipated.

Changes that have a significant impact on expenditures

Methods delays delayed expenditures, concentrating substantial expenditure in the final three months.

Significant changes in use or care of human subjects

Nothing to Report

Significant changes in use or care of vertebrate animals

Nothing to Report

Significant changes in use or care of biohazards

Nothing to Report