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# Functional Diversity of Subsurface Deposit Feeders

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## Preview of Award 0851172 - Final Project Report

[Cover](#) |  
[Accomplishments](#) |  
[Products](#) |  
[Participants/Organizations](#) |  
[Impacts](#) |  
[Changes/Problems](#)

### 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, Principal Investigator Sara M Lindsay, Co-Principal Investigator
Recipient Organization:	University of Maine
Project/Grant Period:	06/01/2009 - 09/30/2013
Reporting Period:	06/01/2013 - 09/30/2013
Submitting Official (if other than PD\PI):	Peter A Jumars Principal Investigator
Submission Date:	01/27/2014
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Peter A Jumars

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### 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 concerning 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 deployment 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 K.T., 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.

## Products

### Books

### Book Chapters

### Conference Papers and Presentations

### Inventions

### Journals

Du Clos, K., S.M. Lindsay and P.A. Jumars (2013). Wall effects in mud and sand: Behavior of *Allitta virens* and *Clymenella torquata* near rigid walls. *Journal of Marine Research*. 71 (3), 211. Status = PUBLISHED;

Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Du Clos, K.T. (). Visualizing subsurface burrowing by the polychaete *Alitta virens* with particle image velocimetry. *Limnology and Oceanography: Methods*. . Status = UNDER\_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Jumars, P.A., K.M. Dorgan and S.M. Lindsay (2015). Diet of worms Emended: An update of polychaete feeding guilds. *Annual Review of Marine Science*. 7 . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

## Licenses

### Other Products

*Audio or Video Products.*

We are editing video recordings and plan to post versions that are useful for visualizing aspects of burrowing and chemosensing in polychaetes

### Other Publications

#### Patents

*Method and Apparatus for Investigating Mechanical Properties of Soft Materials. Patent No. 20120234102. UNITED STATES. Application Date = 03/18/2011. Date Issued = 09/20/2012. Status = Granted*

### Technologies or Techniques

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.

### Thesis/Dissertations

Du Clos, K. T.. *Polychaete burrowing behavior in sand and mud*. (2012). University of Maine. Acknowledgement of Federal Support = Yes

### Websites

Nothing to report.

## Participants/Organizations

### What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Jumars, Peter	PD/PI	1
Lindsay, Sara	Co PD/PI	2
Du Clos, Kevin	Graduate Student (research assistant)	3
Hunt, Katelyn	Non-Student Research Assistant	2

### Full details of individuals who have worked on the project:

**Peter A Jumars****Email:** jumars@maine.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 1

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

**Funding Support:** One month of summer salary was provided.

**International Collaboration:** No

**International Travel:** No

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**Sara M Lindsay****Email:** slindsay@maine.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 2

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

**Funding Support:** Two months of salary were provided during this final phase of the grant.

**International Collaboration:** No

**International Travel:** No

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**Kevin T. Du Clos****Email:** kevin.duclos@maine.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 3

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

**Funding Support:** K. Du Clos was supported for all three months on this grant as a half-time RA.

**International Collaboration:** No

**International Travel:** No

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**Katelyn Hunt****Email:** katelyn\_hunt@umit.maine.edu**Most Senior Project Role:** Non-Student Research Assistant**Nearest Person Month Worked:** 2

**Contribution to the Project:** K. Hunt conducted many of the chemosensing experiments.

**Funding Support:** After her graduation from UMaine, she was paid two months to work on the project.

**International Collaboration:** No

**International Travel:** No

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**What other organizations have been involved as partners?**

Nothing to report.

**What other collaborators or contacts have been involved?**

NO

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## 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 trophic 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.

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## Changes/Problems

**Changes in approach and reason 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.