

3-18-2002

# POWRE: A Pilot Study of Chemoreception Mechanisms in Deposit-Feeding Polychaetes

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## Recommended Citation

Lindsay, Sara M., "POWRE: A Pilot Study of Chemoreception Mechanisms in Deposit-Feeding Polychaetes" (2002). *University of Maine Office of Research and Sponsored Programs: Grant Reports*. 258.  
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**Final Report for Period:** 07/1999 - 12/2001**Submitted on:** 03/18/2002**Principal Investigator:** Lindsay, Sara M.**Award ID:** 9973327**Organization:** University of Maine**Title:**

POWRE: A Pilot Study of Chemoreception Mechanisms in Deposit-Feeding Polychaetes

**Project Participants****Senior Personnel****Name:** Lindsay, Sara**Worked for more than 160 Hours:** Yes**Contribution to Project:****Post-doc****Graduate Student****Name:** Riordan, Jr., Timothy**Worked for more than 160 Hours:** Yes**Contribution to Project:**

As part of his graduate work, Tim developed molecular biological methods to identify putative chemoreceptors in spionid polychaetes. He also conducted behavioral experiments examining polychaete responses to sediment bound odorants and developed immunocytochemistry methods to label activated sensory cells. His salary was supported in part by a research assistantship from the Univ. Maine School of Marine Sciences, and a partial Research Fellowship from the Maine Sea Grant Program. This NSF award has supported the costs associated with his research program.

**Undergraduate Student****Name:** Tomlinson, Kirsten**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Kirsten conducted preliminary behavioral observations on one species of polychaete worm, *Streblospio benedicti*, as part of her senior capstone project in my laboratory.

**Name:** Jackson, Jennifer**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Jennifer Jackson continues to work on this project as an undergraduate at the University of Maine. She is learning microscopy techniques (fluorescence, confocal, scanning electron microscopy), histology & immunocytochemistry, and will begin learning molecular biological techniques as she explores her own interest in anterior regeneration in polychaetes. This NSF Award has provided support for her subsistence at field collection sites and registration for the recent Society for Comparative & Integrative Biology meeting at which she presented a poster.

**Other Participant****Research Experience for Undergraduates****Organizational Partners****Other Collaborators or Contacts**

Dr. Paul Rawson, Assistant Professor, School of Marine Sciences, University of Maine has collaborated on developing the molecular biological methods for identifying putative chemoreceptors in polychaete worms. As planned, he has provided access to all the necessary molecular

biological equipment. Dr. Seth Tyler, Professor, Department of Biological Sciences, University of Maine, assisted with initial training on the confocal microscope. Dr. Harold (Dusty) Dowse, Department of Biological Sciences, University of Maine, provided access to a microinjection system for preliminary neuronal tracing experiments and helped build a computer-control system for apparatus used in the cell-labeling studies.

### Activities and Findings

#### **Research and Education Activities:**

This award supported the initiation of a novel, integrated approach to studying marine invertebrate feeding biology by a junior, non-tenure track faculty member. To link sensory mechanism with ecologically important biogenic disturbance, research focused on common deposit feeding spionid polychaetes. Several types of experiments were conducted. Histological studies using electron microscopy examined the external anatomy of spionid polychaetes to determine if peripheral sensory structures were present. Recent efforts established methods to identify neuroanatomy using fluorescent dyes and confocal microscopy. Behavioral experiments were conducted to determine if polychaetes responded to particle-bound chemical cues. These experiments tested in part whether peripheral sensory structures were involved in coordinating feeding behavior. We attempted to use molecular biological techniques to identify portions of genes that might encode chemoreceptors in spionid polychaetes. We adapted an immunocytochemistry approach to label polychaete sensory cells that were activated by chemical cues. The award supported research by one high school student (Jennifer Jackson), two undergraduates (Jennifer Jackson, Kirsten Tomlinson), and one M.S. degree student (Timothy Riordan). Preliminary results were presented at the Society for Integrative and Comparative Biology meetings in 2000-2002, and at the Benthic Ecology Meetings in 2000.

#### **Findings:**

Results of electron microscopy confirm the presence of ciliated sensory cells on the lateral and abfrontal surfaces of feeding palps and on the prostomium in three species of spionid polychaetes, including *Streblospio benedicti* and *Dipolydora quadrilobata*. Preliminary transmission electron microscopy studies of the *D. quadrilobata* abfrontal sensory cells reveal an abundance of apical mitochondria and short ciliary rootlets, similar to chemoreceptor cells of other polychaetes. Behavioral experiments indicate that spionid feeding appendages respond to particle bound amino acids and sugars, implicating the palp sensory structures as chemoreceptors. Molecular biological experiments demonstrated that the proposed method for identifying putative chemoreceptor genes was not viable. In contrast, experiments in the last 3 months using immunocytochemistry to label activated sensory cells have yielded exciting preliminary results that suggest the palp sensory structures may be both chemoreceptors and mechanoreceptors.

#### **Training and Development:**

Timothy Riordan, Jr. completed his M.S. degree in Marine Biology working on several aspects of this project. He had a strong background in marine ecology, and during his tenure he refined his background in behavioral ecology, and learned basic molecular biological techniques, neurobiology, and extensive histology methods. Indeed, the strong toolbox of skills he developed helped him land a job working as a technician in a molecular biological research lab in Oregon. In addition, Tim has strengthened his communication skills substantially by repeated presentations at meetings. As an undergraduate Marine Science major, Kirsten Tomlinson had no research background. By conducting a two-semester long project examining the feeding behavior of spionid polychaetes, Kirsten learned how to collect, sort, and identify numerous polychaete species; how to obtain and analyze video records of behavior; and how to write a scientific report of her results. Jennifer Jackson began working on this project as a High School senior. She also began by learning how to collect, sort and identify common polychaetes. Her initial project also focused on the behavior of spionid polychaetes, and she presented her results at the New England Junior Science and Humanities Symposium, taking 2nd place and earning a trip to the national competition. Jennifer was so captivated by invertebrates that she conducted a year-long independent study in marine invertebrates with me during her senior year in high school. As an undergraduate at the University of Maine, Jennifer has continued to work with me on this project. She has learned how to use the scanning electron microscope, basic darkroom techniques, how to analyze video records, use spreadsheets and statistical analyses. She is learning techniques of histology and molecular biology this year. She has also begun her own project on anterior regeneration in spionids, presenting work from this summer at the 2002 Society for Integrative and Comparative Biology meeting in Anaheim, CA.

#### **Outreach Activities:**

I was interviewed by Jennifer Jackson for a nationally televised program, Real Science, produced by San Jose Public Television (episode number 601 'It's In the Water'). This program follows teenagers spending a day with a scientist. The episode showed Jennifer learning about mudflats and polychaetes with me at the University of Maine Darling Marine Center.

### Journal Publications

Riordan, Jr., T.J. and S.M. Lindsay., "Feeding responses to particle-bound cues by a deposit-feeding spionid polychaete, *Dipolydora quadrilobata* (Jacobi 1883).", *Journal of Experimental Marine Biology and Ecology*, p. , vol. , ( ). Accepted

Lindsay, S.M. and T.J.Riordan, Jr., "Preliminary identification and activity-dependent labeling of peripheral sensory structures of a spionid polychaete, *Dipolydora quadrilobata* (Jacobi 1883).", *Biological Bulletin*, p. , vol. , ( ). Unpublished Manuscript, to be submitted by 3/29/2002

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