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# Symposium Support: Integrative Biology of Animal Regeneration - Seattle, WA January 2010

Sara M. Lindsay

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**Final Report for Period:** 10/2009 - 09/2010

**Submitted on:** 12/22/2010

**Principal Investigator:** Lindsay, Sara M.

**Award ID:** 0940753

**Organization:** University of Maine

**Submitted By:**

Lindsay, Sara - Principal Investigator

**Title:**

Symposium Support: Integrative Biology of Animal Regeneration - Seattle, WA January 2010

### Project Participants

#### Senior Personnel

**Name:** Lindsay, Sara

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Sara Lindsay served as PI for this project. She assisted with organizing the symposium program, and was responsible for organizing all reimbursements for symposium participants. She spent approximately 0.75 academic months working directly on the project.

**Name:** Bely, Alexandra

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Alexandra Bely served as co-principal investigator on this project. She took the lead in organizing the symposium program and recruiting speakers. She spent a total of 0.5 academic months working directly on this project.

#### Post-doc

#### Graduate Student

#### Undergraduate Student

#### Technician, Programmer

#### Other Participant

#### Research Experience for Undergraduates

### Organizational Partners

### Other Collaborators or Contacts

### Activities and Findings

#### Research and Education Activities:

Funding from this award supported a Symposium entitled 'Animal Regeneration: Integrating Development, Ecology & Evolution' at the Society for Integrative and Comparative Biology Meeting in Seattle, WA, January 3-7, 2010.

The ten invited symposium speakers represented a diverse scientific perspective, as well as diverse demographic. Two speakers were senior

researchers recognized as leaders investigating the mechanisms and evolution of regeneration, three speakers were junior scientists, four were women, and one was from an underrepresented minority.

In addition to the 10 speakers and public round-table discussion that comprised the Symposium, eight contributed posters (including one education related poster titled 'Regeneration in the classroom: linking infaunal injury and ocean literacy using integrated concept mapping'), and 12 contributed oral presentations were made by scientists and students in complementary sessions.

A list of all symposium and complementary presentations follows.

Symposium participants (in speaking order)

Ecology of injury and regeneration in marine benthic invertebrates: from individuals to ecosystems LINDSAY, S.M.; University of Maine, Orono slindsay@maine.edu

Sponge regeneration in ecological context WULFF, Janie; Florida State University wulff@bio.fsu.edu

Costs of arm loss and regeneration in stellate echinoderms LAWRENCE, J.M.; Univ. of South Florida lawr@cas.usf.edu

Regeneration: a framework for future research MAGINNIS, Tara L; The University of Texas at Austin taramaginnis@austin.rr.com

Evolutionary morphology of regenerative abilities among crinoids: a paleontological perspective GAHN, Forest J\*; BAUMILLER, Tomasz K; Brigham Young Univeristy-Idaho; University of Michigan gahnf@byui.edu

Evolutionary loss of animal regeneration: pattern and process BELY, A.E.; Univ. of Maryland, College Park abely@umd.edu

Evolution of mechanisms underlying limb regeneration in salamanders BROCKES, Jeremy P; UCL j.brockes@ucl.ac.uk

Stem cells, regeneration and the developmental plasticity of planarians SANCHEZ ALVARADO, A; Howard Hughes Medical School, University of Utah School of Medicine sanchez@neuro.utah.edu

Bioelectric Events and Vertebrate Appendage Regeneration TSENG, A\*; LEVIN, M; Tufts University; Tufts University aisun.tseng@tufts.edu

Exploring Hydra regeneration and budding with genomics, transgenics, and chemical genetics STEELE, Rob; University of California, Irvine resteele@uci.edu

Complementary Oral Session: Animal Regeneration 1

Bloody Whole Body Regeneration! BROWN, FD\*; KEELING, EL; LE, AD; SWALLA, BJ; University of Washington, Seattle; Universidad de los Andes, Bogot?; University of Washington; California Polytechnic State University, San Luis Obispo; University of Washington, Seattle federico.brown@tuebingen.mpg.de

How many mouths are too many? Induction of oral fates in the cnidarian *Nematostella vectensis*. HARMON, S.; BURTON, P.M.\*; Wabash College; Wabash College burtonp@wabash.edu

Evolution of developmental trajectories: regeneration and fission in nauidid annelids ZATTARA, E.E.\*\*; BELY, A.E.; University of Maryland, College Park ezattara@umd.edu

Transcriptome characterization via 454 sequencing of an oligochaete annelid (*Pristina leidyi*) used in regeneration research NYBERG, Kevin G.\*; BELY, Alexandra E.; University of Maryland, College Park; University of Maryland, College Park kevingnyberg@gmail.com

Echinoderm nervous system as an emerging model to study neural regeneration MASHANOV, V.S.\*\*; ZUEVA, O.R.; HEINZELLER, T.; GARCIA-ARRARAS, J.E.; University of Puerto Rico; University of Puerto Rico; LMU, Munich; University of Puerto Rico mashanovvlad@googlemail.com

Central Nervous System Development and Regeneration in Hemichordates LUTTRELL, S.; BENGTTSSON, B.C.; SWALLA, B.J.\*; University of Washington bjswalla@u.washington.edu

## Complementary Oral Session: Animal Regeneration II

The Proboscis of Predatory Conus: Sensory Structures and Tissue Regeneration MARTIN, G.G.; JAMES, D.M.\*; SCHULZ, J.; Occidental College, Los Angeles; Occidental College, Los Angeles; Occidental College, Los Angeles gmartin@oxy.edu

Effects of repeated injury on the activity and condition of a malidanid polychaete PAGE, J.L.\*\*; LINDSAY, S.M.; University of Maine, Orono; University of Maine, Orono jennifer.page82@gmail.com

Models of Cardiac Repair and Regeneration in Teleost Fish LAFONTANT, P.J.\*; GRIVAS, J.A.; GOLDEN, B.L.; LESCH, M.A.; FROUNTFELTER, T.; DePauw University; DePauw University; DePauw University; DePauw University; DePauw University pascallafontant@depauw.edu

Reparative regeneration in a novel amniote model MCLEAN, K.E.\*; VICKARYOUS, M.K.; Univ. of Guelph, Guelph ON; Univ. of Guelph, Guelph ON kmclean@uoguelph.ca

Morphology and histology of the earliest stages of tail regeneration in the leopard gecko, *Eublepharis macularius*. VICKARYOUS, MK\*; ZWEERMAN, CL; University of Guelph; University of Guelph mvickary@uoguelph.ca

Evolution of diverse asexual reproduction strategies and reversal of the primary body axis in *Convolutiloba* acoels SIKES, J.M.\*; BELY, A.E.; Univ. of Illinois, Urbana-Champaign; Univ. of Maryland, College Park jsikes@illinois.edu

## Complementary Poster Session:

Regeneration in the classroom: linking infaunal injury and ocean literacy using integrated concept mapping CAMPBELL, B.R.\*\*; LINDSAY, S.M.; DECHARON, A.V.; University of Maine, Orono; University of Maine, Orono; Darling Marine Center, Walpole ME beth.campbell@umit.maine.edu

Does temperature affect Whole Body Regeneration (WBR) rate in *Botrylloides* spp? PINNICK, G.L.\*; COHEN, C.S.; San Francisco State University; San Francisco State University sarahcoh@sfsu.edu

Expression of piwi during development and regeneration in the marine polychaete *Capitella teleta* GIANI, V. C.\*; SEAVER, E. C.; University of Hawaii; University of Hawaii vinny\_giani@hotmail.com

Ionizing irradiation produces a delay in pupation in the hornworm, *Manduca sexta*. RAMOS, L.; OMONDI, C.; HALME, A.; FUSE, M.\*\*; San Francisco State University ; San Francisco State University ; University of California, Berkeley; San Francisco State University fuse@sfsu.edu

Expression pattern of anti-apoptotic genes survivin and mortalin in the regenerating digestive tube of a sea cucumber MASHANOV, V.S.; ZUEVA, O.R.\*\*; ROJAS-CARTAGENA, C.; GARCIA-ARRARAS, J.E.; University of Puerto Rico; University of Puerto Rico; University of Puerto Rico; University of Puerto Rico zuevaolga@yahoo.com

Inflammation, and Repair in a Giant danio (*Danio aequipinnatus*) Model of Heart Injury LESCH, M.A.\*; GRIVAS, J.A.; FROUNTFELTER, T.; GOLDEN, B.L.; FITZHARRIS, N.T.; NIDA, B.A.; LAFONTANT, P.J.; DePauw University; DePauw University; DePauw University; DePauw University; DePauw University; DePauw University pascallafontant@depauw.edu

Inflammation and Repair in a Goldfish (*Carassius auratus*) Model of Heart Injury. GRIVAS, J.A.\*; GOLDEN, B.L.; FROUNTFELTER, T.; LESCH, M.A.; COBB, A.; LAFONTANT, P.J.; DePauw University; DePauw University; DePauw University; DePauw University; DePauw University; DePauw University pascallafontant@depauw.edu

The Neurogenic Effect of Injury and Regeneration in Ctenophores ANDRILENAS, KK\*; MOROZ, L; University of Washington, Seattle; Whitney Laboratory for Marine Biosciences, University of Florida, St. Augustine andrik@u.washington.edu

**Findings:****Training and Development:**

There was no formal training component to this project, although both PIs gained valuable experience in organizing a research symposium.

### **Outreach Activities:**

Science News published a feature article on animal regeneration that mentioned the symposium and that highlighted the work of several of the symposium speakers, including co-PI Alexa Bely. The article can be found at:

[http://www.sciencenews.org/view/feature/id/55730/title/Starting\\_aneu](http://www.sciencenews.org/view/feature/id/55730/title/Starting_aneu)

### **Journal Publications**

Lindsay, S.M., "Frequency of injury and ecology of regeneration in marine benthic invertebrates.", *Integrative & Comparative Biology*, p. 479, vol. 50, (2010). Published, 10.1093/icb/icq099

Wulff, J., "Regeneration of sponges in ecological context: is regeneration an integral part of life history and morphological strategies?", *Integrative & Comparative Biology*, p. 494, vol. 50, (2010). Published, 10.1093/icb/icq100

Lawrence, J.M., "Energetic costs of loss and regeneration of arms in stellate echinoderms", *Integrative & Comparative Biology*, p. 506, vol. 50, (2010). Published, 10.1093/icb/icq027

Bely, A.E., "Evolutionary loss of animal regeneration: patterns and process", *Integrative & Comparative Biology*, p. 515, vol. 50, (2010). Published, 10.1093/icb/icq118

Acely Garza-Garcia, A.; Driscoll, P.C.; Brockes, J.P., "Evidence for the local evolution of mechanisms underlying limb regeneration in salamanders", *Integrative & Comparative Biology*, p. 528, vol. 50, (2010). Published, 10.1093/icb/icq022

Gahn, F. J.; T. K. Baumiller, "Evolutionary history of regeneration in crinoids (Echinodermata)", *Integrative and Comparative Biology*, p. , vol. , (2010). Accepted,

### **Books or Other One-time Publications**

Gahn, F.J., Baumiller T.K., "Evolutionary morphology of regenerative abilities among crinoids: a paleontological perspective", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e58  
doi: 10.1093/icb/icq106

Maginnis, T.L., "Regeneration: a framework for future research.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e106.  
doi: 10.1093/icb/icq106

Sanchez Alvarado, A., "Stem cells, regeneration and the developmental plasticity of planarians", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e155  
doi: 10.1093/icb/icq106

Steele, R., "Exploring Hydra regeneration and budding with genomics, transgenics and chemical genetics", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e169  
doi: 10.1093/icb/icq106

Brown, FD, Keeling EL; Le, AD, Swalla, BJ, "Bloody whole body regeneration.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e18.  
doi: 10.1093/icb/icq106

- Harmon, S., Burton P.M., "How many mouths are too many? Induction of oral fates in the cnidarians *Nematostella vectensis*", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e68.  
doi: 10.1093/icb/icq106
- Lafontant, P.J., Grivas, J.A., Golden, B.L., Lesch, M.A., Frountfelter, T., "Models of cardiac repair and regeneration in teleost fish.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e96.  
doi: 10.1093/icb/icq106
- Luttrell, S., Bengtsson, B.C., Swalla, B.J., "Central nervous system development and regeneration in hemichordates.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e105. doi: 10.1093/icb/icq106
- Martin, G.G., James, D.M., Schulz, J., "The proboscis of predatory *Conus*: sensory structures and tissue regeneration.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e109. doi: 10.1093/icb/icq106
- Mashanov, V.S., Zueva, O.R., Heinzeller, T., Garcia-Ararras, J.E., "Echinoderm nervous system as an emerging model to study neural regeneration", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e110. doi: 10.1093/icb/icq106
- McLean, K.E., Vickaryous, M.K., "Reparative regeneration in a novel amniote model.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e115.  
doi: 10.1093/icb/icq106
- Nyberg, K.G., Bely, A.E., "Transcriptome characterization via 454 sequencing of an oligochaete annelid (*Pristina leidyi*) used in regeneration research.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e126.  
doi: 10.1093/icb/icq106
- Page, J.L., Lindsay, S.M., "Effects of repeated injury on the activity and condition of a malidanid polychaete.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e131.  
doi: 10.1093/icb/icq106
- Sikes, J.M., Bely, A.E., "Evolution of diverse asexual reproduction strategies and reversal of the primary body axis in *Convolutriloba* acoels.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e163.  
doi: 10.1093/icb/icq106
- Vicaryous, M.K., Zweerman, C.L., "Morphology and histology of the earliest stages of tail regeneration in the leopard gecko, *Eublepharis macularius*", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e182.  
doi: 10.1093/icb/icq106
- Zattara, E.E., Bely, A.E., "Evolution of developmental trajectories: regeneration and fission in naidid annelids.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e195. doi: 10.1093/icb/icq106
- Andrilenas, K.K., Moroz, L., "The neurogenic effect of injury and regeneration in Ctenophores.", (2010). Conference Proceeding, Published  
Bibliography: *Integr. Comp. Biol.* (2010) 50 (suppl 1): e200 doi: 10.1093/icb/icq107
- Campbell, B.R., Lindsay, S.M., Decharon, A.V., "Regeneration in the classroom: linking infaunal injury and ocean literacy using integrated

concept mapping.", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e212  
 doi: 10.1093/icb/icq107

Giani, V.C., Seaver, E.C., "Expression of piwi during development and regeneration in the marine polychaete *Capitella teleta*.", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e233  
 doi: 10.1093/icb/icq107

Grivas, J.A., Golden, B.L., Frountfelter, T., Lesch, M.A., Cobb, A., Lafontant, P.J., "Inflammation and repair in a Goldfish (*Carassius auratus*) model of heart injury.", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e236  
 doi: 10.1093/icb/icq107

Lesch, M.A., Grivas, J.A., Frountfelter, T., Golden, B.L., Fitzharris, N.T., Nida, B.A., Lafontant, P.J., "Structure, inflammation, and repair in a Giant Danio (*Danio aequipinnatus*) model of heart injury.", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e258  
 doi: 10.1093/icb/icq107

Mashanov, V.S., Zueva, O.R., Rojas-Cartagena, C., Garcia-Arraras, J.E., "Expression pattern of anti-apoptotic genes survivin and mortalin in the regenerating digestive tube of a sea cucumber.", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e265  
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Pinnick, G.L., Cohen, C.S., "Does temperature affect whole body regeneration (WBR) rate in *Botrylloides* spp.?", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e282  
 doi: 10.1093/icb/icq107

Ramos, L., Omondi, C., Halme, A., Fuse, M., "Ionizing irradiation produces a delay in pupation in the hornworm, *Manduca sexta*", (2010). Conference Proceeding, Published  
 Bibliography: Integr. Comp. Biol. (2010) 50 (suppl 1): e285  
 doi: 10.1093/icb/icq107

### Web/Internet Site

### Other Specific Products

### Contributions

#### **Contributions within Discipline:**

The primary goal of this project was to bring together scientists investigating animal regeneration from different research perspectives in order to foster exchange of ideas. As part of the symposium, we held an open forum for discussion, which involved the symposium participants and attending scientists. The discussion was quite rich, and several developmental biologists commented that they had a much better appreciation for the ecological perspective of animal regeneration. Similarly, ecologists gained a better understanding of the mechanisms of regeneration that might contribute to the costs incurred by animals that do regenerate. One exciting part of the symposium discussion was the general consensus among those present that future research should better measure the energetic costs of regeneration in animals that are capable of regeneration but that are prevented from doing so.

Another contribution the symposium made was to serve as a good model of organizing a symposium with a diverse speaker list. Often at the SICB meetings, symposia have very few speakers from underrepresented groups or who are junior in the field. We received several positive comments from meeting attendees concerning the diverse nature of the animal regeneration symposium speaker list.

**Contributions to Other Disciplines:**

**Contributions to Human Resource Development:**

**Contributions to Resources for Research and Education:**

**Contributions Beyond Science and Engineering:**

**Conference Proceedings**

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Organizational Partners

Activities and Findings: Any Findings

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Contributions: To Any Other Disciplines

Contributions: To Any Human Resource Development

Contributions: To Any Resources for Research and Education

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Any Conference