

## Molly F. Miller

Ph.D. UCLA, 1977

*Paleoecology, Clastic Sedimentology, and Ichnology*

(Interim Chair, EES, 2008-2009)

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### General Interests

What is the relationship between soft-bodied animals and physical and biologic components of their environment, and how has this relationship changed through the Phanerozoic? Has the history been different for those living



*Graduate students examining animals burrowing in sandflats, Bodega Harbor, CA.*

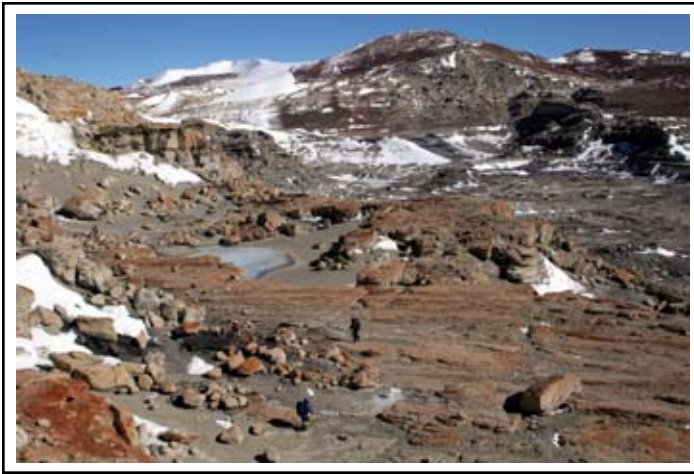
in marine vs. freshwater conditions? Molly Miller's long-term research goal is to find answers to these questions. To reach this goal, she integrates sedimentologic data with information about biogenic structures and the ecology of living organisms in order to reconstruct the ecological controls on ancient soft-bodied organisms.

### Current Research

Molly Miller's most recent project is a study of taphonomic, sedimentologic, and bioturbation processes in sediments off the coast of Antarctica (Explorers Cove). She and collaborators S. Bowser, S. Walker and D. Furbish will identify the processes and rates, construct models, and use them to refine interpretations of cores recently recovered from Cenozoic deposits off the coast of Antarctica. The idea is to link modern biologic, sedimentologic and taphonomic processes to the characteristics of cores in order to enhance interpretation of ancient ecosystems.

Another component of Molly Miller's research involves diverse aspects of late Paleozoic – Triassic history of Antarctica and its life. She is using the spectacularly well exposed and thick section of Permian to Jurassic continental rocks in the Transantarctic Mountains to reconstruct the benthic communities of freshwater ecosystems extant at the time and develop a model of how they changed through the Phanerozoic. She uses biogenic structures and extent of bioturbation as a proxy for fossils of bottom-dwellers, and interprets the type and abundance of benthic animals in different environments (e.g. lakes, streams) during this crucial period in the development of freshwater habitats. Development of a semi-quantitative method for assessing bioturbation allows for comparison of benthic activity in rocks of similar age deposited in the same environment in high latitude vs. low latitude settings and for comparison of animal activity in marine vs. freshwater depositional systems. This work has documented that freshwater habitats were colonized by burrowing animals much later than those in the marine realm, and raises questions about mechanisms of colonization (Miller and Labandeira, 2002; Miller et al., 2002).

The paucity of active infaunal animals in the Permian and Triassic led to the question: How abundant are burrowing animals in modern lakes and streams and to what extent do they disrupt the sediment? With Dr. David White, Director of the Hancock Biological Station on Kentucky Lake, Molly Miller has been evaluating the amount of animal activity in lake sediments vs. marine sediments and assessing the ecological and ichnological implications. Permian and Triassic biogenic structures in the Transantarctic Mountains yield unique paleoecologic and paleoclimate information. With collaborators J. Isbell, C. Sidor, and D. Briggs, Molly Miller is using biogenic structures to document climate change between the Permian



*Permian-Triassic boundary in Allan Hills, Antarctica. In upper left, coal-bearing Permian sandstones are overlain by rust-colored Triassic sandstone.*

and Triassic and to constrain timing of the colonization of Antarctica by tetrapods.

### **Graduate Classes Taught**

Molly Miller teaches two graduate level courses:

- (1) Animal-sediment relations, with emphasis on integrating modern animal distribution and behavior with observations of Paleozoic biogenic structures and sedimentary environments; includes field trips to Bodega Bay, CA and Kentucky coal fields.
- (2) Antarctic Earth Science: A survey of diverse topics emphasizing interactions between components of earth systems, combined with student-run discussions of topics of individual interest.

### **What Students Do**

Molly Miller's students have undertaken a wide variety of projects ranging from sedimentologic and petrologic studies of shales and sandstones, to studies of modern and ancient bioturbation to taphonomic investigations. The students use this preparation to pursue research in PhD programs and to enter careers in secondary education and environmental management.

The following are some examples of current and recent theses:

Roberta Challener (M.S. 2008) Alteration of sand-sized sediments by scutelline sand dollars (Echinodermata: Echinoidea)

Maria Ruiz-Yantin (M.S. in progress) Taphonomy of the brittle star *Ophionotus victoriae* from New Harbor, Antarctica

Brooke Traynham (2007): Factors controlling the distribution of the burrowing mayfly *Hexagenia* in Kentucky Lake

Nichole Knepprath (2006): Reconstruction of a high-latitude Permian forest, Antarctica

### **Selected Publications (\*student author)**

- Miller, M.F., Cowan, E.A., and Nielsen, S.H.H., in press, Significance of the trace fossil *Zoophycos* in Pliocene deposits, Antarctic Continental margin. *Antarctic Science*.
- Miller, M.F., and Isbell, J.L., in press, Reconstruction of a high-latitude post-glacial lake: Mackellar Formation (Permian), Transantarctic Mountains: Geological Society of America Special Publication.
- Sidor, C.A., Miller, M.F., and Isbell, J.L. 2008, Tetrapod burrows from the Triassic of Antarctica: *Jour. Vertebrate Paleontology*, June issue.
- White, D.S. and Miller, M.F., 2008, Benthic invertebrate activity in lakes: linking present and historical bioturbation patterns. *Aquatic Biology*, v. 2, p. 269-277.
- Miller, M.F. and White, D.S., 2007, Ecological and evolutionary controls on the composition of marine and lake ichnofacies, in Miller, W., ed., *Trace Fossils: Concepts, Problems, Prospects*: Elsevier, p. 531-544.
- Ruiz-Yantin, M., Miller, M.F., and Bowser, S.S., 2007, Ophiuroid adaptations to Antarctic waters linked to taphonomic loss, poor fossil record: *Geological Society of America Abstracts with Programs*, v. 39.
- Miller, M.F., Briggs, D.E.G., and Isbell, J.L., 2007, Trace fossils and environments across the Permian-Triassic boundary in the Transantarctic Mountains. *Geological Society of America Abstracts with Programs*, v. 39.
- Miller, M.F., and White, D.S., 2007, Ecological and evolutionary controls on the composition of marine and lake ichnofacies, in Miller, W., ed., *Trace Fossils: Concepts, Problems, Prospects*: Elsevier, Amsterdam, p. 531-544.
- Traynham, B., White, D.S., Furbish, D.J., and Miller, M.F., 2006, Distributional controls and burrow characteristics of the mayfly *Hexagenia* in Kentucky Lake: implications for the stratigraphic record: *Geological Society of America Abstracts with Programs*, v. 37.
- \* Knepprath, N.E., Miller, M.F., Isbell, J.L., Furbish, D.J., 2005, Permian high-latitude Gondwanan climate and environment constrained by plant taphonomy: *Geological Society of America Abstracts with Programs*, v. 37, p.484.



*Giant reptile burrow in Triassic floodplain deposits, Shackleton Glacier area, Antarctica.*