

Spring 2013

IB-113L: Paleobiological Perspectives on Ecology and Evolution

Course format Two lectures (1 hr 20 min ea)/wk; one 3 hr laboratory/wk (4 units)

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Description What do the fossil and geologic records have to tell us about the nature of ecological and evolutionary processes? What do they teach us that cannot be learnt from the living world alone? In answering these questions, this course provides an introduction to the analysis of key problems in paleobiology, with an emphasis on how evolutionary and ecological processes operate on geologic timescales. Topics include: the evolution of ecosystems; dissecting biodiversity dynamics; determining times of origin and extinction; assessing the absolute completeness of the rock and fossil records; stratigraphy and phylogeny reconstruction; theoretical and functional morphology; major events in the history of life, including Precambrian evolution, the Cambrian explosion, and the mass extinctions.

Labs Scientific understanding flows from raw data, in our case from the morphologies, ecological associations, environments and age of fossils. The labs will engage the students in these empirical aspects of the fossil record. Each will have a formal assignment that will be assessed as part of each student's final grade.

Reading There is no text adequate for this course; instead weekly readings (see syllabus) will be made available via b-space.

Prerequisites Prior biology experience or permission of instructor. No paleontological or geological background required.

<u>Assessment:</u>	<u>% of Final Grade</u>
Weekly lab exercises	25%
Mid-semester Exam (March 5 th)	25%
Lab Exam (May 1 st)	15%
Final Exam (May 13 th , 11:30–2:30)*	<u>35%</u>
	100%

**Graduate students may replace the final exam with a term paper. Oral presentations on preliminary findings will be presented in the last lecture, constituting 10% of the 35%.*

Syllabus (with readings)

- Jan 22 1) Introduction to the course
 Jan 24 2) The fossil record and its completeness
No LAB this week
Reading: Chapter 1: "Nature of the Fossil Record" in Foote, M.J. and A.I. Miller. 2007. *Principles of Paleontology*. Pp. 1–30.
- Jan 29 3) Geological time
 Jan 31 4) Continental drift and plate tectonics
LAB 1: Intro to Fossils; Tour of the UCMP Collections
Reading: Chapter 1: "Earth as a System" in Stanley, S. M. 1999. *Earth System History*. Pp. 1–27.
- Feb 5 5) Ecosystems: tectonic controls and coherency
 Feb 7 6) Precambrian life
LAB 2: Fossilization
Reading: Jacobs, D.K., T.A. Haney, K.D. Louie. 2004. Genes, diversity, and geologic process on the Pacific Coast. *Annual Review of Earth and Planetary Sciences* **32**: 601-652.
 Porter, S.M. 2004. The fossil record of early eukaryotic diversification. *Paleontological Society Papers* **10**: 35-50.
- Feb 12 7) Time in the rock record
 Feb 14 8) Biomarkers
LAB 3: Nature of the Rock Record
Reading: Chapter 4: "Sequence Stratigraphy" in Coe A.L., D.W.J. Bosence, K.D. Church, S.S. Flint, J.A. Howell, and R.C.L. Wilson. 2003. *Sedimentary Record of Sea-Level Change*. Pp. 57–95.
- Feb 19 9) Diversity over time
 Feb 21 10) Extinction: Patterns and processes
LAB 4: Diversity Dynamics – DNA vs. The Fossil Record
Reading: Knoll, A.H. and R.K. Bambach. 2000. Directionality in the history of life: diffusion from the left wall or repeated scaling of the right?. *Paleobiology* **26**: (Supplement): 1–14.
- Feb 26 11) The emergence and evolution of plants (Guest Lecturer: Dr. Looy)
 Feb 29 12) Diversity dynamics
LAB 5: Fossil plants
Reading: Taylor T.N., Taylor E.D. and Krings M., 2009. Chapter 1: Introduction into paleobotany, how fossil plants are formed. In: *Paleobotany – The biology and evolution of fossil plants*. Academic Press, Pp 1-42.
- March 5 **MIDTERM**
 March 7 13) Systematics and the fossil record
No LAB this week
Reading: p.96–113 in: Foote, M.J. and A.I. Miller. 2007. *Principles of Paleontology*.
 Chapter 6 "The construction of evolutionary trees" in: Smith A.B. 1994. *Systematics and the Fossil Record*. Pp. 125–141.

- March 12 14) Stratigraphic data and phylogeny reconstruction
 March 14 15) Missing links and ancestors in the fossil record
 LAB 6: Dinosaurs and some of their Relatives
 Reading: Marshall, C.R. 1999. "Missing links in the history of life." In: *Evolution: Facts and Fallacies* (J.W. Schopf, ed.). Pp.37-69.
- March 19 16) Estimating times of origin; fossils and molecular clocks
 March 21 17) Punctuated equilibrium
 LAB 7: Dinosaurs in Motion
 Reading: Chapter 7 "Models of molecular evolution" In: Holmes R.D.M. and E.C. Holmes. 1998. *Molecular evolution. A phylogenetic approach*. Pp. 228-279.
 Gould S.J. and N. Eldredge. 1993. Punctuated equilibrium comes of age. *Nature* 366: 223-227.
- SPRING BREAK**
- April 2 18) Macro-evolution; the filling of ecospace
 April 4 19) Ecosystem evolution
 LAB 8: Early life and Sepkoski's Cambrian and Paleozoic faunas
 Reading: Jackson, S.T. and J.T. Overpeck. 2000. Responses of plant populations and communities to environmental changes of the late Quaternary. *Paleobiology* **26**: (Supplement): 194-220.
- April 9 20) CO₂ O₂ over the Phanerozoic – the central role of geology
 April 11 21) Stable isotopes: past climates and paleoecology
 LAB 9: The Paleozoic fauna (continued)
 Reading: Koch P.L. 2007. Isotopic study of the biology of modern and fossil vertebrates. In: Michener R, Lajtha K (eds) *Stable Isotopes in Ecology and Environmental Science*, 2nd Ed. Pp. 99-154.
 Reference: Kendall, C. and E.A. Caldwell. 1998. Fundamentals of Isotope Geochemistry. In: *Isotope Tracers in Catchment Hydrology*, C. Kendall and J.J. McDonnell (Eds.). Pp. 51-86.
- April 16 22) Life in moving fluids
 April 18 23) Diversity versus disparity; theoretical morphology
 LAB 10: Sepkoski's Modern Fauna
 Reading: p. 25-33; 41-51; 61-81; 127-129; 141-143; 152-157; 241-243 In: Vogel, S. 1989. *Life in moving fluids*.
 p. 135-148; 243-248 in: Foote, M.J. and A.I. Miller. 2007. *Principles of Paleontology*.
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- April 23 24) Morphological complexity and the Principle of Frustration
 April 25 25) Cambrian "Explosion"
 LAB 11: Ecology through time: Evolutionary escalation
 Reading: Marshall, C.R. 2006. Explaining the Cambrian "explosion" of animals. *Annual Review of Earth and Planetary Sciences* **34**: 355-384.
- April 30 26) A change-in-biodiversity equation
 May 2 27) HOT topics – cutting edge paleobiology/Graduate student presentations
 LAB 12: LAB FINAL EXAM
 Reading: No reading

Background Texts

Text: Principles

Foote, M.J. and A.I. Miller. 2007. *Principles of Paleontology*. W.H. Freeman, New York, 354 pp.

Texts: Principles and taxonomy of fossil groups

Prothero, D.R. 2004. *Bringing Fossils to Life: an Introduction to Paleobiology*. 2nd Ed. McGraw-Hill, Dubuque, Iowa, 503 pp.

Benton, M.J. and D.A.T. Harper. 1997. *Basic Palaeontology*. Prentice Hall, London, 360 pp.

Texts: Taxonomy of fossil groups

Benton, M.J. 2005. *Vertebrate Palaeontology*, 3rd Ed. Blackwell Science, Oxford, 455 pp.

Clarkson, E.N.K. 1993. *Invertebrate Palaeontology and Evolution*. 3rd Ed. Chapman and Hall, London, 434 pp.

Boardman, R.S., A.H. Cheetham, and A.J. Rowell (eds.). 1987. *Fossil Invertebrates*. Blackwell Science, Oxford, 713 pp.

(An advanced text too hard for most intro. Classes)

Text: The evolution of life in the context of our evolving planet

Stanley, S. M. 1999. *Earth System History*. W.H. Freeman and Company, New York, 615 pp.

Text: Paleoecology (an underdeveloped field; there are no great texts)

Brenchley, P.J., and D.A.T. Harper. 1998. *Palaeoecology: Ecosystems, environments and evolution*. Chapman and Hall, London, 402 pp.

Flessa, K.W. et al. 2005. *The Geological Record of Ecological Dynamics*. National Research Council of the National Academies, National Academies Press, Washington, DC, 2000 pp.

(A report, not a textbook)

Concise Syntheses

Briggs, D.E.G. and P.R. Crowther (eds.). 1990. *Paleobiology: A Synthesis*. Blackwell Scientific, Oxford, 583 pp.

(Some 100 topics covered, 3-8 pages each, with about 110 authors)

Briggs, D.E.G. and P.R. Crowther (eds.). 2001. *Paleobiology II*. Blackwell Scientific, Oxford, 583 pp.

(Similar the volume above, but with contributions from 170 authors)

Lagerstätten

Bottjer, D.J., Etter, W., Hagadorn J.W. and C.M. Tang (eds.). 2002. *Exceptional Fossil Preservation: A unique view on the evolution of marine life*. Columbia University Press, New York, 403 pp.

Muller, K.J. and D. Walossek. 1987. *Morphology, Ontogeny, and the Life Habit of *Agnostus pisiformis* from the Upper Cambrian of Sweden*. Universitetsforlaget, Oslo, 125 pp.

Briggs, E.G., Erwin, D.H. and F.J. Collier. 1994. *The Fossils of the Burgess Shale*. Smithsonian Institution Press, Washington, London, 238 pp.

Xian-Guang, H., Aldridge, R.J., Bergstrom, J., Silvester, David.J., Silvester Derek J. and F. Xiang-Hong. 2004. *The Cambrian Fossils of Chengjiang, China*. Blackwell Science, Oxford, 233 pp.