

Spring 2019

OEB/EPS 107: Plant Evolution in Geologic Time

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Meet: Tuesdays and Thursdays 1:30–2:45 pm
One 2 hour lab per week

A brief (10-12 pp.) term paper is required. Papers are due no later than 5:00 pm on Friday May 3.

Grades will be based on the following formula:

Midterm Exam I	25%
Lab Grade	20%
Term Paper	25%
Final Exam	30%

WEEK 1

Jan 29: Introduction to Plant Fossils

Jan 31: Preservation -- What is the Nature of our Window on the Past?

No Lab

Readings: WM Ch. 1

WEEK 2

Feb 5: Telling Time in the Geologic Record

Feb 7: Photosynthetic Life before Land Plants

Lab I: Precambrian Paleontology

Readings: WM Ch. 2; Knoll (2014)

WEEK 3

Feb 12: A Primer on Plant Morphology

Feb 14: The Origin of Land Plants: Comparative Biology

Lab II: Fundamentals of Plant Anatomy and Morphology

Readings: WM Ch. 3; Gensel (2008); Hetherington and Dolan (2018)

WEEK 4

Feb 19: The Origin of Land Plants: Rhynie

Feb 21: Early Land Plants II

Lab III: Preservation

Readings: TTK Chs. 6 and 8; Remy et al. (1993), Hetherington and Dolan (2018)

WEEK 5

Feb 26: Early Land Plants III

Feb 28: Early Land Plants IV

Lab IV: Devonian Fossils

Readings: WM Ch. 4; Friedman and Cook (2000); Rothwell et al. (2014); Stein et al. (2012)

WEEK 6

Mar 5: Ancient and Modern Lycopods

Mar 7: The Zenith of Lycopod Evolution

Lab V: Fossil Lycopods and Review for Midterm

Readings: Niklas (1994)

WEEK 7

Mar 12: **MID-TERM EXAM**

Mar 14: Ancient and Modern Sphenopsids

Lab VI: Fossil Sphenopsids

Readings: None

Spring Break: March 16-24

WEEK 8

Mar 26: Ferns: Diversity and History

Mar 28: The Origin of Seed Plants

Lab VII: Fossil Ferns

Readings: WM Ch.5

WEEK 9

Apr 2: Paleozoic Seed Plant Diversification I

Apr 4: Paleozoic Seed Plant Diversification II

Lab VIII: Paleozoic Seed Plants

Readings: Poort et al. (1996); DiMichele et al. (2009)

WEEK 10

Apr 9: Conifer Diversification: Comparative Biology

Apr 11: Conifer Diversification through time

Lab IX: Cordaites and Conifers

Readings: Wilson and Knoll (2010); Pitterman (2010); Leslie et al. (2018)

WEEK 11

Apr 16: Late Paleozoic Plant Ecology, Biogeography, and Extinctions

April 18: Mesozoic Seed Plant Radiations: Ginkgo, Cycads and More

Lab X: Mesozoic Seed Plants: Characters, Taxa, and Phylogeny

Readings: Rydin et al. (2004); Schuettpelz and Pryer (2009); Soltis et al. (2011)

WEEK 12

Apr 23: Angiosperms: Comparative Biology

Apr 25: The Angiosperm Radiation: Paleontology

Lab XI: Fossil Angiosperms

Readings: WM Ch. 6; Boyce et al. (2009), Friis et al. (2009); Doyle (2012)

WEEK 14

Apr 30: Cenozoic Plant Evolution

May 2: Plant Evolution in Geologic Time – A review and overview

No Lab

Readings: WM Ch. 7-8; Beerling and Royer (2002); Edwards et al. (2010)

Review session to be held during reading period.

Biology 107 Reading List

Text:

The main text will be:

Willis, K.J. and J.C. McElwain (2014) *The Evolution of Plants* (2nd Edition). Oxford University Press, Oxford, UK.

<https://tinyurl.com/300-W19-OEB-107-1>

<https://tinyurl.com/300-W19-EAPS-107-1>

Another text, which provides more anatomical and morphological detail, will also be available online from the Harvard Library via Hollis:

Taylor, T.N., E.L. Taylor, and M. Krings (2009) *Paleobotany: the Biology and Evolution of Fossil Plants*. Academic Press, Burlington MA.

[https://www.sciencedirect-com.ezp-](https://www.sciencedirect-com.ezp-prod1.hul.harvard.edu/book/9780123739728/paleobotany)

[prod1.hul.harvard.edu/book/9780123739728/paleobotany](https://www.sciencedirect-com.ezp-prod1.hul.harvard.edu/book/9780123739728/paleobotany)

Assigned Readings:

Beerling, D.J. and D.L. Royer, 2002, Reading a CO₂ signal from fossil leaves. *New Phytologist* 153: 387-397.

Boyce, C.K., Brodribb, T.J., Field, T.S., and Zwieniecki, M.A., 2009, Angiosperm leaf vein evolution was physiologically and environmentally transformative. *Proceedings of the Royal Society B-Biological Sciences* 276: 1771-1776.

DiMichele, W.A., I.P. Montañez, C.J. Poulsen, and N.J. Tabor, 2009, Climate and vegetational regime shifts in the late Paleozoic ice age earth. *Geobiology* 7: 200-226.

Doyle, J.A., 2012, Molecular and fossil evidence on the origin of angiosperms. *Annual Review of Earth and Planetary Sciences* 40: 301-326.

Edwards, E. J., C.P. Osborne, C.A.E. Strömberg et al., 2010, The origins of C₄ grasslands: Integrating evolutionary and ecosystem science. *Science* 328: 587-591.

Friedman, W.E. and M.E. Cook, 2000, The origin and early evolution of tracheids in vascular plants: integration of paleobotanical and neobotanical data. *Philosophical Transactions of the Royal Society B* 355: 857-868.

- Friis, E.M., K.R. Pedersen, and P.R. Crane, 2009, Diversity in obscurity: fossil flowers and the early history of angiosperms. *Philosophical Transactions of the Royal Society B* 365: 369-382.
- Gensel, P., 2008, The earliest land plants. *Annual Review of Ecology, Evolution, and Systematics* 39:459-77.
- Hetherington, A.J. and L. Dolan (2018) Bilaterally symmetric axes with rhizoids composed the rooting structure of the common ancestor of vascular plants. *Philosophical Transactions of the Royal Society B-Biological Sciences*. 373: Article Number: 20170042
- Knoll, A.H. (2014) Paleobiological perspectives on early eukaryotic evolution. *Cold Spring Harbor Perspectives in Biology*, doi: 10.1101/cshperspect.a016121.
- Leslie, A.B., J. Beaulieu, G. Holamn, C.S. Campbell, W. Mei, L.R. Raubeson, and S. Mathews (2018) An overview of extant conifer evolution from the perspective of the fossil record. *American Journal of Botany* 105: 1531–1544.
- Niklas, K.J., 1994, Morphological evolution through complex domains of fitness. *Proceedings of the National Academy of Sciences, USA* 91: 6772-6779.
- Pitterman, J., 2010, The evolution of water transport in plants: an integrated approach. *Geobiology* 8:112-139
- Poort, R.D., H. Visscher, and D.L. Dilcher, 1996, Zooidogamy in fossil gymnosperms: The centenary of a concept, with special reference to prepollen of late Palaeozoic conifers. *Proceedings of the National Academy of Sciences, USA* 93: 11713-11717.
- Remy, W., P.G. Gensel, and H. Hass, 1993, The gametophyte generation of some Early Devonian land plants. *International Journal of Plant Science* 154: 34-58.
- Rydin, C., K.R. Pedersen, and E.M. Friis, 2004, On the evolutionary history of *Ephedra*: Cretaceous fossils and extant molecules. *Proceedings of the National Academy of Sciences, USA* 101: 16571-16576.
- Rothwell, G.W., S.E. Wyatt, and A.M.F. Tomescu (2014) Plant evolution at the interface of paleontology and developmental biology: an organism-centered paradigm. *American Journal of Botany* 101: 899–913
- Schuettpalz, E. and K.M. Pryer, 2009, Evidence for a Cenozoic radiation of ferns in an angiosperm-dominated canopy. *Proceedings of the National Academy of Sciences, USA* 106: 11200-11205.

Soltis, D.E., S.A., N. Cellinese et al., 2011, Angiosperm phylogeny: 17 genes, 640 taxa. *American Journal of Botany* 98: 704-730.

Stein, W.E., C.M. Berry, L.V. Hernick et al., 2012, Surprisingly complex community discovered in the mid-Devonian fossil forest at Gilboa. *Nature* 483: 78-81.

Wilson, J.P. and A.H. Knoll, 2010, A physiologically explicit morphospace for water transport in seed plants. *Paleobiology* 36: 335-355.