

Evolutionary history of plants: Following the paths to today's botanical diversity

Plants represent an important and extraordinarily diverse group of organisms. Photosynthesis in plants and algae contributes the energy supporting life in nearly all of the Earth's ecosystems. Oxygen, produced by photosynthesis, has also radically changed the composition of the Earth's atmosphere and all life dependent on it. We are most familiar with flowering plants, which now dominate most environments on land, but these species are relatively recent innovations in plant evolution. In this course, we will go back millions of years in time, and discuss early life on Earth, the emergence of photosynthesis, and the first plants that appeared on land. We will then follow the changes in form and function that have resulted in the diverse assemblages of modern plants. Our discussions will include now extinct plants, and surviving ancient species as well as particular modern plants that demonstrate novel evolutionary outcomes.

Topical outline:

A. Foundations

1. What is a plant?
2. What is evolution?
 - a. Sources of diversity
 - b. Natural selection and the importance of the environment

B. Earth history and early life

1. Time and importance of fossils
2. Early earth and the appearance of life
3. Photosynthesis and oxygen in the atmosphere
4. Simple organisms invading each other and coexisting

C. Invasion of land and air

1. Live close to the moist ground
2. Have water retaining aboveground surfaces with openings
3. Reproduce successfully

D. Diversification of land plants

1. Vascular tissues allow plants to get tall
2. Wood (and trees)
3. Seeds!
4. Flowers and how plants with them came to dominate
5. Special evolutionary tools plants use

E. Exploring modern plant diversity

1. Cacti and extreme adaptations to aridity
2. Silverswords and their adaptation to Hawaii's diverse environments
3. Coevolution on steroids: The orchids
4. Corn is the product of people driving evolution

Readings for lecture development (Not required):

Armstrong, Joseph E. 2015. How the Earth Turned Green: A Brief 3.8-Billion-Year History of Plants. The Univ. of Chicago Press, Chicago.

Essig, Frederick B. 2015. Plant life: a brief history. Oxford Univ. Press, Oxford.

Niklas, Karl J. 2016. Plant Evolution: An Introduction to the History of Life. The Univ. of Chicago Press, Chicago.

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Steve Smith is an Associate Professor in the School of Renewable Natural Resources and the Environment at the University of Arizona where he has been on the faculty since 1984. He grew up in the central valley of California where he first began working with plants under the supervision of his father, a commercial plant breeder. After receiving a B.S. in Plant Sciences from the University of California, Davis, he received M.S. and Ph.D. degrees from Cornell University in Plant Breeding and Botany. Postdoctoral research at the University of Wisconsin-Madison preceded his arrival in Arizona. His research interests reflect both his training in application-oriented plant improvement and his fascination with plant adaptation in natural plant communities in arid environments. He is also involved in consulting with other researchers on experimental design and analysis. Dr. Smith teaches undergraduate courses in biology, field botany, and sustainability. He received the Bart Cardon Sustained Excellence in Teaching Award in 2015 from the College of Agriculture and Life Sciences, and the Ted and Shirley Taubeneck Superior Teaching Award in 2019 from the Humanities Seminars Program in the College of Humanities.