9.4: Early Evolution of Plants

Which moved onto land first, plants or animals?

This fossilized fern may be millions of years old. Over 200 million years ago, the first evidence of ferns related to several modern families appeared. The "great fern radiation" occurred in the late-Cretaceous, which ended 65 million years ago, when many modern families of ferns first appeared. And if animals were the first on land, would many have starved?

Evolution of Plants

As shown in Figure below, plants are thought to have evolved from an aquatic green alga protist. Later, they evolved important adaptations for land, including vascular tissues, seeds, and flowers. Each of these major adaptations made
plants better suited for life on dry land and much more successful.

From a simple, green alga ancestor that lived in the water, plants eventually evolved several major adaptations for life on land.

**The Earliest Plants**

The earliest plants were probably similar to the stonewort, an aquatic algae pictured in Figure below. Unlike most modern plants, stoneworts have stalks rather than stiff stems, and they have hair-like structures called rhizoids instead of roots. On the other hand, stoneworts have distinct male and female reproductive structures, which is a plant characteristic. For fertilization to occur, sperm need at least a thin film of moisture to swim to eggs. In all these ways, the first plants may have resembled stoneworts.

Modern stoneworts may be similar to the earliest plants. Shown is a field of modern stoneworts (right), and an example from the Charophyta, a division of green algae that includes the closest relatives of the earliest plants (left).

**Life on Land**

By the time the earliest plants evolved, animals were already the dominant organisms in the ocean. Plants were also constrained to the upper layer of water that received enough sunlight for photosynthesis. Therefore, plants never became dominant marine organisms. But when plants moved onto land, everything was wide open. Why was the land devoid of other life? Without plants growing on land, there was nothing for other organisms to feed on. Land could not be colonized by other organisms until land plants became established.
Plants may have colonized the land as early as 700 million years ago. The oldest fossils of land plants date back about 470 million years. The first land plants probably resembled modern plants called liverworts, like the one shown in Figure below.

![Liverwort](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Introductory_Biology_(CK-12)/09%3A_Plants/9.1%3A_Land_Plants/9.1.2%3A_Land_Plants_Evolve.html)

The first land plants may have been similar to liverworts like this one.

Colonization of the land was a huge step in plant evolution. Until then, virtually all life had evolved in the ocean. Dry land was a very different kind of place. The biggest problem was the dryness. Simply absorbing enough water to stay alive was a huge challenge. It kept early plants small and low to the ground. Water was also needed for sexual reproduction, so sperm could swim to eggs. In addition, temperatures on land were extreme and always changing. Sunlight was also strong and dangerous. It put land organisms at high risk of mutations.

Vascular Plants Evolve

Plants evolved a number of adaptations that helped them cope with these problems on dry land. One of the earliest and most important was the evolution of vascular tissues. Vascular tissues form a plant’s “plumbing system.” They carry water and minerals from soil to leaves for photosynthesis. They also carry food (sugar dissolved in water) from photosynthetic cells to other cells in the plant for growth or storage. The evolution of vascular tissues revolutionized the plant kingdom. The tissues allowed plants to grow large and endure periods of drought in harsh land environments. Early vascular plants probably resembled the fern shown in Figure below.
Early vascular plants may have looked like this modern fern.

In addition to vascular tissues, these early plants evolved other adaptations to life on land, including lignin, leaves, roots, and a change in their life cycle.

- **Lignin** is a tough carbohydrate molecule that is hydrophobic (“water fearing”). It adds support to vascular tissues in stems. It also waterproofs the tissues so they don’t leak, which makes them more efficient at transporting fluids. Because most other organisms cannot break down lignin, it helps protect plants from herbivores and parasites.

- Leaves are rich in **chloroplasts** that function as solar collectors and food factories. The first leaves were very small, but leaves became larger over time.

- **Roots** are vascular organs that can penetrate soil and even rock. They absorb water and minerals from soil and carry them to leaves. They also anchor a plant in the soil. Roots evolved from rhizoids, which nonvascular plants had used for absorption.

- Land plants evolved a dominant diploid sporophyte generation. This was adaptive because diploid individuals are less likely to suffer harmful effects of mutations. They have two copies of each gene, so if a mutation occurs in one gene, they have a backup copy. This is extremely important on land, where there’s a lot of solar radiation.

With all these advantages, it’s easy to see why vascular plants spread quickly and widely on land. Many nonvascular plants went extinct as vascular plants became more numerous. Vascular plants are now the dominant land plants on Earth.
Summary

- The earliest plants are thought to have evolved in the ocean from a green alga ancestor.
- Plants were among the earliest organisms to leave the water and colonize land.
- The evolution of vascular tissues allowed plants to grow larger and thrive on land.

Review

1. What were the first plants to evolve?
2. What are vascular tissues of a plant? What is their function?
3. Explain why life on land was difficult for early plants.
4. Why did plants need to become established on land before animals could colonize the land?