The Critically Important Plants Called Mosses

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Abstract

Mosses were assumed for years to play a minor role in ecology, but we now know they play a critical role in the earth's complex biomass ecosystem. Without mosses and their relatives life probably could not exist on our planet unless the Creator supplied another means to carry out their functions. What was once regarded as an independent class of plants is now recognized as a part of a complex interrelated ecosystem. If any one part is too seriously disrupted, then the whole is threatened. These tiny plants have design features they share with the rest of the Kingdom Plantae, as well as unique characteristics of their own. Mosses exist in the lowest parts of the fossil record and are not much different today. The lack of evidence for moss evolution is common to most plants and poses a significant problem for evolutionary naturalism.

Introduction

Mosses are probably most well known as the plants that can help persons who are lost in the woods find their way home. One of the first lessons many children used to learn is that moss grows on the north side of trees for the reason that this side is damp and shady. Many types of moss must have moist conditions in order to grow and excessive sunlight is harmful (Raven, Evert and Eichorn, 1986). Most need at least a damp environment to survive and for this reason bryophytic plants are said to straddle the boundary between aquatic and terrestrial existence (Audesirk and Audesirk, 1996, p. 444). The word *moss* refers to the very small, green, *bryophytic* plants that are classified with the liverworts and hornworts in the phylum Bryophyta (Klein and Klein, 1988, p. 13). *Bryophyte* means "moss plant," *bryon* means moss and *phyton* means plant (Hutchins, 1966, p. 118). They grow in a velvety cluster on rocks, trees, and other moist places.

Mosses are small tree-like plants that do not produce either flowers or seeds but reproduce by means of spores that are spread by the wind (Figure 1). Spores are similar to the seeds of higher plants, but are usually far smaller: so small that a mass of spores actually looks like a dust cloud. In the tips of many "female" moss plants grow *archegonia* in which the eggs develop; in the male plant grow structures called *antheridia* in which sperm develops (Dodd, 1978).

When a film of water, such as from the morning dew, covers the plant, the sperm use their hair-like appendages called *cilia* to swim from the antheridia over to the archegonia. Some of those sperm that make it to the female moss plant then fertilize an egg cell there. From a fertilized cell grows a thin green stalk structure. This structure grows in the top of the archegonial plant where the egg first developed. On the top of this stalk develops a capsule covered by a lid which contains spores. When the capsule (which functions like a womb) is ready, its lid opens and the ejected spores are then scattered about by the wind. Some types release their spores explosively, others are slowly jostled out by the wind. A spore which falls to Earth in a warm, moist, fertile place develops into a protonema, completing the moss life cycle. This structure produces buds which grow into a small leafy moss plant.

The Gametophyte

Botanists call the green, leafy plant that produces the gametes the *gametophyte*, meaning "the plant body bearing the sex cells." The second stage of the life cycle, the plant that bears the spore case, is the *sporophyte* or "the spore plant." This system by which a plant produces sex cells (the gametophytes) in one generation and then diploid spores (the sporophyte generation) in the next is referred to as *alternation of generations* reproduction. Both ferns and liverworts use a similar life cycle system to reproduce.

The Huge Moss Family

So far, over 16,000 species of mosses have been identified by botanists (Audesirk and Audesirk, 1996). They have been found in almost every part of the world in every kind of habitat, from the Arctic to the Antarctic and even in deserts. Most kinds grow in moist, shaded places. The two main divisions of mosses are the *sphagnum*, often called peat moss, and the *true mosses*.

All mosses lack defined vascular systems to carry fluids to their cells. Instead of tubes, they have spongy structures that use diffusion to move water and nutrients throughout the plant. Sphagnum moss, because it absorbs liquids rapidly, makes an ideal surgical dressing. It also is used for

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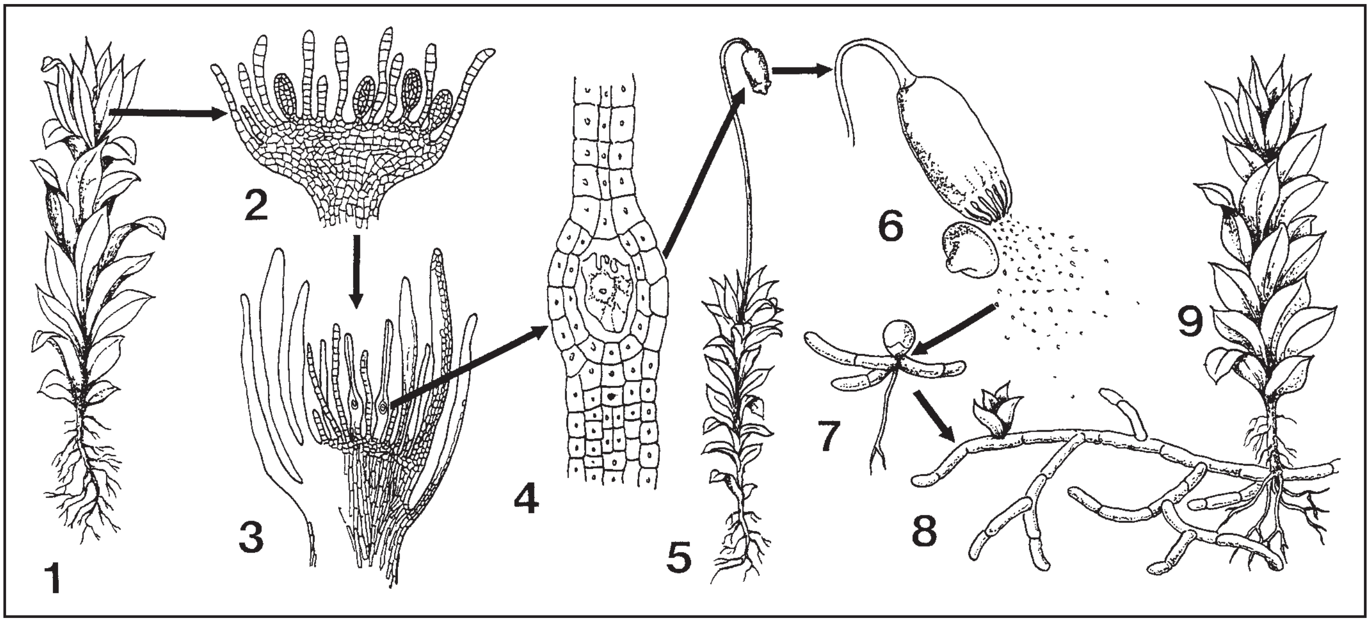


Figure 1. The Life Cycle of the Moss Plant
A typical moss gametophyte plant (1) has at the top either antheridia (2), which produce sperm, or archegonia (3), which produce eggs. The sperm swim through a film of water to the archegonia and fertilize the eggs. The new embryo (4) develops into a moss sporophyte plant, which spends its life attached to the top of the female gametophyte (5). The sporophyte reproduces by asexual spores formed in the capsule (6), and they are dispersed by the wind after the lid of the capsule drops off. Spores that land in a suitable location germinate (7) into a protonema (8). A new gametophyte plant (9) then develops from the protonema (adapted by Rich Geer from Compton's Pictured Encyclopedia, 1987, University of Chicago Press).

packaging plants which must be kept moist during shipping. It grows in large patches in damp meadows, bogs, and swamps. When sphagnum moss grows along the shores of a lake or pond, it often gradually fills up the whole pond with its spongy growth. Growth of sphagnum that has accumulated for thousands of years slowly decomposes and settles to the bottom, forming huge peat deposits. Major peat deposits can be found in England, Ireland and many other countries.

Moss Types and Their Look-alikes

One of the best known true mosses is the haircap moss which grows erect to a height of several inches. Another true moss, the pincushion moss, grows in a dense, round clump. Yet another type, plume moss, resembles a green ostrich plume. The fern moss looks like a tiny fern, but with a heavy spore-bearing stalk.

Mosses are similar to, and thus are sometimes confused with *liverworts*, which also grow in damp places and are of the same green color. Liverworts have thicker leaves that are softer and fleshier than mosses, which usually lie flat on the ground. These leaves have little hair like rootlets on their under surface. Other similar looking plants, although often called mosses, are not classified as mosses by biologists today, include the Irish moss, which is actually a type of seaweed. Other moss look-alikes are the club mosses. They are related to ferns and are vascular plants, thus classified as *tracheophyta*. Likewise, Iceland moss and reindeer moss are not mosses either but are *lichens* which are symbiotic units of fungi and algae.

The Critical Importance of Mosses

Many people assume that mosses are, at best, a useless member of the plant kingdom or, at worst, a gardener's bother. This is a totally incorrect view of these plants. Without the Mosses and their cousins, the earth's surface would probably be largely solid rock like most of the known planets. They are called pioneer plants because they help to prepare the Earth's surface for higher level plant and animal habitation ("Moss," 1987, p. 502). Microorganisms help initial soil development by slowly decomposing organic matter and forming weak acids that dissolve rock much faster than pure water. Mosses are also among the first colonizers of burned-over forests and grassland, flood, or lava covered land (Nadakavukaren and McCracken, 1985, p. 355).

The very first plants to grow on rocks are often crust-like lichens (Donahue, Miller and Shickluna, 1985). Lichens can grow on solid rock because they need only sunlight, water and a few minerals which they obtain from dissolving the rock they grow on with their acid secretions.

Algae and fungi also soon carpet rock near water or damp areas, and in time they break up the rock enough so that the mosses are able to follow. As moss plants grow they are held on decaying wood or on rock surfaces by small roots called *rhizoids* which absorb water and minerals. From these simple materials, the mosses manufacture complex organic compounds that allow other plants to grow (Klein and Klein, 1988, p. 16). In this way they serve a critical role in the chain of life. The dead bodies of these plants slowly accumulate, building up "soil," especially in the rock cracks. The process of one plant starting to make soil, and then another taking the process a step farther is called *succession*. Each step makes the soil rich enough for the next higher plant types in the succession process. The mosses and the higher plants together form a material which is fertile enough to support other vegetation. Eventually the plant life can support vegetarian forms of animal life.

Today mosses still function as part of the cycle that produces fertile soil from barren rock. After land is stripped bare of plant life by volcanic eruptions, floods or fire, moss is often a major player in preparing the land for vascular plants again. As Audesirk and Ausdesirk note:

> Succession on dry land takes two major forms: primary and secondary. During *primary succession*, an ecosystem is forged from bare rock, sand, or a clear glacial pool where there is no trace of a previous community…. Bare rock, such as that exposed by a retreating glacier, begins to liberate nutrients such as minerals by weathering. Cracks form as the rock alternately freezes and thaws, contracting and expanding. For lichens (symbiotic associations of fungi and algae), the weathered rock provides a place to attach where there are no competitors and plenty of sunlight. Lichens can photosynthesize, and they obtain minerals by dissolving some of the rock with an acid they secrete. As the pioneering lichens spread over the rock, drought-resistant, sun-loving mosses begin growing in the cracks. Fortified by nutrients liberated by the lichens, the moss forms a dense mat that traps dust, tiny rock particles, and bits of organic debris. The death of some of the moss adds to a growing nutrient base, while the moss mat itself acts as a sponge, trapping moisture. Within the moss, seeds of larger plants germinate. Eventually, their bodies contribute to a growing layer of soil. As woody shrubs such as blueberry and juniper take advantage of the newly formed soil, the moss and lichens may be shaded out and buried by decaying leaves and vegetation (Audesirk and Audesirk, 1997, p. 589).

If an area becomes dry, mosses become shriveled and brown. When water is again available "their tissues quickly absorb it, and they seem miraculously to come to life" (Klein and Klein, 1988, p. 16). Mosses are also important in reducing wind and water erosion (Bold and LaClaire, 1987, p. 83). The peat mosses form peat bogs that are a "conspicuous feature of cold and temperature regions throughout the world." Their importance is indicated by the fact that peat bogs cover "an enormous area equivalent to that of half of the United States." (Raven et al., 1986, p. 298).

Evidence for the Evolution of Mosses

No fossil evidence exists for moss, hornwort or liverwort evolution and consequently theories of phylogeny are based on comparative morphology of living plants (Bold and LaClaire, 1987). Hutchins notes that they have been around since ancient times and have changed little since then (1966, p. 111). In his words they "got in an evolutionary rut and remained there" (1966, p. 111). Beck, in a summary of the literature, notes that they appear very early in the fossil record and have not changed since they first appeared (Beck, 1976).

Little agreement even exists on the general path of evolution that mosses may have traveled. Some believe that they formed a link between water-living plants, others argue that they developed from a vascular plant such as Rhyniophyta by reduction (Bold and LaClaire, 1987, p. 80). Others concluded that they likely evolved from algae and land ferns, but others that it is more likely mosses evolved directly from algae (Hutchins, 1966, p. 118). Yet other researchers argue their origin was either from a monobiontic haploid or dibiontic green algae ancestor.

The reason for the enormous amount of disagreement is that all these views are based on pure speculation, not evidence. This lack of evidence for evolution is not only true of mosses; little evidence exists as to the origin of any land plants. Delevoryas calls green algae "possible ancestors of mosses" but cites no evidence except biochemical similarities of the plant life that he has examined (1966, p. 49). He recognizes that the problems of the evolution of water plants to land life are enormous and we have few clues as to how this did or even could have occurred.

Mosses and liverworts lack a water conducting system, and are for this reason speculated to be a "bridge" between water and land plants. The problem with this explanation is that mosses and liverworts are small and grow in moist places, and consequently do not need a fluid conducting system such as the xylem and phloem of vascular systems found in larger plants. No evidence of evolving vascular systems has been found, only systems designed to meet the individual plants needs. Since mosses are classified as primitive plants and are found very early in the fossil record, the question what they evolved into is also of major concern. On this point Nadakavukaren and McCracken conclude:

> The bryophytes appear to represent an evolutionary dead end although the adaptations that developed in this group were sufficiently successful that the bryophytes have survived to this day. For some reason, however, mutations that would have led to the development of more efficient conducting tissue, roots, and cuticle did not appear in the genetic information of the bryophytes, thus limiting them in size and distribution. Modern and fossil species are very similar, indicating lack of change within the group. In fact, the habitat of the group has not really changed from that of the ancestral bryophyte: terrestrial regions with constant or periodically high moisture levels (1985, p. 362).

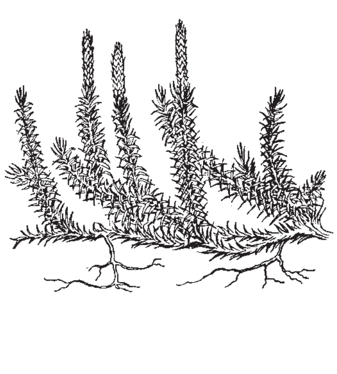
It is not only the evolution of mosses which has stymied evolutionists, but the evidence for the origin of *almost all plant groups* is totally lacking. Even the evidence for the evolution of the major plant groups is totally lacking. Cronquist concluded that "the origin of angiosperms was an 'abominable mystery' to Charles Darwin, and it remains scarcely less so to modern students of evolution" (1968, p. 35). Duddington said "The carnivorous plants are a remarkable. . . group that defeats the imagination when one speculates on how they have evolved" (1974, p. 234). This problem prompted Briggs and Walters to conclude that the evidence for evolution lies primarily in variations within kinds:

> Since 1859… with the publication of *On the Origin of Species*, all such studies have been made in the light of Darwin's profound generalization of evolution by natural selection. Even though this theory has not always been accepted by biologists, it could never be ignored. It is too easy for this generation to forget the tremendous impact made upon biology by Darwin's work. The fact of evolution is taken for granted, in part because of the wealth of evidence assembled by Darwin and other scientists. There is often at the same time an uncritical acceptance of the theory—it must be true, for it is in all the books. Implicit in Darwin's ideas is the assumption that evolution is still taking place. Thus in this book we shall not only look at the problems of species and patterns of variation, but also indicate evidence for evolution, particularly evidence, in part experimental, for evolution on a small scale, which is often called 'microevolution' (1969, p. 16).

Conclusions

Scientific research on the moss plant family supports the understanding that the earth consists of a complex biomass which has many parts, each one which is critical and without them all life as we know it would be threatened. Evolution must explain the existence of these separately evolving parts. How can it be that each part plays a role in the whole and yet the whole cannot exist without each part. If natural selection selected for the fittest of each type, we would not expect the extensive complex interconnections that exist everywhere in the natural world.

Nor would we expect the enormous variety seen in the moss family unless each variety filled an ecological niche. The variety in the case of moss is due to the enormous gene pools that each created kind possesses. This gene pool allows certain aspects of the moss phenotype to be maximized or sometimes new traits can be caused to appear by breeding (Moore, 1967, p. 12). This interdependency problem is the same as exists for the animal and plant cell—each part is useless without the whole and each part manifests irreducible complexity. The law of irreducible complexity argues that life could not have evolved because each part of the organism and the ecosystem as well could not exist until all parts were in place and developed to the extent necessary for propagation of life.



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