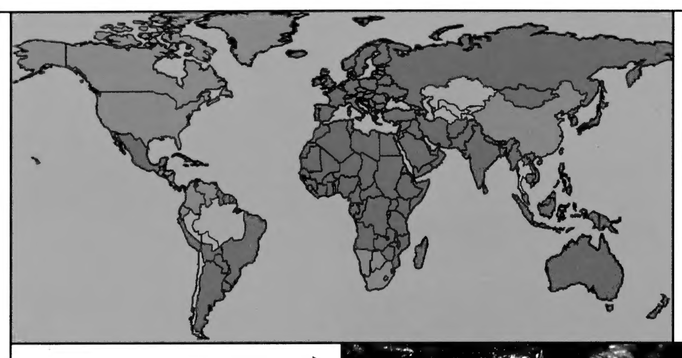
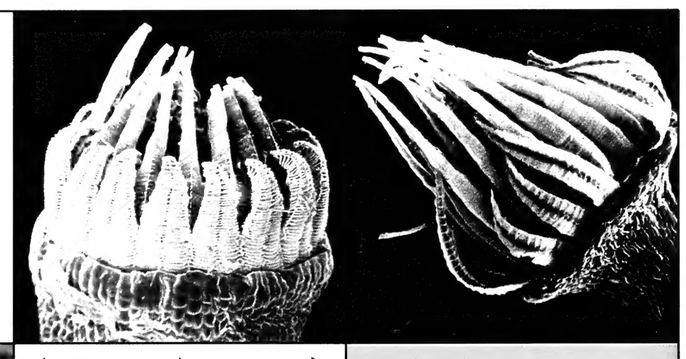
Research at the Missouri Botanical Garden

Bryology

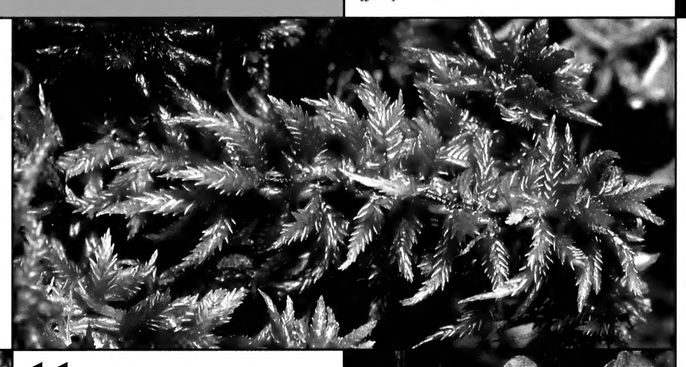
◀ **Bryology — Mosses are often grouped together with liverworts and hornworts in a formal or informal group called bryophytes.** There are about 250,000 species of flowering plants on earth, and about 18,000 species of bryophytes in about 1200 genera. Like ferns, **bryophytes produce spores for reproduction rather than seed and so are thought to be more primitive than flowering plants.** Unlike fungi, bryophytes are green and make their own food through photosynthesis. The plants are usually small and share similar life cycles. However, recent research suggests that mosses are more closely related to vascular plants than to either liverworts or hornworts. **Many unrelated plants are often confused with mosses,** including reindeer moss (a lichen), Spanish moss (a bromeliad), and terrestrial or freshwater green algae. At left, an unusual epiphytic *Sphagnum* moss on a tree in Cerro Colorado, Panama. [BH]



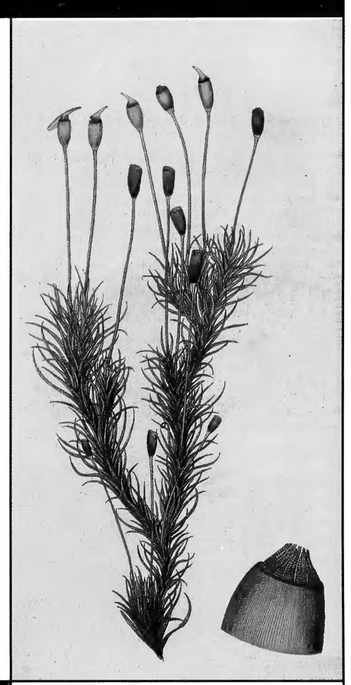
◀ **Distribution: Mosses are a component in every natural ecosystem in the world,** equally distributed between temperate and tropical regions. MBG conducts bryological research in many areas around the globe (red and yellow areas on map), leading to a better understanding of distribution of mosses, variations exhibited by distant populations of the same species, and relationships between and within remote continental floras. [JM]



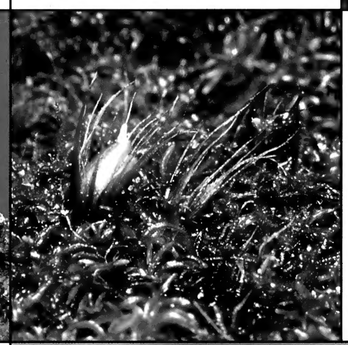
▶ **Moss Groups — Relationships: Mosses, with about 800 genera and 13,000 species, are usually classified into seven subclasses.** With about 300 species, *Sphagnum,* or peat moss, is the only genus in its subclass, Sphagnidae, characterized by simple, nearly spherical sporophytes and leaves with specialized cells that absorb tremendous amounts of water. The great northern bogs, the source of peat moss, have been formed through the millennia by the growth of mosses, especially *Sphagnum.* [RM]



▲ ▲ ▶ **Structures — Mosses are composed of two major parts** (right): The **gametophyte** is the conspicuous, sexual, leafy portion that bears antheridia, male structures, and/or archegonia, female structures. The asexual **sporophyte** is attached to the gametophyte and partly dependent on it. It consists of a seta, or stalk, bearing the spore-producing capsule. **Features of the peristome teeth at the capsule mouth are important in moss classification.** At right, the elegant engraving of *Cynodontium polycarpum*, a moss widely distributed in north temperate regions, provided state-of-the-art details when published in Hedwig's *Descriptio et Adumbratio Muscorum Frondosorum* in 1789. Electron micrographs of two tropical genera, above, reveal sub-microscopic details of two major peristome types. *Lepidopilidium* (above, left) features a **hypnoid** peristome, and *Lepidopilum* (above, right) displays the **daltonioid** type. [SC] [SC] [MBGL]

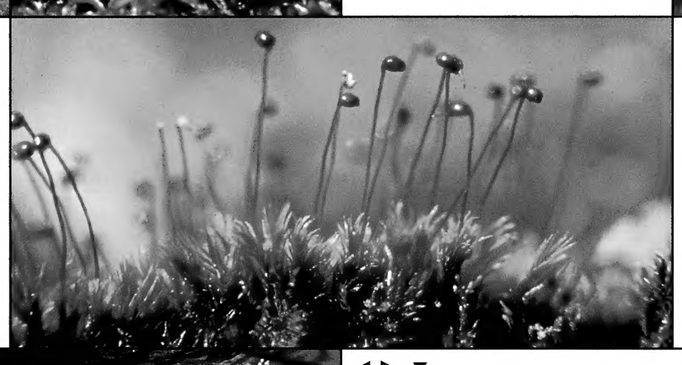


▼ **Hairy Cap Mosses — Subclass Polytrichidae**: This group, characterized by massive peristome teeth formed of entire cells, includes about 250 species **ranging in size from only a few millimeters tall to the Australasian genus** *Dawsonia*, **the tallest known terrestrial moss** at 60 centimeters. *Pogonatum pensylvanicum*, below, and related genera are thought to have shared a common ancestor with the Bryidae, or "true mosses." [RM]

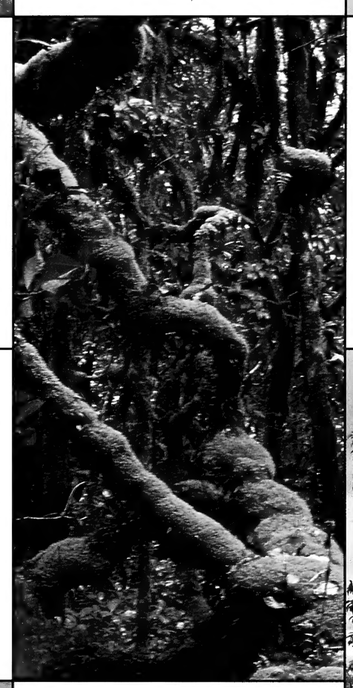


◀ ◀ **Bug Mosses — Subclass Buxbaumiidae**: With fewer than 40 species, members of this group exhibit **sporophytes that are disproportionately large** in relation to the often inconspicuous leafy gametophytes. *Buxbaumia aphylla* (far left) and *Diphysicium foliosum,* left, are two examples. [BA] [BA]

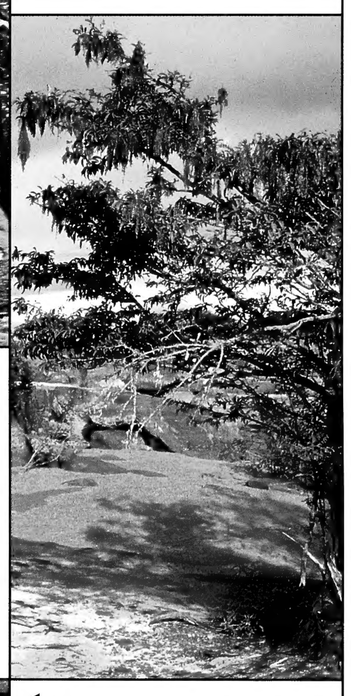
▶ **True Mosses — Subclass Bryidae** is characterized by delicate peristome teeth formed from portions of cell walls. The **"true mosses" include about 95% of all known kinds of moss,** some 12,400 species. Two major groups are determined by whether the peristome has a single or double series of teeth. Upright plants that form tufts, with the **sporophyte produced terminally, are called acrocarps,** such as *Catascopium nigritum*, right, widespread in cool northern temperate wetlands. [BA]



▲ **True Mosses — Pleurocarps:** In contrast to acrocarps, the second group of true mosses, called **pleurocarps, grow as prostrate mats, wefts, or epiphytic pendant forms with the sporophyte produced laterally on the stem.** An example is *Hookeria lucens*, above, a species found in cool temperate forests of northwestern North America and Eurasia. [BA]



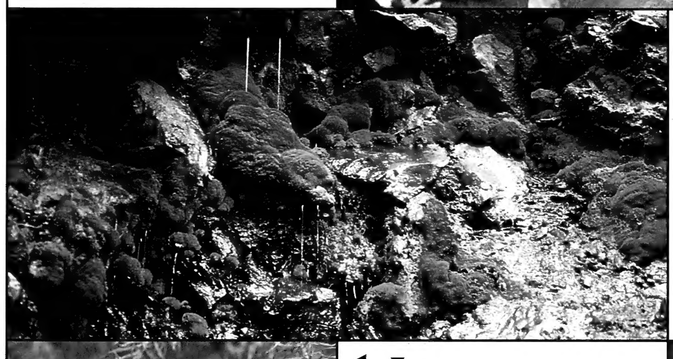
◀ ▼ **Habitats — Diverse:** Mosses occur in a wide range of environments and habitats. **Epiphytes are conspicuous in tropical lowland and montane forests,** such as those in Madagascar, left. Although a moist environment is most common, *Hydropogon fontinaloides*, below, is a lowland moss commonly found in inundated sites along the Orinoco and upper Amazon Rivers, where they survive hanging from trees during the dry season. [RM] [BA]



▼ ▶ **Habitat — Wet Temperate: The greatest diversity of mosses is found in seasonal moist or wet temperate forests and montane tropical forests,** where they are found growing on the forest floor, on decaying logs, on bases of trees, and on rocks along streams as in the Xinjiang province in China, below. The genus *Fontinalis*, right, is exclusively aquatic, typically found attached to rocks in streams. [SH] [BA]

◀ ▶ ▼ **Ecology & Environment: Mosses can be found in most habitats occupied by plants,** from the hot deserts of North America, Africa, and Australia, to the frigid zones of the Arctic or Antarctic. They are a dominant element in some tropical ecosystems or wet temperate forests, such as those of the Pacific Northwestern U.S. **Mosses perform a vital function in their ecosystems by holding massive amounts of water,** helping to regulate moisture. Moss cushions also serve as collection points for wind-blown soil and seeds, forming a **natural nursery for forest plants and providing homes for insects, fungi, and micro-organisms that aid in the production of humus.** Mosses are supreme colonizers of exposed sites, aiding in the initial stages of stabilization on newly graded banks or recent landslides. [BA] [RM] [SC]

Botanical research provides the basic information needed to manage ecosystems sustainably.

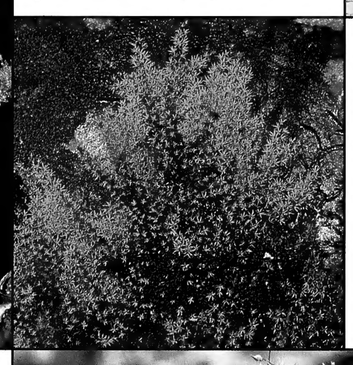


▼ **Spore Dispersal — Wind: Typically the spores of mosses are dispersed by air currents.** The Splachnaceae is the only family of mosses known to exhibit **entomophily, or dispersal of spores by insects.** The yellow, umbrella-like hyophysis of *Splachnum luteum*, below, serves as a landing pad for insects attracted there by its bright color and the aromatic chemicals that it emits. [DV]

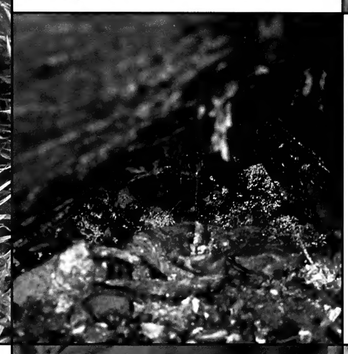
◀ **Biodiversity — Regional: In the tropics, high diversity is found in montane regions,** while lowland forests have relatively few species. For example, the entire Amazon basin has only about 300 species of mosses, while the much smaller area of the tropical Andes has about 2,000. New World paramos such as Paramo Frontino in Colombia, left, are similar to temperate alpine zones. Paramos cover only 1-2% of the northern Andes but are home to some 530 species of mosses. [SC]

◀ ▼ **Growth Habits — Diverse**: A mostly tropical montane genus with fewer than 100 species, *Breutelia* (left) grows in **loose tufts** in open, often wet sites in mountains and alpine regions. The **luminous** moss, *Schistostega pennata*, below, occurs only at the entrance of caves or dark depressions, where lens-shaped cells of its thread-like protonemata concentrate the little available light for photosynthesis, reflecting some of it with a golden-green glow. [RM] [BA]

▶ **Habit — Epiphyte**: A very common pendant moss found most in the Neotropics is *Zelometeorium patulum*, right. It is an epiphyte, a plant that grows perched on other plants. **Two-thirds of all species of plants occur in tropical regions, where ecosystems face severe pressures from poverty, development, and rapid population growth. MBG operates the world's most active program in tropical botany, working to identify species before they become extinct.** [MP]



◀ **Diversity — Preservation:** *Macromitrium*, left, is one of the many diverse and attractive tropical genera. It has been estimated that **about 80% of the montane Andes has been deforested, compared to only 12–15% in the Amazon basin.** Epiphytes in the Andes account for as much as 30% of the total diversity of about 2,000 species of mosses. Thus **epiphytic mosses are at great risk of extinction** or severe population fragmentation. [RM]



▶ **Diversity — Endangered:** *Sematophyllum aureosulphureum* is a tropical epiphytic species found on bamboo nodes in transitional high montane forests and paramos of Colombia. This zone, the interface between high montane regions and paramo, may contain as much as **50% of the total species diversity in the tropical Andes. Scientists estimate that virtually all tropical forests will be destroyed or degraded within the next 20 years.** [SC]

▶ **Diversity — Neotropics**: *Campylopus* **is one of the most diverse genera in the tropics,** and about 65 of the estimated 180 species of *Campylopus* occur in the Neotropics. Of that number, about half are found in the tropical Andes, ranging from lowlands to higher elevations. As with many species of this mostly terrestrial genus, *C. umbellatus*, right, is commonly found in open sites. [RM]

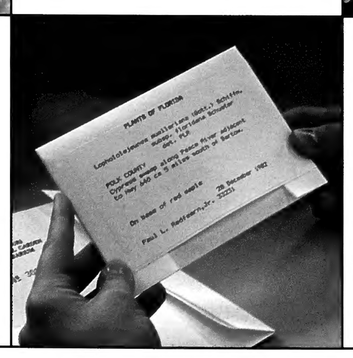
▶ **Weft form** — *Abietinella abietina*, right, is common throughout deciduous and conifer forests of temperate and montane tropical regions of the world. In the temperate region, **moss diversity is often greater in conifer forests than in deciduous forests.** [BA]

Only about 10% of all plant species have been scientifically evaluated for their usefulness to humans.

◀ ▶ **Cushion and Tuft Form — Moist Temperate**: *Grimmia*, left, with some 90 species, is a widely distributed cushion moss inhabiting rocks in exposed sites. *Rhodobryum roseum*, right, is found in loose tufts over soil and humus in well-shaded forests. [BA] [RM]

▼ ▶ **Uses — Economic and Ethnobotanical**: *Sphagnum,* or **peat moss, is the most commercially valuable moss,** widely used in the horticulture trade. In some regions mosses have employed as surgical dressings and diapers, and in Latin America and China, mosses are sold in market centers, below, for use as decorations and medical treatments. Many birds in both temperate and tropical regions use mosses for nesting material, right. [RM] [MC]

◀ ▶ **Taxonomy: Johannes Hedwig,** left, 1730-1799, a contemporary of Linnaeus, is considered the **founder of modern moss taxonomy.** Hedwig's *Species Muscorum*, 1801, is the starting point for most moss names. Hedwig is acknowledged as the first to correctly interpret the sexuality and life cycle of mosses and the first to emphasize the importance of the form and function of the peristome. **Herbarium: With some 300,000 specimens to date, MBG's bryophyte herbarium is one of the largest and richest in the world.** It includes specimens from throughout the world, some collected in the early 18th century. The dried specimens are kept in 4- by 6-inch packets filed in index card cabinets, right. An index to all moss names (MOST) is maintained in the MBG database, **TROPICOS, the world's largest and most widely used botanical database system.** MBG is using the information to prepare an ambitious global checklist of the world's mosses. [MBGL] [CW]



MBG Research: MBG bryologists are preparing **floras** (red on map, above) for Central America, the northern Andes, China, southern Africa, and several states and regions in the U.S., including treatments for the Flora of North America. **Checklists** (yellow on map) for the Amazon, Chile, the tropical Andes, China, and Thailand are in preparation, as well as MBG's global checklist project. **Publications** include *Index of Mosses* and *Recent Literature on Mosses.* MBG also trains **graduate students** in bryological systematics.

Dedication

We dedicate this poster to the many volunteers who have contributed so much to the bryology program at the Garden during the past thirty years, especially Roma Wittcoff and Bertha Burton.

Research at the Missouri Botanical Garden

About fifty Ph.D.-level scientists, many of whom live abroad, technical staff, and graduate students are devoted to studying plants. These efforts are concentrated in Mesoamerica, South America, subsaharan Africa, Madagascar, China, and North America. Individual MBG scientists are specialists in the plants of particular regions or in the classification of major plant families.

MBG serves as headquarters for the Center for Plant Conservation and for the major collaborative projects Flora of China, Flora Mesoamerica, and Flora of North America. To help disseminate botanical information, MBG floristic research and library resources are available on the Internet at **http://www.mobot.org.**

MBG botanists collaborate with local institutions in each country where they conduct research, providing technical expertise, assisting with fundraising, establishing better communication with the worldwide scientific community, training botanists in the field and at MBG, and helping to build infrastructure. Botanical research provides basic scientific knowledge needed to develop conservation policies to preserve global biodiversity.

Photo Credits/Key to Symbols

MBG	Missouri Botanical Garden
MBGL	Missouri Botanical Garden Library
BA	Bruce Allen, MBG
BH	Barry Hammel, MBG
CW	Cliff Willis, MBG
DV	Dale H. Vitt, Univ. of Alberta
JM	Jesús Muñoz, MBG
MC	Marshall R. Crosby, MBG
MP	Michelle Price, MBG
RM	Robert E. Magill, MBG
SC	Steven P. Churchill, MBG
SH	Si He, MBG

Printed on recycled paper

© 1998, Missouri Botanical Garden