

Selectivity in Indiana Mosses

WINONA H. WELCH, DePauw University

Mosses, in a general sense, grow in a great variety of situations, as for example, *Amblystegium varium*, in moist shaded places, on soil, at base of trees, on decaying wood, and on rock. Mosses characteristically grow in moist shaded habitats although they do occur in dry exposed situations and in water. Common substrata are rocks, soil, bark of living and dead trees and shrubs, and decaying organic matter. However, many species are very selective in choice of habitats. Because of this selectivity, several mosses may be regarded as plant indicators of certain conditions of the substratum. Upon approaching a specific habitat, a bryologist searches for certain species or genera of mosses. And, conversely, certain species and genera of mosses are often indicators of specific substrata and habitats.

Since mosses have no roots, they are frequently quite dependent upon atmospheric moisture. The mosses are usually more shade-tolerant than the more highly developed plants, although some prefer full sunlight. In shade, there is more moisture in the atmosphere and a reduced rate of transpiration from the plant and evaporation from the substratum. Those living in the sun are tolerant of high rates of transpiration and evaporation, low humidity, and higher temperature.

Some mosses prefer habitats such as lakes, pools, ponds, swamps, bogs, and slow rivers, while others choose swiftly flowing streams. The rate of movement of the water influences the amount of mechanical action and affects the aeration of the water.

The response of mosses to edaphic factors is usually quite distinct. Some of the common preferences in Indiana are rock, humus, bark, bare soil, bogs, and swamps. Other species are more particular and require certain kinds of rock, soil, and humus. In preparation of data for this paper, species have been omitted if they usually grow on more than one kind of substratum; e.g., on rocks, soil, and bark. An attempt has been made to include only those species of mosses known to grow in Indiana, which appear to be selective or specific in habitat or substratum, and thus may be regarded, frequently, as plant indicators of specific conditions.

Knowledge of the genera and species of mosses frequently aids in a speedy and general recognition of the acidity or alkalinity of a substratum. All species of *Sphagnum* and some species of *Polytrichum* avoid the slightest traces of lime, and *Hypnum molluscum* has a definite preference for alkalinity, at least a slightly alkaline substratum. *Cratoneuron flicinum* thrives in water, especially occurring in springs and rivulets, preferring those which have a pH above neutral. *Campylium stellatum* and *Drepanocladus aduncus* either prefer or are tolerant of fens (alkaline bogs). *Gymnostomum* appears to be an obligate calciphile, *G. calcareum* occurring on damp ledges of limestone and *G. recurvirostrum* on dripping ledges. *Grimmia apocarpa* is calcicolous, selecting the horizontal surface of more or less flattened rocks, either in sun or shade. *Didymodon tophaceus* grows

in calcareous habitats, on wet soil and cliffs and in springs and brooks, and is regarded as important in the building of tufa.

Other Indiana mosses which are usually calcicolous or calciphiles (normally growing on calcareous substrata) are *Amblystegiella confervoides*, *A. minutissima*, *Barbula unguiculata*, *Desmatodon obtusifolius*, *D. Porteri*, *Didymodon trifarius*, *Myurella Careyana*, *Orthotrichum strangulatum*, *Rhytidium rugosum*, *Thuidium pygmaeum*, and *Tortula ruralis*. *Thuidium recognitum* occurs in limestone regions, but not necessarily on stone as it also occurs on soil and rotten wood.

Moss species may be recorded as calcicoles because they occur in a calcareous area and appear to be growing on limestone, when actually the plants are growing on a layer of acid humus on the stone or on the upper portion of the limestone which has a pH reading below neutral as the result of leaching. Thus, these plants may be calcifugous (not normally growing on calcareous soils) instead of calcicolous. On the contrary, a collection of moss plants on sandstone may be recorded erroneously as calcifugous. Often sandstone contains lime compounds. Without tests, one may not be aware of this condition, but calcicolous mosses on sandstone are regarded as excellent indicators of the presence of the calcareous inclusions; e.g., *Desmatodon Porteri*.

Many mosses grow only on rock. Some prefer the surface, others grow in the crevices; some choose calcareous rock, others non-calcareous; some like moist shaded habitats, and others the full sunshine. Although the records report rock as the substratum, there is a sufficient supply of humus available on the rock for the growth of the moss. *Porotrichum alleghaniense*, *Amblystegiella minutissima*, and *Bryoxiphium norvegicum* occur in moist shaded ravines, the *Porotrichum* on damp rock near streams, the *Amblystegiella* preferring limestone, and the *Bryoxiphium* the almost vertical faces of sandstone. Indiana crevice-mosses are *Fissidens Closteri*, preferring decomposing rocks, *Myurella Careyana*, *Plagiothecium Muellerianum*, and *P. elegans*. The mosses in the state which especially like dripping ledges are *Gymnostomum recurvirostrum*, a calciphile, and *Hookeria acutifolia*, which has the westward limit of its known distribution in Indiana, on the surface of sandstone forming almost vertical sides of canyons. Since the latter moss also grows near cool springs and on stream banks, it is apparent that an abundance of moisture is one of its habitat requirements.

Mosses in Indiana which grow specifically on shaded and somewhat moist to very damp rocks include *Dicranum fulvum*, *Fissidens exiguus*, *F. minutulus*, *Hyophila tortula*, and *Sematophyllum carolinianum*; on wet rocks, *Mnium marginatum* and *M. punctatum*; and on rock and stones in brooks or streams, possibly submerged at times, *Brachythecium flagellare*, *B. rivulare*, *Fissidens obtusifolius*, *Grimmia apocarpa* var. *alpicola*, *Hygroamblystegium irriguum*, *H. orthocladon*, and *Hygrohypnum palustre*. It is apparent that these mosses not only select rock substratum but are also able to distinguish, in a general sense, between the different amounts of water on the rock which seem to be optimum for their growth.

Although the majority of mosses grow on moist shaded substrata, some species are known to grow only on dry rocks in full sunshine; e.g.,

Grimmia apocarpa and var. *conferta*, and *G. pilifera*. Those preferring exposed non-calcareous substratum are *Grimmia laevigata*, *G. Olneyi*, *Hedwigia ciliata*, and *Ulota americana*. Others select silicious rock in the open, as *Ptychomitrium incurvum*, or somewhat calcareous rock, as *Rhytidium rugosum*.

Many mosses in the state use soil for their specific substratum. We may regard soil as a mixture of weathered or disintegrated rock and varying amounts of organic material. The soil mosses are particular in several instances as to the kind and/or condition of the soil, whether it is shaded or exposed to full sunlight, moist or dry, recently disturbed or undisturbed for a long period, poor or rich in organic substances, sand or clay, etc.

*Bryum caespiticiu*m may be regarded as an indicator of poor soil or one not rich in organic matter. On the contrary, *Aulacomnium heterostichum*, a moss of the woods, is indicative of soil rich in humus. In old fields, in the open and yet partially shaded by taller plants and on soil more or less smooth because of lack of cultivation, *Astomum Muhlenbergianum*, *Bruchia Sullivanti*, *Ditrichum pusillum*, *Phascum cuspidatum* var. *americanum*, and *Weisia microstoma* find their favorite habitat. Those that thrive on soil which is periodically disturbed are *Barbula unguiculata*, *Ephemerum serratum*, *E. spinulosum*, *Leptobryum pyriforme*, and *Weisia viridula*. These plants are short, 1-20 mm. high, and the soil of fields, roadside banks, and paths makes it possible for them to pioneer with little competition. The disturbed soil provides numerous pockets for catching the wind blown spores and sufficient moisture for the germination of the spores. Others choose clayey soil, as *Aphanorhegma serratum*, *Atrichum undulatum*, and var. *altecristatum*. *Dicranella varia* and *Ditrichum pusillum* prefer to grow on freshly exposed clay, where they may be regarded as pioneers and where competition with other plants is nil. *Anomodon rostratus* occurs on soil at base of trees, cliffs, or rocks, having a somewhat wet habitat as water runs down these structures into the soil where it is retained in accumulated humus. Other species thrive on the soil of lawns, between grass plants and weeds, and thus are provided with humus and shade. Here we frequently find *Atrichum angustatum*, *Leptodictyum brevipes*, and *Physcomitrium turbinatum*, and occasionally *Pleuridium subulatum*. *Dicranum condensatum* and *Ditrichum pallidum* thrive on dry sandy soil, which would seem to indicate that they do not need much humus for holding water or as a source of food materials. Other mosses occurring on sandy soil are *Atrichum angustatum* and *Bryum bicolor*. *Philonotis fontana* and varieties *falcata* and *pumila* and *P. marchica* live on very wet soil. *Mnium medium* likes wet ground in woods. Indiana mosses which prefer moist shaded soil are *Atrichum undulatum*, *Eurhynchium hians*, *Fissidens bryioides*, *F. osmundioides*, *F. taxifolius*, *Mnium cuspidatum*, *Plagiothecium geophilum*, *P. Roeseanum*, and *Polytrichum commune*. *Polytrichum juniperinum* grows on soil, usually exposed to the sun, but sometimes in the shade.

One of the common mosses, not only in Indiana but all over the world, is *Ceratodon purpureus*. It prefers barren habitats whether the substratum is soil, burned area, rock, sand, or an old roof. Thus it is tolerant

of exposed or open habitats with small amount of humus and moisture, and is able to grow as a dense sod of moss, often with little competition with other plants.

Upon moist banks or roadsides where the soil has been recently disturbed, *Pogonatum brachyphyllum* or *P. pensilvanicum* grow abundantly before other plants establish themselves. These mosses have an abundant, conspicuous, and persistent protonema. Such soil is frequently covered with the thin layer of perennial protonema and attracts one's attention at some distance because of the beautiful yellow-green mass of filaments. The stems of these mosses are short (1-3 mm.). The leaves are also small and are erect or erect-spreading. Only by close examination are these portions of the gametophyte evident in the field. The sporophytes are conspicuous and abundant. These mosses cover the freshly disturbed earth before their plant competitors are able to develop. The persistent protonema is not only important to the plant as it apparently carries on considerable photosynthetic activity, but also to man, as it seems to be very effective in preventing or retarding surface erosion of clayey banks. *Buxbaumia aphylla*, a moss of open woods, also has protonema on surface of barren soil. These green filaments carry on photosynthesis for the moss as the leaves are so minute that they are almost obsolete. Other Indiana mosses which select to live on damp clayey or silty banks, usually shaded, are *Aphanorhegma serratum*, *Barbula fallax*, *Dicranella heteromalla*, *Ephemerum serratum*, and *E. spinulosum*.

Humus is a required substratum for some bryophytes. Mosses which grow on rock really have sufficient supply of humus available although it may not be evident to the collector until after careful examination of the substrate. In some parts of the United States and Canada there are mosses which are obligately nitrophilous. No moss in Indiana is now known to live on a specific nitrogen-rich substratum. Richards suggests that *Bryum argenteum* is probably nitrophilous. This *Bryum* is a common Indiana species. *Buxbaumia aphylla* and *Mnium stellare* prefer moist shaded places, especially woods, and grow on a substratum of humus.

The habitat recorded in the manuals for *Tetraphis pellucida* is humus and decaying wood in cool, moist, shaded places. In Indiana, *Tetraphis pellucida* is a common plant on distinctly different habitats which appear to have something in common that is favorable for the growth of this moss. It occurs in moist shaded places on either sandstone or on decaying wood, or on peaty banks of streams. Apparently it seeks a habitat rich in organic matter. If humus is present on sandstone or in accumulated soil on the stone, *Tetraphis pellucida* is able to grow there as well as on decaying wood. Dr. Conard, in *Vegetation of Iowa*, regards water supply as the factor in common in rotten wood and in porous sandstone, since both habitats contain sufficient moisture and can supply the plants with water easily. It seems to the writer that it may be a combination of a ready source of water and sufficient organic matter that provides the favorable habitat. Another moss in Indiana which seems to prefer rotten wood but can also thrive as well on peaty banks is *Dicranum flagellare*. Grout, in *Mosses with a Hand-lens*, referred to *Tetraphis pellucida* and *Dicranum flagellare* as saprophytes, but not to the extent that they could survive

without chlorophyll. Additional Indiana mosses which grow chiefly on decaying or rotten wood are *Hypnum imponens* and *Heterophyllum Haldanianum*.

At or near the base of some tree trunks one frequently finds abundant growth of moss. Apparently this habitat is more moist than the upper bark because the water draining from the upper portion of the trunk accumulates in the basal area. Some kinds of mosses grow above the base for a distance of a few feet, others occur throughout the surface of the trunk as well as on the branches, and others prefer only the basal portion of the tree because of the accumulation of humus. The bark of deciduous trees seems to be preferable as mosses do not commonly grow on trunks of coniferous trees. The lack of epiphytic mosses on birch and pine trees may be due to the continued peeling and scaling of the bark. Corticolous mosses (epiphytes) in Indiana include *Chamberlainia acuminata*, *C. cyrtophylla*, *Clasmatodon parvulus*, *Drummondia prorepens*, *Entodon compressus*, *Homalotheciella subcapillata*, *Leucodon brachypus*, *L. julaceus*, *Lindbergia brachyptera* var. *Austinii*, *Orthotrichum obtusifolium*, *O. ohioense*, *O. pumilum*, *O. pusillum*, *O. sordidum*, *O. stellatum*, *Platygyrium repens*, *Pylaisia intricata*, *P. Selwynii*, *Thelia asprella*, *T. hirtella*, *Tortula pagorum*, and *Ulota crispa*. *Orthotrichum* spp. are most frequent on trees about houses, in orchards, and on village streets, but they occur elsewhere where trees are somewhat apart. They prefer fruit and shade trees in country towns rather than in cities. According to Grout, *O. stellatum* grows especially on apple and butternut tree trunks. The species of *Orthotrichum* and *Pylaisia* prefer an atmosphere with high humidity. *Dicranum viride* grows on either living trees or decaying logs. Epiphytic mosses are very sensitive indicators of an atmosphere without any noticeable amount of smoke or gas.

The age of the host tree is important to the moss plants because the older trees have a thicker and rougher bark and thus retain more water for the bryophytic epiphytes and increase the deposition of dust and accumulation of humus. Pessin (Ecol. 6: 17-38. 1925) presents evidence that there is nitrogen in the humus of the bark and minerals in the dust from the air.

One of the most interesting mosses in Indiana is *Anacamptodon splachnoides*. Because of its unusual habitat in knotholes of deciduous living trees, it has been given the name of "the knothole moss." In these cavities it has a substratum of decaying wood soaked with water during portions of the year.

Upon approaching burned areas in Indiana, whether in the woods or in the open, the anticipation of finding *Funaria hygrometrica* and/or *F. flavicans* is usually realized, providing sufficient time has elapsed since the fire. *Leptobryum pyriforme* and *Bryum argenteum* may also occur in such habitat. *Funaria* is a very reliable indicator of a place in which there has been a fire. Even if the cinders or charcoal are not evident on the surface, fragments may be found in the soil. One assumes that *Funaria* has a strong preference for moist carbon, but this moss sometimes grows in rock crevices, and also occurs on limestone, mortar, and plaster, suggesting that it requires a porous habitat with good drainage. Hesselman

(Medd. från Statens Skogsförsöksanst. Hfte. 13-14, Bd. 2, 1916-1917, pp. ci-cv of the English summary) has given evidence that a sudden great increase in nitrifying power results from the burning of raw humus soils. Herzog (Geographie der Moose, Jena, 1926, p. 69) suggested that some of these mosses of burnt ground may be nitrophilous. Richards adds to these possibilities the suggestion that these species may prefer high concentrations of potassium or of mineral salts.

Numerous moss species select habitats with considerable moisture in the substratum or choose to live in water a portion of or throughout the year. Swamps, ponds, lakes, streams, springs, and spray from waterfalls satisfy this water requirement. Some of the mosses live in the water and others choose the margins or close proximity to the water. Indiana species which occur in these subaquatic or aquatic habitats include *Aulacomnium palustre*, *Brachythecium flagellare*, *B. rivulare*, *Calliergon cordifolium*, *Campylium polygamum*, *C. stellatum*, *Climacium Kindbergii*, *Cratoneuron filicinum* (preferring those containing lime), *Dichelyma capillaceum*, *Drepanocladus exannulatus* f. *orthophyllus*, *D. vernicosus*, *Fissidens julianus*, *F. obtusifolius*, *Fontinalis biformis*, *F. dalecarlica*, *F. disticha*, *F. Duriaei*, *F. novae-angliae*, *F. novae-angliae* var. *latifolia*, *Helodium paludosum*, *H. paludosum* var. *helodioides*, *Hygroamblystegium fluviatile*, *H. irriguum*, *H. irriguum* var. *spinifolium*, *Hypnum Patientiae*, *Leptodictyum riparium* and forms *fluitans*, *longifolium*, and *obtusum*, *Mnium affine*, *Philonotis fontana* and vars. *falcata* and *pumila*, *P. marchica*, and *Pohlia Wahlenbergii*.

Mosses which usually grow on wet, spongy earth containing quantities of decaying moss and other vegetable matter (bogs and fens) are *Aulacomnium palustre*, *Campylium stellatum*, *Helodium paludosum*, *H. paludosum* var. *helodioides*, *Polytrichum juniperinum* var. *alpestre*, *Sphagnum capillaceum*, *S. compactum*, *S. fimbriatum*, *S. Girgensohnii*, *S. imbricatum* var. *affine*, *S. magellanicum*, *S. palustre*, *S. recurvum*, *S. recurvum* var. *tenue*, and *S. subsecundum*. *Campylium stellatum* is a characteristic moss of both bogs (acid) and fens (alkaline), so it may be assumed that the wet organic matter rather than the pH factor is the determining habitat condition in the case of this moss. *Drepanocladus aduncus* is an associate of *Campylium stellatum* in the fens. The other species may be regarded as indicators of an acid substratum.

Some species of mosses prefer to grow in a layer of soil which has collected on stone or brick walls or on soil between buildings and walks or on soil between bricks, stones, or segments of concrete in walks. *Bryum argenteum* is one of the most common mosses in this kind of habitat. It has also been collected on roofs.

An interesting observation is that species within the same genus are very selective with regard to their habitats. The following mosses will illustrate this condition in Indiana. *Amblystegiella subtilis* on bark and *A. confervoides* on limestone rocks; *Dicranum flagellare* on rotten wood and *D. fulvum* on rock; *Orthotrichum anomalum* on rock and *Orthotrichum* spp. on bark; *Aulacomnium heterostichum* on moist rich soil in woods and *A. palustre* in swamps and wet shaded hollows; *Drepanocladus aduncus* in calcareous waters or wet meadows and *D. exannulatus* in non-cal-

careous waters or swamps; *Leptodictyum riparium* f. *fluitans* and f. *longifolium* in water of springs or pools and *L. brevipes* on soil of shaded lawns; *Climacium americanum* on soil in woods and *C. Kindbergii* in wet places or in water; *Grimmia apocarpa* var. *alpicola* on rock in or close to streams and *Grimmia* spp. on dry rock; and *Thelia asprella* and *T. hirtella* on bark and *T. Lescurii* on sand or rock.

The ability of many Indiana mosses to select specific habitats seems evident. It is more difficult to discover all of the controlling factors in each instance of selectivity than to observe the choice of substrata. Because of these conditions, the data on herbarium labels are frequently inadequate and sometimes incorrect (especially as to sandstone and calcareous sandstone). Often, in the correct determination of moss species, specific knowledge regarding the substratum and habitat is helpful.

Acknowledgments

The writer is deeply indebted to H. S. Conard, Director of the Moss Clinic of the Iowa Lakeside Laboratory for counsel in regard to the determination of mosses as associated with specific habitats and substrata, to the State University of Iowa for a series of Honoraria which made possible the summers in research at Lakeside, to the Indiana Academy of Science for grants which made possible the collecting of the mosses throughout the state, and to the Graduate Council of DePauw University for research grants for use in study of Indiana mosses in herbaria in other institutions.

Bibliography

- CONARD, H. S. 1944. How to Know the Mosses.
CONARD, H. S. 1952. The Vegetation of Iowa. State University of Iowa Studies in Natural History 19, No. 4; 97-139.
DUNHAM, ELIZABETH M. 1951. How to Know the Mosses, pp. 73-257.
GAMS, H. 1932. Quarternary Distribution. Manual of Bryology, edited by F. Verdoorn, pp. 318-322.
GAMS, H. 1932. Bryo-cenology (Moss Societies). Manual of Bryology, edited by F. Verdoorn, pp. 323-366.
GROUT, A. J. 1903. Mosses with Hand-lens and Microscope.
GROUT, A. J. 1924. Mosses with a Hand-lens, pp. 1-224.
GROUT, A. J. 1928-1940. Moss Flora of North America North of Mexico. 3 vols.
RICHARDS, P. W. 1932. Ecology. Manual of Bryology, edited by F. Verdoorn, pp. 367-395.
RICHARDS, P. W. 1950. A Book of Mosses.