GUIDE TO THE MOSSES OF COLORADO

KEYS AND ECOLOGICAL NOTES BASED ON FIELD AND HERBARIUM STUDIES

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INTRODUCTION

Mosses are extremely sensitive indicators of enviromental nuances, and they occupy, for the most part, very precisely delimited habitats. These habitats are often small, and few mosses rapidly colonize large virgin areas. Their distribution patterns, on the world-wide as well as the local scale, reflect relictual or vanishing microhabitats. This is especially true in the Rocky Mountains, where aridity is the rule. The habitats of our mosses, except for a few pioneering species, are sites that have remained stable for extremely long periods of time. The presence of certain moss colonies can be used to indicate the presence of certain chemical ions or relative soil acidity, local anomalies of relative humidity, duration of snow cover, the occurrence of intermittent or seasonal liquid water seepage, and other environmental variables that exist on almost too local a scale to justify the use of continuous sensitive recording devices in order to obtain comparable data.

There is every reason, then, why ecologists should begin to pay serious attention to mosses, because they are able to tell us more about local environments than the more conspicuous trees and herbs. But identification tools in this field are slow to reach a wide audience because the path to understanding these plants is tortuous, requiring critical and tedious research and attention to minute detail, thorough experience in the field and in excellent herbaria, long hours at the microscope, comprehensive libraries of the world literature, and the development of special skills of dissection that are foreign to the work habits of most plant taxonomists.

Mosses often have much larger or more widely disjunct distribution patterns than do flowering plants. The Southern Rocky Mountains draws its flora from the obvious migration pathway afforded by the immense north-south extent of the Western American Cordillera, and some of our species are here as a result of mountain connections which no longer exist. Every drainage system that radiates from the core of the range also serves as a highway of migration for riverine and lowland or desert species. An apt analogy is that of a great wheel, whose hub -- the Southern Rockies, preserves the most ancient survivors, and whose axle and spokes -- the Cordillera and the drainage systems, provide the pathways along which migration has taken place through time under the pressures of climatic shifts and orogenic movements.

At the present time the moss flora is predominantly circumboreal--montane, as testified to by the fact that all but a very small number of species are common to Colorado and Scandinavia. A residuum of desert and lowland elements enters along the drainage systems from the Southwest and East (Crossidium, Aloina, Pterygoneurum). A very small number of world-wide disjuncts can be considered to be ancient relicts of Tertiary floras (Anacolia laevisphaera, Leptodon smithii, Oreas martiana). There is virtually no endemism in the moss flora of the Southern Rocky Mountains although certainly there are mosses endemic to the larger Cordilleran system.

This guide to the Colorado mosses is patterned after the excellent series of little books produced by Prof. Helmut Gams of Innsbruck, Austria, entitled "Kleine Kryptogamenflora von Mitteleuropa." They are field guides to the mosses, lichens, ferns, fungi and algae of Central Europe, and their author is one of the keenest field men in Europe. As a compromise to the field requirement, they contain only keys and ecological notes. For more detailed descriptions and illustrations they assume the availability of more comprehensive literature. They also expect a certain amount of background on the part of the user.

I intend to enlarge this guide to include an instructional introduction, a glossary of terms, and illustrations of the species, but the present version is offered for testing and criticism in the meantime. Although this distillation represents more than twenty-five years of sporadic research, the work is now only well begun. The stones are laid, but the building has not assumed its final shape. We think we know what grows here, but there will be additions as soon as active field work by many students begins. We have some notions of habitats, but they are primitive notions and need refinement. Every observer comes to the field with a different pair of eyes and a different core of experience, and there have been too few of us up to now. I shall be satisfied if this guide will serve to bring bryology within the competence of students and ecological researchers, and serve as a guide to visiting bryologists from abroad, until such time as a more sophisticated work is made possible.

One who constructs diagnostic keys can usually make a key that satisfies himself, that is, he can distinguish his species if all of the necessary things needed for identification are present. It is quite another thing to produce a key that is satisfactory to his students, and that has to work even if vital parts are missing. This is the great problem with mosses, expecially in an arid area like this one -- that most of our mosses are rarely or never found in fruiting condition, so that the sporophyte information, so vital in identification, cannot be honestly used in the key. The writing of the key thus becomes a difficult art, with inevitably equivocal results.

Furthermore, without sporophytes it is impossible to write a satisfactory key to the larger groups -- families and genera, so that a different method has to be tried. Mrs. Patricia Nelson has worked out a very useful polyclave key on IBM cards, called Random Access Key to the genera of Colorado Mosses, which we consider to be an indispensable adjunct to the Guide. In this device, the IBM cards represent attributes, such as "leaves linear," "peristome absent," "plants reddish-brown." Each genus is assigned a fixed position on the card, and this position is punched out for each attribute. To make an identification, one simply selects the appropriate cards with attributes of the unknown moss, and the cards are superimposed. When only one hole

remains open, the identification has been made. This is a method that facilitates identification not only for non-fruiting material, but by relatively inexperienced students.

All of the species listed in the Guide are documented by herbarium specimens in the herbarium (COLO) of the University of Colorado Museum. We welcome comments and criticisms, and are always interested in adding to the collections through contributions from collectors.

Acknowledgements

Although most of the keys are original, one can hardly improve upon a good key already available; I freely acknowledge the use of any and all published keys and critical observations made by my colleagues and predecessors. I am most of all indebted to my sharpest critics -- my students, who have encouraged and stimulated me to provide good keys for them rather than for my own amusement. I must thank my professional colleagues whose helpful instruction over the years, in the field and laboratory, and through correspondence, have been of great counsel. I dedicate the work to my first tutor in bryology, Dr. Henry S. Conard, who broadened my taxonomic perspective to include cryptogamic plants.

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This publication is timed to coincide with the first meeting of the International Association of Bryologists and the First International Congress of Systematic and Evolutionary Biology at Boulder, August 4-11, 1973. We are pleased to issue it in celebration of the first IAB field trip in the Colorado Rocky Mountains.

KEYS TO THE TAXA

AMBLYSTEGIACEAE

1a. Stems with abundant paraphyllia; alar cells inflated, sharply differentiated; leaf cells more or less papillose. . . . . .Cratoneuron
1b. Stems without paraphyllia; alar cells various; leaf cells smooth or nearly so . . . . . .(2)

2a. Leaves usually squarrose. . . . . .Campylium
2b. Leaves never squarrose. . . . . .(3)

3a. Leaves with a single costa extending at least to mid-leaf . . . . . .(4)
3b. Leaves lacking a costa, or the costa short and double . . . . . .(8)

4a. Leaves cordate-ovate, oblong-ovate, or oblong, never long-acuminate; margins entire . . . . . Calliergon
4b. Leaves always distinctly acuminate; margins either entire or serrulate. . . . . .(5)

5a. Leaves usually falcate (except in some submerged forms) or plicate or both. . . . . .Drepanocladus
5b. Leaves neither distinctly falcate nor plicate.(6)

6a. Costa strong, percurrent or excurrent; plants in water . . . . . .Hygroamblystegium
6b. Costa shorter; plants terrestrial or in wet places, rarely submerged. . . . . .(7)

7a. Leaves small (1-1.2 mm long); alar cells rectangular. . . . . Amblystegium
7b. Leaves larger, or if small, the alar cells otherwise . . . . . Leptodictyum

8a. Leaves and branches very small and slender, leaves up to 0.45 mm long, ovate-lanceolate, never squarrose, entire or often serrulate at the base; 2-3-celled gemmae present in the leaf axils. . . . . .Platydictya
8b. Leaves larger, or if small, then squarrose. . . . . .(9)

9a. Leaves ovate to ovate-lanceolate, acuminate, usually squarrose but sometimes merely wide-spreading. . . . . .Campylium
9b. Leaves otherwise, not tapering to a narrow apex. . . . . .(10)

10a. Leaves small or large, less than twice as long as wide, or if longer, then somewhat falcate; basal cells rarely with pitted walls; on wet rocks in or near streams..Hygrohypnum
10b. Leaves usually 2 mm or longer, commonly twice as long as wide or more, deeply concave, never falcate; walls of basal cells often pitted; not attached to rocks, but in loose gravel of snow-melt rills . . . . . .Calliergon turgescens

Amblystegium

The genus Amblystegium is often construed to include Hygroamblystegium, Platydictya, Leptodictyum and other genera. In its narrower sense, however, we have a single species in Colorado,

Amblystegium serpens (Hedw.) B.S.G. var. juratzkanum (Schimp.) Rau. et Herv. A small, undistinctive pleurocarp, usually fruiting. The leaves are about 0.6 mm long and gracefully acuminate, with costa to about mid-leaf. The median leaf cells are about 6:1 or 35u x 5-7u, smooth and moderately thick-walled. The leaf margin is slightly denticulate from projecting distal ends of the cells. The alar region is quite clearly differentiated, consisting of quadrate and broader cells forming a more or less triangular patch at the basal angles. The capsule is curved and the operculum conic, and the urn strongly constricted below the mouth.

The species is generally distributed on wet boulders, soil, bases of saplings or shrubs, exposed roots, rotten logs, etc., from the foothills up to the subalpine. It can be mistaken for small species of Campylium, especially C. hispidulum. The leaves are neither secund nor falcate, and generally do not spread very widely from the stem, slightly more when wet. Rhynchostegiella compacta may also be taken for Amblystegium serpens.

I am inclined to follow Nyholm in treating A. juratzkanum Schimp. as a variety of serpens. The variety is distinguished by having the leaves more widely spreading and with the marginal basal cells rectangular instead of quadrate.

Calliergon (see also Addendum)

1a. Leaves oblong-ovate, distinctly cucullate with rounded apex, or minutely apiculate, some leaves frequently with a tuft of rhizoids arising from the lamina just back of the leaf apex; leaves not over 1.5 mm long, the median cells thick-walled and porose; alar region a small sharply-defined group of inflated cells. . . . . .C. stramineum
1b. Leaves broadly ovate, not or only very slightly cucullate, no rhizoids from the leaves; leaves commonly over 2 mm long; median cells thin-walled, only obscurely porose; alar cells either inflated or thick-walled. . . . . .(2)

2a. Leaves golden-brown to dark red-purple or almost black. . . . . .(3)
2b. Leaves green, or only some leaves with a coppery tint. . . . . C. cordifolium

3a. Leaves lanceolate or ovate-lanceolate, tapering to the apex, not strongly convex, the costa strong and ending just below the apex; alar cells large, thin-walled; leaves and stems often very dark-colored. . . . . C. sarmentosum
3b. Leaves broadly ovate, very obtuse at the apex but abruptly mucronate with a recurved tip; costa 1/3-2/3 the length of the leaf, usually slender and unequally forked; alar cells colored, thick-walled, not well-differentiated from the other basal cells. . . . . .C. turgescens

C. cordifolium (Hedw.) Kindb. Plants of pools and lake-side swamps, upper montane and subalpine, not in the tundra. Our records are from the plateaus of western Colorado.

C. sarmentosum (Brid.) Kindb. Very common in tundra pools, where it forms floating or submerged purple-red masses along with Drepanocladus species.

C. stramineum (Brid.) Kindb. Common in very wet ground along the edges of tundra pools and in shallow water, upper subalpine and alpine.

C. turgescens (T. Jens.) Kindb. (Scorpidium turgescens). Infrequent in the tundra, forming floating or submerged mats in very wet places along snow-melt rills.

Campylium

1a. Leaves 0.5 mm long; tiny matted mosses, the branches not more than 1 mm wide . . . . . .(2)
1b. Leaves at least 1 mm long, usually longer; medium-sized loosely spreading mosses with branches 2 mm wide or more . . . . . .(3)

2a. Leaves regularly and strongly squarrose-recurved, the tips commonly pointed back toward the stem; branches neatly cylindrical; younger growth reddish-golden, the older growth becoming dark brown, contrasting strongly. . . . . C. halleri
2b. Leaves widely spreading but not so strongly or regularly recurved; younger and older growth green. . . . . .C. hispidulum

3a. Costa well-developed, reaching to beyond mid-leaf; median cells not strongly porose; alar cells well-developed but not forming large auricles. . . . . C. chrysophyllum
3b. Costa short and sometimes double, less than half the leaf-length; median cells long and narrow, thick-walled and porose; alar cells very sharply delimited, forming prominent auricles. . . . . .C. stellatum

C. chrysophyllum (Brid.) J. Lange. A species of wet rocks along streams in the foothills canyons, and also found in willow bogs in the upper montane, but nowhere very common.

C. halleri (Hedw.) Lindb. A rare subalpine species growing on rocks, our only record from the San Juan Mountains in southwestern Colorado.

C. hispidulum (Brid.) Mitt. Frequent in the lower foothills, on wood, tree bases etc.

C. stellatum (Hedw.) C. Jens. In wet ground of subalpine and alpine willow-bogs and peat-bogs. Easily recognized by the stiffly-spreading leaves with a rich russet-gold tint.

Cratoneuron

1a. Stem leaves plane or slightly concave, not plicate; central strand distinct . . C. filicinum
1b. Stem leaves distinctly plicate; central strand absent or indistinct. . . . . (2)

2a. Leaf cells of lower and central part of leaf short and broad, with a tall papilla in the upper (distal) end; cells 5-8 x 18-30 microns . . . . . C. decipiens
2b. Leaf cells elongate, narrow, thick-walled (the wall often equalling the lumen in thickness) and slightly S-shaped, (5 x 30-70 microns) smooth or with relatively indistinct papillae, mostly from the projecting end walls . . . . . .C. commutatum

C. commutatum (Hedw.) Roth. All of the species of Cratoneuron are mosses of cold running water of streamlets in the alpine and subalpine. This and the next are probably indistinguishable in the field and probably occur in similar places.

C. decipiens (DeNot.) Loeske. I am applying this name to the species commonly called C. williamsii which seems to be synonymous.

C. filicinum (Hedw.) Spruce. This species tends to be more abundant in the subalpine forests and the other two on the open tundra or in more open sites in the subalpine.

Drepanocladus

1a. Leaves strongly plicate; margin denticulate; alar cells decurrent, very variable in size and number . . . . . .D. uncinatus
1b. Leaves not or only slightly plicate; margin denticulate or entire . . . . . (2)

2a. Leaves distinctly denticulate on the upper margins, the alar cells numerous, thin-walled, large and inflated, often reaching the costa. . . . . (3)
2b. Leaves entire; alar cells numerous or few, sometimes indistinct or absent, thin-walled or incrassate, mostly not reaching the costa . . . . . .(4)

3a. Nerve long excurrent . . . . . D. trichophyllus
3b. Nerve reaching about 3/4 of the way up the leaf, rarely percurrent, never long excurrent . . . . . .D. exannulatus

4a. Leaves usually curved into a circle with the leaf tip suddenly curved the other way; alar cells few and hyaline . . . . . D. revolvens
4b. Leaves long or short, straight or mostly falcate; the alar cells numerous, more or less thin-walled, or fewer and incrassate, with age often brownish, sometimes indistinct. . . . . D. aduncus

D. aduncus (Hedw.) Warnst. An extremely variable species and very wide-ranging in altitude from the plains up to the alpine.

D. exannulatus (B.S.G.) Warnst. Abundant in tundra pools, where it forms deep beds of submerged deep green to purplish-black plants.

D. revolvens (Sm.) Warnst. A beautiful reddish-copper-colored species of alpine bogs and tundra pools, not abundant.

D. trichophyllus (Warnst.) Podpera. Infrequent or rare on swampy streamsides in the subalpine.

D. uncinatus (Hedw.) Warnst. The only species found in relatively dry sites in the montane and subalpine forests, at the bases of trees and shrubs, and up to the tundra, but not in the wetter bog-sites. The plicate leaves suggest Hypnum revolutum, and care must be exercised not to mistake the leaf folds of that species for a costa.

Hygroamblystegium

1a. Leaf apex (use well-developed older leaves) obtuse under microscope; costa green, in age green-brown; leaves usually under 1 mm long . . . . . H. fluviatile
1b. Leaf apex acute or acuminate; costa and basal cells tending to become yellowish in age; leaves larger, 1-1.5 mm long. . . . . .H. tenax

H. fluviatile (Hedw.) Loeske var. orthocladum (P. Beauv.) Crum, Steere et Anderson. I list this species very tentatively, based on a collection from near Fort Collins, because I find it very difficult to consider the alleged distinctions between this and the next valid, at least as far as Colorado material is concerned. Aquatic mosses such as this one are highly variable and I suspect that what we have here belongs to one, somewhat variable species. Nevertheless, most authors recognize H. fluviatile, as well as other minor segregates clustering around H. tenax.

H. tenax (Hedw.) Jennings. A frequently encountered species tightly attached to rocks in the lower foothill canyons. As far as I know, its altitudinal range is quite limited in Colorado to the areas near the mouths of the foothill canyons. It is a coarse, harsh moss with wiry stems and the older parts are denuded of leaves as in the larger Hygrohypnum species. The costa is extremely stout, however, and persists as a spine long after the cells of the lamina have been worn away. In Hygrohypnum the costa is never so well developed and resistant to water erosion. The stems and leaves accumulate bits of sand and crustacea, diatoms, etc., and often have a very gritty "feel."

Hygrohypnum

1a. Leaves narrowly ovate or lanceolate, often falcate or homomallous, loosely imbricate or ascending, never widely spreading; leaf margins incurved especially near the apex. . . . . .(2)
1b. Leaves broadly ovate or orbicular, standing out from the stem and characteristically slightly twisted, the lamina flat, or if curved, not on each side, hardly ever falcate or homomallous . . . . . (3)

2a. Outermost row of stem cortex cells (only section actively growing stems, not the older ones) large and hyaline, thin-walled, collapsing. . . . . H. ochraceum
2b. Outermost row of stem cortex cells small, incrassate. . . . . H. luridum

3a. Leaves orbicular, broadest at the middle, less than 2 mm long, the stems only 1-2 cm. long; autoicous. . . . . H. dilatatum
3b. Leaves broadly ovate, usually broadest below the middle, 2 mm or more long, the stems 3 cm. or more long, stiff and naked of leaves below; dioicous . . . . . .H. bestii

Hygrohypnum is found attached firmly to rocks which are inundated by water of swift-flowing streams or at least wet periodically by spray. They are often coppery in color. Species with falcate leaves might be mistaken for Drepanocladus but lack the prominent percurrent costa. Drepanocladus does not occur firmly attached to rocks. H. bestii and dilatatum might be mistaken for Calliergon turgescens but the Calliergon likewise is not firmly attached to rocks and grows in snow-melt rills (see key also).

Unfortunately we do not understand the subtleties of the microhabitats for these species or we probably could separate them quite nicely on their preferences. They probably do not occur together in the field. Taxonomically they are very difficult if one considers relationships of the species over a broader range. Quite possibly there are more species in our area than we recognize at the moment.

H. bestii (Ren. et Bryhn ex Ren.) Holz. ex Broth. Very closely related to H. dilatatum but differing in the consistently larger stems and leaves. In both species the older stems tend to become harsh in texture and more or less denuded of leaves. The dioicous character is not easily demonstrated. When fresh, the leaves stand out stiffly from the stems and are curiously twisted like rose-petals. This is true of both species.

H. dilatatum (Wils. ex Schimp.) Loeske. A common species of rocks wet by spray of cascades, particularly in the subalpine. I suspect that this and H. bestii tend not to grow in sites where they would be inundated by running water, as is true of the next two species.

H. luridum (Hedw.) Jennings. I find H. luridum and H. ochraceum difficult to distinguish without making stem sections, and of course this is impossible to do in the field. Both species have parallel green or reddish, straight or falcate-leaved, imbricate or spreading-leaved forms, and there seems to be a wide range in leaf size. There is also speculation that the outer cortical cells may be showing differences in response to environmental changes, in which case the species may not be separable. Fortunately, a monographic study is being undertaken which may shed light on this.

H. ochraceum (Turn. ex Wils.) Loeske. A very common moss on wet rocks in subalpine and alpine rivulets. See the discussion of H. luridum above.

Leptodictyum

1a. Plants commonly submerged in water; leaves entire, usually attached obliquely to the stem, the branches somewhat complanate; median leaf cells 50-100u x 5-10u (relatively long and slender) . . . . . L. riparium
1b. Plants not usually submerged but often in very wet places; leaves entire or serrulate; leaf base attached to the stem transversely (bowed out at the base), the upper part of the leaf erect-spreading and somewhat twisted; leaf cells 30-60u long x 5-6u wide (relatively short). . .L. kochii

L. kochii (B.S.G.) Warnst. Wet ditches, often in swampy ground beside roads and along meandering streams in the valleys of the western slope, associated with wet-land grasses and sedges. The taxonomy of this whole group is very complicated. We have been calling this plant L. trichopodium, but the consensus in Europe seems to be that L. trichopodium is a form of L. riparium. L. kochii has been treated as a variety of L. trichopodium but evidently is not too closely related to it. Both of these species are often included in the genus Amblystegium.

L. riparium (Hedw.) Warnst. Common in very wet places, particularly in areas where livestock or other pastoral activity is strongly evident. I have found it abundant in drinking troughs, on check-dam sluices and in relatively still water through the middle altitudes.

Platydictya

Platydictya jungermannioides (Brid.) Crum, (Amblystegiella sprucei) is rare or so inconspicuous that it is simply overlooked. The plant forms thin mats in the shaded overhangs of cliffs or large rock outcrops, usually in deep spruce-fir forests, not

far from streams. The stems are minute, much finer even than Pseudoleskeella tectorum and pale green. Under the microscope the few-celled gemmae are usually quite easily located in the leaf axils.

ANDREAEACEAE

This monotypic family is characterized by the peculiar dehiscence of the capsule, which splits into four valves with the valves remaining attached at the top and bottom, elastically constricting the capsule in the manner of a paper-lantern. The sporophyte parts are not strictly homologous to those in other mosses, so that this family forms a separate class, Andreaeobrya.

Andreaea rupestris Hedw. This is a strictly alpine species, forming black tufts, looser than those of most Grimmia species, on siliceous rocks above timberline. The tufts resemble those of Grimmia but the individual stems are very slender, totally black with a brownish tinge when wet, and the leaves lack hair-points. The leaves of A. rupestris lack a costa, so cannot be confused with the most slender of Grimmia species. Andreaea will usually be found with at least a few old capsules, but many Grimmia tufts will be examined in vain before finding Andreaea, which is a real rarity.

AULACOMNIACEAE

Aulacomnium

1a. Leaves small, mostly less than 1.5 mm long; basal leaf cells green, not distinctly different from the upper ones, unistratose; stems characteristically with a terminal pseudopodium bearing a ball-like cluster of few-celled, fusiform gemmae; habitat on rotting, often charred, wood . . . . . A. androgynum

1b. Leaves larger, 2-4 mm long; basal leaf cells yellow-brown, often enlarged, bistratose; pseudopodia when present naked or bearing relatively few green, minute but leaf-like ecostate gemmae in an erect cluster; bogs and slow streams. . . . . A. palustre

A. androgynum (Hedw.) Schwaegr. An infrequent species of a very specific habitat -- rotten, often charred, wood, on the ground on slopes in the foothills canyons, under Pseudotsuga. The stalked gemmae clusters are very characteristic.

A. palustre (Hedw.) Schwaegr. One of the most abundant mosses of wet areas, occurring in willow-bogs and peat-bogs in the upper montane and subalpine. The typical form is yellow-green, with loosely-spreading, undulate or crumpled leaf-blades and strongly brown-tomentose stems. In the alpine, however, an unusual form (var. imbricatum B.S.G.) occurs with very densely matted growth, imbricate leaves and little tomentum. This resembles the Arctic species A. turgidum, but is smaller.

BARTRAMIACEAE

1a. Leaves from a more or less clasping or sheathing differentiated and greatly enlarged basal portion, the lamina subulate (Bartramia). . . . . (5)

1b. Leaves from a non-clasping, non-sheathing, usually ovate base, the lamina subulate or broader . . . . . (2)

2a. Lamina subulate or linear; tufted or matted plants of cliff-sides, not associated with seeps, springs, or running water . . . . (3)

2b. Lamina lanceolate or ovate; branches frequently in whorls, with the spreading short branches subtending antheridial buds; plants of springs, seeps, streamsides and bogs . . . . . .(see key to) Philonotis

3a. Leaves broadly linear; stem 3-angled in cross-section; plants with erect stems, forming rounded tufts, usually fruiting. . . .Plagiopus oederiana

3b. Leaves with subulate laminae; stem 5-angled in cross-section; plants with reclining stems, matted; sterile in our area . . . . . (4)

4a. Costa very prominent, light-colored; leaves dull green, from an ovate base; upper half of leaf bistratose and opaque, the cells very strongly mammillose in cross-section; upper leaf cells quadrate to short-rectangular, the lower basal ones elongate-rectangular and hyaline; leaves not as densely arranged as in the next; on soil in talus, very rare . . . . . .Anacolia laevisphaera

4b. Costa hardly visible under dissecting microscope; leaves yellow-green, glistening, extremely attenuate and brittle, from a broader but not definitely broadened base; upper half of leaf not strongly bistratose, the cells hardly mammillose in cross-section; upper leaf cells rectangular-rhomboidal, the basal cells short, quadrate; leaves very densely arranged; on cliffs in the outer foothills . . . . . .Bartramia stricta

5a. Costa usually visible as a whitish shining line; leaves fragile, many of the upper ones with broken tips; older leaves stiff, patent, strongly marcescent and clothing the stem like the petioles of a palm tree; never with capsules in our region. . . . . .Bartramia subulata

5b. Costa not easily visible with dissecting microscope; older leaves withering and not conspicuously marcescent nor fragile; almost always fertile . . . . . .Bartramia ithyphylla

Anacolia

A. laevisphaera (Taylor) Flowers. There is one locality known for this in Colorado, and it has evidently been totally destroyed in recent years by tourist pressure, at Boulder Falls. This species represents an ancient Tertiary distribution pattern. Aside from the single Colorado record, A. laevisphaera occurs in scattered localities in Arizona and New Mexico, and goes down through the mountains of Central and South America to Juan Fernandez. In the Old World, it occurs in Ethiopia and India. Another American species, A. menziesii roughly follows the distribution of the redwood forests, with an outlier in northwest Wyoming.

Bartramia

B. ithyphylla Brid. A fairly common species of the subalpine and alpine, the only Bartramia that will be generally met with. The variety breviseta (Lindb.) Kindb. is an alpine form with a very short seta.

B. stricta Brid. Like Anacolia laevisphaera, this species is known in Colorado from a single locality in the outer foothills in Boulder County. The two are extremely similar and take careful examination and attention to the characters mentioned in the key.

B. subulata B.S.G., (B. viridissima). A rare species, this occurs on rock ledges in the foothills canyons, on north-facing cliffs. It appears to be generally distributed from Larimer to El Paso County, but is nowhere abundant.

(B. pomiformis Hedw. was listed by Grout as occurring in Colorado, but there seems to be no substantiating evidence of this.)

Philonotis

Note: The taxonomy of Philonotis is extremely complex and the characters used are at best variable and difficult to explain in words. I have not found a single treatment of them that is satisfactory. Each author gets around the problem by claiming intergradation. The following key seems to work for our material. Time will tell if it is really satisfactory.

1a. Leaves broadly ovate, strongly keeled and with a strong, reddish costa usually very papillose on the back; leaves bowed out at the base and concave above, incurved on the back and apex, remote and showing much of the stem, not very long hair-pointed; probably mostly montane and subalpine. . . . . .P. americana

1b. Leaves narrowly ovate or appearing so because of long attenuate tips, not strongly keeled, the costa usually not very papillose on the back; leaves appressed to the stem (the older shoots at least), overlapping and not exposing much of the stem, either hair-pointed or not or both types on the same stem . . . . . (2)

2a. Leaves with long excurrent costa (hair-point), but the leaves of the shorter androecial shoots below the "inflorescence" on male plants shorter, broader, and often blunt-pointed; leaves on female plants uniform; plants of alpine springs and snow-melt areas . . . . . .P. tomentella

2b. Leaves with percurrent or shortly excurrent costa, uniform even on male plants; plants of low and medium altitudes . . . P. fontana

P. americana (Dism.) Dism. The peculiar leaf arrangement resembles more that of a Bryum than a Philonotis, and it seems that the leaf color may always be more blue-green than yellow-green. Our collections are from the middle mountain altitudes, from 8000 to 9500 ft.

P. fontana (Hedw.) Brid. This is probably the only species to be found in the lowest levels of the mountains, but probably occurs together with americana at its upper limits. Field work is badly needed to settle points on ecological preference of these species.

P. tomentella Mol. in Lor. This species is probably restricted to alpine or upper subalpine situations, but is certainly the most abundant Philonotis in the region. Older treatments usually make this a subspecies or variety of P. fontana, but most authors in boreal regions now seem to agree in keeping them at the specific level.

Plagiopus

P. oederiana (Sw.) Limpr. This species forms dense and extensive sods over seeping rocks in the subalpine and lower alpine zones. As Mrs. Nyholm writes (M. Fl. Fennoscandia), "In moist, deeply shaded habitats the tufts become shorter and denser and the leaves shorter and more crowded. On dry alpine rocks forma alpinus (Schwaegr.), with smaller capsules, grows in small tufts." This form is very abundant in the upper valley of Monte Cristo Creek in Summit County below Hoosier Pass.

BRACHYTHECIACEAE

1a. Leaves concave, cucullate, rounded at the apex but then abruptly extended into a long filiform point; stems often julaceous. . . . .Cirriphyllum

1b. Leaves without the above combination of characters. . . . . (2)

2a. Leaves blunt-pointed or rounded at the apex, erect-spreading when moist, serrulate from base to apex; costa ending below the leaf apex, the terminal cell protruding from the dorsal side of the lamina as a small spine. . . . . .Eurhynchium

2b. Leaves definitely acute or acuminate; variously smooth or denticulate along the margins; costa not protruding as a dorsal spine (except in Rhynchostegium). . . . .(3)

3a. Leaves linear-lanceolate, very strongly plicate, appressed, glossy; stems with copious masses of rhizoids on the older parts; basal cells not differentiated from the median ones . . . . . Homalothecium

3b. Leaves broader, lanceolate or ovate, plane or more or less plicate, the rhizoids usually scattered and not conspicuous; basal leaf cells shorter and broader than the median cells . . (4)

4a. Stems complanate, the leaves more or less distant, never plicate; alar cells not differentiated. . . . . Rhynchostegium

4b. Stems not complanate, the leaves usually not distant, often imbricate, plane or plicate; alar cells usually differentiated . . . .(5)

5a. Small plants in deep compact cushions on moist calcareous sandstone cliffs or ledges; leaves never plicate; margin serrate, the teeth at the leaf base often double and recurved; short-cylindric gemmae commonly produced along the costa near the leaf apex. . . . . .Rhynchostegiella

5b. Medium-sized to large plants on the forest floor, soil of canyonsides, bogs or tundra; leaves plane or plicate; teeth of leaf base not as above; gemmae absent. . . . . .Brachythecium

Brachythecium
(adapted from Lawton, 1972)

1a. Stem leaves distinctly plicate in wet or dry condition; branch leaves usually plicate also.(2)

1b. Leaves not plicate or only very slightly so. .(5)

2a. Leaves distinctly falcate..B. erythrorrhizon

2b. Leaves not falcate or only slightly so. .(3)

3a. Seta rough; leaves only slightly plicate. . . . . .B. rutabulum

3b. Seta smooth; leaves strongly plicate. . . . . (4)

4a. Branches in erect tufts, somewhat julaceous, the leaves densely arranged; plants of wet tundra. . . . . .B. turgidum
4b. Branches prostrate-spreading, not julaceous; plants growing on rotten wood or forest floor . . . . . .B. salebrosum

5a. Plants small, with concave imbricate leaves and more or less julaceous branches; leaves serrulate from base to apex, more or less abruptly acuminate . . . . . B. collinum
5b. Plants not as above . . . . . (6)

6a. Stem leaves strongly concave . . . . . (7)
6b. Stem leaves not strongly concave . . . .(10)

7a. Leaves very deeply concave, ovate, not long-acuminate . . . . . (8)
7b. Leaves not very deeply concave, triangular-ovate, acuminate or acute. . . . . (9)

8a. Branches usually julaceous; plants in running water, attached to stream boulders . . . . . (Scleropodium)
8b. Branches not julaceous, the leaves not strongly overlapping; plants of mesic but not wet sites . . . . . .B. plumosum

9a. Stem leaves triangular-ovate, slenderly long-acuminate entire. . . . . B. nelsonii
9b. Stem leaves more or less abruptly acute or shortly acuminate denticulate . . . . B. rivulare

10a. Leaves strongly decurrent; seta rough throughout or smooth below. . . . B. starkei
10b. Leaves not decurrent or only moderately so . . . . . (11)

11a. Plants large; stem leaves 2-3 x 1-1.8 mm; seta rough throughout. . . . . .B. rutabulum
11b. Plants smaller; stem leaves 0.7-1.8 x 0.3-0.6 mm. . . . . .(12)

12a. Synoicous; capsule erect or nearly so; cilia of endostome absent or rudimentary; seta smooth or only weakly papillose..B. fendleri
12b. Autoicous; capsule more or less horizontal; cilia well-developed, rough or smooth . . . . . B. velutinum

Without a doubt, Brachythecium is our most difficult genus. Identification is very difficult without sporophytes, and most of our most critical species fruit rarely. At the present time we do not have enough field observations to support our notions of habitat preferences, and much intelligent observation and collecting needs to be done.

B. collinum (C.M.) B.S.G. Our most abundant species on slopes in the outer foothills where it inhabits sites that are dry except in springtime. It also occurs in optimum moss tundra and probably throughout the middle altitudes. Fortunately it fruits in the lower foothills, where it occurs with B. fendleri and is distinguished by the inclined rather than erect capsule.

B. erythrorrhizon B.S.G. Our records are scattered through the middle altitudes and upper subalpine, where it occurs on the forest floor and over rotting wood.

B. fendleri (Sull.) Jaeg. et Sauerb. Frequent in rocky canyonsides in the outer foothills. The erect capsule serves to distinguish this from the very closely related B. collinum.

B. nelsonii Grout, (B. latifolium). A beautiful species of wet ground in willow bogs and wet tundra. It is quite close to B. starkei and sterile specimens are not easy to separate.

B. plumosum (Hedw.) B.S.G. We have only one record of this, from foothills west of Fort Collins, but it might not be as rare as supposed.

B. rivulare B.S.G. An abundant species wherever there are springs and moss-lined forest brooks.

B. rutabulum (Hedw.) B.S.G. Our specimens are from scattered locations through the middle altitudes. It grows on forest floors and old wood, but it usually occurs sterile and we do not have good information on its ecology.

B. salebrosum (Web. et Mohr) B.S.G. A species of the forest floor, and sometimes in open meadow sites, in the subalpine.

B. starkei (Brid.) B.S.G. A species of moist or wet forest floors in the subalpine. More observation is needed, since we have few records.

B. turgidum (C.J. Hartm.) Kindb. Frequent in moist tundra. This is our most robust species, generally growing in almost erect clumps.

B. velutinum (Hedw.) B.S.G. In my experience, this resembles a large, loosely branched and lax-leaved B. collinum, but our collections are few and not too convincing. It occurs over rock outcrops in moist canyons from the foothills to the subalpine.

Cirriphyllum

C. cirrosum (Schwaegr. ex Schultes) Grout. This occurs in the upper subalpine and alpine zones on wet tussocks and in wet tundra. Often it occurs as scattered solitary stems mixed with other mosses, but occasionally pure stands occur as loose mats. C. brandegei (Austin) Grout does not appear to be more than an ecological modification, said to differ by a more caespitose habit, looser leaf cell areolation, and an entire rather than denticulate acumen.

Eurhynchium

E. pulchellum (Hedw.) Jennings. Typically this is very characteristic of mesic Pseudotsuga stands on moderate to steep slopes in the foothill canyons on north-facing slopes. Once recognized, it is easy to know. The leaves are short, broad, and even under a hand-lens the neatly rounded apices on the neatly spreading leaves have a very characteristic appearance shared by no other species.

Homalothecium

1a. Main stems very thickly covered with red-brown rhizoids; plants with straight branches; plants of willow and Sphagnum streamside bogs in the subalpine . . . . . H. nitens
1b. Main stems not bearing conspicuous areas of rhizoids; plants with the branches up-curved when dry, of a shining golden color; plants of vertical cliff faces in the foothills. . .H. nevadense

H. nevadense (Lesq.) Ren. & Card. One of the most beautiful mosses of our area. When moist its

large size, more or less regularly pinnate branching and burnished golden color is very attractive on cliff-sides. When dry the species has a totally different aspect, with the short lateral branches having their leaves strongly appressed and the axes curved upwards and of a distinctly golden color with little green.

H. nitens (Hedw.) H. Robinson, (Tomenthypnum nitens). One of the most common and constant components of subalpine peat bogs and willow bogs, commonly occurring in association with Sphagnum warnstorfii and Helodium blandowii. In unusually cool moist sites the species may occur in ravines along streams in the foothills down to 7,000 ft., but this is a rare situation.

Rhynchostegiella

R. compacta (C.M.) Loeske, (Amblystegium compactum). This species very much resembles Amblystegium serpens but the leaves are distinctly serrulate from base to apex, the median cells are longer and narrower (sometimes up to 10:1), the costa going well into the apex, often expanding in the apex, and stouter than in A. serpens. Fertile specimens may be distinguished from Amblystegium because the operculum has a narrowed beak in R. compacta but is conical in Amblystegium. When the characteristic gemmae are present there is no problem.

R. compacta appears to be restricted to calcareous sandstone cliffs and ledges at low altitudes. We have collections from Mesa Verde, White Rocks (Boulder) and Mount Gibson (locality?). The plant is light green, often rather densely matted and mixed with calcareous deposits, which the moss evidently is instrumental in accumulating into a travertine deposit.

Rhynchostegium

R. serrulatum (Hedw.) Jaeg. et Sauerb. We have only one small collection, from Mesa Verde National Park, where it was growing under the lip of a cliff over which water seeps intermittently. Here it was associated with Timmia. We would not expect it to occur at high altitudes, since it is essentially a southern species.

(Scleropodium obtusifolium was once reported from a fish stomach but has not been collected since.)

BRYACEAE

1a. Leaves narrowly linear-setaceous; plants usually fruiting abundantly, the capsule pendent or horizontal, pyriform with a narrow neck; common on burned ground, burned peat etc., in middle and higher altitudes. . . . . .Leptobryum pyriforme
1b. Leaves broader than linear; capsules present or lacking, of various forms . . . . . (2)

2a. Leaves silvery-white (at least most of them), giving this color to the tuft. . . . . (3)
2b. Leaves some shade of green, yellowish-brown, golden or reddish. . . . . (4)

3a. Forming dense, extensive tufts, tightly packed; leaves minute (0.3 mm), broadly ovate, acuminate, the costa not conspicuous, often disappearing in mid-leaf; cells of basal area green, rectangular; almost always sterile and common at all altitudes, often in cracks in sidewalks etc.; capsule short-cylindric without prominent neck, pendent. . . . . Bryum argenteum
3b. Occurring (with us) as scattered stems in tufts of other alpine mosses; leaves 0.5 mm (the older stem leaves up to 2 mm), broadly ovate, suddenly recurved-apiculate; costa conspicuous to the apex; all cells of leaf pale and often the basal more or less collapsed; capsule, when present, with very long neck, horizontal or inclined; very rare, only in tundra. . . . . .Plagiobryum zierii

4a. Leaves very large and translucent, 5-6 x 2-3 mm, in a rosette at the stem apex, not much changed or scarcely contorted in drying, papery in texture; leaf cells thin-walled and very large (150 x 50 microns) . . . . . .Roellia roellii
4b. Leaves smaller, usually somewhat altered in drying; leaf cells never so large . . . .(5)

5a. Plants with sporophytes . . . . . (6)
5b. Plants without sporophytes. . . . . (8)

6a. Seta stout, curved below the capsule; capsule with a distinctly oblique mouth as in Funaria; rare or infrequent plant of the tundra. . . . . Plagiobryum demissum
6b. Seta slender; capsule with the mouth perpendicular to the capsule axis . . . . . .(7)

7a. Outer peristome lacking or rudimentary; capsules pyriform, erect or inclined, not pendent; leaves minute, 0.6-0.8 mm long, without border, not altered in drying; plants forming dense tufts of very slender stems, on copper ore or tailings, or on limestone cliffs . . . . . .Mielichhoferia
7b. Outer peristome present and well-developed; capsules usually oblong and cylindric, if pyriform, then definitely pendent; leaves over 1 mm long, often bordered, usually altered in drying; plants of various substrates . . . . . (8)

8a. Median leaf cells 5:1 or longer; leaves never bordered; costa ending below the apex or percurrent, never excurrent. . . . Pohlia
8b. Median leaf cells 4:1 or often shorter and broader; if longer, then with at least one of the following characters: leaves broadly ovate, oblong, or oblong-ovate; apex obtuse to rounded; costa excurrent; leaf margins bordered by longer cells; cilia of the endostome clearly appendiculate . . . . . .Bryum

Bryum

The analysis of species of Bryum, our most difficult genus, is a complicated business. There are some few that can always be recognized by one or two striking features, but most of them are very difficult, and we still do not know them well enough to even be sure of what we have in the area. The following table of characters can be used to sort them out, and is easily translated into a punch-card key if so desired. The numbers correspond to the species number in the list below. Try the characters one at a time, noting the numbers that fit. Then take another character and see which numbers are still common to both characters. After four or five characters are chosen, very often a name will be selected as the only possibility.

Habitats:

plains, foothills, western canyons: 2, 3, 4, 5, 6, 8, 11
sandy sites, plains: 2, 3, 4, 5, 11
middle altitudes: 2, 3, 6, 8, 11
subalpine and alpine: 1, 2, 3, 7, 8, 9, 10, 11, 12
dry, packed, and disturbed sites: 3, 4, 5

floodplain, poor drainage: 8, 11
moist rocks, seepage lines: 2, 6, 11
peat bogs, willow bogs: 7, 8, 9, 10, 11, 12
snowbed, alpine tussocks: 1, 9, 10, 11

Sexuality:

fertile here (*=rarely): 1, 3*, 6, 8, 9*, 10, 11*
only vegetative here: 2, 3, 4, 5, 7, 9, 11, 12
dioicous: 2, 3, 4, 5, 6, 7, 9, 11, 12
synoicous: 1, 8, 10
autoicous: 8

Stems:

very short, branches plump, leaves near stem apex: 1, 3, 4, 5
longer, leaves spread along or distant: 2, 6, 7, 8, 9, 10, 11, 12
rhizoidal mat conspicuous on lower stems: 6, 8, 9
rhizoids inconspicuous: 1, 2, 3, 4, 5, 7, 10, 11, 12

Leaves:

not much altered in drying: 2, 3, 4, 5, 11
collapsed, twisted etc. on drying: 1, 6, 7, 8, 9, 10, 12
closely imbricate: 1, 2, 3, 4, 5, 10
more or less distant: 6, 7, 8, 9, 11, 12
distinctly decurrent: 7, 9, 12
silvery-white: 3
acuminate: 1, 3, 5, 6, 8, 10
merely acute: 2, 4, 9, 11, 12
obtuse or rounded: 4, 7, 11(juveniles especially)
minute (0.5-1.0 mm): 3, 4, 7
larger (1.5-4.0 mm): 1, 2, 5, 6, 8, 9, 10, 11, 12

Leaf details:

not or indistinctly bordered: 2, 3, 4, 5, 7, 11
distinctly bordered: 1, 6, 8, 9, 10, 11, 12
costa percurrent or ending below leaf apex: 2, 3, 4, 7, 9, 11, 12
costa excurrent: 1, 3, 5, 6, 8, 9, 10, 11
median leaf cells short, narrow (30-50 x 7-15 microns): 1, 3, 4, 8, 9
median leaf cells long, narrow (55-80 x 8-17): 2, 5
m.l.c. short, broad (35-50 x 15-25): 7, 10, 12
m.l.c. long, broad (50-80 x 20-35): 6, 11
m.l.c. thin-walled: 3, 4, 5, 6, 7, 8, 11, 12
m.l.c. incrassate: 1, 2, 9, 10

Gemmae:

gemmae present, filamentous and in leaf axils: 6, 7
gemmae present, bud-like, in leaf axils: 4
gemmae present, globular, on rhizoids: 2

Capsule:

capsule elongate: 5, 6, 8, 9, 10
capsule short and plump: 1, 3, 4, 11
capsule horizontal or inclined, not pendulous: 6
urn not shrunken under the mouth: 1, 10

Species Numbers:

1. B. algovicum
2. B. alpinum
3. B. argenteum
4. B. bicolor
5. B. caespiticium
6. B. capillare
7. B. cyclophyllum
8. B. pallescens
9. B. pseudotriquetrum
10. B. stenotrichum
11. B. turbinatum
12. B. weigelii

B. algovicum Sendtner in C.M., (B. pendulum, B. roellii, B. angustirete). Locally abundant on moister parts of the tundra. It is usually abundantly fertile and, except for this, might be overlooked because of its small size. The capsules are short, fusiform-ellipsoid (if opercula are present the capsule is pointed at each end). The seta is curved below the urn, and the peristome teeth are unique. The lamellae (divisions separated by horizontal walls) have several cross-walls which are irregularly widened; this is most easily seen from the ventral side. There has been a spate of nomenclatural changes. We are following Crundwell (1970).

B. alpinum With. This is a beautiful species, forming large soft deep turfs trending downslope on smooth, sloping surfaces of irrigated granite outcrops, from the base of the mountains to the alpine. The plants are hardly anchored to the rock but are held together by eroded gravel and sand. The plants are bright green when fresh, but when dry they become golden-brown. According to Crundwell (1964) the rhizoids always have small round gemmae attached, but this is not always easy to demonstrate, since the rhizoids are so mixed with detritus.

B. argenteum Hedw. Probably the easiest of all mosses to learn to recognize, and found in all of the continents including Antarctica. It is a weed in sidewalk cracks, lawns and gardens, but also occurs widely in naturally disturbed areas. It rarely fruits in our region, but a fruiting colony was found around the fountain area in the garden of the Hamill House, in Georgetown.

B. bicolor Dicks. This is a weed-moss. We have only a few records of it. It grows between the stones of the steps of the Univ. of Colorado Museum, and on sandy ground at the White Rocks east of Boulder. It is characterized by the very minute leaves and clusters of bulbils (gemmae with foliar tips) in the axils of the upper leaves.

B. caespiticium Hedw. Another weedy moss, fairly frequent in sandy soil on the eastern plains. It probably does not occur in the mountains.

B. capillare Hedw. A frequent moss in the foothills, characterized by the leaves with excurrent costae, distinctly twisted spirally around the stem when dry, the capsule that leans but does not usually become really pendent, and the characteristic green filamentous and papillose gemmae that are usually found in clusters in the axils of the upper leaves. B. capillare seems to prefer growing on thin soil over rock rather than on deep soils.

B. cyclophyllum (Schwaegr.) B.S.G. This is a very rare species occurring in peat bogs; our only records are from Left Hand Bog west of Ward. It is characterized by the very obtuse rounded leaves and the filamentous-branched gemmae in the leaf axils. The juvenile leaves of B. turbinatum are also small and broadly rounded, and can easily be mistaken for something exciting like B. cyclophyllum; the temptation must be resisted.

B. pallescens Schleich. This is one of the most common Brya of wet ground in the subalpine zone, especially in willow bogs.

B. pseudotriquetrum (Hedw.) Gaertn., Meyer et Scherb. A common species of wet places from the foothills to the alpine, not usually occurring in large pure stands but consisting of few scattered stems in amongst other bog mosses. It is a handsome moss, with quite large leaves somewhat decurrent on the stem. It does not seem to fruit regularly here.

B. stenotrichum C.M. This species occurs commonly in the alpine tundra, where it may replace B. pallescens on drier sites. B. biddlecomiae Austin, described from Alma, Park County, is now considered a variety of stenotrichum (Lawton, 1972).

B. turbinatum (Hedw.) Turn. A very common and often puzzling species. In the alpine, the young growth shows very small round leaves. Williams described this as a new species in another family -- Splachnobryum kieneri. The older leaves, as seen farther down the stem, are larger and of quite another shape. B. turbinatum ranges widely through the mountains from the streamsides of the outer foothills up to the tundra.

B. weigelii Spreng. A very unusual Bryum with very distant leaves, growing in springs and half-submerged in willow-bogs of the subalpine. It is always sterile, and may be mistaken for Pohlia wahlenbergii, but the leaves of B. weigelii are greatly shrunken and contorted when dry, and much more strongly decurrent.

Leptobryum

L. pyriforme (Hedw.) Wils. Frequent in disturbed soils, often on burned ground, peaty banks which have been quarried, definitely a moss of weedy tendencies, mostly found in the middle and higher altitudes.

Mielichhoferia

1a. Leaves green, appressed to the slender (up to 0.3 mm wide) stems, stems without rhizoidal mat; capsule elongate-pyriform, the operculum conical; inner peristome well-developed, papillose; plants found only on substrates containing copper. . . . . .M. mielichhoferi

1b. Leaves pale to hyaline, more or less spreading, the stems compacted together by reddish rhizoidal mat; capsule short-pyriform to subglobose, operculum flat, without a point; inner peristome much reduced and very fragile, smooth; plants of (especially limestone) cliffs, very rare. . . . . M. macrocarpa

M. macrocarpa (Hook. ex Drumm.) Br. et Schimp. ex Jaeg. et Sauerb. We have only one report of this, from cliffs in the Gunnison Basin. Probably this species should be sought in the Black Canyon of the Gunnison. Utah specimens have come from limestone cliffs.

M. mielichhoferi (Funck ex Hook.) Loeske. This is one of the "copper mosses" which are considered excellent indicators of copper ore. Our only locality is in the vicinity of Red Mountain in the San Juan Range of southwestern Colorado. General account of the copper mosses is given by Persson (1956) and Shacklette (1967) and the ecology of this species in Colorado was discussed by Hartman (1969).

Plagiobryum

1a. Capsule long, more or less horizontal; sterile branches elongate with broad, concave, imbricate leaves; plants whitish. . . . . P. zierii

1b. Capsule pyriform, inclined; sterile branches short with ovate-lanceolate, more spreading leaves; plants brownish . . . . . P. demissum

P. demissum (Hoppe et Hornsch.) Lindb. Rare or infrequent, in crevices of tundra rocks, on hummocks of solifluction lobes, in soil pockets of screes, etc., in the alpine.

P. zierii (Hedw.) Lindb. Extremely rare tundra species. Our only modern record is a small scrap from Summit Lake, Mount Evans, at 3900 meters.

Pohlia

1a. Elongate (up to 10 cm long), pale green mosses of very wet places, with reddish stems, distant, pale green, dull, ovate leaves little altered when dry and with cellular detail easily seen; always sterile here . . . . . P. wahlenbergii

1b. Low tuft-formers of wet places or dry forest soils; leaves imbricate or somewhat spreading.(2)

2a. Plants always sterile, reproducing by means of bud-like gemmae borne in the axils of the upper leaves. . . . . .(3)

2b. Plants producing capsules; gemmae absent.(5)

3a. Gemmae solitary in the leaf-axils, red-purple, with leaf-like green apical growths.P. drummondii

3b. Gemmae clustered, green, the apical outgrowths hardly foliar . . . . . (4)

4a. Leaves indistinctly denticulate at apex, more or less decurrent; gemmae variable, from slender and spirally twisted to obovoid, 220-235 microns long, with elongate, several-celled apical teeth. . . . P. camptotrachela

4b. Leaves distinctly denticulate at apex, not decurrent; gemmae uniform along the length of the stem, obovoid, 100-230 microns long, with broad triangular teeth incurved over the summit and trapping an air bubble within. . . . . P. bulbifera

5a. Inner peristome hyaline, the segments widely gaping along the median line; leaves broadly lanceolate to ovate . . . . . (6)

5b. Inner peristome yellowish, the segments entire or with a narrow slit along the median line; leaves lanceolate or narrower . . . . . (8)

6a. Leaves broadly ovate, keeled, the costa dark; cells thin-walled; inner peristome thin and fragile, often breaking off and disappearing early; new leaves clear yellowish, the older ones blackened. . . . . P. obtusifolia

6b. Leaves lanceolate; inner peristome well-developed, usually long-lasting . . . . .(7)

7a. Leaf-cells moderately thick-walled; plants more or less lustrous; abundant in forests everywhere, on duff, soil, stumps, etc.; capsule pendent. . . . . P. nutans

7b. Leaf cells long and narrow, thin-walled; plants strongly glossy, with a golden or iridescent sheen, often somewhat glaucous; capsule inclined, not strictly pendent; perichaetial leaves much longer than the normal stem leaves. . . .P. cruda

8a. Urn usually longer than the neck of the capsule; seta short, thick, more or less contorted, the capsule inclined; leaf-cells

thin-walled; basal membrane of endostome about half the height of the endostome; leaves stiffly erect, golden-lustrous; stem dark red-brown or black; wet hummocky moss tundra. . . . . .P. longicolla

8b. Neck usually longer than the urn of the capsule; seta elongate, slender, straight; capsule horizontal or inclined; leaf cells with thickened walls; basal membrane 1/3-1/4 the height of the endostome; in montane and subalpine forests, often on boulders over forest duff . . . . . .P. elongata

P. bulbifera (Warnst.) Warnst. We have only a very scanty specimen from soil on a road embankment above Eldora, in Boulder County, in the subalpine. Probably it has been generally overlooked. It is very closely related to the next species.

P. camptotrachela (Ren. et Card.) Broth. in Engl. et Prantl, (P. annotina, P. proligera). Infrequent, usually on loose bare earth around springs and along gullies in the upper subalpine. When fresh, the gemma clusters can be seen with a hand lens. I am following Wilczek and Demaret (1970) who consider the various forms of the gemmae, formerly used as distinguishing features of P. proligera and P. camptotrachela, to represent different stages of growth.

P. cruda (Hedw.) Lindb. A beautiful species, commonly growing in protected recesses of boulders, under rock overhangs, etc. The colonies are usually very loose, often only a few stems. The golden or opalescent sheen is very characteristic. Foothills to alpine.

P. drummondii (C.M.) Andrews. Infrequent and little known, probably because of its lack of obvious characters. Our collections are from the subalpine.

P. elongata Hedw. This species was listed on the basis of old reports of Rothrock, Porter, and Lesquereux and James, from "high mountains; fissures of rocks." We have a recent record from a streamside tributary of Clear Creek in the outer foothills west of Golden. The inclined or horizontal, very slender capsule with long shriveled neck and very small operculum are diagnostic.

P. longicolla (Hedw.) Lindb. A rare but characteristic species of optimum moss tundra.

P. nutans (Hedw.) Lindb. This is, with Ceratodon purpureus, the most common species of forest floors, stumps, and old wood, throughout the mountains, and until one thoroughly understands it, it will be mistaken for any number of more interesting species of Pohlia or Bryum.

P. obtusifolia (Brid.) L. Koch, (P. cucullata). The characteristic moss of snowbeds in the tundra, usually associated with Polytrichastrum alpinum. It is usually sterile and makes extensive black mats, of which only the newest leaves are green.

P. wahlenbergii (Web. et Mohr) Andrews, (P. albicans, Mniobryum wahlenbergii). Common in springs and seeping banks, usually in open sites, in the subalpine and alpine. It may be mistaken for Bryum weigelii when fresh, but the leaves of B. weigelii are very strongly long-decurrent, the leaves and stems are usually quite reddish, and the leaves are much shrunken and contorted when dry. Old reports of Pohlia ludwigii probably refer to one of these species.

Roellia

R. roellii (Broth. ex Roell) Andrews ex Crum, (Bryum sandbergii). This strikingly handsome moss occurs on the forest floor under spruces in the subalpine of Rocky Mountain Park and in Middle Park. It can be mistaken for nothing else but the large species of Rhizomnium. However, those species grow in wet places in the forest and have strongly bordered leaves without marginal teeth, contorted when dry, and the stems are clothed with rhizoids. The old report of Rhodobryum roseum (Porter, 1876) probably represents a misidentification of Roellia. Rhodobryum has the erect stems arising from horizontal underground stems, while Roellia does not.

BUXBAUMIACEAE

Represented in Colorado only by the genus Buxbaumia. These mosses are so unusual that unless one is ready for them by having seen an illustration, they will be passed over for anything but mosses. Mrs. E. G. Britton is said to have called them "The Humpbacked Elves." To A. J. Grout they "look like bugs on a stick" -- more particularly, a bedbug on a stick. The leaves are small and ephemeral and are usually gone by the time the sporophyte is visible.

1a. Capsule very broad, almost circular, flat on top, reddish-brown and glossy; cuticle of the capsule rolling back from the mouth at dehiscence . . . . . .B. aphylla

1b. Capsule narrow, subterete and elongate, green or becoming pale brown, not highly glossy; cuticle of the capsule splitting longitudinally at maturity. . . . . .B. indusiata

B. aphylla Hedw. Both of our species are very rare, and are found only in virgin spruce forests with a moist to wet and boggy floor. Both species have been found in the Gothic Natural Area, in that part of the State with the highest annual precipitation. The forest floor is laced with many seasonal run-off streamlets and with a tangle of down timber. B. aphylla occurs on mounds of clay soil probably raised by the falling of a tree and stabilized by algae and moss protonema, a very precise habitat and very locally developed.

B. indusiata Brid. This species occurs on soggy, rotting wood and seems to be somewhat more plentiful than B. aphylla.

CLIMACIACEAE

Climacium

C. dendroides (Hedw.) Web. et Mohr. An easily recognized species, being our only moss with a dendroid habit. The primary stems are creeping and embedded in the soil. Erect secondary stems are dark and clothed with appressed leaves, often brownish or pale, and branch at the top, the radiating branches suggesting the fronds of miniature palm trees. Climacium is a common moss of wet streamsides from the lower foothills on up to the subalpine. The plants are sterile in our area, since they are dioicous and only the female plants occur.

The branch leaves are ovate, strongly irregularly plicate, with a prominent costa disappearing just below the tip. The margin is coarsely serrate at the

apex, the median cells are narrowly rhomboid to linear, and the basal cells nearest the costa are thick-walled, pitted, and orange. Toward the basal margin the cells become thinner-walled, hyaline, and form a distinct area in the cordate-auriculate leaf base.

THE DICRANOID MOSSES
(DICRANACEAE, DITRICHACEAE, SELIGERIACEAE)

1a. Leaves distichous, lying in one plane when wet, with a broad sheathing base suddenly narrowed into a divergent, filiform lamina consisting mostly of the costa . . . . . Distichium (Ditri.)
1b. Leaves spirally arranged around the stem, not lying in one plane. . . . . (2)

2a. Cells of the distal half of the leaf papillose or mammillose. . . . . (3)
2b. Cells of the distal half of the leaf smooth or only slightly mammillose. . . . . (7)

3a. Papillae or mammillae low and rounded, never projecting saliently as teeth; plants forming dense mats of shaded cliffs; capsules with very short seta, the urn strongly ridged and constricted below the mouth (suggesting Orthotrichum) . . . . . .Amphidium (Dicra.)
3b. Papillae or mammillae high, sharp-pointed, directed forward and projecting from the leaf margins and back. . . . . (4)

4a. Leaf margin bistratose . . . . . (5)
4b. Leaf margin unistratose. . . . . (6)

5a. Antheridia enclosed in a bud on a short stalk just below the archegonia; extremely rare, one collection known, from outer foothills on slightly calcareous rocks . . . Cnestrum (Dicra.)
5b. Antheridia enclosed in a few perichaetial leaves, not in a stalked bud; on rocks in subalpine forests . . . . . Cynodontium polycarpum (Dicra.)

6a. Leaves broadly lanceolate; on wet rocks along alpine snow-melt streams; capsule not striate . . . . . .Dichodontium (Dicra.)
6b. Leaves narrowly lanceolate; habitat unknown but collected in the alpine or subalpine; capsule distinctly striate-ribbed . . . . . .Cynodontium gracilescens (Dicra.)

7a. Alar and basal cells sharply delimited, thick-walled, orange; leaves coppery-brown or dark green; leaf tip blunt, rounded (microscopically); costa broad, occupying most of the distal half of the leaf. . . . . Blindia (Selig., page 35)
7b. Alar and basal cells not sharply delimited, or if so, not thick-walled or orange; leaves otherwise different . . . . . (8)

8a. Alar cells not or only slightly differentiated; leaf margin recurved or plane or incurved. . . . . .(9)
8b. Alar cells differentiated (enlarged-quadrate, thin-walled), leaf margins not recurved. . . . . (16)

9a. Leaves pale bluish-green, always partly intertangled with a weft of fine white flexuous organic crystals (resembling "mold" or "cotton candy"); rare plants of the subalpine and alpine slopes. . . . . Saelania (Ditri.)
9b. Leaves never intertwined with white wefts . .(10)

10a. Cells of the distal part of the leaf mostly elongate, parenchymatous or prosenchymatous; leaves erect-spreading, flexuous. . . . . .Dicranella (Dicra.)
10b. Cells of the distal part of the leaf mostly quadrate. . . . . (11)

11a. Capsules short, strongly ribbed, on a short, curved seta and usually hidden among the leaves, mostly not fruiting at all; plants forming very compact, deep golden-brown sods on alpine slopes; very rare. . . . . Oreas (Dicra.)
11b. Capsule cylindric, on elongate seta, well exserted above the leaves, commonly fruiting; plants of various habitats . . . . . (12)

12a. Plants very short-stemmed, forming loose tufts on decaying wood and occasionally rocks in rather dry forested sites; leaves strongly crisped when dry; capsule symmetrical, erect, not strumose. . . . . .Dicranoweisia crispula (Dicra.)
12b. Plants often long-stemmed, forming compact sods on the ground. . . . . (13)

13a. Leaves broadly lanceolate; capsule strumose..(14)
13b. Leaves narrowly lanceolate or linear; capsule erect, cylindrical, not strumose. . . . . .(15)

14a. Leaves lacking a sheathing base; capsule straight but more or less horizontal, purple-brown, with a few prominent longitudinal grooves; operculum conic; plants of dry, disturbed sites (probably the most abundant weed moss everywhere in our area). . . . . Ceratodon (Ditri.)
14b. Leaves with a prominent sheathing base, the lamina abruptly spreading above it; capsule curved and inclined, furrowed when dry and empty; operculum prominently beaked; plants of bogs, dripping ledges, or wet streamsides . . . . . .Oncophorus (Dicra.)

15a. Leaves long-attenuate, the filiform distal half consisting mostly of the costa, widely spreading and tortuous, spirally twisted and serrulate; plants of wet cliff sites in the subalpine and alpine. . . . . Ditrichum flexicaule var. sterilis (Ditri.)
15b. Leaves with short distal part, never long-attenuate, the spiral twisting not conspicuous; plants forming compact sods on moist cliffs and ledges usually at lower altitudes . . . . . Ditrichum flexicaule (Ditri.)

16a. Costa narrow, thin or thick, in cross-section convex without thin-walled hyaline cells on the ventral surface; laminal cells homogeneous from the costa to the margin. . . . . .Dicranum and Orthodicranum (Dicra.)
16b. Costa broad and flat, often occupying the greater part of the leaf width; hyaline cells on one or both surfaces of the costa; laminal cells decreasing in size from the costa out to the margins. . . . . (17)

17a. Plants small, with leaves less than 3 mm long; hyaline cells present only on the ventral side of the costa . . . . . Campylopus (Dicra.)
17b. Plants robust, leaves commonly over 5 mm long; hyaline cells on both sides of the costa, enclosing central chlorophyllose cells . . . . . Paraleucobryum (Dicra.)

DICRANACEAE

Amphidium

A. lapponicum (Hedw.) Schimp. This genus has usually been placed in the Orthotrichaceae, but its affinities are probably more close with the Dicranaceae. This is a very attractive little moss, only occurring on shaded cliffs and easily recognized by the characteristic capsules which are almost always found if one looks hard enough. Amphidium is almost always likely to be found intermixed with the rare Grimmia torquata Hornsch. which has much shorter, more strongly crisped leaves.

Campylopus

C. subulatus Schimp. in Rabenh., (C. schimperi). A very rare or overlooked species of the alpine snow-melt areas, occurring on saturated soil around lakes and solifluction terraces. It is an inconspicuous and nondescript sod-former without any obvious field characters.

Cnestrum

C. schistii (Wahlenb.) Hagen, (Cynodontium schistii). A rare species, known in Colorado from a single collection in Boulder County. It should be sought on the sedimentary hog-backs of the outer foothills where it probably occurs infrequently on ledges of somewhat calcareous rock.

Cynodontium

C. gracilescens (Web. et Mohr) Schimp. Not much can be said about the ecology of this species because the only record is from "Colorado" and about a hundred years old. It should be sought in the subalpine and alpine.

C. polycarpum (Hedw.) Schimp. Our only record is a collection from the subalpine forest in Gilpin County, in crevices of rocks at 10,000 ft.

The species of Cynodontium, Cnestrum, and Dichodontium form a difficult group which may be easier understood when more observations are made on their habitats. Dichodontium, which with us had only been found sterile, might be most difficult to separate from Cynodontium gracilescens and evidently differs only in the somewhat broader leaves of Dichodontium. In fruit the striate-non-striate capsule is diagnostic. The Cynodontium species are distinguished further by the cygneous (swan-necked) seta of C. gracilescens, and the acute seta of C. polycarpum.

Dichodontium

D. pellucidum (Hedw.) Schimp. Rare, occurring on wet stones in snow-melt streams in the upper subalpine or alpine. The strongly papillose-mammillose cells of the leaves of this and Cnestrum and Cynodontium will lead students astray, since the leaf morphology strongly suggests the Pottiaceae. Hence, access to these in the key to the Pottiaceae is provided.

Dicranella

1a. Leaf margin recurved; exothecial cells with thickened longitudinal and thin transverse walls; operculum short-rostrate. . . . . .D. varia
1b. Leaf margin plane; exothecial cells with uniformly thickened walls; operculum long-rostrate.. . . . . D. subulata

D. subulata (Hedw.) Schimp. Rare or overlooked in the alpine and subalpine. A tiny, obviously dicranoid moss with very narrow subulate leaves, falcate-secund from a broader, more or less sheathing base. All of our specimens are fertile; the red seta and long-rostrate operculum are good field characters. It evidently occurs on soil in open spruce-fir forests.

D. varia (Hedw.) Schimp., (Anisothecium varium). One record, from a Salix-Betula thicket beside a peat bog at 10,000 ft. altitude in Boulder County.

Dicranoweisia

Although we have records of only one species, it is possible that in the moist forests of northern Colorado the second species, D. cirrata, may occur. The key provided by Flowers (1956) which distinguished them is given below.

1a. Margins strongly and widely recurved in many leaves; lamina smooth, unistratose except for the margins; inner perichaetial leaves with a long, more or less clasping base but scarcely convolute, the upper portion acuminate, shorter than the base. . . . . .D. cirrata
1b. Margins of the leaves plane, erect to incurved, sometimes narrowly recurved; lamina usually longitudinally striate with narrow cuticular ridges, these appearing in cross-section as minute papillae; lamina unistratose to bistratose in the distal half. . . . . D. crispula

D. crispula (Hedw.) Lindb. ex Milde. This is undoubtedly one of the most common mosses in the forested areas and occurs on decaying logs and on boulders. The old capsules persist on the tufts for a long time but lose their peristomes and become quite bleached in color. It is a relatively nondescript moss and for some reason has been often mistaken for Weissia controversa.

Dicranum and Orthodicranum

1a. Costa in cross-section lacking stereids, the guides bounded by the epidermis on each side, thus the costa not prominent dorsally; leaves not at all crispate when dry, only slightly secund or falcate; cells of the leaf margins mostly bistratose, the cells above the basal cells toward the costa enlarged and hyaline; capsule erect, straight, never strumose (Orthodicranum) . . . . . (2)
1b. Costa in cross-section with stereids on each side of the guides, the costa prominent dorsally; leaves usually crispate or strongly falcate when dry (except D. elongatum); cells of the leaf-margins mostly unistratose, the cells above the basal cells toward the costa not differentiated; capsule curved, often strumose (Dicranum) . . (3)

2a. Leaves and plant small (1 cm or less), leaves yellow-green, brittle, many of the tips broken off, the tufts slightly secund; leaf cells not pitted; usually on old wood, outer foothills . . . . . .Dicranum tauricum

2b. Plants robust, several cm. high, forming large rounded tufts; leaves deep green, straight or slightly secund, not brittle; leaf cells thick-walled and strongly pitted. . . . . Orthodicranum rhabdocarpum

3a. Distal part of the leaves with elongate, porose, prosenchymatous cells; leaf apex acute or subulate, the costa strong, in section usually with four low lamellae dorsally in the distal half; capsule without annulus of large cells. . . . . .Dicranum scoparium

3b. Distal part of the leaves with quadrate or rectangular, parenchymatous cells; costa never with dorsal lamellae; capsule with annulus of large cells . . . . . (4)

4a. Leaf cells a little thickened to incrassate and porose; leaves strongly curved when dry, narrowly involute above from a broad base, loosely or densely tufted, the stems with prominent tufts of rhizoids; forests and slopes, not in bogs . . . . . .(5)

4b. Leaf cells extremely incrassate; leaves straight, the tips only curved, narrow throughout; tufts very firm, held together by the rhizoids; subalpine and alpine bogs.. . . . . Dicranum elongatum

5a. Leaves unistratose throughout; costa in cross-section showing a surface layer of larger-lumined cells above the ventral stereids; capsule smooth, elongate and curved, not strumose. . . . . .Dicranum muehlenbeckii

5b. Leaves bistratose here and there along the margins; costa in cross-section without a ventral layer of larger-lumined cells above the stereids; capsule smooth or striate, strumose or not. . (6)

6a. Leaves strongly falcate, not undulate above; plants in loose tufts . .Dicranum fuscescens

6b. Leaves somewhat crispate or contorted but not falcate; the narrow tips slightly undulate; plants in higher, dense tufts . . . . . Dicranum acutifolium

(Dicranum)

D. acutifolium (Lindb. et Arn.) C. Jens. in Weim. A puzzling plant, standing between D. fuscescens and D. muehlenbeckii and treated by Nyholm as a variety of D. muehlenbeckii and by other authors as closer to Dicranum undulatum. Our plants are very little undulate and the leaves are much narrower than they should be in D. undulatum, and resemble mostly D. muehlenbeckii but the costa lacks the surface layer of larger-lumined cells above the stereids. We have collections made long ago by Brandegee, but the locality is not precise and the ecology unknown.

D. elongatum Schleich. ex Schwaegr. Rare, in alpine and subalpine bogs or wet moss tundra.

D. fuscescens Turn. Known in Colorado from a single collection in San Juan County. It should occur in montane and subalpine forests, but perhaps only in the San Juans is the moisture high enough to sustain it.

D. muehlenbeckii B.S.G. Frequent in forests of the middle altitudes and up into the subalpine and alpine.

D. scoparium Hedw. Common in forests of the foothills, easily recognized when typical by the strongly falcate-secund leaves as if combed in one direction. Forms with short, more or less straight leaves with broad tips and lacking strong dorsal lamellae have been placed in D. bonjeanii de Not., but this is probably only an ecological form.

(Orthodicranum)

Dicranum tauricum Sapehin , (Dicranum strictum). Infrequent in the outer foothills (Pseudotsuga), usually on decaying wood. This is undoubtedly an Orthodicranum, but the combination has not yet been proposed and I prefer not to make it herein.

O. rhabdocarpum (Sull.) Holzinger. An abundant species in the foothill canyons and especially on shaded north slopes. In fruit it is easily known by its erect straight capsules, and sterile by its dense tufts with non-falcate leaves held together by a rich development of reddish tomentum.

Oncophorus

1a. Leaf limb not sharply differentiated from the sheathing base and not diverging sharply away from it when dry; upper portion of leaf not narrowly subtubulose; leaf margin recurved in the middle; alar cells somewhat enlarged. . O. virens

1b. Leaf limb plane, not recurved in the middle; basal portion of leaf sheathing, strongly clasping the stem, the upper portion abruptly narrowed into a subtubulose limb which diverges sharply away from the sheath; alar cells not enlarged. . . . . O. wahlenbergii

O. virens (Hedw.) Brid. The species of Oncophorus are quite difficult to distinguish until one gains a broad acquaintance with each. One would suppose that two so similar species might have distinct ecological niches, but we have no information on this, only that both species occur in boggy places with permanent water sources available.

O. wahlenbergii Brid. This is one of the characteristic and abundant species of alpine and subalpine bogs and snow-melt basins. It is very variable in the height and density of the tufts. In places that dry out in summer the growth is limited and the tufts are extremely compact and the leaves small (forma compactus (Funck) B.S.G.).

Oreas

O. martiana (Hoppe et Hornsch. ex Hornsch.) Brid. This must be one of the rarest mosses in North America. It is known from North Greenland, from Lake Peters in Alaska, and from Mount Evans in Colorado. It occurs on the boggy shore of Summit Lake at 12,800 ft., and on the steep slopes above the north-facing wall of the lake. It is extremely rare although well represented locally at the Lake, and very rarely occurs in fruiting condition. It is in a protected area (National Park Service Natural Landmark) so should not be collected. Recently several additional localities have been discovered in the Indian Peaks region.

Paraleucobryum

1a. Leaf-margin serrulate; costa rough on the back; leaves strongly falcate-circinate..P. longifolium
1b. Leaf-margin smooth or with a few teeth at the apex; costa smooth; leaves straight or somewhat curved. . . . . P. enerve

P. enerve (Thed. ex C.J. Hartm.) Loeske, (Campylopus hallii). Usually a plant of moist tundra, inhabiting the most optimum wet tundra sites. We have one record from a north-facing slope in the foothills, so the species does occur in compensating environments at lower altitudes. It characteristically forms solid tufts several inches deep and very tightly compacted. The color varies from glossy pale green to greenish black. We have never found it fertile.

P. longifolium (Hedw.) Loeske. This species is ecologically the reverse of enerve, being found characteristically in the foothill canyons in cool north-facing forested slopes along with such common species as Rhytidium rugosum, Orthodicranum rhabdocarpum and Timmia. At first glance it would appear to be a Dicranum, possibly scoparium, but the Paraleucobryum is more distinctly gray-green and the costa less distinct. The leaves are also more finely attenuate than in Dicranum.

A form with the costa narrower (less than one-half the basal leaf width) is segregated by some authors as P. sauteri (B.S.G.) Loeske. A collection by E. Hall belongs here, but it is questionable whether the narrower costa is simply the natural variation of the larger species. Until more collections are available it seems best to recognize only P. longifolium.

DITRICHACEAE

Ceratodon

C. purpureus (Hedw.) Brid. Ceratodon is one of the half-dozen abundant weedy mosses in the world and no less so in Colorado. It occurs on packed earth, recently disturbed forest soils, burned areas, sidewalk cracks and neglected ground at all altitudes. It should be one of the first mosses learned by a student. When it is fruiting there is nothing that can be confused with it. The capsules are purple-brown, prominently furrowed, with a conical operculum and the urn is strumose at the base, where the capsule leaves the seta at a definite angle.

In the sterile condition Ceratodon can be mistaken for almost anything and usually is. The leaves may be broadly triangular-ovate or quite attenuate depending on conditions of soil, light and moisture. It resembles Barbula particularly, but the rather uniformly quadrate cells in the distal half of the leaf have a characteristic appearance that will be recognized with experience. Nevertheless, sterile Ceratodon is always troublesome at best.

Distichium

1a. Capsule erect, oblong-cylindric to ovoid-cylindric; spores 17-20 microns diameter . . . . . .D. capillaceum
1b. Capsule inclined, ovoid and somewhat unsymmetric; spores over 25 microns diameter . . D. inclinatum

D. capillaceum (Hedw.) B.S.G. Distichium is unique in its distichous leaf arrangement and need never be confused with any other genus. The species of Distichium, however, seem to be impossible to distinguish without fruit, and even with fruit, it takes some experience and intuition to decide whether the capsules are really straight or inclined. There does not seem to be any distinctive ecology to separate the two either. These are abundant in wet or moist situations in the subalpine and alpine, occurring in bogs, on solifluction terraces, and swampy streamsides. D. capillaceum is the common species, while D. inclinatum has been collected only a few times.

D. inclinatum (Hedw.) B.S.G. The spore size is evidently a very reliable character. Spores in most instances range from 30-45 microns and seldom down to 20. The capsule of D. inclinatum tends to be shorter and plumper than that of D. capillaceum and in most instances the leaves, which usually diverge widely from the stem in D. capillaceum, are more erect and their distichous arrangement is not so evident.

Ditrichum

D. flexicaule (Schwaegr.) Hampe. This species, as noted in the key, occurs in two very distinct forms. The plant of the foothills forms very compact mats or sods in seepage areas over rocks and has rather short leaves. It might be mistaken for Barbula acuta. Careful examination will demonstrate the characteristic spiral twisting of the distal lamina. In the subalpine and alpine zones a large lax form with very long and filiform leaves occurs in which the spiral twisting is very well marked. This is var. sterilis DeNotaris, (D. giganteum Williams).

Saelania

S. glaucescens (Hedw.) Broth. This is an example of a species which is better recognized by a metabolic byproduct than by its morphology. Saelania is a relatively nondescript plant with lanceolate leaves and an oblong-cylindric capsule as in Ditrichum or Distichium. The leaves are always a pale blue-green, which color is accentuated by a blue-gray coating on the leaves which "spins off" as a tangled weft of cobwebby material. This has been identified by Nyholm as "fine fungal or algal threads which are usually copiously entwined around the stem and leaf bases." This material, however, is not an organism but evidently biochemical. Such materials occur in the liverwort, Anthelia, and in Lethocolea. In Anthelia, at least, Dr. Siegfried Huneck has identified the threads as a diterpene compound. This very unusual phenomenon must be investigated in more detail.

ENCALYPTACEAE

One genus with vegetative appearance very much like Tortula or Desmatodon and difficult for the beginner to distinguish in the sterile condition. Fortunately, one nearly always encounters it with sporophytes and in fruit Encalypta is the easiest moss to recognize because of its unique cylindrical-mitrate calyptra with an abruptly narrowed tubular apex (resembling a sausage-balloon partially inflated). Because of the resemblance of the calyptra to some old-fashioned candle-snuffers, the plants are called "extinguisher-mosses."

Encalypta usually occurs in small tufts of a dozen or so fruiting stems in rock crevices or over poorly developed flakes of mineral soil on rock ledges or cliffs. It never forms extensive sods like Desmatodon or Tortula (E. procera may be an exception).

The basal cancellinae of the leaves are seldom as clearly differentiated as in Tortula. E. procera is the only species likely to be found without fruit most of the time, and may be separated from similar species of Tortula by its production of multicellular filamentous reddish-green papillose gemmae on the stems. The leaves of Encalypta are never strongly revolute as they are in many Tortula species.

1a. Leaves oblong-lanceolate, broadest at the middle, tapering gradually to the piliferous apex; leaf-margins plane; peristome lacking; calyptra lacerate at base but the basal cells of the teeth not differentiated. . . . . E. alpina
1b. Leaves oblong-lingulate or spatulate, or broadest at the base, the leaf apex often broad, with or without a hair-point. . . . . (2)

2a. Calyptra lacerate or fringed at the bottom; leaf-margins sometimes recurved; when sterile, recognized by production of filamentous papillose gemmae. . . . . (3)
2b. Calyptra not fringed at the base; leaf-margins very rarely recurved; if sterile and gemmiparous, the gemmae leaf-like and clustered at the top of the stem. . . . . .E. vulgaris

3a. Calyptra fringed, the teeth clearly differentiated as narrowly triangular often darker units, their bases marked by rows of small quadrate cells; capsule smooth or irregularly wrinkled; peristome single; never with gemmae . .E. ciliata
3b. Calyptra lacerate but the teeth irregular, often paler than the body, and lacking distinctive basal cells; capsule spirally ribbed; peristome double; if sterile, with filamentose multicellular gemmae. . . . . .E. procera

E. alpina Sm. Rare in the alpine tundra, our only record from Hoosier Pass.

E. ciliata Hedw. Frequent in the foothill canyons and up to the tundra, nowhere common.

E. procera Bruch. Rare or infrequent, our records coming from the San Juan Mountains. Another close relative not yet found but likely to occur is E. streptocarpa, generally occurring on calcareous rocks. It differs from E. procera in not having a central strand and never having recurved leaves. In E. procera the stem has a central strand of smaller, often collapsed, thin-walled cells, and the leaves are often recurved at mid-lamina.

E. vulgaris Hedw. Common in rock crevices in the foothills canyons and going over to bare ground in the tundra. Two varieties are recognized: var. vulgaris, with muticous leaf and absent or rudimentary peristome, and var. rhabdocarpa, with piliferous leaves and single well-developed peristome, but there are intergradations.

ENTODONTACEAE

A rather heterogeneous group of genera sharing the following characters: leaf cells elongate-linear (except for Pterigynandrum in which they are rhombic), costa short, double or lacking; alar cells often well-developed (but Orthothecium hardly shows any).

1a. Leaves very concave, rounded or obtuse at the apex. . . . . (2)
1b. Leaves flat, narrow or broad but acute or acuminate. . . . . (3)

2a. Leaves densely imbricate, the stem hardly visible; alar cells green, forming a zone of small quadrate cells near the margin; stems not very pinnate; plants of mossy tundra. . . . . .Entodon concinnus
2b. Leaves loosely imbricate, exposing the bright reddish stem; alar cells forming a well-defined small orange group of thick-walled empty cells; plants of dry subalpine forest floors . . . . . Pleurozium schreberi

3a. Leaves broadly ovate-orbicular, acute, leaf cells rhombic; large area of quadrate alar cells filling the lower part of the lamina; costa double, usually well-developed; leaves often with dorsal papillae formed by the end walls of the cells . . . . . .Pterigynandrum filiforme
3b. Leaves lanceolate, acuminate, the alar cells very inconspicuous or lacking; costa very short and double or absent; leaves never papillose; median leaf cells elongate, thick-walled and porose. . . . . .Orthothecium

Entodon

E. concinnus (DeNot.) Par. An alpine species, usually occurring mixed with other mosses in optimum moist mossy tundra sites.

Orthothecium

1a. Leaves 2 mm long, strongly plicate, triangular lanceolate, narrowed in a straight line from base to apex . . . . . O. chryseum
1b. Leaves 0.6-1.0 mm long, not plicate but merely slightly revolute or explanate, rounded to an acuminate apex. . . . . .O. diminutivum

O. chryseum (Schwaegr. ex Schultes) B.S.G. Rare at high altitudes, subalpine and alpine, along seepage lines on fixed rock exposures. Plants large, burnished golden-reddish. Might be mistaken for Homalothecium nitens, but the stems do not have the matted tomentum of that species and the color is very distinctive. Homalothecium also has a costa, although in strongly plicate leaves the costa is often difficult to distinguish from a leaf fold unless a cross-section is made.

O. diminutivum (Grout) Crum, Steere et Anderson. Very rare, subalpine, in moist rock crevices. Plants small and forming dense mats. Possibly not distinct from O. intricatum (Hartm.) B.S.G. which differs in its longer, narrower leaves. The type locality of O. diminutivum is Tolland, Gilpin County, but we have a recent collection from the San Juan Mts. Dr. Lawton identified this collection as O. strictum, but in that the leaves are not as acuminate. This species complex is evidently in need of clarification.

Pleurozium

P. schreberi (Brid.) Mitt. A large and coarse, irregularly pinnate moss of relatively dry and duff-covered forest floors, in our area locally abundant in Rocky Mountain National Park, where it forms a continuous deep cover under stands of Vaccinium scoparium in

the subalpine spruce-fir forest. The plant is easily recognized by its habit, together with its red stems, rounded cucullate leaves. Under the microscope the leaf has margins rolled under in the upper half, and the alar cells form a conspicuous group of quadrate, thick-walled, orange-brown cells. The median leaf cells are very long and narrow (70-100 x 5 microns) and porose. Leaves are 1.5-2.0 mm long.

Pterigynandrum

P. filiforme Hedw. A small, creeping moss with elongate julaceous leafy stems, hardly pinnate, and broadly ovate, acute leaves, characterized by: rhombic cells throughout, except for a large area on each alar region, of smaller quadrate cells, costa short and double but usually well-developed. The leaves are small, only 0.5 mm long, broadly orbicular-ovate, papillose dorsally by projecting cell angles. Common on cliffs in the foothills and montane canyons.

FABRONIACEAE

We have the single genus and species, Fabronia pusilla Raddi. Fabronia is the tiniest and most delicate of our pleurocarpous mosses. The creeping stems, leaves and all, are only about 0.3 mm wide when dry (to about 0.5 mm when wet). The plants can be recognized very easily under the microscope, however, because of the large teeth which project outward from the margins of the leaves. These teeth are commonly hyaline, contrasting with the green cells of the leaf-lamina. The leaf-tip is also hyaline, abruptly long-attenuate from the ovate blade, and frequently forked at the apex. This very unusual serrate or even fimbriate condition is unique among our mosses. Because of the ciliate margins and the long, slender, often colorless leaf-tips, the branches of Fabronia often appear fuzzy under the hand-lens.

Fabronia almost always grows in the innermost recesses of rock crevices of cliffs in the foothill canyons. Our collections are all from siliceous rocks. The tufts are loosely attached to the substrate, sometimes almost lying free, and they range in color from bright green to pale yellowish-green.

The species of Fabronia are differentiated by the admittedly variable characters of leaf-shape, cell-size, and especially as to whether the teeth of the leaf are composed of single cells or of several cells. All of our Colorado material is alike characteristically with leaves having mostly single-celled teeth. These teeth range from shortly triangular to long and finger-like. On most leaves one or more of the teeth near the middle of the leaf-margin are larger than the others and are composed of a pyramid of from three to five cells, the terminal one the largest. The capsule of Fabronia is goblet-shaped on a well-exserted seta; the peristome is like that of Orthotrichum. All of our Colorado collections thus far have been without capsules.

It is interesting to note under F. pusilla an ecological situation somewhat analogous to that discussed under Orthotrichum obtusifolium. F. pusilla in Colorado is found exclusively in rock crevices, while to the north and south of our area it occurs commonly on the bark of trees. I suspect that this is because our humidity is generally too low to support the plant on corticolous substrates.

FISSIDENTACEAE

The leaves of the Fissidentaceae are in two ranks, lying in a single plane and thus giving the shoot a frond-like appearance. The leaves are unique among our mosses. The lower half of the leaf has a large, single lamella extending from the costa toward the stem, forming in effect a second leaf-blade lying over and partly covering the inside half of the lamina. This smaller "half-leaf" is called the dorsal lamina. The "sheath" formed by this structure is called the "vaginant lamina."

The species of Fissidens, our only genus, are limited to wet ground, dripping cliffs, and shelving streambanks and road-cuts of wet clay. A few species even live submerged in pools and streams.

1a. Completely submerged in pools or pot-holes in sandstone stream-channels; plants slender, with long, narrow, rather distant leaves . . . . . F. fontanus
1b. Terrestrial but often in very wet places; leaves not as above, usually touching each other and forming a flat frond-like shoot . . . . . (2)

2a. Leaves wholly or in part bordered by a band of narrow elongated and colorless cells..(3)
2b. Leaves not bordered by narrower elongated cells . . . . . F. osmundoides

3a. Border mostly confined to the vaginant lamina; leaves rounded-obtuse . . . . . F. obtusifolius
3b. Border extending nearly or quite to the leaf apex on both sides; leaves acute . . . . . (4)

4a. Border confluent with the costa at the apex of most leaves. . . . . .F. bryoides
4b. Leaf border ceasing some few cells below the apex. . . . . .(5)

5a. Border of vaginant lamina edged with many small cells at the base . . . . . .F. sublimbatus
5b. Border of vaginant lamina not so edged. . . . . .F. viridulus

F. bryoides Hedw. Common on moist banks from the foothills through the subalpine. Possibly this species only occurs near rocks of granitic or siliceous type.

F. fontanus (Pyl.) Steud., (F. debilis, F. julianus). This is a very distinctive species, forming frondose tufts in pools of intermittent streams. The leaves are long and narrow, up to 3-4 mm, and except for the distichous arrangement, might be thought to resemble a small Fontinalis rather than a Fissidens. We have no Colorado record, but F. fontanus has been collected in the Canadian River Canyon in Mora County, N.M., and should be expected in the drainage of the Purgatoire or Apishapa in similar situations in south-eastern Colorado.

F. obtusifolius Wils. A species of cool moist recesses and overhangs of sandstone cliffs in the Colorado Plateaus region of southwestern Colorado.

F. osmundoides Hedw. Easily recognized by the lack of a leaf border and the crenulate margin caused by the protruding corners of the marginal cells. F. osmundoides is found only on peaty banks in the alpine and subalpine.

F. sublimbatus Grout. We do not know this species well enough in the field to understand its ecology. It occurs in the subalpine at least and probably ranges fairly widely in the higher elevations.

F. viridulus (Web. et Mohr) Wahlenb. Some authorities equate this with F. bryoides, and we do not have any evidence as to whether the two are distinct ecologically; the characteristics given in the key are somewhat equivocal to say the least.

FONTINALACEAE

The Fontinalaceae are large mosses attached to rocks in mountain streams. The leaves are tristichous (no other mosses in Colorado are tristichous) and the branching is irregularly pinnate. The sporophytes are borne on short lateral shoots and the capsule is almost hidden by the closely enveloping perichaetial leaves. The peristome of the Fontinalaceae is also unique, consisting of an outer row of 16 teeth and an inner row of 16 cilia variously united to form a cone-like trellis.

1a. Leaves without a costa, dark green to blackish, plane or keeled, not falcate-secund . .Fontinalis
1b. Leaves with a costa, always keeled and folded, reddish- or golden-brown, strongly falcate-secund . . . . . Dichelyma

Dichelyma

D. falcatum (Hedw.) Myrin. Infrequent to rare. It grows attached to stones in cold rocky streamlets on slopes in the subalpine aspen forests.

Fontinalis

1a. Leaves (examine the median cauline leaves) usually keeled or keeled and folded along the keel.. . . . . (2)
1b. Leaves usually plane. . . . . (3)

2a. Ends of leafy stems and branches conspicuously elongated, triangular-pyramidal in shape, with closely imbricate leaves, the branch clearly triangular in gross form; leaf keel straight or slightly curved, leaf apex acute, entire; perichaetial leaves apiculate . . . . . .F. neomexicana
2b. Ends of leafy stems and branches not as above; keels moderately to strongly curved (from base to apex), leaf apex obtusish to broadly obtuse; perichaetial leaves obtuse. . . . . .F. antipyretica

3a. Leaves broadly ovate-lanceolate or oval-lanceolate, 1-2.5 mm wide; margins tapering from approximate leaf-middle to the apex; apices short and broadly acuminate; leaf-bases often auriculate. . . . . .F. duriaei
3b. Leaves generally narrowly ovate-lanceolate or lanceolate, 0.5-1.75 mm wide; margins tapering from the basal fourth or half into the apex; apices long, acuminate; auricles usually not developed . . . . . .F. hypnoides

F. antipyretica Hedw. Common in the subalpine zone. In my experience it seems to prefer slow-moving water, while F. neomexicana prefers swift water. Field study is needed to determine what precise ecological distinctions there may be in the respective habitats.

F. duriaei Schimp. This species and the next also seem to prefer slow-moving water of ditches and swamps. F. duriaei and F. hypnoides are so-called "critical species" and may in fact not be distinct from each other. If one chooses to consider the complex a single species, then the older name which should be used is F. hypnoides. In her recent monograph, Winona Welch (1960) wrote: "Plants of Fontinalis hypnoides show great variation in vegetative and fruiting structures. On some plants in the same collection or in different collections, all leaves are typical of F. hypnoides. Some branch leaves on plants of F. duriaei resemble median cauline leaves of F. hypnoides. It is very important that median cauline blades of well-developed or mature plants be used for accurate determination. Occasionally it is difficult to name the species with certainty. However, plants which are distinctly F. hypnoides and those which are F. duriaei without question have leaves which are definitely different and give cause for retaining the two species."

In Colorado both species have been collected in the same localities by the same collectors on the same day, suggesting that here at least what we are dealing with is variability of a single taxon. There seems to be no evidence of separate ecologies for the two, and not enough field observation has been made in the light of Dr. Welch's notes. The F. hypnoides phenotype is the more infrequent of the two.

In Europe two species may very well be involved, since there F. duriaei has a more southerly distribution than F. hypnoides, being absent from Scandinavia but going into North Africa and Iraq, while F. hypnoides occurs widely in Scandinavia and reaches Italy but goes no farther south. Both species occur widely throughout the rest of Europe.

F. hypnoides C.J. Hartman. See discussion above.

F. neomexicana Sull. et Lesq. Common in swift-moving water of streams in the foothills and subalpine. This is the easiest of the group to recognize, since the strongly triquetrous and dense terminal shoots are usually quite evident especially in the fresh condition.

FUNARIACEAE

1a. Capsule elongate, widest at the top, asymmetric, deeply furrowed, the mouth oblique instead of perpendicular to the axis (Funaria) . . . . . (2)
1b. Capsule straight, goblet-shaped, erect, smooth, with the mouth perpendicular to the axis (Physcomitrium) . . . . . (3)

2a. Annulus present and revoluble (falling when the operculum is removed, the high vitreous thick-walled cells fanning out like flower petals; to see this, remove the operculum in a water droplet on a slide); plants with tall slender seta and large capsule 3 mm long or more. . . . . .F. hygrometrica
2b. Annulus absent; plants minute, the seta up to 6 mm high; capsule small, to 2 mm long... . . . . F. americana

3a. Seta much shorter than the capsule, the capsule deeply immersed in the perichaetium. .P. immersum
3b. Seta 1-3 mm long, usually much longer, the capsule at least emergent. . . . . (4)

4a. Annulus large and revoluble as in Funaria hygrometrica; capsule mouth bordered with about five rows of horizontally elongated cells . . . . . P. hookeri

4b. Annulus small, not revoluble, consisting of a single row of thick-walled orange cells remaining attached to the capsule; capsule mouth bordered with about 6-8 rows of horizontally elongated cells. . . . P. pyriforme

Funaria

F. americana Lindb. We have one certain record, from soil in a deep recess at the base of a calcareous sandstone boulder, in Unaweap Canyon in Delta County. An old report of "Funaria hybernica Hook." (Porter, 1876) may have referred to this species but the specimen has not been found.

F. hygrometrica Hedw. A very abundant moss of sandy soil along streams, and in burned areas in forests, where the burned wood and depressions where trees once were provide seasonally moist sites. The offset operculum is unmistakable. Hygrometrica evidently refers to the seta, which was seen to twist and untwist with changes in relative humidity.

Physcomitrium

P. hookeri Hampe, (P. coloradense E.G. Britton). Infrequent in our area and poorly represented by only a very few records. One definite report was from Twin Lakes about one hundred years ago. Physcomitrium grows in wet, sandy or silty areas on the open.

P. immersum Sull. in A. Gray. There is one old report of this from Twin Lakes in 1873, collected by Wolf and Rothrock. It was incorrectly reported then as Aphanorhegma serratum. It grows on silty ground in drying edges of lakes and streams.

P. pyriforme (Hedw.) Hampe. The only relatively common species, P. pyriforme has been found only a few times, once in a chain of beaver ponds in Routt County, and once in a sandy floodplain near Boulder. It frequently occurs in greenhouse pots, so is likely to escape into adjacent wet areas almost anywhere.

Note: Pyramidula tetragona (Brid.) Brid. was reported by Porter (1876) from "moist, sandy soil on the plains, Hall." The specimen, in the T.P. James Herbarium at Harvard is from "moist sandy soil on the Platte, E. Hall." This probably came from the Scottsbluff area of Nebraska, but the eastern tier of Colorado counties has never been explored for mosses and some of the ephemeral spring-growing species are very likely to be found here.

GRIMMIACEAE

1a. Stems with short lateral branchlets arising along its length and creating the impression of a main stem with horizontal side-branchlets; leaves with the basal cells and usually the median cells with sinuose-nodulose walls; never fruiting in our region; plants of moist or wet depressions in the subalpine or alpine . . . . . Racomitrium

1b. Stems branched more or less dichotomously, the branches all ascending together; leaves without sinuose-nodulose cells or with this character not strongly developed; most species found fruiting here; plants of various sites. . . . . .Grimmia and related genera

Grimmia and related genera (excl. Racomitrium)

1a. Leaves concave, obtuse, oblong-lanceolate, lacking hair-points; lamina unistratose throughout, margins incurved; costa narrow, ending below apex; leaf cells rather uniform, quadrate to short-rectangular with smooth thin walls throughout; rare, forming dull green tufts in icy water from melting snow-banks in the alpine region; never fruiting here . . . . . Hydrogrimmia mollis

1b. Leaves not as above, if broad then acute and/or with hair-points, or with revolute margins, and in different habitats . . . . . (2)

2a. Leaves, even when dry, widely spreading and contorted, or spirally twisted around the stem; hair-points very short or absent. .(3)

2b. Leaves never wide-spreading or crisped or spirally twisted around the stem when dry; with or without hair-points . . . . . .(4)

3a. Leaves when dry spirally twisted around the stem, the tips often coiled into a circle, erect-spreading when wet; upper leaves sometimes with a short hair-point; gemmae often present on the back of the costa of the upper leaves; rare, forming continuous sods on cliff faces, almost always associated with Amphidium. . . . . .Grimmia torquata

3b. Leaves crisped and contorted when dry, linear-lanceolate, the hair-points absent or very short; median leaf cells rectangular-quadrate, the walls often sinuose with nodular thickenings; marginal basal cells hyaline, elongated, thin-walled; in small tufts on protected overhangs of alpine fell-field boulders; rare . . . . Grimmia incurva

4a. Stems very slender, less than 0.5 mm wide, about 2 cm long, almost unbranched; leaves 1 mm long or less, the upper ones with a spinose hair-point; always sterile here, on vertical cliffs wet with seepage water. . . . . .Schistidium tenerum

4b. Stems stouter, usually more or less branched, with longer leaves. . . . . .(5)

5a. Leaves strongly papillose in cross-section; uppermost leaves with green multicellular gemmae; hair-points lacking; leaf-tips blunt; rare. . . . . Grimmia anomala

5b. Leaves not papillose, lacking gemmae; leaves with or without hair-points. . . . . (6)

6a. Leaves plane or concave, dark green or blackish, bistratose, with a long flat hair-point; costa hardly visible; plants forming very low tufts which separate into individual stems upon handling, the leaves immediately spreading upon wetting; on sandstone ledges in southern Colorado . . . . . .Grimmia laevigata

6b. Leaves not as above in all respects . . .(7)

7a. Robust, stems up to 10 cm long, in sods with the stems usually trending downslope; leaves 3-5 mm long, linear-lanceolate, elongate, revolute; lower leaf cells rectangular, with thickened sinuose walls; capsules rare, strongly longitudinally ribbed; abundant on massive granite outcrops, foothill canyons to alpine . . . . . Grimmia elatior

7b. Stems and leaves shorter (usually up to 2.5 cm); basal cells usually not sinuose-thickened; usually fertile; NOTE: this group best avoided

unless capsules are present, until one becomes familiar with them. . . . . (8)

8a. Seta shorter than the capsule, which is therefore immersed. . . . . .(9)
8b. Seta equalling or longer than the capsule, which is exserted . . . . . (15)

9a. Columella falling with the operculum; leaves revolute on one edge, bistratose distally; plants brownish or black; hair-point lacking or short; tufts small, often loose; usually on granitic rocks . . . . . .(10)
9b. Columella not deciduous; leaves plane or incurved, unistratose; plants in low dense tufts or sods, very short and often filled with soil or sand, the upper leaves at least with a distinct hair-point (except sometimes in Grimmia plagiopodia); on sedimentary rocks at low altitudes . . . .(13)

10a. At least the upper leaves with a short hair-point, acute; empty capsule short-cylindric; mostly on dry rocks . .Schistidium apocarpum
10b. Leaves lacking hair-points, blunt; empty capsule goblet-shaped or funnel-form; on moist rocks and near running water, frequently in and along streamlets in the higher mountains. . . . . (11)

11a. Leaves not keeled, the margins plane to slightly recurved, not distinctly revolute, lanceolate and somewhat falcate; lamina unistratose, or bistratose only at the extreme tip; capsule distinctly longer than broad, not tapering to the base . . . . . .Grimmia [Schistidium] occidentalis
11b. Leaves keeled, often distinctly revolute, variously shaped, unistratose or bistratose; capsule tapering to the base, short and broad . . . .(12)

12a. Leaves strongly and narrowly revolute; lamina and margin bistratose in the upper part; capsule goblet-shaped with parallel sides . . . . . Schistidium alpicola
12b. Leaves plane-margined, the lamina and margin unistratose; capsule funnelform-conical especially in age . . .Schistidium agassizii

13a. Calyptra mitrate, covering most of the capsule; capsule symmetrical, on a short, straight seta; hair-point long; leaves very broadly ovate or obovate, erose-denticulate above the middle, with long hair-point; plants green or gray-green; perichaetial leaves not conspicuously larger than the others; crevices of sandstone outcrops. . . . . Coscinodon wrightii
13b. Calyptra mitrulate, covering only the upper end of the capsule, irregularly split; leaves not erose-denticulate; hair-points developed on upper leaves but often short; plants usually brownish or black; perichaetial leaves conspicuously larger and broader than the others; on horizontal surfaces of sedimentary outcrops. . . . . .(14)

14a. Peristome well-developed, cribrose; hair-points poorly developed..Grimmia plagiopodia
14b. Peristome absent; hair-points strongly developed on perichaetial leaves. . . . . Grimmia anodon

15a. Tufts low, very dense, blackish, the leaves with plane or incurved margins, usually less than 2 mm long; capsules small, about 1 mm long . . . .(16)
15b. Tufts taller, loose, green or brownish-green; leaves usually over 2 mm long, with the margins usually revolute along one edge (except Grimmia ovalis); capsules larger, more than 1 mm long. . . . . .(18)

16a. Marginal lower leaf cells with the end walls thicker than the longitudinal walls; quadrate or short-rectangular; leaves erect and appressed when dry. . . . . (17)
16b. Marginal lower leaf cells elongate, several rows hyaline, without thicker end walls; leaves more or less spreading when dry. . . . . Grimmia donniana

17a. Cells at base of leaf nearest the costa elongate-rectangular, longer than those of the marginal rows; leaves narrowly oblong-lanceolate; stems uniformly leafy; operculum rostrate, with straight beak . . . . . Grimmia montana
17b. Cells at base of leaf nearest the costa quadrate or short-rectangular with thicker end-walls, similar to those of marginal rows; leaves ovate at base, more or less abruptly narrowed to the hair-point, often glaucous; leaves sometimes crowded at the summit of the stem; operculum rostellate or short-pointed, the beak oblique . . . . . Grimmia alpestris

18a. Leaves broad, abruptly narrowed to the broad-based hair-point; green apex of leaves distinctly rounded or even emarginate; hair-points long, making the tufts hoary-looking; calyptra mitrate or mitrulate . . . . . (19)
18b. Leaves narrow, the green apex acute and grading into the narrow-based hair-point; hair-points evident but relatively short and inconspicuous, the tufts green; calyptra cucullate . . . . . (20)

19a. Calyptra large, mitrate and longitudinally wrinkled, brownish, covering most of the capsule even when mature; capsule smooth or nearly so; seta straight; leaves not strongly keeled or folded. . . . . .Coscinodon calyptratus
19b. Calyptra mitrulate, smooth, pale yellowish, covering only the top of the capsule and falling early; capsule sharply longitudinally ridged; seta arcuate; leaves sharply keeled and folded. . . . . Grimmia pulvinata

20a. Leaf-margins plane or incurved; leaves channeled above, thickish and waxy-looking; costa broad, not terete; leaves not keeled; plants dioicous . . . . . Grimmia ovalis
20b. One or both leaf margins revolute; costa terete; leaf keeled; plants autoicous . . . . . .Grimmia affinis

Grimmia and its related genera form the largest group of mosses in our flora and the species have been notoriously difficult to identify. However, they do sort out quite well into rather distinct ecological situations, and the following list of sites, with their respective species, may help in instances where the key may be equivocal.

1. Wet gravels of snow-melt streams (plants not anchored firmly to rock): Hydrogrimmia mollis, Schistidium apocarpum var. gracilis.

2. Vertical cliff faces, granitic: G. torquata, S. tenerum, S. apocarpum.

3. Sloping rock faces, irrigated periodically, siliceous: G. elatior, G. occidentalis, S. alpicola, S. agassizii.

4. Siliceous boulders, not permanently wet by seepage: G. anomala, S. apocarpum, G. donniana, G. montana, G. alpestris, Coscinodon calyptratus, G. pulvinata, G. ovalis, G. affinis.

5. Crevices of sedimentary rocks horizontally layered: C. wrightii, G. anodon.

6. Surfaces of sedimentary rock formations: G. plagiopodia, G. anodon, G. pulvinata.

Coscinodon

C. calyptratus (Hook. ex Drumm.) C. Jens. in Kindb. Very abundant and characteristic of boulders in the outer foothills in the ponderosa pine stands. Fruiting abundantly and easily recognized in the field by the hoary aspect and large mitrate calyptra.

C. wrightii Sull. Characteristic of crevices in the horizontally-bedded sandstones of the foothills cuestas, especially on the eastern slope of the mountains. The plants are light green and somewhat resemble Crossidium, which often occurs with it, but of course do not have the lamellae of the latter.

Grimmia

G. affinis Hornsch. Replacing Coscinodon calyptratus in the middle and upper elevations in the mountains. Common in the spruce-fir zone and even up to the alpine.

G. alpestris (Web. et Mohr) Schleich. ex Nees, Hornsch. et Sturm. G. alpestris, G. montana and G. donniana form a complex of species which are too close for comfort, morphologically. We have technical characters by which we distinguish them, but ecologically they do not seem to be separated well, and there are individual collections that are terribly difficult to be certain of. Whether we really have G. donniana here is still an unresolved question. They are all small blackish Grimmia especially conspicuous on alpine rocks although they do occur at lower elevations. It would be very useful if we could demonstrate that G. alpestris and G. montana replace each other altitudinally, and this may be the case but the evidence is not yet conclusive.

G. anodon B.S.G. G. anodon and G. plagiopodia are both brownish mosses rather than green; both grow on sandstone surfaces, and the only good distinguishing feature for them are the absence and presence of a peristome, respectively. The immersed capsule and the enlarged perichaetial leaves serve to mark the group.

G. anomala Hampe, (G. hartmanii var. anomala). A very distinctive species, but since we have only a single collection, from the San Juan Mountains, we do not yet understand its ecology well enough to predict its wider occurrence.

G. donniana Sm. See notes under G. alpestris.

G. elatior Bruch ex Bals. et DeNot. This is one of the dominant and characteristic species of sloping irrigated rock outcrops in the foothill canyons. It is our largest Grimmia, but varies a good deal in its development, and is rarely fertile, hence can be troublesome until one knows it. G. elatior also occurs in the alpine so does not have an altitudinal restriction.

G. incurva Schwaegr. This is a rare species, restricted to fell fields in the alpine, where it grows mostly on the overhanging undersides of large boulders. Once recognized, it can hardly be mistaken for any other Grimmia. No other species combines the very narrow elongate leaves and loose, spreading-contorted arrangement. It rarely fruits, but we do have fruiting plants from Mount Evans.

G. laevigata (Brid.) Brid. Characteristically a plant of the warmer steppe-desert areas, this species seems to be rare and enters Colorado only in the southern part, on sedimentary rocks of the pinyon-juniper belt. The immediate response to wetting, and the very wide-spreading leaves when wet, together with the blackish color and bistratose lamina, are diagnostic.

G. montana B.S.G. See discussion under G. alpestris.

G. ovalis (Hedw.) Lindb. This species is closely related to G. affinis, and has been infrequently encountered, so we really do not understand its occurrence or its ecology. Presumably it is found on boulders in the granite areas but more field observations are needed.

G. plagiopodia Hedw. A common species on sandstones in the southwestern corner of Colorado, and locally occurring in the east at White Rocks near Boulder and probably on similar outcrops elsewhere.

G. pulvinata (Hedw.) Sm. This species is very abundant southward and in the midwest, but in Colorado we have only a few scattered collections of it, mostly from the outer foothills near Boulder, and near Hot Springs in the Steamboat Springs area.

G. torquata Hornsch. et Grev. This species can almost be recognized by its constant association with Amphidium lapponicum. There are many places where the latter grows alone, but I know of none where G. torquata occurs without Amphidium. G. torquata is very isolated in the genus. The leaves have a characteristic spiral torsion and curled tips, and the first young growth is green, but immediately back from the tip the stems and leaves become glossy black. Instead of forming hemispherical tufts, G. torquata covers the rock in a uniform sod.

Hydrogrimmia

H. mollis (B.S.G.) Loeske. Usually considered to be an extremely rare species, we have found that once the habitat is understood, one can find Hydrogrimmia throughout the alpine area of at least the Front Range. In areas of very late snow-melt the plants are submerged or at least very wet throughout the summer, but they are also found quite dry in snow-melt channels that exhaust the flow earlier. Hydrogrimmia can be confused with no other Grimmia. The real problem is to recognize it as a Grimmia-relative at all, since it has broad, flaccid leaves and does not bear fruit here.

Schistidium

S. agassizii Sull. et Lesq. in Sull. Rare and thus far only found in the foothills canyons west of Fort Collins. A very black species with slender acuminate leaves and a characteristically broad funnel-shaped capsule.

S. alpicola (Hedw.) Limpr. Common on irrigated rocks from the foothills to the alpine, commonly occurring in the company of S. apocarpum.

S. apocarpum (Hedw.) B.S.G. Very common on boulders, moist cliffs and along seep lines, very variable in size and possibly consisting of several distinctive races or "species." In the alpine region the slender variety "gracilis"occurs on moist sand and gravel of frost scars.

Grimmia [Schistidium] occidentalis Lawton. An alpine or subalpine species of wet rocks and rills in the northern part of Colorado, thus far known from Rocky Mountain National Park, but probably more widely distributed. This is a Schistidium, but I prefer not to make the combination formally herein.

S. tenerum (Zett.) Nyholm. Not uncommon on irrigated vertical cliffs in the middle altitudes. In addition to the very slender stems, the tufts have a peculiar tan-brown color which is difficult to describe but once recognized is a good diagnostic feature of an otherwise rather nondescript moss.

Racomitrium

Although most authors use the spelling Rhacomitrium, Racomitrium was the original spelling and must be maintained since it was not an error.

1a. Leaves strongly papillose with high papillae; hair-point usually present. . . . . .R. canescens
1b. Leaves smooth or with low, relatively inconspicuous papillae; hair-point absent in all of our material. . . . . (2)

2a. Leaf margin (make section) unistratose throughout; upper leaf-cells short-rectangular or isodiametric . . . . . R. sudeticum
2b. Leaf margin bistratose in the upper part of the leaf; upper (distal) leaf-cells three times as long as wide or longer . . . . . R. fasciculare

R. canescens (Hedw.) Brid. The genus Racomitrium has to be regarded as rare in Colorado. It requires more mesic conditions on well-drained ground than is found in this continental climate. R. canescens is the most frequently encountered species, occurring inconspicuously in the alpine tundra and in open subalpine sites. In all, we have only about three collections of this, and one each of the other species.

R. fasciculare (Hedw.) Brid. Our single record is from the south slope above Summit Lake on Mount Evans at 13,000 feet.

R. sudeticum (Funck) B.S.G. The single record is from the west side of the Continental Divide in the Indian Peaks area, at Mt. Achonee Lake, 11,500 ft. alt.

HEDWIGIACEAE

We have one genus and species, Hedwigia ciliata (Hedw.) P. Beauv. Hedwigia is one of the most easily recognized of all mosses and should be found by every beginning bryologist. It occurs exclusively on siliceous rocks. The stems are in sprawling tufts, the leaves are dull gray-green to blackish, closely imbricate when dry, thick and opaque, ecostate, and are tipped with a broad hyaline point. The white tip varies considerably from one population to another. Microscopically the leaf cells have papillae ranging from short, squat ones to tall, branched ones. The capsules are almost sessile, short with a flat operculum and terminal on the branchlets. The perichaetial leaves are elongate, with the margin ciliate from hyaline projections. Antheridia occur in axillary bud-like branches. The species is abundant in the the mountains from the foothills to the subalpine.

Beginners may not recognize the plant when wet if they have seen it only in the dry state, for when moistened it expands dramatically to produce a bright yellow-green tuft with widely spreading leaves.

HYLOCOMIACEAE

Hylocomium

Large, stiff, pinnate plants; characteristic paraphyllia present, consisting of 1-2 rows of narrow, elongate cells, branching widely. In well developed plants, H. splendens is immediately recognized by its beautifully bipinnate stems, with the new branches arising from the back of the old and arching upwards in a stair-step fashion.

1a. Stem usually regularly 2-3-pinnate; leaves only slightly plicate, the branch leaves much smaller than the stem leaves (an alpine form has stems only once-pinnate, resembling Pleurozium schreberi). . . . . .H. splendens
1b. Stem irregularly once-pinnate; leaves deeply plicate, the branch leaves narrower and more acuminate than the stem leaves but not much smaller. . . . . H. pyrenaicum

H. splendens (Hedw.) B.S.G. One of the most abundant mosses of forest floors in the boreal forests. In Colorado, however, conditions tend to be too dry and the species is restricted to the most optimum moist subalpine forest areas. Sometimes occurring in deep mats along cascades, it also occurs under spruce-fir forming dense cover along with Pleurozium schreberi. The dwarf matted alpine form occurs at 13,000 ft. on Mount Evans (var. alpinum Kindb. or var. alaskanum (Lesq. et James) C. Jens.).

H. pyrenaicum (Spruce) Lindb. More restricted in its occurrence, having been found only along cascades in Rocky Mountain National Park although it is locally abundant where it occurs.

HYPNACEAE

1a. Leaves straight or slightly curved, pointing upward, away from the ground, the stems and branches short, firmly attached to the substrate; capsules freely produced. . . . . (2)
1b. Leaves more or less curved, sometimes falcate or circinate (if the leaves are more or less straight, then the plants have elongate stems loosely attached to the substrate and not pointing upwards); relatively common fruit-producers . . . . . .Hypnum

2a. Capsules erect and straight; leaves ovate-lanceolate, long-acuminate, plane or slightly concave, the margins not distinctly recurved; alar cells forming a relatively small triangular area of pale or clear

cells; leaf margins usually somewhat denticulate above. . . . . .Pylaisiella

2b. Capsules curved below the mouth; leaves broadly ovate, short-acuminate, very concave, with the margins flared and recurved; alar cells numerous, quadrate, green, the group extending far up the margins; leaf margins always entire . . . . . .Homomallium

Homomallium

H. adnatum (Hedw.) Broth. Infrequent but probably not rare where it occurs, on sandstone ledges in the Mesa de Maya region of southeastern Colorado. In addition to the characteristics mentioned in the key, the plants usually have a brown tinge whereas Pylaisiella is usually clear green. In most parts of its range H. adnatum occurs on trees, but here and in other parts of the Middle West it may occur on sandstone.

Hypnum

1a. Stem with a rind consisting of several layers of small, dark, thick-walled cells; alar cells usually very numerous, quadrate and green, or some of the lower ones larger; plants of relatively dry sites, on rocks or on the ground, or on moist edges of streams mostly in the foothills, never in bogs . . . . . (2)

1b. Stem with an outer layer of large, thin-walled cells (hyalodermis) outside the rind of incrassate cells, these sometimes collapsed and sloughed away, in which case the incrassate layer, with remnants of the walls of the hyalodermis, appears ragged or dentate; alar cells few, or if more numerous, then mostly large and inflated; plants of subalpine bogs, never in the foothills . . . . . (4)

2a. Leaf margin recurved or revolute almost its entire length; ubiquitous moss especially on rocks throughout the forested zone. . . . . H. revolutum

2b. Leaf margin plane, or slightly recurved only in the lower part; leaves very smooth and concave, with a glossy shell-like texture... . . . . .(3)

3a. Median leaf cells short and broad (25-35-40 u long X 5-6 u wide), the alar cells very numerous, quadrate, green, homogeneous, the lower ones not conspicuously larger; leaves short and very concave, broad and relatively short, forming neat cylindric shoots usually with a good deal of brown color . . . . . H. vaucheri

3a. Median leaf cells longer (50-100 u long), the alar cells very numerous, the upper ones quadrate and green, often compressed, the lower ones larger, pale, almost inflated; leaves long, concave or almost flat and ribbon-like, with a long tapered apex, forming coarser shoots, the leaves ranging from distinctly curved to almost straight, usually of a clear pale green color . . . . . .H. cupressiforme

4a. Alar cells several (2-3 vertical and horizontal rows), inflated, hyaline or yellowish; plants green, often in erect clumps, not conspicuously complanate; abundant in subalpine bogs . . . . . .H. lindbergii

4b. Alar cells few (one basal row) not very differentiated; plants with reddish tints, the stems flattened and the leaves strongly complanate; rare in subalpine bogs. . . . . .H. pratense

H. cupressiforme Hedw. A very common species throughout the mountains, often growing nearby H. revolutum but in slightly more mesic sites, along bases of boulders where there is often a slight seepage, and along stream-banks. It is easily recognized when large and with its characteristic pellucid shell-like leaves, but develops curious slender forms in which the leaves are hardly falcate (var. resupinatum [Wils.] Schimp.).

H. lindbergii Mitt. An abundant species in subalpine bogs; the colonies are usually dense, with elongate, almost erect stems.

H. pratense Koch in Brid. Rare or infrequent in subalpine willow bogs.

H. revolutum (Mitt.) Lindb. Probably the most abundant and conspicuous pleurocarpous moss throughout the forested area, from the lower foothills up to the alpine. Typically it covers boulders with a smooth shiny green carpet of beautifully "braided" stems. It tolerates considerable drought, probably getting only a little melted snow-water and intermittent wetting from rain.

H. vaucheri Lesq. A close relative of H. cupressiforme but possibly recognizable in the field by the short and very concave leaves, forming neat cylindric shoots usually with a good deal of brown color. Frequent in the outer foothills and mesas, particularly on sedimentary rocks.

Pylaisiella

P. polyantha (Hedw.) Grout. Infrequent in the foothill canyons, usually at the base of tree-trunks.

LESKEACEAE

1a. Leaf cells irregularly rounded and short, with a large papilla in the center of the lumen. . . (2)

1b. Leaf cells variable in shape, without papillae or if papillose then the papillae formed by the projecting cell ends . . . . . (3)

2a. Leaves biplicate, otherwise not very concave; stems with many simple unbranched paraphyllia 2-3-cells wide; leaves erect-spreading when moist; bud-like gemmae absent. . . . . Lescuraea patens

2b. Leaves plane, concave; stems with few if any paraphyllia; leaves widely spreading or squarrose when moist; bud-like gemmae present, consisting of minute papillose leaf-clusters. . . . . Lindbergia brachyptera

3a. Stems with paraphyllia; leaves irregularly plicate; papillae usually present, formed by the projecting cell ends. . . . . Lescuraea

3b. Stems lacking paraphyllia; leaves concave, not plicate but with the margins broadly and abruptly flared outward, suggesting a slight fold on each side of the leaf; papillae lacking. . . . . (4)

4a. Nerve single and stout, extending into the leaf acumen; plants often with crowded buds of gemmiform bulbils in the upper leaf axils . . . . . .Leskeella nervosa

4b. Nerve lacking or short or double, or simply represented by some more elongate cells than those adjacent. . . Pseudoleskeella tectorum

Lescuraea

1a. Leaf cells with a single high papilla over the lumen, on both sides; leaf cells small (about 10 μ), irregularly rounded or almost isodiametric. . . . . L. patens

1b. Leaf cells with small papillae, often not easily distinguished, formed by the projecting ends of the cells, or papillae lacking; leaf cells larger, elongate . . . . . (2)

2a. Alar cells of stem leaves in part quadrate and in part transversely elongate; median leaf cells mostly 12-20 μ long, if longer then the walls very thick and shorter cells intermingled. . . . . L. incurvata

2b. Alar cells of stem leaves quadrate; median cells of stem leaves commonly longer than 20 μ, often 30-40 μ long; if shorter, then the walls not conspicuously thickened . . . . . .L. radicosa

L. incurvata (Hedw.) Lawton, (Pseudoleskea incurvata). On boulders in the forests, from foothills to subalpine. The distinction between L. incurvata and L. radicosa is not always easy and should always be done by measurement of the median leaf cells.

L. patens (Lindb.) Arn. et C. Jens. We have relatively few collections of this and do not understand its ecology. It has been found on moist rocks along subalpine rills near timberline.

L. radicosa (Mitt.) Moenk., (Pseudoleskea radicosa). This species seems to be intolerant of the drier conditions of the lower forested slopes and so far has been found only in the subalpine zone. L. radicosa may be recognized in the field by its somewhat larger size and more spreading leaf-tips. Both species may be separated from Leskeella and Pseudoleskeella by the light green younger leaves and the older coppery-reddish ones, but this takes considerable experience with the group.

In Colorado, two named varieties of L. radicosa occur, which differ from the species proper by having the leaves merely acute rather than long-acuminate, and with the apical leaf cells short (less than 30 μ). These may be local environmental responses. In var. pallida (Best) Lawton the branch leaves are strongly concave at the apex and the leaves are a clear light green. In var. compacta (Best) Lawton the branch leaves are not strongly concave at the apex and the leaves are darker green to brownish.

Leskeella

L. nervosa (Brid.) Loeske, (Leskea nervosa). A very wide-ranging species occurring on rocks along streams from the outer foothills at 1600 m. up to 3600 m. in the alpine. It is larger than Pseudoleskeella with which it often grows, has longer tapered leaf apices, and the costa is stronger, going into the narrowed acumen. Leskeella is intermediate in size between Pseudoleskeella and Lescuraea. In early spring the clusters of bulb-like branchlets that behave as gemmae are often conspicuous. Lindbergia also has these but in that genus the conspicuous papillae on the cells are distinctive.

Lindbergia

L. brachyptera (Mitt.) Kindb. var. austinii (Sull.) Grout. At the present time there is only one collection, from granite rocks in the upper part of Phantom Canyon in Fremont County. See the key for distinctions between this and Lescuraea patens, with which it might be confused.

Pseudoleskeella

P. tectorum (Funck ex Brid.) Kindb. ex Broth., (Leskea tectorum, Leskeella tectorum). This is the smallest and probably the most common plant in the family, occurring on fairly dry sites in forests, often covering large areas of boulder faces. Its extremely small size and its short, broad leaves usually strongly incurved toward the stem (catenulate) are good field characters. The leaf cells, under the microscope, are large, chlorophyllose and peculiarly clear and smooth in aspect. There is a great deal of variation in the length of the costa and the narrowness of the acumen.

MEESIACEAE

The Meesiaceae are rather rare bog-mosses with tall slender seta bearing an erect but curved sporangium upon a narrowed elongate neck. The plants are usually turf-forming, with brown tomentum on the stems. The distinguishing features are chiefly in the leaf characters. The leaves are prominently costate, with the costa ending just below the apex. We have two genera, Amblyodon and Meesia.

1a. Leaf-margins plane; leaves lanceolate or broader, acute, the cells large, thin-walled, visible under the hand lens; capsule pale olive-brown . . . . . Amblyodon dealbatus

1b. Leaf-margins revolute; leaves linear-lanceolate, the apex lingulate; leaf-cells small, thick-walled, not distinguishable with the lens; capsule pale when young, reddish-brown and quite dark when old and empty . . . . .Meesia uliginosa

Amblyodon

A. dealbatus (Hedw.) B.S.G. This is a monotypic genus. In Colorado we know it from only a few collections, in bogs in the subalpine. It often occurs on the sides of peaty hummocks at the bases of willows, usually not close to rapidly-flowing water. Because of the relatively large leaves with loose areolation, and the strongly curved capsule, Amblyodon will at first glance be mistaken for some sort of Funaria, but on examination, the mouth of the capsule is not really oblique, and is perpendicular at least to the distal portion of the capsule.

Meesia

M. uliginosa Hedw. After one has learned to recognize Meesia by the peculiarly shaped capsule and elongate, slender seta, it is quite easy to recognize the sterile plant by the leaves. They are narrowly oblong, with a disproportionately broad and prominent dorsally convex costa. The lamina is hardly wider than the costa and much thinner. The leaf apex is blunt and the leaves themselves have a metallic sheen. M. uliginosa is probably quite frequent along streamsides of bogs in the alpine and subalpine zones although it is rarely collected since it may fruit infrequently and the plants are easily overlooked if sterile.

MNIACEAE

1a. Leaves entire, rounded or emarginate at apex, costa usually not quite reaching the apex; stems conspicuously clothed with reddish-brown rhizoids (Rhizomnium). . . . . (2)

1b. Leaves serrate or denticulate, often pointed; costa usually reaching the apex (if leaves apparently entire, then leaves less than 2 mm long). . . . . (3)

2a. Leaves 4-8 x 3-6 mm; dioicous; capsule 2.4-4.0 mm; peristome tooth with 25-42 horizontal lamellae. . . . . Rhizomnium magnifolium

2b. Leaves 3-7 x 2.5-5.0 mm; synoicous; capsule 1.4-3.0 mm; peristome tooth with 12-18 horizontal lamellae. .Rhizomnium pseudopunctatum

3a. Leaves small, (1.0-1.5 mm long), elliptic-ovate, the border weak, of only one or two rows of cells, the teeth nearly obsolete; dioicous. . . . . Mnium blyttii

3b. Leaves larger (up to 4 mm or more long), variously shaped, the border strong; margin distinctly toothed . . . . . (4)

4a. Teeth usually double; leaf margin bi- to multi-stratose; leaves decurrent; stems usually all erect in tufts (Mnium) . . . . .(5)

4b. Teeth single; leaf margin unistratose; leaves may or may not be decurrent; stems with erect fertile shoots and arching or trailing complanate sterile shoots rooting by rhizoids (Plagiomnium) . . . . . .(9)

5a. Median leaf cells large, longer than wide, uniformly incrassate and pitted, 20-45 μ long, forming diagonal rows . . . . . (6)

5b. Median leaf cells small, more or less isodiametric, 20-25 μ long, not forming distinct rows.. . . . . (7)

6a. Leaves large (4 x 2 mm), very broadly elliptic or obovate, strongly narrowly decurrent; very rare species, known from only a few alpine collections. . . . . Mnium spinosum

6b. Leaves small (2 x 1 mm), elliptic or narrowly elliptic, weakly decurrent; common species from foothills to alpine. . . . . Mnium arizonicum

7a. Leaf border terete, with a group of inner stereid cells; cell walls not thickened at the corners; teeth very prominent; leaves not distinctly spiral-ascending around the stem when dry . . . . . .Mnium spinulosum

7b. Leaf border less stout, without inner stereid cells; cell walls with thickened corners; teeth variable; leaves often distinctly spiral-ascending around the stem when dry. . . . . (8)

8a. Synoicous; costa never toothed on the back near the apex . . . . . Mnium marginatum

8b. Dioicous; male plants with conspicuous antheridial heads; costa frequently toothed on the back near the apex . .Mnium thomsonii

9a. Leaves obovate-elliptic, toothed on the upper half of the leaf only; leaf cells mostly rounded-hexagonal, small (up to 30-35μ) . . . . . Plagiomnium cuspidatum

9b. Leaves elliptic or elliptic-oblong, teeth present down to near the base; leaf cells hexagonal, often elongated, large (40-80μ) . . . . . .(10)

10a. Leaf apex mucronate, the leaf cells clearly elongated; teeth of border blunt, with 1-3 (-4) cells. . . . . .Plagiomnium ciliare

10b. Leaf apex acutish, median leaf cells slightly elongated or isodiametric; teeth sharp, with 1-2 cells . . . . . (11)

11a. Leaves with broad and long decurrent bases; teeth at leaf border 35-100 μ long; trailing stems richly brown-rhizoidal; plants of streamsides in ravines, mostly in the foothills. . . . . .Plagiomnium medium

11b. Leaves not decurrent; teeth at leaf border 12-40μ long; not always conspicuously rhizoid-forming; plants of willow streamsides and bogs, subalpine and lower alpine. . . . . .Plagiomnium ellipticum

Mnium

M. arizonicum Amann, (M. saximontanum Bowers). Probably one of the most frequent species throughout the mountains, with the widest altitudinal range. It is endemic to Western North America.

M. blyttii B.S.G. Common in alpine and subalpine moist grounds. Doubtful specimens are easily distinguished by the following chemical test: heat a leaf with alcohol to destroy the chlorophyll, then add a drop of KOH. The leaf should turn blue-green.

M. marginatum (With.) Brid. ex P. Beauv. Also quite common and widely distributed altitudinally. Unfortunately, certain determination is difficult unless one can be certain of the sexuality.

M. spinosum (Voit) Schwaegr. A very rare Arctic-Alpine species found thus far only once, at Summit Lake on Mount Evans. The large size, about double that of M. arizonicum, is diagnostic.

M. spinulosum B.S.G. An infrequent species representing the Eastern Deciduous forest distribution pattern. It has been found in several places in Boulder County, from the foothills to alpine. The very stout, internally reinforced leaf margin seems to keep the leaves relatively uncontorted when dry, in comparison with the leaves of M. arizonicum and M. thomsonii. Instead of being spirally twisted around the stem, the leaves of M. spinulosum tend to arch over the stem.

M. thomsonii Schimp. Common throughout the area from the foothills through the subalpine but probably not as abundant as M. arizonicum.

Plagiomnium

P. ciliare (C.M.) Kop. An Eastern North American species occurring rarely in the outer foothills of the Front Range. It has been found only once, near Pikes Peak.

P. cuspidatum (Hedw.) Kop. The most abundant representative of the genus, found throughout the foothills and montane on moist forest floors. It does not seem to be as moisture-requiring as either P. medium or P. ellipticum.

P. ellipticum (Brid.) Kop., (M. rugicum). Frequent in bogs and willow swamps, beaver-dams and similar still-water wet places in the subalpine, never very conspicuous because it tends to occur in mixture with other semiaquatic mosses.

P. medium (B.S.G.) Kop. Most abundant in the foothills, where it commonly occurs in wet leaf-mold and over rotting twigs in the bottoms of ravines in deep shade. It is a handsome species with large leaves and long arching sterile stems covered with red-brown rhizoidal tomentum.

Rhizomnium

R. magnifolium (Horikawa) Kop., (M. punctatum var. elatum of American authors, R. perssonii). A magnificent moss characteristic of the most mesic and often virgin spruce-fir forests of the interior parks and valleys. It and R. punctatum are very similar. Koponen (1968) discusses them as follows: "R. pseudopunctatum shares the leaf and rhizoid characters of R. magnifolium. However, the leaves are shorter in R. pseudopunctatum and in most cases also more definitely obovate or more broadly elliptic than in R. magnifolium, in which they may even be oblong. The shape of the marginal cells at the apex differs in being often quadrate or shortly rectangular in R. pseudopunctatum but elongated and rectangular in R. magnifolium."

R. pseudopunctatum (Br. et Sch.) Kop. Evidently occurs in similar habitats, but not enough field observations have been made to know how the requirements of each differ. Both are evidently restricted to the subalpine forested zone.

NECKERACEAE

1a. Leaves transversely undulate; stems complanate, not circinately curled when dry . . . . . (2)
1b. Leaves not transversely undulate; stems not complanate, strongly circinately curled when dry . . . . . .Leptodon smithii

2a. Costa lacking or very short and faint . .(3)
2b. Costa reaching the middle of the leaf or beyond. . . . . .Metaneckera menziesii

3a. Leaves entire or slightly denticulate above . . . . . Neckera pennata
3b. Leaves with numerous very slender sharp teeth in the apical part . . . . . Neckera douglasii

Leptodon

L. smithii (Hedw.) Web. et Mohr. It is known from a single station in Clear Creek Canyon, where it grows on cliffs of calcareous schist. The occurrence of Leptodon smithii is one of the most extraordinary in America, since this is a species with a widely disjunct distribution including the Mediterranean region, South and Central Africa, southern South America and eastern Australia and New Zealand. It belongs to the Tertiary Relict element of the Southern Rocky Mountain flora.

Metaneckera

M. menziesii (Hook. in Drumm.) Steere, (Neckera menziesii Hooker in Drummond). This species has not been reported for Colorado but should be present, since it has been collected in the Black Hills of South Dakota and in the Salt Lake City area. It may occur on rocks or tree trunks, and should be sought in Routt County, where many northern Rocky Mountain species occur, or in protected moist canyons of the western slope.

Neckera

N. douglasii Hook. This species is reported by Grout, M.F.N.A. without reference to specimens, but I have seen a specimen (NY) from "wet rocks, Colorado, Brandegee" with additional data "hab. ground, Colorado, Mrs. Spence." Brandegee's collections were collected "within 100 miles of Canyon City," and while this species is a distinctly Pacific Coast type, rarely collected east of the Cascades, it is unlikely that Brandegee's collections were not collected where he says they were. There is, of course, always the possibility of errors in transposition of data. In this case the label is transcribed, from the herbarium of E.A. Rau.

N. pennata Hedw. Frequent in deep shaded crevices of rock outcrops and ledges of granitic rocks, ranging widely in altitude from the lower foothills at 7,000 ft. to suitable sites in the subalpine to 10,000 ft.

ORTHOTRICHACEAE

Orthotrichum

Note: Do not expect to be able to identify material lacking capsules. Most of the critical characters are in the capsules, peristome and calyptra. On a strictly local basis it is possible to learn with experience to recognize the species after one has a thorough understanding of them but many are almost identical vegetatively.

1a. Upper leaves with long serrate hair-points as in Grimmia; rarely fruiting; on oak and juniper in southwestern Colorado . . . . . .O. diaphanum
1b. Leaves lacking hyaline hair-points. . . . . (2)

2a. Leaf-margins plane and involute throughout; lamina with many gemmae scattered on the ventral surface; minute plants with immersed capsules; on Populus tremuloides at high altitudes in southwestern Colorado. . . . . .O. obtusifolium
2b. Leaf-margins revolute for at least a portion of their length; larger plants on rocks or on broad-leaf trees or conifers . . . . .(3)

3a. Stomata superficial (the accessory cells on the same plane with the guard cells); basal leaf cells elongate, more or less thick-walled and nodose. . . . . (4)
3b. Stomates immersed (the guard cells situated below the accessory cells, whose margins usually conspicuously overlap and hide them, except in O. pallens in which the overlap is very slight); basal leaf cells rectangular, thin-walled and not nodose. . . . . (6)

4a. Capsules cylindric, fully exserted; endostome rudimentary or lacking. .O. laevigatum
4b. Capsule usually oblong and emergent, if cylindric then distinctly 8-ribbed and endostome well-developed. . . . . .(5)

5a. Capsule oblong, smooth or only faintly ribbed; exostome teeth erect or somewhat spreading; endostome never present . . . . . O. rupestre
5b. Capsule cylindric, ribbed the entire length; exostome teeth reflexed; endostome often present . . . . . O. affine

6a. Exostome teeth erect or spreading, striate, reticulate or papillose-striate; endostome

absent; preperistome usually present; leaves at least partially bistratose; capsule with 8 or 16 ribs; calyptra with papillose hairs; on rocks. . . . . .(7)

6b. Exostome teeth reflexed or recurved, papillose, rarely striate at the tips; endostome usually present; preperistome absent; leaves unistratose; capsules smooth or 8-ribbed; calyptra naked or with smooth hairs (except O. alpestre); on trees or rocks . . . . (10)

7a. Capsules fully exserted, cylindrical with a twisted seta, usually with 8 long and 8 short ribs; leaves unistratose. . . . . O. anomalum

7b. Capsules immersed or emergent, rarely shortly exserted, ovate or oblong, usually with 8 or 16 more or less uniform ribs; leaves unistratose or bistratose. . . . . (8)

8a. Capsules short and broad (ovate, goblet-shaped), with 16 ribs, immersed or slightly emergent; leaves ovate-lanceolate, acute, unistratose or rarely with bistratose streaks . . . . . O. cupulatum

8b. Capsules with 8 ribs, more or less emergent, oblong or oblong-ovate; leaves lanceolate to ligulate, obtuse or blunt, bistratose or unistratose . . . . . .(9)

9a. Leaves bistratose or partially bistratose, green, lanceolate, obtuse, loosely appressed, not incurved when dry; papillae small and conical; exostome teeth usually 8. . . . . O. hallii

9b. Leaves unistratose, usually thick and glaucous, ligulate, blunt, stiff, incurved when dry; papillae large, 2-3-forked; exostome teeth about 16. . . . . O. jamesianum

10a. Accessory cells of the stomata thin-walled, with very little overlapping of the margins over the guard cells. . . . . O. pallens

10b. Accessory cells of the stomata with the protruding walls thick, usually overlapping the guard cells conspicuously . . . . . (11)

11a. Exostome teeth with striate-reticulate ornamentation in the upper portion; calyptra with strongly papillose hairs; leaf cells papillose, with regular, long-forked papillae . . . . . O. alpestre

11b. Exostome teeth papillose; calyptra hairs smooth or the papillae formed by projecting end walls; leaf cells smooth or with low, conical papillae, the papillae never forked . . . . . .O. pumilum

(This key adapted from Dale H. Vitt, A revision of the genus Orthotrichum in North America, north of Mexico. Bryophytorum Bibliotheca 1: 1-208. 60 plates. 1973.)

O. affine Brid. This species has not been recorded from Colorado but evidently approaches very closely in southern Wyoming. However, it is said to grow mostly on trunks of broad-leaved trees, which, if true, would limit its likelihood here.

O. alpestre Hornsch. ex B.S.G. Next to O. rupestre this is probably the most common and wide-ranging species in our region, occurring on a variety of rock types and occasionally on trees.

O. anomalum Hedw. A species of the outer foothills, often occurring on limestone but not at all restricted to it. It is relatively infrequent or rare.

O. cupulatum Brid. A species of the outer foothills and canyon country, probably restricted to sedimentary rocks. The capsule shape is distinctive but inconspicuous because it is immersed or nearly so on a short seta. Vitt cites a specimen from La Plata County. Other species such as O. anomalum are sometimes confused with this but the long and twisted seta and more elongate capsule should distinguish them.

O. diaphanum Brid. The hair-point of this species would suggest Grimmia, which, however, does not occur on tree trunks. The leaves usually have gemmae. O. diaphanum is common in the southwest plateau country on junipers and oaks.

O. hallii Sull. et Lesq. ex Sull. One of the more common species of rocks and rarely tree-trunks in the outer foothills. It does not venture up into the montane or subalpine, but occurs commonly with O. rupestre and O. laevigatum at lower altitudes.

O. jamesianum Sull. ex James in Watson. Characteristically a plant of limestone or limey sandstone cliffs where it occurs on vertical faces over which water seeps. The leaves are often encrusted with calcium carbonate and the plant has a distinct reddish-bluish glaucous color. Our collections are from the Mesa Verde.

O. laevigatum Zett. A common species on boulders in the outer foothills. It may be recognized in the field by the cylindric, pale exserted capsules as contrasted to the more oblong ones of O. rupestre and O. hallii with which it commonly occurs. It does not seem to ascend very high into the mountains.

O. obtusifolium Brid. This is the most distinctive of all our Orthotrichum species, and some authors prefer to segregate it as the genus Nyholmiella. It occurs in very mesic sites, on the bark (often exposed wood of the self-pruned branch stumps) of Populus tremuloides, in the San Juan Mountains. In most of the Colorado mountains the relative humidity is too low to support much epiphytic vegetation on Populus.

O. pallens Bruch ex Brid. A rare or infrequently collected species of trunks of deciduous trees in the outer foothill canyons and outwash ravines.

O. pumilum Sw. An infrequent or rare species on trunks of deciduous trees, particularly Acer negundo, in the outer foothills outwash streams.

O. rupestre Schleich. ex Schwaegr. The most abundant species throughout the mountains, on large granitic boulders and outcrops from the outer foothills through the subalpine. It is able to tolerate considerable aridity but the sites in which it occurs are probably indicative of local high temporary humidity rather than wet moisture.

PLAGIOTHECIACEAE

Except for Isopterygium pulchellum, the Plagiotheciaceae in our area may be recognized without much difficulty. The stems are creeping over wood or soil or occasionally ascending when growing in boggy places. The leaves are usually distinctly complanate, often quite asymmetric (one side broader than the other). The costa is absent or short and double, and the leaf cells are elongate-linear. Isopterygium pulchellum is an exception and will be discussed in detail below. These are forest mosses except for the

open ground forms of Plagiothecium denticulatum discussed below. The leaves are almost or quite entire.

1a. Leaves with decurrent bases (examine a stem partly stripped of leaves), strongly asymmetric, distinctly complanate . . . . . (2)
1b. Leaves without decurrent bases, more or less symmetric, complanate or not. . . . . Isopterygium pulchellum

2a. Median leaf cells 12-20 microns broad, tending to be more elongate-rhomboid than elongate-linear; decurrent part of the leaf composed of a broad group of rectangular or usually quadrate, inflated and bulging cells . . . . . Plagiothecium denticulatum
2b. Median leaf cells 5-7 microns broad, distinctly linear rather than rhomboid; decurrent part of the leaf narrow, consisting of only rectangular cells..Plagiothecium laetum

Isopterygium

I. pulchellum (Hedw.) Jaeg. et Sauerb. This, to me, suggests Amblystegium serpens superficially, but the median leaf cells are more elongate. The leaf base characteristically has a few shallow teeth on the rounded corner. I. pulchellum seems to be frequent on rotting logs in spruce-fir forests. It is rather nondescript and is not easily mastered.

Plagiothecium

P. denticulatum (Hedw.) B.S.G. This is a frequent plant on the bases of trees and over rotting logs in the forests from the lower foothills up into the subalpine. It is easily recognized as a Plagiothecium by the beautifully complanate leaves, strongly asymmetric, and curving outward and often somewhat back. In the alpine zone a robust form occurs in wet tundra and boggy places that is less complanate, with the leaves more crowded and overlapping. This has been called Plagiothecium ruthei by Grout and is known in Europe as P. denticulatum var. obtusifolium Turn. It appears to be a robust form of highly sunlit places and seems to agree in its morphological details with the species proper.

P. laetum B.S.G. This species is similar to the last but somewhat smaller, and differs distinctly by the characters given in the key. It is rare, and like Isopterygium muellerianum it seems to be restricted to the virgin spruce forests in Middle Park and the Gunnison Basin.

POLYTRICHACEAE

1a. Plants with sporophytes . . . . . (2)
1b. Plants lacking sporophytes. . . . . (6)

2a. Capsule smooth, perfectly round in cross-section or with up to six indistinct ridges, never clearly 4-angled. . . . . .(3)
2b. Capsule clearly quadrangular, equally so or with the two upper angles closer together than the others . . . . . .(5)

3a. Calyptra smooth; leaf lamellae 2-6, the costa narrow and the unistratose lamina broad, not obscured by the lamellae. . . . Atrichum selwynii
3b. Calyptra very hairy; leaf lamellae more than 20 (but see also 9). . . . . (4)

4a. Capsule perfectly round and smooth. . . . . .Polytrichastrum alpinum
4b. Capsule indistinctly angular. . . . . Polytrichastrum longisetum

5a. Capsule equally quadrangular, the base with a constriction between the urn and the button-like apophysis . . . . . (6)
5b. Capsule unequally quadrangular, two of the ridges closer together than the others; apophysis not set apart by a constriction . . . . . Polytrichastrum lyallii

6a. Leaves with the margins thin and hyaline, folded in over the lamellae, the margins thus not toothed. . . . . .(7)
6b. Leaves with plane or merely inrolled margins, thick to the often serrate margin . . . .(9)

7a. Leaves with a white or hyaline hair-point; leaves usually crowded along the apex of the stem. . . . . Polytrichum juniperinum
7b. Leaves with a reddish pointed apex, not prolonged to a hair-point; leaves usually more generally distributed along the stem. . . . . (8)

8a. Stems tightly matted together by masses of white rhizoids extending well up among the leaves; plants forming dense hard tufts in subalpine bogs. . . . . Polytrichum strictum
8b. Stems not tightly matted, lacking conspicuous white rhizoidal felt; plants with a wide ecological amplitude, ranging through the mountains from foothills to alpine. . . . . .Polytrichum juniperinum

9a. Leaves with few (2-6) lamellae; not or very slightly sheathing, the unistratose lamina broad, undulate, contorted when dry; plants of the foothills douglas-fir zone. . . . . Atrichum selwynii
9b. Leaves with many (20-40) lamellae, with well-developed basal sheath, the lamina narrow and costa very broad, covered by the lamellae (note: in very wet sites the lamellae of Polytrichastrum longisetum may be reduced or almost lacking, and the lamina broad, but normal plants are always found nearby in drier sites). . . . . .(10)

10a. Terminal (marginal) cell of lamella (make cross-section) rounded convex or conical. . . . . (11)
10b. Terminal (marginal) cell of lamella depressed in the middle, appearing saucer- or goblet-shaped. . . . .Polytrichum commune

11a. Apical (marginal) cell of lamella (make cross-section) similar to the others, or slightly larger, not unequally-thickened, the surface smooth. . . . . .Polytrichastrum longisetum
11b. Apical (marginal) cell of lamella with the upper wall thicker than that of the sides and base (or if not distinctly so, then the cell strongly and coarsely round-papillose) . . . . . .(12)

12a. Apical cell of lamella (in cross-section) wider than high, with the walls about equally thickened all around; upper wall (and well down along the sides) with very coarse round papillae (these show up in longitudinal view as round papillae also). . . . . .Pogonatum urnigerum
12b. Apical cell of lamella (in cross-section) as high as or higher than wide with greatly thickened upper wall and thinner side and basal ones. . . . . (13)

13a. Apical cell of lamella smooth or slightly papillose in cross-section, in longitudinal view the "papillae" showing up as faint horizontal ridges; plants of forest floors as well as along rivulets in the subalpine and alpine . . . . . Polytrichastrum lyallii

13b. Apical cell of lamella coarsely papillose in cross-section, but in longitudinal view the "papillae" showing up as distinct horizontal ridges; plants restricted to late snow-melt areas in the alpine zone, rarely elsewhere. . . . . Polytrichastrum alpinum

Atrichum

A. selwynii Austin, (A. undulatum var. selwynii). Although it has a very wide altitudinal range, occurring from the cool foothill canyons under douglas fir, to the moister spruce forests of the subalpine and sparingly in the moister alpine areas, it seems to be rather rigidly restricted to specific microsites probably connected with high local humidity.

Without capsules, Atrichum might be mistaken for Timmia. In the fresh state the broad, thin leaves have that general appearance, and one might miss the few low lamellae which are rather inconspicuous. When dry the leaves curl inward and are undulate-margined, looking more like an Encalypta than one of the Polytrichaceae.

Pogonatum

P. urnigerum (Hedw.) P. Beauv. In Colorado this species is exclusively alpine, often occurring in dry shelves under boulders. It sometimes occurs intermixed with Polytrichastrum alpinum, from which it usually can be distinguished by the broader, boat-shaped, glaucous leaves. Whereas P. alpinum forms dense sods on peaty soil, P. urnigerum grows scattered, only a few stems together, on more sandy substrates. When in doubt, the characters of the lamellae may be used as a last resort to distinguish them. P. alpinum is quite likely to be found in fruit, while we have never found P. urnigerum in fruit here.

Polytrichastrum

P. alpinum (Hedw.) G. L. Smith, (Polytrichum alpinum Hedw., Pogonatum alpinum (Hedw.) Rohl.). This is a characteristic plant of the wet tundra, especially in late snow areas and on frost-push hummocks. It commonly fruits and has short, broad, light-colored capsules. Leaf-length seems to vary a great deal depending on the seasonal snow-cover, and striking variation can be seen from one margin of a patch to the center.

P. longisetum (Sm. ex Brid.) G. L. Smith, (Polytrichum gracile Dicks. in Menzies). This is evidently exclusively found in peat bogs in the subalpine zone. Fortunately it frequently occurs in fruit, for vegetatively it is somewhat difficult to recognize in the field. This species shows remarkable environmental plasticity, since when the plants are in very wet sites or even seasonally submerged in melt-water, the lamellae may be few in number or even lacking, and the lamina thin and broad.

P. lyallii (Mitt.) G. L. Smith, (Polytrichadelphus lyallii Mitt.). A common species of the forest floor in the subalpine, but quite widely distributed above and below, in moist slopes under Pseudotsuga in the foothills, and along rivulets in open sites in the upper subalpine and alpine. Large plants with long leaves, widely spreading when moist, are very distinct and will remind the eastern bryologist of Polytrichum commune, which is quite rare here. When dry the leaves are more appressed to the stem, with the long tips curving outward. There are times, nevertheless, when P. lyallii and P. alpinum are so similar that the lamellar characters must be used to distinguish them.

Polytrichum

P. commune Hedw. We have this only from a stand of non-fruiting plants at the edge of a subalpine Carex nebraskensis bog in the Silver Lake area of the Boulder watershed. Vegetatively this species is very similar to Polytrichastrum lyallii, which tends to grow in less marshy sites. In the absence of fruit the shape of the terminal lamellar cell is absolutely diagnostic.

P. juniperinum Willd. ex Hedw. This species is very abundant and widely distributed from the foothills through the alpine. In contrast to the next species, which is equally abundant, P. juniperinum occurs in heavier soils with more humus and tends to avoid excessively dry or exposed sites, and tolerates more shade. With a hand-lens, the infolded margin of the leaf and the reddish leaf-tip are diagnostic.

The male sex organs are formed in terminal "flowers," rosettes of reddish or yellowish perigonial leaves. These are often very conspicuous in all four species, and in optimum condition the antheridia can be teased or squeezed out of the antheridial head and when placed on a slide with water the free-swimming sperm can be easily examined under the microscope.

P. piliferum Hedw. Abundant on gravelly open ridges and windswept summits, fell-fields and ledges of siliceous gravel, P. piliferum is one of the first mosses learned by a beginner. When it forms dense sods with very short stems it can be mistaken for Selaginella densa with which it often occurs. Despite its abundance, P. piliferum seems to have rather rigid ecological requirements or tolerances.

P. strictum Menzies ex Brid. Very closely related to P. juniperinum and not impossibly a race of that species, but distinguished by the characters in the key, and the habitat, a plant of subalpine bogs (willow and Sphagnum).

POTTIACEAE

1a. Leaves with superficial outgrowths (lamellae, plates, chlorophyllose filaments) arising from the upper (ventral) surface of the costa. . . (2)

1b. Leaves lacking any superficial outgrowths except papillae. . . . . (4)

2a. Leaves with several sheet-like lamellae arising from the costa near the leaf apex. . . . . .Pterygoneurum

2b. Leaves with a dense cluster of erect green filaments on the upper lamina . . . . . .(3)

3a. Leaves thick and rigid, with an obtuse, cucullate apex, lacking any hair-point. . . . . .Aloina

3b. Leaves with a long hyaline hair-point, the lamina thin-textured, not cucullate or rigid..Crossidium

4a. Capsule cleistocarpous (the lid not differentiated and the capsule rupturing irregularly, almost always present; ephemeral plants of early spring and summer . . . .(5)

4b. Capsule with a differentiated operculum, or the plants lacking sporophytes. . . . . .(6)

5a. Capsule sessile or nearly so, spherical, hardly pointed at the apex; common on open grassy sites on outer foothills outwash slopes . . . . Phascum
5b. Capsule with a short but definite seta about as long as the capsule; capsule conical or broadest below the middle, with a distinct, often shriveled point; rare, in calcareous soil, western slope . . . . . .Pottia

6a. Leaves broadly ovate, very concave, in a tight cabbage-like cluster, the cells not papillose; minute alpine mosses with or without a hair-pointed leaf; peristome of 16 undivided teeth. . . . . Stegonia
6b. Leaves oblanceolate, lingulate or spatulate; peristome divided into filiform prongs, or elongate and spirally twisted . . . . . .(7)

7a. Leaves with a hyaline, golden or reddish hair-point often half as long as the leaf or longer. . . . . (8)
7b. Leaves lacking a distinct hair-point, but sometimes short-pointed . . . . . (9)

8a. Minute species with small (up to 1.5 mm) leaves, without distinct basal hyaline "windows" . . . . . Desmatodon
8b. Larger plants; leaves usually over 2 mm long, usually with well-developed inner basal hyaline "windows"; cells usually papillose . .Tortula (but see also Encalypta in Encalyptaceae)

9a. Leaves broad, oblanceolate, oblong or spatulate, often broadest above the middle . . . . . .(10)
9b. Leaves narrowed from base to apex, sometimes from a relatively broad base . . . . . .(11)

10a. Leaves large (2-6 mm) with inner basal hyaline "windows". . .Tortula inermis (see also Encalypta)
10b. Leaves small (up to 2 mm), no distinct basal hyaline "windows" although leaf base may consist generally of rectangular hyaline cells not framed by shorter green marginal cells . . . . . Desmatodon

11a. Leaf margin recurved or revolute. . . . . .(12)
11b. Leaf margin plane or involute . . . . . .(13)

12a. Minute, densely tufted mosses of calcareous travertine cliffs, the leaves often encrusted with lime; capsules usually present, the urn short and wide; operculum with a long bent beak. . . . . .Hymenostylium
12b. Larger mosses in loose tufts, usually without capsules; capsules elongate, cylindric; growing in various habitats . . . . . .(Barbula and its relatives)

13a. Leaves with a basal area of rectangular, transparent cells encroaching upwards along the margin, thus forming a V-shaped contact line between these and the inner and upper chlorophyllose cells . . . . . .Tortella
13b. Leaves without a distinct V-shaped contact zone.. . . . . .(14)

14a. Leaf cells with a single high and sharply conical mammilla on upper and lower surfaces giving the costa and margin a strongly toothed appearance, the lamina in cross-section accordion-pleated in appearance due to the mammillae. . . . . .(Dichodontium, in Dicranaceae)
14b. Leaf cells smooth or only low-papillose.(15)

15a. Leaves with a few distinct marginal teeth at the "shoulder" (the junction of the lower elongate cell zone and the upper quadrate cell area. . . . . Eucladium
15b. Leaves lacking distinct marginal teeth at the shoulders . . . . . .(16)

16a. Leaves obtuse, ribbon-like; densely tufted plants of cliff faces, frequently calcareous or travertine-forming . . . . . .Gymnostomum
16b. Leaves acute or acuminate . . . . . (17)

17a. Leaves entire, neither undulate nor fragile, very narrowly involute from base to apex, the basal portion not clearly differentiated into a semi-sheathing base; leaves forming a short basal rosette, the stem never elongate; commonly fruiting; plants of moist rock crevices in mostly sedimentary rocks . . . . . Weissia
17b. Leaves irregularly dentate near apex, the lamina undulate and fragile; basal portion forming a somewhat sheathing base; stems elongate, in erect tufts; sterile; plants of moist places in tundra . . . . . .Trichostomum

Aloina

A. rigida (Hedw.) Limpr. A very inconspicuous moss of arid sandy bluffs above the rivers of the eastern plains, in sites that are only moist for very short periods. Usually there are only scattered individual stems intermixed with Bryum caespiticium and Pterygoneurum subsessile. Our only collection is from South Pawnee Butte. The leaves are brown, very thick, rounded-triangular and involute with the edges rolled over the cushion of photosynthetic filaments.

Barbula and its relatives

1a. Leaves, the lower at least, with a distinctly reddish color . . . . . (2)
1b. Leaves green, brown, or blackish. . . . . (4)

2a. Leaves semi-sheathing, bent and not lying flat on the slide; apex usually denticulate; upper leaf cells strongly papillose with C-shaped papillae . . . . . .(3)
2b. Leaves not sheathing, lying flat when dissected; apex smooth; leaves mammillose but never strongly papillose, with beautifully golden cell walls; leaves spreading widely when moistened . . . . . Didymodon asperifolius

3a. Common and usually fertile; plants of forest floors and streamsides in the middle altitudes, forming loose tufts with distinctly reddish lower leaves; gemmae lacking. . . . . .Bryoerythrophyllum recurvirostre
3b. Rare, always sterile; minute plants of tundra slopes, forming very dense tufts; multicellular gemmae occurring on the rhizoids. . . . . Bryoerythrophyllum ferruginascens

4a. Leaves oblong with rounded, blunt, or merely apiculate apex. . . . . .(5)
4b. Leaves with pointed, often acuminate tips, or if blunt, then with an ovate outline broadest at the base. . . . . .(6)

5a. Leaves tightly revolute their whole length, more or less spirally contorted when dry; dark green plants of cliff-sides and crannies. . . . . .Barbula spiralis

5b. Leaves revolute only toward the base; leaves somewhat contorted but not in spirals; yellow-green plants of wet sandy or muddy places along streams . . . . . Barbula unguiculata

6a. Leaves decurrent (strip off a leaf from the stem when moist), obtuse to rounded or rarely acute. . . . . .Didymodon tophaceus

6b. Leaves not decurrent; acute or acuminate. . . . . .(7)

7a. Leaves narrow, scarcely broadened below; upper leaves curved in one direction (pin-wheel fashion) when wet, contorted and spreading in all directions when dry; leaves bistratose on the margins and partially so on the upper lamina, the upper cells strongly papillose. . . . . Didymodon rigidulus

7b. Leaves with broader base, triangular-ovate or more or less acuminate, usually appressed to the stem when dry; leaves unistratose, the cells smooth or papillose . . . . . (8)

8a. Leaves smooth, the cells quadrate and clear; costa usually somewhat excurrent in the narrow apex . . . . . .Barbula acuta

8b. Leaves papillose with low, blunt, often C-shaped papillae; costa usually ending in the leaf apex, not excurrent. . . . . .(9)

9a. Leaves minute, 1 mm or less, broadly ovate with rounded apex, the tips curving into the stem. . . . . .Barbula andreaeoides

9b. Leaves usually over 1 mm long, with acute apices, variously appressed or twisted. . . . . .(10)

10a. Leaves triangular-ovate, usually not very sharp-pointed; lower leaf cells numerous, quadrate and not differentiated from the median cells; leaf margin recurved from base to apex . . . . . Barbula brachyphylla

10b. Leaves ovate-lanceolate, with slender apex; lower leaf cells rectangular, distinctly larger and longer than the median cells; leaf margin recurved to above the middle. . . . . Barbula vinealis

Barbula

B. acuta (Brid.) Brid. B. acuta occurs from the outer foothills up to the tundra and takes on a variety of aspects. On ledges of calcareous sandstone in the outer foothill hogbacks it is a blackish plant (var. bescherellei). Elsewhere it is usually dull green. It is most abundant on cliffs in the foothills, often on granite, but it can occur in rock crevices on the high mountain summits.

From Didymodon asperifolius it differs in never having a red coloration and never occurring in the snow-flush habitat and in having smooth, not mammillose or papillose cells. From B. vinealis, by having generally narrower leaves and non-papillose cells.

B. andreaeoides Kindb. Our only record is from soil pockets in a granite bluff near Silverton.

B. brachyphylla Sull. in Whipple. Evidently a fairly common species of siliceous rocks and ledges in the outer foothills. Closely related to B. vinealis, and the distinctions between them are not too clear.

B. spiralis Schimp. A rare species representing the northernmost extension of an essentially Mexican distribution pattern. We have only one collection from cliffs in the outer foothills near Lyons, Boulder County.

B. unguiculata Hedw. A somewhat weedy species common in sandy soils of floodplains on the eastern plains, but volunteering in lawns and beside streams in the outer foothills and piedmont valleys.

B. vinealis Brid. Records of this are so few that it is difficult to make a clear ecological statement for it. Apparently much of what has been collected earlier belongs to B. brachyphylla, and perhaps the species are too closely related to be distinguished.

Bryoerythrophyllum

B. ferruginascens (Stirt.) Giac. A rare species of the high alpine tundra, occurring sterile and so nondescript as to be overlooked except by specialists. The vital characteristic for certain identification is the presence of the multicellular gemmae attached to the rhizoids.

B. recurvirostre (Hedw.) Chen. Unlike the other Barbula relatives, this species tends to grow on the forest floor, especially along damp gullies. The plants often reach a centimeter high and are strongly rusty-tinged, all but the youngest leaves being reddish. The leaves are lanceolate from a sub-sheathing base, and the lamina curves out from the base so that the leaf cannot lie flat. The blades are irregularly curled, showing a prominent costa, and the margin is revolute. The upper leaf cells are quadrate, papillose with C-shaped papillae and contrast sharply with the elongate-rectangular hyaline cells of the sheath. Plants commonly bear elongate, straight, reddish capsules resembling those of Desmatodon.

Crossidium

1a. Costal filaments very numerous, high, making a brush-like surface; plants of crevices of bedding planes in limey sandstone ledges. .C. squamigerum

1b. Costal filaments few, very short, often consisting of only the terminal cell, with one or more knobby papillae; under greasewood bushes on alkali flats. . . . . C. aberrans

C. aberrans Holz. et Bartr. Probably common on greasewood alkali flats in the western tier of counties. We have it abundantly from near Whitewater in Mesa County. This is a difficult identification to make. One first has the impression of a richly-fruited Tortula, but the leaves are small, ovate, and the cells practically smooth (somewhat mammillose in cross-section), and arranged in a "cabbage-head"; careful observation of the ventral side of the costa in the distal end of the leaf will show some protruding cells with a few knobby papillae, but the costa is very little enlarged by these "filaments." Besides, their occurrence and development is very variable. The peristome is definitely that of a Tortula, as is the slender cylindric capsule. It was growing intermixed with masses of Pterygoneurum subsessile.

C. squamigerum (Viv.) Jur. ssp. griseum (Jur.) Giac. We have a single record, from a sandstone ledge in northern Boulder County in the outer foothills. Elsewhere in America it has been found in Arizona

and California. The filaments arising from the costa consist of thin-walled quadrate cells terminated by one or two thick-walled cells. The terminal cell usually has a greatly thickened terminal end wall and is provided with large papillae on the corners.

Desmatodon

1a. Leaves with distinct border of narrow, linear, elongate cells; capsule curved, cernuous or pendulous . . . . . (2)
1b. Leaves without border or with the marginal cells not more than twice the length of the inner; capsule erect and symmetrical. . . . . (3)

2a. Leaf cells smooth, rarely papillose in upper lamina; capsule ovoid (short and fat), curved or cernuous; at low or middle altitudes, evidently along watercourses in alkaline areas. . . . . D. cernuus
2b. Leaf cells with extremely minute C-shaped or circular papillae, up to 20-25 per cell, much smaller than the lumen and not visible except under high power and not obscuring the cells; capsule narrowly elliptical, pendulous; wet sites in alpine tundra and subalpine slopes. . . . . D. laureri

3a. Leaves not papillose; rare plants of alpine tundra (see also Stegonia) . . . . . .D. systylius
3b. Leaves papillose on the distal half; alpine or lowland . . . . . (4)

4a. Upper leaf cells less than 10 microns diam.; leaves rounded at the apex, with or without an excurrent hair-point or costa; plants of the plains, canyons and outer foothills, on sedimentary rocks . . . . . .(5)
4b. Upper leaf cells 11-30 microns diam.; leaves various; plants of soil, alpine and subalpine. . . . . .(6)

5a. Leaves muticous. . . . . .D. obtusifolius
5b. Leaves with a long smooth hair-point often as long as the leaf; plants resembling a tiny Tortula when moist . . . . . D. plinthobius

6a. Leaves oblong or spatulate, with or without a hair-point, the upper leaf cells 15-21 microns diam. . . . . .D. latifolius
6b. Leaves gradually tapering from the middle or below, slender-pointed, or more or less acute; upper cells 11-16 microns diam. . . . . .D. leucostoma

D. cernuus (Hueben.) B.S.G. Our two collections come from Larimer and Chaffee counties. The ecology is not known, but one came from a railroad right-of-way and the other from a ditch. Probably these were alkaline areas at low altitudes.

D. latifolius (Hedw.) Brid. A very common species in the subalpine and alpine. In the tundra it is often the only moss growing on dry sites of fellfields. It fruits abundantly. The hair-point is very variably developed. The plant without a hair-point is var. muticus (Brid.) Brid.

D. laureri (Schultz) B.S.G. A very rare species found only in the more optimum mossy tundras and subalpine. Even when sterile this species can be recognized by the tiny dispersed papillae and the large leaf cells (up to 60 x 20 microns).

D. leucostoma (R. Br.) Berggr. Probably frequent in the alpine although we have relatively few collections.

D. obtusifolius (Schwaegr.) Schimp. A very common plant on thin soil over sedimentary rocks in the outer foothills and plains.

D. plinthobius Sull. et Lesq. ex Sull. Common on sedimentary outcrops on the plains and outer foothills.

D. systylius Schimp. The epithet "systylius" alludes to the fact that the operculum remains attached to the columella after separating from the capsule rim, so that the operculum stands like an umbrella over the open capsule mouth, for a long time. This is not unique to D. systylius, however, and may occur in D. latifolius and in Stegonia. D. systylius is frequently confused with Stegonia latifolia, and both are tundra plants. They are distinguished as follows:

Stegonia	D. systylius
Cells in upper half of leaf:	
generally lacking chlorophyll	highly chlorophyllose
Lower leaf cells:	
enlarged but not much differentiated in shape from the upper ones, often with stored oil drops	distinctly elongate and strongly differentiated from the upper ones, empty
Leaves:	
very concave, broadly ovate	ovate but not broadly so, often broader above the middle, not concave and usually collapsing when dry
crowded into a cabbage-like cluster	not so crowded, stem more distinct

Didymodon

(for key see Barbula)

D. asperifolius (Mitt.) Crum, Steere et Anderson, (Barbula rufa, Didymodon rufus, Tortula rufa). D. asperifolius is a characteristic species of snowmelt basins in the alpine tundra, occurring in loose mats, loosely attached to sandy gravels in periodically inundated meltwater rills. It is recognized by its handsome reddish coloration and leaves which are recurved from the stem when moist (when dry the leaves are fairly well appressed to the stem). Under the microscope the leaves are particularly beautiful. The cells are incrassate, the upper ones quadrate with rounded lumina, the lower more rectangular but with rounded edges. The cells are chlorophyllose, often with an accumulation of oil drops. The combination of copper-gold and green and the clearly visible cell structure is most attractive. The leaves are narrowly revolute, ovate at the base.

We had been confusing this with Barbula reflexa, a species evidently belonging to lower areas, certainly not occurring in the Rocky Mountains above treeline. If one tries to identify our plant by using Nyholm, one inevitably goes to B. reflexa, since the leaves are strongly recurved and the upper cells are

definitely papillose. The papillae of the leaf cells vary a good deal in size and visibility, some leaves being almost smooth, others being highly mammillose, and some having discrete papillae but never so high, slender or apparent as in B. reflexa. In B. asperifolia one often has to search for the papillae.

Barbula reflexa also seems to be a plant with more slender stems, narrower leaves, and has the leaves more remotely situated along the stem. The leaves recurve more strongly, possibly only because they are narrower. Herbarium specimens are usually pale brown and never have the strong reddish color of asperifolia. The upper leaf cells in reflexa seem to be consistently more incrassate and angular. Nyholm gives the measurements of the upper cells in reflexa as 8-10 microns wide and asperifolia 10-13, a valid distinction.

Limpricht seems to have known asperifolia very well, for he described the leaves: "Lamina unistratose (occasional cells bistratose), papillose-mammillose the length of both surfaces, all leaf cells strongly and equally-thickened all around, thus the lumen rounded (8-11 microns) and quadrate-oval, only at the base next to the costa elongate-rectangular (1:3 and 1:5). . ." He also calls this a true alpine moss.

Reports (Grout, M.F.N.A.) of Barbula reflexa and B. recurvifolia from Colorado can be attributed to D. asperifolius.

D. rigidulus Hedw., (Barbula rigidula). On boulders and ledges in the foothills on the eastern slope from 6-9,000 ft. altitude. D. rigidulus forms loose mats on periodically irrigated rocks. From the other Barbulas it is distinguished in the field by its leaves which when moist spread and curve around in one direction, suggesting a pinwheel. The color is yellow-green. When dry, the upper leaves still spread in several directions, giving a shaggy appearance. The leaves are long and narrow, from a base that is not much wider and semi-sheathing. The distal leaf cells are quadrate, the lower cells distinctly elongated. The distal cells are distinctly papillose with low papillae and in section the margin and parts of the lamina are bistratose. Gemmae are said to be present almost always in European material and we find them in material from the eastern plains. In the field it is possible to mistake this for well-developed Ceratodon purpureus, but that has smooth cells and grows usually in drier sites.

D. tophaceus (Brid.) Lisa. On wet faces of small check-dams and other seepy sites generally at lower elevations in the canyons.

Eucladium

E. verticillatum (Brid.) B.S.G. A species of seeping limestone or limey sandstone cliffs in the plateau and canyon country of western Colorado. It forms large bulging rounded tufts along bedding planes and may become encrusted with lime. It is usually sterile but is recognized by the distinct teeth on the leaf margins at the point where the basal hyaline area meets the distal half of the leaf in which the cells are quadrate and papillose.

Gymnostomum

1a. Upper leaf cells about 10 microns diameter; costa with dorsal and ventral stereids; spores 12-14 microns diameter. . . . . .G. aeruginosum

1b. Upper leaf cells about 5 microns diameter; costa with dorsal stereids only; spores 8-10 microns diameter. . . . . .G. calcareum

G. aeruginosum Sm. This was reported by Porter (1876) from Glen Eyrie, and by Rothrock in the Wheeler Expedition report (1878) from Twin Lakes. Our only modern collection is from Ouray County. The two species are rather difficult to distinguish, and apparently G. aeruginosum is the more uncommon.

G. calcareum Nees, Hornsch. et Sturm. A common moss on calcareous cliffs, forming dense tufts often becoming encrusted with lime. It occurs in the foothill and canyon country on calcareous sedimentary or metamorphic substrates. The stems are slender, tightly packed together, and the leaves are narrow and ribbon-like with a well-differentiated papillose distal half with quadrate cells about 6-8 microns diam., and a basal third with elongate-rectangular cells. The leaves are plane or slightly incurved in the margins.

Gymnostomum can be confused with Eucladium verticillatum and Hymenostylium recurvirostre, which grow in similar sites. Eucladium always shows a few distinct marginal teeth at the leaf "shoulders" and has narrower leaves with the costa occupying almost a third of the width. The upper leaf cells of Eucladium are more irregular, with rectangular and quadrate cells mixed. The leaves of Gymnostomum are fragile, flat, and irregularly crisped or crumpled when dry, while those of Hymenostylium are strongly inrolled, longer and more rigid, stiffly curving over each other at the stem tip, and on careful observation the margins of moist leaves are distinctly recurved. Gymnostomum is usually found in fruit, while Eucladium does not fruit here.

Hymenostylium

H. recurvirostre (Hedw.) Dix., (Gymnostomum recurvirostrum). On calcareous or travertine cliffs in the middle altitudes of the western slope. The plants often form tight tufts impregnated with lime. The leaves are linear-lanceolate with slightly recurved margins. Usually found fruiting and easily recognizable by the short seta (2 mm), short broad urn (1 mm) with flat operculum provided with a slender beak, bent to the side. The leaves when dry are curved over the imaginary stem axis in a characteristic way. The recurved leaf margin will distinguish sterile material from Gymnostomum calcareum, which grows in similar habitats.

Phascum

P. cuspidatum Hedw. var. americanum (Ren. et Card.) Card. et Theriot. This is a species that one hardly ever encounters except in early spring when the ground is moist and the plants are fruiting. After a few weeks the soil is baked dry and the mosses go into a summer dormancy and disappear from view. Phascum is a species primarily of the open grassland or grassy slopes in the lower outer foothills.

Fruiting material is very easily recognized because the capsule is sessile, spherical, has no differentiated operculum (thus cleistocarpous) and of course no peristome. The spores are densely papillose and about 25 microns diameter.

The leaves form a concave cluster surrounding the reddish-brown capsule. They are broadly oblong-ovate and abruptly narrowed to the apex. The costa is long excurrent into a slender, smooth, golden hair-point.

Vegetatively the plant resembles a small Bryum more than a small Tortula, but the quadrate or rectangular cells mark it as pottiaceous, whereas the leaf cells of Bryum are usually hexagonal. The leaf cells may or may not be distinctly papillose.

Pottia

P. bryoides (Dicks.) Mitt. We have only one record of this species, from calcareous soil in a deep recess under an overhanging sandstone block, near Unaweap Canyon, Mesa County. The leaves are ovate and folded and curved when dry, with a strong excurrent costa. The upper leaf cells are multipapillose.

Pterygoneurum

1a. Sporophyte immersed to emergent, calyptra small, mitrulate, shorter than the capsule and splayed out on the sides; leaves with very long hair-points, concealing the leaves . . . P. subsessile
1b. Sporophyte exserted on a seta longer than the capsule; calyptra cucullate, often longer than the capsule; hair-points shorter, the leaves usually evident. . . . . P. ovatum

P. ovatum (Hedw.) Dix. A species of loose soils derived from sandstone or limestone, rare east of the mountains in the hogbacks of the outer foothills, but locally abundant on the western plateaus and canyons.

P. subsessile (Brid.) Jur. Occurring with the preceding, and very abundant on the western arid lands. Like Crossidium, Pterygoneurum is easily recognized by the superficial outgrowths on the leaves. These, in Pterygoneurum, are a few chlorophyllose lamellae arising from the costa. They are narrow at the base of the leaf, only one cell high, increasing toward the leaf apex so as to resemble extra leaf-laminae. These lamellae are toothed and irregular distally and sometimes have protonema-like projections.

Pterygoneurum is a very inconspicuous moss of semi-desert areas, but it occurs on favorable sites on the Great Plains as well. The plants form bulb-like shoots, the leaves being broad, pale, and concave, and usually provided with long hair-points which so dominate the plant as to hide the leaves from view. It often occurs in company with Phascum, and like Phascum its active season is in the early spring. Ecologically, Pterygoneurum seems to be sensitive to soil instability and is absent from microsites where there is much soil movement.

Stegonia

S. latifolia (Schwaegr. ex Schultes) Vent. ex Broth. Common on alpine tundra sites, mostly on relatively dry gravelly places (fell-field). The usual form is very easily distinguished by its broadly ovate, concave leaves that are aggregated into a cabbage-like head. Otherwise the plant resembles a Desmatodon. The common form has rounded or only shortly-apiculate leaves, but a race occurs side by side with this, forma pilifera (Brid.) Moenkemeyer, with long hair-pointed leaves. This might be mistaken for Desmatodon systylius (see that species for comparisons).

Tortella

1a. Leaves strongly curled and with the tips spirally contorted when dry, linear and not much broader at the base, not fragile or showing many broken tips, distinctly undulate . . . . . (3)
1b. Leaves curved but quite stiff, and the tips tending to be fragile and broken off, usually not spirally contorted when dry, narrowed above from a broader base, not strongly undulate . . . . (2)

2a. Lamina in apex unistratose; cells in upper part of leaf 11-14 microns diameter . . . . . .T. rigens
2b. Lamina in apex bistratose; cells in upper part of leaf 6-10 microns wide. .T. fragilis

3a. Young leaves yellow-green, older leaves pale; leaves strongly undulate even when wet; leaf base hyaline; lower altitudes, often on calcareous soil. . . . . T. tortuosa
3b. Young leaves deep green, older leaves blackish; leaves hardly undulate; leaf-base yellowish; alpine tundra . . . . . .T. arctica

T. arctica (H. Arn.) Crundwell et Nyholm. Frequent in moister parts of the tundra, commonly on solifluction terraces. The sods formed by this species tend to be more compact than in the lowland T. tortuosa.

T. fragilis (Hook. ex Drumm.) Limpr. Although this species reaches its best development on seeping granite ledges in the foothill canyons, where it forms extensive yellowish sods over the rocks, it also occurs on limestone in the outer hogbacks, sandstone cliffs in the western canyons, and on alpine screes (probably calcareous).

T. rigens N. Albertson. This recently-described species is known so far from Scandinavia and has not been reported in the United States. Dr. A. C. Crundwell examined our single collection from Paradox Valley and suggested it might be this. There seems to be no other possibility. This species has the fragile leaves of T. fragilis but the strongly curled leaves of T. tortuosa. The leaves seem to be slightly broader than either. The leaf cells are larger than those of either species, 11-14 microns. The strong development of the papillae makes it difficult to establish the limits of the leaf cells. T. rigens occurs in Scandinavia on limestone pavement on the island of Gotland. The Colorado material also occurs on calcareous rocks whereas T. tortuosa with us usually occurs on soil and sometimes on siliceous rock.

T. tortuosa (Hedw.) Limpr. Locally abundant on cliffs, soil of ravines, usually of a granitic or sandstone parent rock, in the outer foothill canyons. All of our records happen to be from Boulder County, but the species must be generally distributed at the lower altitudes in the outer foothills. T. tortuosa is a good example of a species that in the more oceanic climates of western Europe, behaves as a distinct calciphile. In the Rocky Mountains this observation simply does not apply to many of the European so-called calcicolous mosses. It may mean simply that calciphily in Europe is equivalent to a more arid substrate than is generally available.

Tortula

1a. Upper leaf cells not papillose. . T. mucronifolia
1b. Upper leaf cells papillose. . . . . (2)

2a. Leaves bordered below the middle with a row of elongate cells . . . . . .T. subulata
2b. Leaves not bordered . . . . . .(3)

3a. Costa (except in very rare instances, in populations of the normal form) excurrent as a long or

short awn . . . . . (4)
3b. Costa percurrent, or excurrent only as a very short mucro or apiculus, never a conspicuous awn. . . . . .T. inermis

4a. Leaves not at all recurved or revolute, but folded and often more or less incurved; costa conspicuously spinulose-papillose dorsally. . . . . T. bartramii
4b. Leaves distinctly recurved or revolute at least along part of the margin. . . . . .(5)

5a. Excurrent costa completely smooth (leaf margins revolute from base to apex) . . . . . T. brevipes
5b. Excurrent costa slightly to strongly serrate from projecting cell tips. . . . . (6)

6a. Leaves short, broadly ovate, bistratose; stereid layer hardly differentiated, all dorsal cells of the costa with large lumina and relatively thin walls . . .T. bistratosa
6b. Leaves longer, ovate-lanceolate or lance-oblong, unistratose; stereids always well-developed . . . . . .(7)

7a. Leaves brown, erect to spreading, but hardly squarrose when moist, usually not over 2 mm long; upper leaf cells usually not greatly obscured by papillae; plants of calcareous soils in desert-steppe areas. . . . . T. intermedia
7b. Leaves green or hoary-gray, usually squarrose-spreading when moist, 3-7 mm long; upper leaf cells usually opaque from the crowded papillae; plants of neutral soils and sandstone or granite cliffs. . . . . (8)

8a. Papillae low, C-shaped . . . . . (9)
8b. Papillae high, branched, in section (upper leaf cells) the papillae arising from a conical hollow extension of the cell, branched as small antlers, the papillar portion of the cell equaling in height the main cell lumen (leaf section three times as high as the cell lumen) . . . . . .T. papillosissima

9a. Hair-point reddish at base; leaves more or less appressed to the stem when dry, showing the stem usually reddish from the overlapping reddish leaf sheaths; leaves weakly squarrose when moist, with margin recurved from the base to half the leaf length, plane in the upper part . . .T. norvegica
9b. Hair-point white (hyaline); stems not conspicuously reddish, the leaves densely clothing the stem and the sheaths not usually very visible; leaves strongly squarrose when moist, the margin recurved along the entire length. . . .T. ruralis

T. bartramii Steere. A rare species found on dripping cliffs of sandstone in the outer foothills. Some specimens appear to have gemmae associated with the leaves and may represent Tortula pagorum, but T. pagorum has a very smooth excurrent costa and our specimens have some protruding cell ends although in some leaves the hair-point is so short that it is hard to say what the condition would be when better developed. At least some of the material is clearly T. bartramii and I would rather withhold judgment on the gemmiparous specimens. It is entirely possible that T. bartramii, which is still imperfectly known, may have gemmiparous phases.

T. bistratosa S. Flowers. A characteristic species of the western sagebrush deserts, commonly occurring at the base of shrubs, where the snow tends to lie the longest in winter. A few records from the eastern base of the mountains. Recognized with experience by its small size and blackish color.

T. brevipes (Lesq.) Broth. Sayre reported a collection of her own from southwestern Colorado, which I have not seen. The species occurs in low, often alkaline situations in Utah and should be in western Colorado but we have no definite records. Grout also credits Colorado with the species, without cited specimens.

T. inermis (Brid.) Mont. Occurring in moist sandy pockets in rimrocks of mesas, our records scattered in eastern Colorado from Baca and Boulder, and in western Colorado, from Mesa County. The dry leaves are folded and curved into a broad sickle-shape or flat spiral--a curious and distinctive arrangement with the flat side of the lamina-half lying horizontal. The report of T. fragilis (Weber, 1963) was a misidentification of this.

T. intermedia (Brid.) Berk. Frequent in arid soils in the same kinds of situations where T. bistratosa occurs. It is intermediate in size between T. bistratosa and T. ruralis.

T. mucronifolia Schwaegr. Common in shaded silty sites, never far from running water or seepage water, on rock cliffs, retaining walls, edges of watercourses in ravines, etc., from the outer foothills up to the subalpine. Grout's report (Tolland) and Clements' report of T. subulata are misidentifications of this.

T. norvegica (Web. f.) Wahlenb. in Lindb. Common on moist rock outcrops in the foothills, usually on granite, and occurring as well on rock outcrops in the tundra. This species takes some experience to distinguish with regularity from T. ruralis. While T. ruralis may occur in the habitat of T. norvegica, T. norvegica never occurs on the desert soils in which T. ruralis is often abundant.

T. papillosissima (Coppey) Broth. Under desert shrubs in western Colorado and Utah. There is a possibility that this is an extremely papillose variant of T. ruralis but the extraordinary development of the papillae seems to be a qualitative difference. Formerly known from Greece and Lebanon, it was discovered in America by Seville Flowers of the University of Utah.

T. ruralis (Hedw.) Gaertn., Meyer et Scherb. Probably one of the most abundant and ubiquitous mosses in Colorado, occurring from soils in the arid steppe up through the mountains to the alpine tundra, usually on soil but also on rocks. Its beautifully squarrose leaves earn it the local name of "star moss."

T. subulata Hedw. We have only one record, from Mesa Verde National Park, in a dry alkaline streambed below a spring in Rock Canyon. Other reports seem to be misidentifications of T. mucronifolia.

Trichostomum

T. tenuirostre (Hook. et Tayl.) Lindb., (Trichostomum cylindricum). Rare or infrequent, alpine tundra.

Trichostomum has the narrow leaves of a Barbula, but with the margins incurved rather than recurved. The basal third is hyaline and sheaths the stem much in the manner of a Tortella. However, the hyaline cells are internal and usually are bounded on the

margin by shorter chlorophyllose cells. In Tortella the entire base is hyaline, with the hyaline cells extending diagonally up the margin. The upper leaf cells of Trichostomum are multipapillose and the margin somewhat crenulate, with here and there a few larger cells protruding as coarse teeth. The blade is undulate and fragile. The costa is inconspicuous in hand-lens view, not strong and yellow and shining as in Tortella. At Summit Lake this species occurs sparingly in wet moss tundra around the shores.

Weissia

1a. Leaves oblong-lingulate to linear-ligulate, broadest above the middle, apex widely acute or rounded . . . . . .W. perligulata
1b. Leaves lanceolate or ovate-lanceolate, broadest below the middle; apex acute or acuminate . . (2)

2a. Leaves broadly to narrowly lanceolate, up to 3 mm long; costa rarely over 50u wide at base; papillae low, simple; leaves not crimped at junction of basal and median cells . . . . . W. controversa
2b. Leaves broadly oblong-ovate to ovate, 0.8-1.0 mm long; costa 60-80u wide at base; papillae high, forked, arising from the summit of the conical-mammillose cell; leaves usually crimped at the junction of the basal hyaline cells and the median papillose cells . . . . . .W. glauca

W. controversa Hedw. All of the material we have from Colorado comes from siliceous soil from sandstone or granitic rocks and ledges. All of the W. glauca has been taken on soil reacting HCl+ (calcareous). The plants of W. controversa are really green without any glaucous or purplish tints, and the blades are much longer and narrower. When dry the leaves of W. controversa are so tightly rolled that they resemble slender wires. Those of W. glauca are shorter and wider and only the upper parts are affectively convolute. The color of W. glauca is a dull, often somewhat glaucous green. W. controversa is common on non-calcareous substrates in the foothills.

W. glauca Bartram. Thus far the species has been found on calcareous soil on sandstone and limey sandstone ledges on the outer edge of the eastern Front Range. However, better study of the western slope will undoubtedly show it to be present in the canyon country.

W. perligulata Flowers ex Crum, The Bryologist 76:291. 1973. This recently-described species is represented by one collection, from a recess under sandstone boulders along East Creek, west of Whitewater, Mesa County. It is similar to the synoicous Arizona species, W. ligulaefolia, but W. perligulata is paroicous and the leaf shape differs in being almost spatulate.

RHYTIDIACEAE

One genus and species, Rhytidium rugosum (Hedw.) Kindb. One of our largest and most easily recognized mosses, occurring over a wide range of altitudes, from protected north slopes in the foothills canyons up onto the alpine tundra. Although its habitats appear to be relatively dry slopes, it is likely that the moss occurs in areas of good drainage, heavy winter snow accumulation but rapid spring run-off (?). It is never fertile here. In Scandinavian tundra it seems to occur on the more snow-free areas.

Plants coarse and shaggy, forming deep but fairly loose cushions. The stems are very irregularly pinnate, closely invested with ovate, transversely rugose, somewhat falcate green or rust-tinged leaves. The leaves are costate to above the middle, with a distinct area of very small incrassate quadrate or rounded alar cells, linear or oblong-linear leaf cells with strongly incrassate and pitted walls, strongly end-papillose on the dorsal side, the leaf appearing coarsely "toothed" on the back.

SELIGERIACEAE

Blindia

B. acuta (Hedw.) B.S.G. A rare species known only from a few localities from the foothills to the alpine. Blindia forms thin turf-like mats less than one cm high, often tightly attached to the granitic substrate, on sites where water percolates over the surface seasonally. It can be recognized by its peculiar copper-brown sheen, more green when wet. The collections we have are sterile, but recognition in vegetative condition is quite easy.

The plant resembles a very small Dicranum, with leaves swept somewhat to one side and tapered to a fine point. The leaf apex, however, is not sharp but under the microscope it is actually rounded. The costa is broad and the entire distal half of the leaf is composed of the costa alone, the proper lamina narrowing and fading out a little above the middle. The leaf base has enlarged alar and basal cells that are orange in color, and thick-walled.

SPHAGNACEAE

Colorado has a poor Sphagnum flora because the elevated landscape provides mineral-rich aquatic habitats and we have no areas in which the bogs are dependent upon rain-water alone. Our bogs are not very acid, so many of the northern Sphagnum species are excluded from this area.

Sphagnum

1a. Branch leaves narrowly ovate-lanceolate, the upper parts not suddenly spreading or squarrose . . . . . (3)
1b. Branch leaves broadly ovate, the upper parts suddenly spreading or squarrose . . . . . (2)

2a. Plants robust, the branch leaves 2 mm or more long, cordate-auriculate at the base and suddenly narrowed at the middle, where the spreading and involute upper portion begins; stem green or pale. . .S. squarrosum
2b. Plants slender, the branch leaves 1-1.3 mm long, ovate, gradually tapered from the base and not suddenly pinched at the middle; stem ranging from pale to dark brown-black . . . . . S. teres

3a. Stems brown, without violet tinge; foliage brown or mixed green and brown; terminal branches short and densely clustered, the stem branches also relatively short. . . . . S. fuscum
3b. Stems pale green to violet; foliage pale green or variegated with violet, often very deep reddish-

violet; terminal branches variable, the outer ones often long and drooping; stem branches also rather long and drooping. . . . . (4)

4a. Branch leaves concave their whole length, with no evident plane or undulate margin showing on the side. . . . . (5)
4b. Branch leaves concave only at the apex, plane below, many leaves showing a somewhat undulate edge. . . . . S. cuspidatum

5a. Branch leaves with very small, strongly bordered ("doughnut-form") round pores on the dorsal side of the cells nearer the leaf apex; outer cortical cells of the stem lacking pores . .S. warnstorfii
5b. Branch leaves with larger, thin-edged, usually oval pores dorsally near the leaf apex; outer cortical cells of the stem commonly having a large pore at one end . . . . . S. russowii

S. cuspidatum Hoffm. Our only collection is an old Wheeler Expedition specimen (as "var. recurvum Beauv.") taken at "Twin Lakes, Colorado Territory" in 1873. In addition to the characters given in the key, this species can be separated from the S. warnstorfii-russowii complex by the fact that the chlorophyllose cells of the branch leaves are more broadly exposed on the dorsal rather than the ventral leaf surface.

S. fuscum (Schimp.) Klinggr. Frequent in subalpine bogs, particularly with Betula glandulosa. This species forms very compact mounds on relatively high ground above the normal water table of the bog, and can be recognized in the field by the brown color of the leaves and stem, the slender stems and short branches.

S. russowii Warnst. Very closely related to S. warnstorfii, this species occurs with that species in willow bogs and on wet forest floors. The combination of large cell pores and porose cortical cells is diagnostic. When cortical pores are difficult to demonstrate, and the cell pores are nevertheless large, there is the possibility that we might be dealing with still another close relative, S. nemoreum, but the evidence is not conclusive on this.

S. squarrosum Sw. ex Crome. This usually occurs in willow and peat bogs along with S. warnstorfii and S. russowii, but it is less abundant and tends to inhabit the more saturated depressions. It is a large species and along with the large leaf size, it is easily known by the stiffly spreading involute leaf-tips.

S. teres (Schimp.) Aongstr. ex C. Hartm. This is like a small edition of S. squarrosum, with leaves more of the magnitude of S. russowii and S. warnstorfii, but has, especially when dry, the characteristic spreading leaf tips. We have this from only a few localities (Cumbres Pass, and the Silver Lake area of the Boulder Watershed).

S. warnstorfii Russ. Study of a large series of specimens is needed for one to become convinced of the value of the pore size character, but once recognized, S. warnstorfii is really easily learned, although in the field I find nothing to surely distinguish it from S. russowii. Both species seem to be equally abundant in the subalpine willow bogs along the beaver-dammed streams of the high country.

SPLACHNACEAE

The Splachnaceae are a peculiar group of mosses, most of our species occurring on dung, decaying animal remains, or other highly organic substrates. Several species have a highly swollen hypophysis (basal part of the capsule); in various species this structure may be colored pink, yellow or white. Such species are commonly called "parasol mosses." In the Colorado species the hypophysis is usually merely differentiated in some minor way from the capsule proper, being either broader or narrower than the urn.

The leaves of the Splachnaceae are usually very loosely areolate, that is, the cells are large and easily visible with a hand-lens, suggestive of casement windows. The species, for the most part, are rare alpine or subalpine mosses growing in moist situations, especially willow-bogs and snow-melt basins. Vegetatively they remind one of Mnium or Funaria, but the leaves are usually narrower and lingulate and are never bordered. Vegetative specimens are virtually impossible to identify.

1a. Peristome absent; capsule long and narrow, tapering to the apex. . . . . .Voitia nivalis
1b. Peristome present; capsule with an evident hypophysis. . . . . (2)

2a. Calyptra constricted below; hypophysis narrower than the urn (genus Tayloria). .(3)
2b. Calyptra not constricted below; hypophysis widened, but at maturity often shrunken and narrower than the urn; peristome teeth reflexed; hypophysis dark purple. . . . . Tetraplodon mnioides

3a. Leaves acuminate, serrate; spores less than 20 microns diameter; peristome teeth divided into 32 prongs. . . . . .Tayloria acuminata
3b. Leaves obtuse, more or less entire; spores more than 20 microns diameter. . . . . (4)

4a. Peristome teeth at maturity in pairs; seta stout, ca. 1 cm tall; spores brown, densely papillose . . . . . .(5)
4b. Peristome teeth at maturity 16, single; seta slender, 3-4 cm tall; spores yellowish-green, granulate or smooth. . . . . Tayloria lingulata

5a. Operculum not deciduous, remaining attached to the exserted columella; leaves clustered at the tip of the stem and branches. . . . . Tayloria hornschuchii
5b. Operculum deciduous; columella not protruding; leaves more or less uniformly distributed down the stem. . . . . Tayloria froelichiana

Tayloria

T. acuminata Hornsch. I have no knowledge of this in the field. We have seen two old Colorado collections "from within 100 miles of Canyon City." New records are much desired.

T. froelichiana (Hedw.) Mitt. ex Lindb. This species is critically close to T. lingulata. According to Howard Crum, in T. froelichiana the peristome has paired teeth and rather erect appressed leaves (conspicuously contorted in T. lingulata when

dry). We have this species from seepage over soils at the base of cliffs near Gothic.

T. hornschuchii (Grev. et Arnott ex Arnott) Lindb. This species typically grows on vertical sides of frost-heaved hummocks in the alpine zone. It is evidently rare because of the rarity of these optimum sites. Usually only a very few plants are found in any one place. Even when sterile, it is recognizable by its very broad, obtuse, loosely areolate leaves.

T. lingulata (Dicks.) Lindb. This species occurs abundantly in a willow-sedge hummock area of a snow-melt basin on the summit of Loveland Pass, where I have found it in association with Drepanocladus revolvens. It does not seem to be associated with animal droppings but forms close turfs in depressions between the hummocks. The hypophysis is narrow and the urn short and broad (wine-glass-shaped) with erect, gray-white peristome teeth.

Tetraplodon

T. mnioides (Hedw.) B.S.G. This species is recognized by its stout reddish or yellowish seta and usually deep purple hypophysis and paler urn with reddish reflexed peristome teeth. The height of the seta is very variable. It is associated with dung, in boggy places in the subalpine.

Voitia

V. nivalis Hornsch. This is one of the rarest of North American mosses. Except for Alaskan records, Colorado is the only State where it has been found, and then only once, on Argentine Pass, in 1886, by William Trelease.

TETRAPHIDACEAE

This family is monotypic, containing only the single genus Tetraphis. It is immediately recognized, since it is almost always found in fruit, by the sporophyte. The slender, tubular, erect capsule is terminated by a peristome consisting of only four narrowly triangular teeth. No other moss has this number, and they can easily be seen and counted under the hand-lens. Vegetative shoots frequently develop elongate, almost leafless shoots terminated by a shallow cup of short, broad leaves in the center of which is a cluster of gemmae. Without sporophytes or gemmae, the species may be recognized with experience by the rather distantly arranged, almost perfectly elliptical leaves which are somewhat prominently keeled and turn a beautiful reddish color when dry or old.

T. pellucida Hedw. Frequent, particularly on tree stumps in moist spruce-fir forests. Probably more common than the few collections would indicate, but does require a moist forest environment and these are not common in Colorado.

THELIACEAE

Myurella

1a. Leaves distinctly acuminate, the margins entire or very slightly crenulate by projecting cell angles; median leaf cells about 25-30 microns long; leaves not as tightly julaceous as the next . . . . . .Myurella tenerrima

1b. Leaves broad and rounded, sometimes suddenly apiculate with an elongate terminal cell or two, but never acuminate, the margins distinctly serrate-dentate; median leaf cells 15-20 microns; leaves tightly julaceous. . . . .Myurella julacea

M. julacea (Schwaegr.) B.S.G. The genus Myurella is very easily recognized, being a minute light blue-green pleurocarp with strongly concave leaves usually strongly appressed to the axis (julaceous) producing a rope-like shoot. There is considerable variability in the leaves in their degree of cell papillosity. In most plants the leaves are smooth but some collections have strongly papillose cells (dorsally), the papillae arising from the distal end of the cell. In these specimens the leaf is often abruptly apiculate with a recurved point consisting of a few cells. One might be tempted to place such extreme specimens in M. sibirica (C.M.) Reim., but in that species the papillae are high and arise from the center of the cell. The leaves also stand out divaricately from the stem before curving upward and inward and one can see space between the leaves. The leaf cells are also shorter and broader, shortly rhombic. M. sibirica has not been found in this part of the country.

M. tenerrima (Brid.) Lindb. This species has been found only once, in Gunnison County. Not enough is known about the habitat to say whether it differs significantly from that of julacea. The species of Myurella occur in the subalpine and alpine, on moist cliffs and solifluction terraces, sometimes occurring in pure tufts but most often found a few stems at a time intertangled with other species of mosses.

THUIDIACEAE

The Thuidiaceae are pleurocarpous mosses, often robust, often pinnately branched and often having the stem leaves larger than the branch leaves (these features excluding Anomodon). The leaves are papillose, with the papillae over the cell lumen. The leaves are never falcate-secund and are often wrinkled when dry. There is always a strong single costa. Some of the genera have prominent paraphyllia.

1a. Plant not distinctly pinnate; paraphyllia absent . . . . . (2)

1b. Plant distinctly pinnate; paraphyllia present, conspicuous . . . . . (3)

2a. Leaves slenderly acuminate, ending in a slender, often hyaline point. . . . . Anomodon rostratus

2b. Leaves broadly lance-ovate, apiculate and more or less toothed at the apex. . . . . .Anomodon attenuatus

3a. Leaf cells short (2:1); paraphyllia broad, several cells wide, toothed from irregularly projecting cells; leaves not strongly narrowed at base; plants of elevated rock outcrops. . . . . .Abietinella abietina

3b. Leaf cells long (3:1 to 5:1); paraphyllia slender, branched, one or two cells wide; leaves abruptly narrowed to the base, with paraphyllia arising from the lower leaf margin; plants of wet streamsides and willow bogs. . Helodium blandowii

Abietinella

A. abietina (Hedw.) Fleisch., (Thuidium abietinum). A robust, pinnately branched plant forming

massive but spongy, loose mats over rock outcrops on steep slopes in the foothills. It occasionally occurs up into the alpine tundra to 12,500 feet. The stem leaves are broadly deltoid, much larger than the branch leaves, and the color is a deep dull green.

The main difference between Abietinella and Thuidium is the simply pinnate branching of Abietinella. Even this is not always reliable, since Abietinella occasionally has bipinnate tendencies. Thuidium microphyllum (=Haplocladium microphyllum (Hedw.) Broth.) was reported by Sayre but the specimen she cited is typical Abietinella. There is little likelihood that Haplocladium microphyllum, a plant of lower altitudes, will be found here, but the following comparison serves to separate the two.

In H. microphyllum the foliage has a distinctly straw-colored to reddish cast (in Abietinella always green), broadly deltoid leaves, the bases of which are strongly arched away from the stem, and the apices are slender (in Abietinella the leaves hug the stem except at the middle), side branches leafy out to the tip (in Abietinella the side-branches become whip-like and the leaves smaller and smaller).

Anomodon

A. attenuatus (Hedw.) Hueb. We have a very few collections, all from the outer foothills, where the plant forms extensive carpets over the downslope edges of [granite] boulders just above the high-watermarks of Boulder and South St. Vrain creeks at about 6,500 feet altitude.

A. rostratus (Hedw.) Schimp. Our few collections are from sandstone cliffs in the southern and western plateau and canyon country at low altitudes (5-6,000 ft.).

Helodium

H. blandowii (Web. et Mohr) Warnst. A large and beautifully pinnate branched moss of bogs in the subalpine zone. The stems are usually erect and rather tightly packed, of a pale yellow-green color, and the side branches gracefully curve out and back from the main stem.

Reports of a second species, Helodium paludosum (Sull.) Austin have proved to be misidentifications of Cratoneuron filicinum and Helodium blandowii.

TIMMIACEAE

Timmiaceae is a monotypic family with the single genus Timmia. The species, with the exception of T. norvegica, are rather large and coarse mosses with the general aspect of Atrichum or Polytrichum, having long straight leaves (when wet) with a distinctly sheathing base. However, there are no lamellae and the leaves are unistratose. Fertile plants show a unique calyptra. The capsule, instead of carrying the calyptra on its ascending apex, escapes from the calyptra, leaving it standing on the seta by its inrolled base just below the base of the capsule. The combination bears a droll likeness to the head of an Indian brave with his single feather standing up behind.

Timmia grows in a variety of situations, from the alpine tundra, where it occurs in loose soil in the lee of large boulders, to north-facing slopes of the foothill canyons in the Pseudotsuga zone where it probably indicates long-lasting snow-cover. Only T. norvegica occurs in really wet sites.

1a. Dioicous; leaf-sheath orange-brown, at least in part; filaments of the inner peristome papillose but not appendiculate . . . . . (2)
1b. Autoicous; leaf-sheath pale or hyaline; filaments of inner peristome appendiculate..T. megapolitana

2a. Sheath smooth, orange-brown throughout; coarse, robust plants of the foothills to alpine. . . . . T. austriaca
2b. Sheath papillose, its basal part hyaline and fragile; low, inconspicuous species of subalpine forests and meadows, rare. . . . . T. norvegica

T. austriaca Hedw. Two forms of the species occur in Colorado, the typical form with leaves spreading and more or less crispate when dry, and forma brevifolia (Ren. et Card.) Sayre, with the leaves stiffly erect and incurved when dry. Forma brevifolia seems to be a high-sunlight ecological modification most commonly occurring in the alpine zone or on sunny canyonsides. In size T. austriaca is similar to T. megapolitana but has broader, more or less plicate leaves which are never strongly involute when dry. The orange-brown sheath is a good field character.

T. megapolitana Hedw. var. bavarica (Hessl.) Brid. Variety bavarica has the upper leaf cells 8-9 microns wide and the leaf sheath is not at all papillose, while T. megapolitana has the upper leaf cells 10-14 microns wide and the leaf sheath has the cells of the collar (junction of sheath and blade) distinctly papillose. In var. bavarica the upper leaf cells appear to be more distinctly arranged in rows than they are in T. megapolitana. All of the Colorado material has checked out to be var. bavarica. T. megapolitana evidently occurs in regions with a less continental climate.

Sayre, in Grout M.F.N.A. (1935) gives the range of T. megapolitana "from the Rocky Mountains east..." but she cited no Colorado records. In her thesis she listed the species on reports by Porter, Brandegee, and Rothrock. These early reports very likely did not attempt to distinguish between the two. The Wolf and Rothrock specimen, from Wheeler Expedition in 1873 (US) belongs to T. bavarica.

T. megapolitana var. bavarica seems to have a narrower ecological and altitudinal range than T. austriaca, occurring in the foothill canyons and the western plateau canyons, but only rarely, in dry sites, up to the subalpine.

T. norvegica Zetterstedt. This is an alpine-arctic species. The Colorado records are the only ones for the United States outside of Alaska. In Eurasia it occurs both in the Arctic and in the southern mountains. It occurs along wet streamsides and moist tundra slopes in the general area of Hoosier Pass. T. norvegica is a very small species and might not be recognized as a Timmia immediately. A cross-section of the leaf shows the characteristic highly-mammillose cells of the ventral surface of the lamina.

DERIVATIONS OF THE GENERIC NAMES

This list is intended to make the study of bryophytes more interesting by giving meaning to the names through their etymological history. Few works on mosses give these derivations; often the authors give no indication of what the name was intended to allude to or in whose honor the name was given. Perhaps it is assumed that the description would give a clue, or that persons commemorated by names were well-known to everyone. In our century much of this lore has been lost and is now difficult to recover. Of the few sources that I have found valuable in the search for derivations, the best is Limpricht. Unfortunately, unless he himself used the name as the valid one, Limpricht gave no derivation. The Barnhart volumes have been useful in ascertaining further facts on the botanists commemorated by moss names.

Useful sources

Barnhart, John Hendley. 1965. Biographical Notes Upon Botanists. 3 volumes. New York Botanical Garden.

Limpricht, K. Gustav. 1890-1904. Die Laubmoose Deutschlands, Oesterreichs und der Schweiz. 3 volumes, Leipzig.

Margadant, W. D. 1968. Early Bryological Literature. xi + 277 pp. Hunt Botanical Library, Pittsburgh.

Sayre, Geneva. 1959. Dates of Publications Describing Musci, 1801-1821. 102 pp. Russell Sage College, Troy, N.Y.

Abietinella: diminutive of Abies, generic name of the fir tree

Aloina: having a resemblance, by the thick, stiff leaves, to the genus Aloe

Amblyodon: from Gr. amblys, blunt, + odous, tooth referring to the peristome

Amblystegium: from Gr. amblys, blunt, + stegos, roof, referring to the operculum

Amphidium: from Gr. amphora, vase or urn, referring to the capsule shape

Anacolia: derivation uncertain (proposed by Schimper, Syn. Musc. 1860)

Andreaea: in honor of Gerhard Reinhard Andreae, 1724-1793, German botanist (?)

Anomodon: from Gr. anomos, different or odd, + odous, tooth, referring to the peristome

Atrichum: from Lat. a-, without, + trichos, hair, referring to the smooth calyptra in contrast to that of Polytrichum

Aulacomnium: from Gr. aulon, channel (?), + Mnion, the name of a moss, possibly referring to the ribbed capsule

Barbula: from dim. of Lat. barba, a beard, referring to the peristome

Bartramia: in honor of the North American botanist, John Bartram, 1699-1777

Blindia: in honor of J. J. Blind, pastor at Muenster, 1834-1848

Brachythecium: from Gr. brachys, short, + theke, case, capsule

Bryoerythrophyllum: from Gr. Bryon, a moss, + erythros, red, + phyllos, leaf

Bryum: from Gr. Bryon, a moss

Buxbaumia: in honor of J. C. Buxbaum, German botanist, 1693-1730

Calliergon: from Gr. kalos, beautiful, + ergon (?)

Campylopus: from Gr. kampylos, bent, + pous, foot, referring to the strongly bent seta of C. pyriformis

Ceratodon: from Gr. keras, horn, + odous, tooth, possibly alluding to the sharply conic operculum

Cirriphyllum: from Lat. cirritus, filamentous, + phyllos, leaf, alluding to the long hair-point of some species

Climacium: from Gr. klimax, ladder, staircase, the meaning uncertain

Cnestrum: from Gr. knestron, a scraper (referring to ?)

Coscinodon: from Gr. koskinon, a sieve, + odous, tooth, referring to the lattice-like peristome

Cratoneuron: from Gr. kratos, strength, + neuron, rib, referring to the stout costa

Crossidium: from Gr. krossos, fringe or tassel, possibly referring to the numerous lamellae on the leaves. Krossos also meant pitcher, pail, urn, so it might refer to the capsule, + diminutive

Cynodontium: from Gr. kynos, dog, + odous, tooth; possibly an allusion to the struma at the base of the capsule

Desmatodon: from Gr. desmis, bundle, package, + odous, tooth, referring to the peristome teeth which may be divided into two or three narrow threads, variously joined together in part

Dichelyma: from Gr. dicha, in two, double, + elymos, case or quiver, referring to the calyptra which is cleft on one side

Dichodontium: from Gr. dicha, in two, double, + odous, referring to the forked peristome teeth

Dicranella: diminutive of Dicranum, which see

Dicranoweis(s)ia: combining Dicranum and Weissia

Dicranum: from Gr. dikranon, pitchfork, + dikros, forked or cloven, referring to the slender forked tine-like peristome teeth

Didymodon: from Gr. didymos, double, + odous, tooth, referring to the divided peristome teeth

Distichium: from Gr. distichos, in two rows, referring to the leaves

Ditrichum: from Gr. dis, twice, + thrix, hair, referring to the deeply divided peristome teeth

Drepanocladus: from Gr. drepanon, sickle, + klados, branch, referring to the strongly falcate leaves and hence, branch tips

Encalypta: from Gr. enkalyptos, covered over, referring to the cylindrical calyptra which completely covers the capsule

Entodon: from Gr. entos, turned inward, + odous, tooth, referring to the outer peristome (but derivation not explained by C. Mueller, the author)

Eucladium: from Gr. eu, true, + klados, branch, referring to the relatively straight branches (?)

Eurhynchium: from Gr. eu, true, + rhynchos, beak, referring to the rostrate operculum

Fabronia: named by Raddi in 1808 for a person, but reference not seen

Fissidens: from Lat. fissum, a cleft or crack, + dens, tooth, referring to the bifid peristome teeth

Fontinalis: from Lat. fons, spring of water, therefore, growing in or by springs

Funaria: from Lat. funis, a rope or cord, referring to the elongate seta

Grimmia: named after Dr. Johann Friedrich Karl Grimm (1737-1821), archiater at Gotha. Bridel dedicated vol. 2 of Muscologia Recentiorum to him.

Gymnostomum: from Gr. gymnos, naked, + stoma, mouth, referring to the lack of peristome

Hedwigia: named for Johann Hedwig, father of bryology, German botanist, 1730-1799

Helodium: from Gr. helos, marsh

Homalothecium: from Gr. omalos, even, level, smooth, + theka, capsule

Homomallium: from Lat., homomallus, turned in the same direction (as leaves)

Hydrogrimmia: from Gr. hydor, water, + Grimmia

Hygroamblystegium: from Gr. hygros, wet, + Amblystegium

Hygrohypnum: from Gr. hygros, wet, + Hypnum

Hylocomium: from Gr. hylokomos, overgrown with woods, sylvan

Hymenostomum: from Gr. hymen, a membrane, + stoma, mouth, named for the tendency of the capsule mouth to remain covered, after the fall of the operculum, by a thin membrane. The peristome is absent.

Hymenostylium: from Gr. hymen, a membrane, + stylos, pillar or column, referring to the slender columella which remains attached to and raises the operculum above the urn at maturity

Hypnum: fr. Gr. hypnon, a classical name of a kind of moss

Isopterygium: from Gr. isos, equal or alike, + dimin. of pteryx, wing, meaning (?)

Leptobryum: from Gr. leptos, slender, + bryon, a moss, referring to the linear leaves which are so unusual in the group of Bryaceae

Leptodictyum: from Gr. leptos, slender, delicate, + dictyon, net, probably referring to the generally delicate branching of the plant as a whole

Leptodon: from Gr. leptos, slender, + odous, tooth, referring to the peristome teeth

Lescuraea: named for Charles Leo Lesquereux, Swiss-American botanist, 1806-1899, who collaborated with Sullivant on the North American moss flora

Leskeella: dimin. of Leopold Loeske, German botanist, 1865-1935

Lindbergia: named for Sextus Otto Lindberg, Finnish botanist, 1835-1889

Meesia: for David Meese, Dutch botanist, 1723-(?)

Mielichhoferia: named for Mathias Mielichhofer, 1772-1847, Austrian botanist

Mnium: from Gr. mnion, classic name for a kind of moss

Myurella: from Gr. mys, mouse, + oura, tail, alluding to the julaceous stems

Neckera: named for N. J. de Necker, German botanist, 1730-1793

Oncophorus: from Gr. onchos, a swelling, + phoreus, bearer, carrier, alluding to the struma on the base of the capsule

Oreas: from Gr. Oreas, a mountain-nymph

Orthodicranum: fr. Gr. orthos, straight, + Dicranum, alluding to the straight capsule, in contrast to the curved one of Dicranum proper

Orthothecium: from Gr. orthos, straight, + thecium, capsule, alluding to the straight capsule

Orthotrichum: from Gr. orthos, straight, + thrix, hair, alluding to the hairs of the calyptra of many species

Paraleucobryum: from Lat. par, like, + Leucobryum, because of the similar leaf structure

Phascum: from Gr. phaskolos, a leather bag, or from Phascon, a classical name for a lichen or moss (according to Jensen), possibly alluding to the capsule

Philonotis: from Gr. phileo, loving, + notia, moisture

Physcomitrium: from Gr. physko, blister or bubble, + mitrion, cap, alluding to the domed operculum

Plagiobryum: from Gr. plagios, oblique, + bryon, a moss, alluding to the oblique angle formed by the operculum and capsule junction

Plagiomnium: from Gr. plagios, oblique, + Mnium, referring to the arching sterile shoots

Plagiopus: from Gr. plagios, oblique, + pous, foot, referring to the angle at which the capsule meets the seta

Plagiothecium: from Gr. plagios, oblique, + theka, capsule

Platydictya: from Gr. platys, broad or wide, + diktyon, net, possibly alluding to the loose areolation of the lamina

Pleurozium: from Gr. pleuron, rib, alluding to the ribbed capsule

Pogonatum: from Gr. pogon, beard, alluding to the hairy calyptra

Pohlia: named for Johann Ehrenfried Pohl, German botanist, 1746-1800

Polytrichastrum: from Polytrichum, + astrum, resembling

Polytrichum: from Gr. poly, many, + thrix, hair, alluding to the calyptra

Pseudoleskeella: from Gr. pseudo, false, + Leskeella

Pterigynandrum: from Gr. pteron, wing, + gyne, female, + andr, male, alluding to the distinctly lateral male and female "inflorescences"

Pterygoneurum: from Gr. pteron, wing, + neuron, rib = costa, alluding to the lamellae

Pylaisiella: named for August J. M. Bachelot de La Pylaie, French botanist, 1786-1856

Racomitrium: from Gr. rhakos, rag, remnant, + mitrium, cap, alluding to the ragged lower edge of the calyptra

Rhizomnium: from Gr. rhiza, root, + Mnium, alluding to the copious rhizoids

Rhynchostegiella: dim. of Rhynchostegium

Rhynchostegium: from Gr. rhynchos, beak, snout, + stegos, cover, alluding to the rostrate operculum

Rhytidium: dimin. of Gr. rhysos, wrinkled, alluding to the rugose leaves

Roellia: named for Julius Roell, German botanist, 1846-1928

Saelania: named for Anders Thiodolf Saelen, Swedish botanist, 1834-1921

Schistidium: diminutive of Gr. schistos, split, divided, possibly alluding to the peristome teeth which are divided or irregularly cleft or perforated

Scleropodium: from Gr. skleros, hard, + podion, foot of a building, alluding to the tough stems

Scorpidium: from Lat. skorpidion, a little scorpion, probably from a fancied resemblance of the falcate branch tips to the tail of a scorpion

Sphagnum: from Gr. sphagnos, a classical name for a moss

Stegonia: from Gr. stegos, a roof or cover, possibly alluding to the leaf-cluster, which "roofs over" the growing tip

Tayloria: named for Thomas Taylor, who collaborated with Sir W. J. Hooker in the Muscologia Britannica

Tetraphis: from Gr. tessares, four (peristome teeth)

Tetraplodon: from Gr. tetraplos, quadruple, + odous

Timmia: named for Joachim Christian Timm, German botanist, 1734-1805

Tortella: diminutive of Tortula

Tortula: diminutive of Lat. tortus, a twist, alluding to the peristome

Trichostomum: from Gr. thrix, hair, + stoma, mouth; referring to the slender peristome teeth

Voitia: named for J. G. W. Voit, German physician and botanist, 1776-1813

Weissia: named for F. G.(or F. W.?) Weiss, German bryologist

MEANINGS OF THE SPECIFIC EPITHETS

aberrans: aberrant, unusual
abietina: like the fir tree, Abies
adnatum: tightly attached
aduncus: hooked
aeruginosum: bluish-green
affinis: akin to
agassizii: Louis Agassiz, Swiss-Amer., Harvard Professor, 1807-1873
algovicum: of Allgau, an alpine region of southern Europe
alpestris, alpicola: of high mountains
andreaeoides: like Andreaea
androgynum: probably an archaism used by Linnaeus to refer to the presence of gemmae
anodon: lacking peristome
anomala: unusual
antipyretica: useful in preventing fires as on thatched roofs
aphylla: lacking leaves
apocarpum: with sessile capsules
argenteum: silvery
asperifolius: rough-leaved
austriaca: of Austria
bartramii: Edwin B. Bartram, Amer. bryologist, 1878-1964
bavarica: of Bavaria
bestii: George N. Best, Amer. bryologist, 1846-1926
bicolor: two-colored
blandowii: Otto C. Blandow, German, 1778-1810
blyttii: Matthias Numsen Blytt, Norwegian, 1789-1862
brachyphylla: short-leaved
brachyptera: short-winged
breviseta: short seta
caespiticium: forming clumps
calcareum: of limestone
calyptratus: with a cap
camptotrachela: with a curved or bent neck
canescens: hoary
capillare: very slender
cernuus: slightly drooping
chryseum, chrysophyllum: golden-leaved
cirrosum: ending in a slender curled or wavy appendage
collinum: of hills
commutatum: changed
concinnus: pretty
cordifolium: heart-leaved
cruda: raw
cupressiforme: resembling the cypress tree
cupulatum: with a cup (-like capsule)
cyclophyllum: round-leaved
dealbatus: whitened
decipiens: deceptive
demissum: humble, low
dendroides: tree-like
diaphanum: colorless and transparent
dilatatum: dilated
douglasii: David Douglas, Scottish explorer, bot., N. Amer. 1799-1834
donniana: David Don, British bot., 1799-1841
drummondii: Thomas Drummond, Scotland, 1780(?)-1835
duriaei: Durieu de Maisonneuve, France, 1796-1878
elatior: taller
enerve: lacking a costa
erythrorrhizon: with red rhizoids
exannulatus: unrolled
fendleri: August Fendler, collector for Asa Gray, 1813-1883
ferruginascens: rusty
filicinum: fern-like
flexicaule: with a curving stem
fluviatile: of streams
fontana: of springs
froelichiana: Friedrich H. W. Frölich, Germany, 1769-1845
fuscescens, fuscum: becoming brown, brown
glaucescens: becoming glaucous
gracilescens: becoming slender
griseum: gray
halleri: Albrecht von Haller, Swiss, 1708-1777
hallii: Elihu Hall, Amer. bot., expl. Colorado, 1822-1882
hispidulum: minutely bristly
hookeri: Wm. Jackson Hooker, British bot., 1785-1865
hornschuchiana: Christian Friedrich Hornschuch, German bot., 1793-1850
hygrometrica: water-measuring
hypnoides: resembling Hypnum
indusiata: with a veil
inermis: unarmed (lacking hair-point)
ithyphylla: leaves like a bundle of sticks
jamesianum: T. P. James, Amer. bryologist, 1803-1882
jungermannioides: like a minute leafy liverwort
kochii: W. D. J. Koch, German bot., 1771-1849
laetum: pleasant
laevigata: smooth
laevisphaera: with a smooth urn
lapponicum: of Lappland
latifolius: broad-leaved
laureri: J. F. Laurer, German bot., 1798-1873
leucostoma: white-mouthed
lindbergii: Sextus Otto Lindberg, Swed.-Finl., 1835-1889
lingulata: tongue-shaped
longicolla: with a long neck
luridum: dirty-brown
lyallii: David Lyall, Scottish bot., expl. Pacific N.W., 1817-1895
martiana: K.F.P. von Martius, German bot., 1794-1868
megalophyllum: with huge leaves
megapolitana: of the duchy of Mecklenburg, N. Germany
menziesii: Archibald Menzies, naturalist with Vancouver Exped., 1754-1842
mielichhoferi: Matthias Mielichhofer, German bot., 1771-1847
mollis: soft
muehlenbeckii: Heinrich Gustav Mühlenbeck, German bot., 1798-1845
nelsonii (Brachythecium): Elias Nelson, Wyoming bot., 1876-(?)
nemoreum: of woodlands
nervosa: with a costa
nitens: shiny
nivalis: of the snows
nutans: nodding, pendent
obtusifolium: obtuse-leaved
occidentalis: western
ochraceum: yellow-brown
oederiana: G. C. Oeder, German-Danish bot., 1728-1791
orthocladum: straight-branched
osmundoides: like the fern, Osmunda
pallens, pallescens: pale, becoming pale
palustre: of swamps
patens: spreading
pellucidum: translucent but not hyaline
pennata: pinnate
perligulata: ligulate throughout
piliferum: with hair-points
plagiopodia: oblique-based (capsule)
plinthobius: growing on bases of columns
plumosum: feather-like
-podium: foot
polyantha: many-"flowered"
procera: very tall

pseudotriquetrum: alluding to a resemblance to Bryum triquetrum
pulchellum: beautiful and small
pulvinata: cushioned
pumilum: dwarf
pusilla: very small
pyrenaicum: of the Pyrenees Mts.
pyriforme: pear-shaped
radicosa: with roots (rhizoids)
recurvirostre: with a recurved beak
revolvens: curved in a circle
rhabdocarpa: furrowed capsule
rigens: stiff
riparium: of streamsides
rivulare: of rivulets
roellii: Julius Röll, German bot., 1846-1928
rostratus: beaked
ruralis: of the country
rupestris: of rocks
russowii: E.A.F. Russow, Esthonian bot., 1841-1897
rutabulum: a little rake
salebrosum: rough, uneven
sarmentosum: twiggy
schistii: of schist rock
schreberi: Johann C. D. von Schreber, German bot., 1739-1810
scoparium: broom-like
selwynii: Alfred R. C. Selwyn, Dir. Geol. Surv. Canada, 1824-1902
serpens: creeping
smithii (Leptodon): J. E. Smith, English bot., 1759-1828
spinosum, spinulosum: with spines, small spines (teeth)
squamigerum: having scales
starkei: Johann Christian Starke, German bot., 1744-1808
stellatum: star-like
stenotrichum: slender thread
stricta: straight (leaves)
sublimbatus: somewhat bordered
subulata: awl-shaped
sudeticum: of the Sudeten area, S. Europe
systylius: with the operculum fixed to the columella
tauricum: of the Crimea
tectorum: of roofs
tenax: durable
tenellum: delicate
tenerrima: very slender
teres: terete
thomsonii: Thomas Thomson, Scottish, expl. Sikkim, 1817-1878
tophaceus: tufa-like, with a gritty surface
torquata: twisted
trichophyllus: thread-leaved
turbinatum: top-shaped, obconic
turgidum: swollen
uliginosa: of marshes
uncinatus: hooked
unguiculata: with a "claw" or stipe
urnigerum: carrying urns
vaucheri: Jean Pierre Vaucher, Swiss bot., 1763-1841
velutinum: velvety
verticillatum: in a whorl
vinealis: of vine-lands
virens: green (viridulus: small green)
wahlenbergii: Göran Wahlenberg, Swedish bot., 1780-1851
warnstorfii: Carl Friedrich Warnstorf, Sphagnologist, German, 1837-1921
weigelii: C. E. von Weigel, German bot., 1748-1831
wrightii: Charles Wright, Amer. plant collector, 1811-1885
zierii: John Zier, Polish-British, (died 1796)

Note: [ ] means not definitely recorded.

POLYTRICHUM (POLYTRICHACEAE) 28
P. commune Hedw.
P. juniperinum Willd. ex Hedw.
P. piliferum Hedw.
P. strictum Menzies ex Brid.

POTTIA (POTTIACEAE). 33
P. bryoides (Dicks.) Mitt.

PSEUDOLESKEELLA (LESKEACEAE) 23
P. tectorum (Funck ex Brid.) Kindb. ex Broth.

PTERIGYNANDRUM (ENTODONTACEAE) 16
P. filiforme Hedw.

PTERYGONEURUM (POTTIACEAE) 33
P. ovatum (Hedw.) Dix.
P. subsessile (Brid.) Jur.

PYLAISIELLA (HYPNACEAE). 22
P. polyantha (Hedw.) Grout

RACOMITRIUM (GRIMMIACEAE). 21
R. canescens (Hedw.) Brid.
R. fasciculare (Hedw.) Brid.
R. sudeticum (Funck) B.S.G.

RHIZOMNIUM (MNIACEAE). 25
R. magnifolium (Horikawa) Kop.
R. pseudopunctatum (Br. et Sch.) Kop.

RHYNCHOSTEGIELLA (BRACHYTHECIACEAE). 7
R. compacta (C. M.) Loeske

RHYNCHOSTEGIUM (BRACHYTHECIACEAE). 7
R. serrulatum (Hedw.) Jaeg. et Sauerb.

RHYTIDIUM (RHYTIDIACEAE) 35
R. rugosum (Hedw.) Kindb.

ROELLIA (BRYACEAE) 10
R. roellii (Broth. ex Roell) Andrews ex Crum

SAELANIA (DITRICHACEAE). 14
S. glaucescens (Hedw.) Broth.

SCHISTIDIUM (GRIMMIACEAE). 20
S. agassizii Sull. et Lesq. in Sull.
S. alpicola (Hedw.) Limpr.
S. apocarpum (Hedw.) B.S.G.
(Grimmia) occidentalis Lawton
S. tenerum (Zett.) Nyholm

SPHAGNUM (SPHAGNACEAE) 35
S. cuspidatum Hoffm.
S. fuscum (Schimp.) Klinggr.
S. russowii Warnst.
S. squarrosum Sw. ex Crome
S. teres (Schimp.) Aongstr. ex C. Hartm.
S. warnstorfii Russ.

STEGONIA (POTTIACEAE). 33
S. latifolia (Schwaegr. ex Schultes) Vent. ex Broth. forma pilifera (Brid.) Moenk.
S. latifolia (Schwaegr. ex Schultes) Vent. ex Broth. var. latifolia

TAYLORIA (SPLACHNACEAE). 36
T. acuminata Hornsch.
T. froelichiana (Hedw.) Mitt. ex Lindb.
T. hornschuchii (Grev. et Arnott ex Arnott) Lindb.
T. lingulata (Dicks.) Lindb.

TETRAPHIS (TETRAPHIDACEAE) 37
T. pellucida Hedw.

TETRAPLODON (SPLACHNACEAE) 37
T. mnioides (Hedw.) B.S.G.

TIMMIA (TIMMIACEAE). 38
T. austriaca Hedw.
T. megapolitana Hedw. var. bavarica (Hessl.) Brid.
T. norvegica Zett.

TORTELLA (POTTIACEAE). 33
T. arctica (H. Arnell) Crundw. et Nyholm
T. fragilis (Hook. ex Drumm.) Limpr.
T. rigens Albertson
T. tortuosa (Hedw.) Limpr.

TORTULA (POTTIACEAE) 33
T. bartramii Steere
T. bistratosa Flowers
T. brevipes (Lesq.) Broth.
T. inermis (Brid.) Mont.
T. intermedia (Brid.) Berk.
T. mucronifolia Schwaegr.
T. norvegica (Web. f.) Wahlenb. ex Lindb.
T. papillosissima (Coppey) Broth.
T. ruralis (Hedw.) Gaertn., Meyer et Scherb.
T. subulata Hedw.

TRICHOSTOMUM (POTTIACEAE). 34
T. tenuirostre (Hook. et Tayl.) Lindb.

VOITIA (SPLACHNACEAE). 37
V. nivalis Hornsch.

WEISSIA (POTTIACEAE) 35
W. controversa Hedw.
W. glauca Bartram
W. perligulata Flowers ex Crum

292 species and varieties

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ADDENDUM

Calliergon megalophyllum Mikut. This remarkable species was discovered during the typing of this manuscript and could not be inserted. It occurs submerged in still water of a subalpine bog in the Boulder Watershed at 3,000 m. between the Mountain Research Lab and Silver Lake. In the key it would come to C. cordifolium, but differs significantly in several ways. The costa is narrower (30-50 microns); the stems are beautifully pinnate with very large (3-4 mm) leaves, dull green to deep brown. This is a new record for the contiguous United States and will be reported in detail elsewhere.

* * *

Anoectangium sp. indet. Specimens collected at Steamboat Mountain, northwest of Lyons, Boulder County, appear to belong to a species of this genus, but the material we have is not sufficient to be certain of its identity.

* * *

Didymodon cf. reedii H. Robinson (The Bryologist 70: 323-325, 1967) has been verified by Robinson in material from caliche soils in Yuma and Weld counties. This species was first described from Maryland. I am tentatively including this material in my concept of Didymodon rigidulus until more material permits a thorough comparison of all of the Colorado plants. The calcareous habitat of "reedii" along with leaf cell differences certainly suggests that two species may be recognized. According to Robinson, D. reedii has leaves strongly revolute nearly to the apex (D. rigidulus being revolute only lower down), and the costa has two distinct stereid bands (one in D. rigidulus). Robinson claims that Colorado material of D. rigidulus lacks propagula in the leaf axils (although European material has them), and that the propagula of D. reedii are uniform in shape and are not noticeably stalked. In D. rigidulus the propagula are said to be variable in shape and with prominent stalks.

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