An annotated checklist of the liverworts and hornworts of Olympic National Park, Washington

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The Olympic National Park covers the mountainous central portion of the Olympic Peninsula of Washington. The Olympic Peninsula is bordered by the Pacific Ocean on the west, the Straits of Juan de Fuca to the north, and Puget Sound to the east. The park extends from 47°30' to 48°05'N and from 123°05' to 124°40'W. It was established by President Franklin D. Roosevelt in 1938 and was formally dedicated in 1946. In 1953, the Queets Corridor and Olympic Ocean Strip were added.

The flora of the park is diverse. The lowland conifer forests that occur as a narrow strip along the major river valleys draining to the west are dominated by *Picea sitchensis*. Eastward the area is dominated by *Tsuga heterophylla*, *Thuja plicata* and *Psuedotsuga menziesii* (Buckingham & Tisch, 1979). The forests of the mid-elevation region are dominated by *Abies amabilis*, *Tsuga heterophylla* and *Pseudotsuga menziesii*. Subalpine forests are dominated by *Abies amabilis* and *Tsuga mertensiana*. The main taxa for the subalpine meadows of the western portion, characterized by late snow banks, are *Carex nigricans* and *Phyllodoce empetriformis*. In the drier eastern portion, *Arenaria capillaris* and *Festuca idahoensis* are common.

During the Pleistocene the peninsula experienced two major glacial periods, the Admiralty and the Vashion, equivalent to the Illinoian and Wisconsinan periods east of the Rocky Mountains (Weaver, 1937). During the Vashion glaciation, continental glaciers from British Columbia extended into the Puget Sound region, but had little effect on the Olympic Mountains. The peak is primarily composed of basalts, sandstones and shales. Marine sediments deposited from the Eocene through the Miocene make up the central core of the mountains.

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The climate of the park is maritime, and characterized by mild, wet winter and relatively cool, dry summers; most precipitation falls between November and March. The mean annual temperature is 9.3°C (weather station, Port Angeles). The mountains, oriented north - south, are effective barriers against the moist. prevailing westerlies. Onshore winds move across the coastal plain, up the broad valleys, rise over the short western mountains, and are forced to rise over the tall mountain barriers dominated by Mt. Olympus and peaks of the Bailey Range. Mean annual precipitation is 200-250 cm along the coastal plain and valleys west of the Bailey Range and 340 cm or more on some of the windward slopes (Kuramoto & Bliss, 1970).

There are several studies of the vascular plants of the park, but there is no study of the Hepaticae, although some species were mentioned from the area by Frye (1908), Clark (1909). Fulford (1936), Frye and Clark (1937-1947) and Schofield (1968). The hepatic flora of the park is very rich, espscially along the Pacific Coast and Hoe River Valley. Microclimatically, there are many areas rich in species due to the presence of waterfalls, streamlets and lake shores.

The senior author made collecting trips to the park during the summer months between 1978 and 1988. Approximately 2,000 collections of liverworts and hornworts were made. Specimens borrowed from CU, FH, NY, TENN, UBC, USNM, YU have also been incorporated. The collection numbers are those of the senior authors. Voucher specimens have been deposited at the College of Great Falls, Montana, with duplicates in the herbarium of University of Cincinnati (CINC). Also included are specimens reported by Frye and Clark (1937-1947), Fulford (1936) and Schofield (1968).

Square brackets denote species collected in nearby areas on the Olympic Peninsula, but not yet collected in Olympic National Park. Records new to the park and the state of Washington are indicated by one or two asterisks, respectively. In general, nomenclature follows Stotler & Crandall-Stotler (1977) and Grolle (1983a, 1983b). Except for the most common species, one representative specimen from each collecting area is cited in the text.

Annotated checklist of the liverworts and hornworts

The liverwort and hornwort flora of the Olympic National Park contains 29 families, 47 genera, 113 species, 3 subspecies, 4 varieties and 2 forms. Twenty-one percent of the taxa are reported from the park for the first time, including 15 genera, 22 species, 2 varieties and a form; of these 3 genera and 3 species are new reports for Washington.

The following abbreviations are used after the name of each taxon for different distributional elements: 1. Circumpolar-arctic-boreal alpine-montane; 2. circumpolar, boreal montane; 3. Circumpolar, arctic-temperate alpine-montane; 4. Circumpolar, boreal-temperate montane; 5. Circumpolar, arctic alpine; 6. Circumpolar, eastern boreal montane; 7. Western North American Endemic species (see Hong et al. 1988).

ANTHOCEROTACEAE

Anthoceros L. emend. Prosk.

1. Convex side of spores with papillae; spores 45-65 µm in diameter; elaters 60-250 µm long .... *A. fusiformis*
1. Convex side of spores with spines; spores 35-45 µm in diameter; elaters 50-110 µm long .... *A. punctatus*

fusiformis Aust. -- moist soil. Clallam Co.: Elwha R. (Clark & Frye 1928). 7.
punctatus L. -- moist soil. Clallam Co.: Blue Mt. 81-841. 2.

HERBERTACEAE

Herbertus S. Gray

* *aduncus* (Dicks.) S. Gray subsp. *aduncus* -- bark of hemlock, western cedar. Clallam.Co., Beach Trail, 87-779. Ozette L., 88-1844. 2.

PSEUDOLEPICOLEACEAE

Blepharostoma (Dum. emend. Lindb.) Dum.

trichophyllum (L.) Dum. subsp. *trichophyllum* -- shaded, moist soil, rocks and decayed wood. 1.

PTILIDIACEAE

Ptilidium Nees

1. Leaf-lobes usually 1-2-ciliate at margin: underleaves deeply lobed (up to 7/8 of their length) .... *P. californicum*
1. Leaf-lobes usually many ciliate at margin; underleaves rather moderately lobed (up to 1/3 to 1/2 of their length) .... *P. pulcherrimum*

californicum (Aust.) Underw. -- bark of alpine fir and hemlock, decayed wood and soil. 4.

pulcherrimum (G. Web.) Hampe -- decayed wood. 4.

LEPIDOZIACEAE

1. Plants rarely pinnately branched; leaves 2-3 dentate at apex ... *Bazzania*
1. Plants regularly 1-2 pinnately branched; leaves 3-4 lobed (for 0.3-0.9 of their length) 2
   2. Plants small (less than 3 cm long, 0.5 mm wide); leaves symmetric, 4-1obed (for 0.5-0.9 of their length); oil bodies absent in certain leaf or epidermal stem cells (if present 1-5 per cell); underleaves 3-4 lobed, ca. 0.2-0.9 of the size of leaves .... *Kurzia*
   2. Plants large (up to 8 cm long, over 1.0 mm wide); leaves asymmetric, 4-1obed (for 0.3-0.5 of their length): oil bodies distinct and large (5-10 per cell): underleaves 4-lobed, ca. 0.3-0.5 of the size of leaves .... *Leoidozia*

Bazzania S. Gray

1. Stems with noncaducous leaves; underleaves wider than long, 3-4 toothed .... *B. tricrenata*
1. Stems with at least some leaves caducous; underleaves about as wide as long, entire or shallowly lobulate 2
   2. Plants green-brownish; cortical cells of stem 1.0-1.5 times as long as wide; leaves mostly 2-dentate at tip; oil bodies ca. 2-4 per median cells; underleaves shallowly 2-4 lobed with acute crescent sinuses ... *B. ambigua*
   2. Plants pure green to yellowish-green (never brownish); cortical cells of stem 2-3 times as long as wide; leaves usually entire but frequently 2-3 dentate at tip; oil bodies 6-12 per median cells; underleaves shallowly 3-4-lobed, with vestigial sinuses .... *B. denudata*

ambigua (Lindenb.) Trev. -- decayed wood and soil. The lateral margins of underleaves of *B. ambigua* are always entire in contrast to the sinuated lateral margins or underleaves of *B. denudata*. 7.

denudata (Torrey et Gott. et al.) Trev. -- decayed wood. 4.

tricrenata (Wahlenb.) Lindb. -- decayed wood. Clallam Co., Ozette L., 88-1870. 3.

Kurzia von Martens

sylvatica (Evans) Grolle -- decayed wood and soil. 2.

Lepidozia (Dum.) Dum.

reptans (L.) Dum. shaded, decayed wood. 4.

CALYPOGEIACEAE

Calypogeia Raddi

1. Oil bodies distinctly deep blue (in fresh plants) .... *C. azurea*
1. Oil bodies hyaline-slightly grayish or colorless 2
    2. Underleaves divided deeply into 2 lobes 3
    2. Underleaves entire or shallowly divided into 2 lobes .. 4
3. Cells small (less than 30 µm in apices of leaves); underleaves over 2 times (2-3.5 times) wider than stem .... *C. suecica*
3. Cells large (over 30 µm in apices of leaves); underleaves less than 2 times (1-2 times) wider than stem 5
    4. Underleaves broadly orbicular, ca. 1.2-1.5 times as wide as long; rhizoid initial area distinct, border of elongated cells undistinc ... *C. integristipula*
    4. Underleaves orbicular, almost as long as wide; rhizoid initial area undistinct, border of elongated cells very distinct .... *C. neesiana*
5. Underleaves ca. 1.5-2.0 times as wide as long, ca. 1.0-1.5 times as wide as stem; leaves bidentate or sharply pointed at tips .... *C. fissa*
5. Underleaves ca. 1.0-1.5 times as wide as long, ca. 2 times as wide as stem; leaves entire or obtusely pointed at tips 6
    6. Lobes of underleaves obtuse-rounded, sinus of underleaves shallow (4-6 cells long to rhizoid initial area); oil bodies colorless ... *C. muelleriana*
    6. Lobes of underleaves acute-subacute, sinus of underleaves deep (over 1/2 of the length to rhizoid initial area); oil bodies deep blue in fresh plants .... *C. azurea*

azurea Stotler & Crotz -- shaded, decayed wood and moist soil. 2.
* *fissa* (L.) Raddi -- moist soil. Jefferson Co.: Graves Cr. Trail, 85-1228. 4.
* *integristipula* Steph. -- shaded, decayed wood and moist loam. 4.
* *muelleriana* (Schiffn.) K. Müll. -- shaded, decayed wood and moist soil. 3.
neesiana (Mass. & Carest.) K. Müll. -- shaded, decayed wood and moist soil. 3.
suecica (H. Arnell & J. Perss.) K. Müll. -- shaded, decayed wood and moist soil. 2.

CEPHALOZIACEAE

1. Leaves shallowly bilobed (up to 0.3 of their length); underleaves large, bilobed, identical to leaves .... *Hygrobiella*
1. Leaves distinctly bilobed (ca. 0.3-0.8 of their length); underleaves absent .... *Cephalozia*

Hygrobiella Spruce

laxifolia (Hook.) Spruce -- wet rocks. Clallam Co., Hoh Cr., Schofield 77657 (UBC). 1.

Cephalozia (Dum. emend. Schiffn.) Dum.

1. Leaves distinctly decurrent, orbicular (as wide as long), horizontally or obliquely inserted, bilobed (0.2-0.5 of their length), lobes connivent 2
1. Leaves never distinctly decurrent, ovate (longer than wide), subtransversely inserted, bilobed (0.5-0.7 of their length), lobes never connivent ... 4
   2. Dioicous; leaf cells 15-35 X 20-35 μm at base; stolons absent ... *C. lunulifolia*
   2. Autoicous; leaf cells 30-50 X 45-60 μm at base; stolons frequent absent .. 3
3. Leaves strongly decurrent, 8-12 cells wide, with sharply pointed connivent lobes, cells 40-50 X 45-60 μm; stolons absent; perianth mouth with acuminate lobes which terminate in 2-4 elongate cells .... *C. connivens*
3. Leaves slightly decurrent, 12-25 cells wide, with short pointed little connivent lobes, cells 30-35 X 40-50 μm; stolons frequent; perianth mouth shortly crenulate .... *C. pleniceps*
   4. Dioicous; cortical cells of stem in 10 rows; leaves transverse, 5-10 cells wide at base 5
   4. Autoicous; cortical cells of stem in 8-12 rows; leaves subtransverse-subhorizontal, 4-6 cells wide at base 6
5. Leaf-lobes narrow and long, 2-4 cells wide at base, bilobed for 0.7 of their length; perianth mouth with teeth of 1-3 cells .... *C. macounii*
5. Leaf-lobes lanceolate-triangular, 4-5 cells wide at base, bilobed for 0.5 of their length; perianth mouth with teeth of 1 cell .... *C. leucantha*
   6. Leaves bilobed for 0.5-0.6 of their length, cells 30-40 X 40-50 μm in leaf base, with thin nonpigmented walls; perianth mouth denticulate ... *C. bicuspidata*
   6. Leaves bilobed for 0.4-0.5 of their length, cells 20-25 X 20-35 μm in leaf base, with thick brownish-golden walls; perianth mouth crenulate ... *C. ambigua*

ambigua Mass. -- moist soil and wet rocks. 1.

bicuspidata (L.) Dum. -- [syn. *C. lammersiana* (Hüb.) Carring.] -- shaded, decayed wood, moist rocks and sandy stream banks. 3.

* *connivens* (Dicks.) Lindb. -- shaded, decayed wood. Jefferson Co.: Rain Forest Trail, 79-324; Hong (1988). 4.

leucantha Spruce -- shaded, decayed wood. Grays Harbor Co., Quinault L., Muenscher 306 (CU). 2.

lunulifolia (Dum.) Dum. -- shaded, decayed wood, wet rocks and stream banks. Many collections made near Boulder Cr. (Clallam Co.) have upper leaf cells much larger than typical, and similar to those of *C. oleniceos*. 3.

macounii (Aust.) Aust. -- decayed wood and moist soil. 2.

pleniceps (Aust.) Lindb. -- shaded, decayed wood and wet stream banks. 2.

ADELANTHACEAE

Odontoschisma (Dum.) Dum.

denudatum (Mart.) Dum. -- decayed wood. Grays Harbor Co.: Quinant Indian Res., Muenscher 393 (CU). 4.

CEPHALOZIELLACEAE

Cephaloziella (Spruce) Schiffn., nom. cons.

1. Gemmae angular, 1-celled; margins of leaf-lobes acutely dentate-serrate .. .. *C. turneri*
1. Gemmae ovoid, 1-2 celled; margins of leaf-lobes entire or weakly dentate ... 2
    2. Leaves often dentate; underleaves present and distinct 3
    2. Leaves never dentate; underleaves absent or minute if present ... 4
3. Plants copper-red or purple; margins of leaf-lobes with small basal tooth; abaxial leaf surface smooth; gemmae abundant, 2-celled, reddish .... *C. divaricata*
3. Plants dark-green or brownish; margins of leaf-lobes dentate; abaxial leaf surface with coarse, conical protuberances; gemmae scarce, 1-2 celled, green .... *C. divaricata* var. *scabra*
    4. Leaf-lobes ovate-lanceolate, 4-8 cells wide at base, cells large, 15-20 μm, thin-walled; underleaves present but small .... *C. stellulifera*
    4. Leaf-lobes lanceolate-triangular, 8-14, cells wide at base, cells small, 10-14 μm, thick-walled; underleaves absent 5
5. Plants green-brown; leaf-lobes ovate-triangular, 5-8 cells wide at bases; gemmae 2-celled, pale-green to brownish, ellipsoidal .... *C. hampeana*
5. Plants red-brwon; leaf-lobes oval-lanceolate, 3-5 cells wide at base; gemmae 1-2 celled, green, ovoid .... *C. rubella*

divaricata (Sm.) Schiffn. -- moist ledges and wet rock outcrops. Clallam Co.: Badger Valley Trail, 81-916. Little R., 82-838. Moose L. Trail, 85-1152. Jefferson Co., N. Fork Trail, 83-1023. Superficially, the distinction between this species and *Marsupella sphacelata* fo. *media* that shares the same habitat, is very difficult. 3.

* *divaricata* var. *scabra* M.A. Howe -- shaded soil. Clallam Co.: Eagle Point Trail, 82-798. 3.

[*hampeana* (Nees) Schiffn.] -- shaded soil. Grays Harbor Co.: Pacific Beach (Clark & Frye, 1928, 1931). 4.

* *rubella* (Nees) Warnst. -- shaded soil. Clallam Co.: Hurricane Hill, 80-383. Moose L. Trail, 85-1173. The oil bodies of this species are 2-5 per cell as in *Eremontus myriocarpus* and show similar shape. Also these two species are superficially similar. However, there are abundant 2-celled pink-brownish gemmae in *C. rubella* in contrast to absence of gemmae of *E. myriocarpus*. 4.

stellulifera (Tayl. ex Spruce) Schiffn. -- moist soil. Grays Harbor Co.: Pacific Beach, Foster 1497 (FH, YU). 4.

turneri (Hook.) K. Müll. -- moist soil. Grays Harbor Co.: Pacific Beach (Frye & Clark, 1937-1947).

GEOCALYCACEAE

1. Leaves entire; underleaves free .... *Chiloscyphus*
1. Leaves bilobed or emarginate: underleaves often connate with leaves at base ... 2
    2. Underleaves with a long tooth on each side; psrianth present, trigonous and

terminal .... *Lophocolea*

2. Underleaves with entire margin; perianth absent, subterranean perigynium present .... *Geocalyx*

Chiloscyphus Corda corr. Dum., nom. et orth. cons.

1. Plant body transparent, pale whitish-green; leaf-cells 35-65 µm; perianth lobes spinose-dentate .... *C. pallescens*
1. Plant body rather opaque, dull or deep green; leaf-cells 20-35 µm; perianth lobes entire or undulate 2
   2. Plants terrestrial, green; leaf-cells 25-35 µm .... *C. polyanthos*
   2. Plants aquatic, usually on stones in running water, blackish green to dark green; leaf-cells 20-30 µm .... *C. polyanthos* var. *rivularis*

* *pallescens* (Ehrh. ex Hoffm.) Dum. -- shaded, decayed wood and sandy soil. 4.

polyanthos (L.) Corda -- shaded, decayed wood, wet rocks, and sandy soil near streams. 4.

polyanthos var. *rivularis* (Schrad.) Nees -- submerged rocks, exclusively occurring as pure stands. 4.

Geocalyx Nees

graveolens (Schrad.) Nees -- shaded, decayed wood, thin soil over rocks and humus. 4.

Lophocolea (Dum.) Dum.

1. Dioicous; leaves uniformly 2-toothed .... *L. bidentata*
1. Paroicous; leaves 2-toothed below only .... *L. heterophylla*

bidentata (L.) Dum. [syn. *cuspidata* (Nees) Limpr.]. -- shaded, decayed wood and burnt stumps. 2.

heterophylla (Schrad.) Dum. -- shaded, decayed wood and sandy soil. 3.

PLAGIOCHILACEAE

Plagiochila (Dum.) Dum., nom. cons.

1. Leaf-cells 30-40 µm in middle, marginal teeth cells 25-35 µm; perianth mouth denticulate; oceanic .... *P. asplenioides*
1. Leaf-cells 20-30 µm in middle, marginal teeth cells 15-25 µm; perianth mouth dentate to denticulate; widespread to North Pacific 2
   2. Marginal cells near apex of leaf 15-20 µm; margins of leaves strongly dentate, teeth large (3-4 cells wide and 5-8 cells long); North Pacific ... *P. satoi*
   2. Marginal cells near apex of leaf 20-25 µm, margins of leaves variable, entire to dentate, teeth small (1 cell wide and 1-3 cells long); widespread ....*P. porelloides*

[*asplenioides* (L.) Dum. = *minor* (Nees) S. Arnell] -- moist soil and dscayed wood. Clallam Co.: Port Angeles (Schofield 1968). 3.

porelloides (Torrey ex Nees) Lindenb. -- wet rocks and soil near streams. 3.

satoi Hatt. -- shaded, bark, decayed wood and moist soil. This species is distinguished from *P. porelloides* not only by the small size of the leaf cells (less than 20 μm in marginal cells), but also by strongly reflexed leaf margins, in contrast to large size of cells (over 20 μm in marginal cells) and slightly reflexed leaf margins of *P. porelloides*. 4.

GYROTHYRACEAE

Gyrothyra M.A.Howe

underwoodiana M.A.Howe -- wet rocks and moist soil near streams. Clallam Co.: Ozette L., 88-1897. Ozette R., 87-739. Jefferson Co., Graves Cr. Trail, 85-1263a. 7.

JUNGERMANNIACEAE

1. Leaves 2-4 lobed 2
1. Leaves unlobed 5
    2. Leaves strongly canaliculate, uniformly 2-1obed; underleaves absent ....*Anastrophyllum*
    2. Leaves not strongly canaliculate, 2-4 lobed; underleaves present or absent .. 3
3. Leaves usually 2 lobed .... *Lophozia*
3. Leaves usually 3-4 lobed 4
    4. Leaves obliquely inserted and symmetrical, predominantly 4-lobed ....*Barbilophozia*
    4. Leaves transversely inserted and asymmetrical, predominantly 3-1obed .. .. *Tritomaria*
5. Underleaves present 6
5. Underleaves absent .... *Jungermannia*
    6. Leaves reniform to orbicular; underleaves subulate to triangular; without sharply bulging trigones .... *Nardia*
    6. Leaves circular to oval; underleaves subulate or filiform; with sharply bulging trigones ....*Mylia*

Anastrophyllum (Spruce) Steph.

minutum (Schreb.) Schust. moist soil. Jefferson Co.: Mt. Olympus (Clark &Frye, 1928). 1.

Barbilophozia Loeske

1. Leaves subtransversely inserted, 2-4 lobed, lobes without mucronate tips ... 2
1. Leaves horizontally inserted and laterally spreading, 4-1obed, lobes frequently with mucronate tips 3

2. Leaves usually 2-1obed, descending to ca. 1/2 of their length, lobes rounded .. ..*B. kunzeana*
2. Leaves usually 3-lobed, descending to 0.2-0.4 of their length, lobes with subacute to acute tips .... *B. floerkei*
3. Plant body larger (3.0-5.0 mm wide, 3-8 cm long); leaves 3-4 lobed, with mucronate lobes: gemmae rare .... *B. lycopodioides*
3. Plant body smaller (1.5-2.5 mm wide, 2-5 cm long); leaves 3-4 lobed, with sub-acute or obtuse lobes; gemmae abundant .... *B. hatcheri*

floerkei (Web. & Mohr) Loeske -- shaded rocks and humus. 1.
hatcheri (Evans) Loeske -- shaded humus and rocks. 1.
** *kunzeana* (Hüb.) Gams -- shaded moist ledges. Clallam Co.: Moose L. Trail, 85-1184. 1.
**lycopodioides* (Wallr.) Loeske -- shaded humus on rocks. Clallam Co.: Steeple Rock, 80-403. 1.

Jungermannia L. emend. Dum.
1. Perianth smooth with a constricted beak; leaves rectangular, trigones bulging; gemmae present .... *J. leiantha*
1. Perianth plicate without a terminal beak; leaves ovate-circular, trigones lacking; gemmae absent 2
2. Perianth adherent to bracts; rhizoids purple .... *J. hyalina*
2. Perianth free; rhizoids white 3
3. Plant bodies distinctly reddish purple; marginal row of leaf cells thick-walled and larger than those of interior .... *J. rubra*
3. Plant bodies green, brownish green to blackish; marginal row of leaf cells almost similar to those of interior 4
4. Plants larger (2-12 cm long), blackish green; leaves cordate; usually aquatic .... *J. exsertifolia* subsp. *cordifolia*
4. Plants rather smaller (1-2 cm long), green; leaves not cordate; usually on wet rocks and moist soil 5
5. Leaf cells with trigones .... *J. sphaerocarpa*
5. Leaf cells without trigones 6
6. Paroicous; perianth fusiform; leaves ovate-lanceolate ... *J. pumila*
6. Dioicous; perianth pyriform; leaves ovate .... *J. atrovirens*

atrovirens Dum. -- wet rocks near small streams. Clallam Co:. Elwha R. (Fulford, 1936). Hurricane Ridge, 79-206. 5.
exsertifolia subsp. *cordifolia* (Dum.) Vána -- wet rocks near streams and waterfalls. 1.
hyalina Lyell -- wet rocks. 2.
leiantha Grolle -- shaded, decayed wood and wet soil near streams. 2.
rubra Gott. ex Underw. -- moist soil. Clallam Co., Brown Cr. (Fulford, 1936; Frye &'

Clark, 1937-1947). Mount Tom Cr., 80-305. Olympic Hot Springs - South Fork, 80-344. 7.

pumila With. -- wet rocks near streams. Clallam Co., Hurricane Ridge, 79-204. Steeple Rock Trail, 83-1150. 1.

sphaerocarpa Hook. -- moist soil and wet rocks near streams. Clallam Co.: Eagle Point, 84-379. Three Forks Trail, 81-867.

Lophozia (Dum.) Dum.

1. Perianth suddenly contracted to mouth; underleaves present 2
1. Perianth gradually contracted to mouth; underleaves generally absent ... 3
   2. Gemmae abundant .... *L. heterocolpos*
   2. Gemmae absent .... *L. collaris*
3. Stems more or less differentiated dorsiventrally; leaf-cells thick-walled; oil bodies granular, few (8-20 per cell) 6
3. Stems not differentiated dorsiventrally; leaf-cells thin-walled; oil bodies homogeneous, numerous (20-50 per cell) .... 4.
   4. Leaves bilobed with obtuse apices .... *L. obtusa*
   4. Leaves 2-5 lobed with acute apices 5
5. Margins of leaf-lobes spinose-dentate, perianth mouth with long teeth to ciliate; on decayed wood; widespread .... *L. incisa*
5. Margins of leaf-lobes entire; perianth mouth denticulate: on soil; subalpine-alpine .... *L. opacifolia*
   6. Leaves quadrate, sinus broad and shallow; gemmae usually absent .... *L. wenzelii*
   6. Leaves variously shaped, sinus never broad and shallow; gemmae usually present 7
7. Plants ascending; leaves oblong .... *L. ascendens*
7. Plants weakly ascending; leaves oblong-ovate to round .. 8
   8. Gemmae golden-brown, reddish-brown or purplish ... *L. sudetica*
   8. Gemmae green 9
9. Trigones strongly bulging; teeth of perianth mouth 3-5 cells long ... *L. longiflora*
9. Trigones not bulging; teeth of perianth mouth 1-2 cells long ... 10.
   10. Oil bodies biconcentric, with one large central eyespot .... *L. ventricosa var. silvicola*
   10. Oil bodies granular, lacking eyespots .... *L. ventricosa* var. *ventricosa*

* *ascendens* (Warnst.) Schust. -- shaded, decayed wood. 6.

* *collaris* (Nees) Dum. -- shaded, decayed wood and moist soil. 1.

* *heterocolpos* (Thed. ex Hartm.) Howe -- moist soil. 1.

incisa (Schrad.) Dum. -- shaded, moist, decayed wood. 1.

longiflora (Nees) Schiffn. [= *ventricosa* var. *longiflora* (Nees) Macoun; =*guttulata* (Lindb. & Arn.) Schiff.] -- decayed wood and soil. 2.

**obtusa* (Lindb.) Evans -- shaded, moist soil. Clallam Co.: Steeple Rock, 80-389. 1.

**opacifolia* Culm. ex Meyl. -- moist soil near or above timberline. 1.
sudetica (Nees ex Hüb.) Grolle -- moist soil. 1.
ventricosa (Dicks.) Dum. -- shaded, decayed wood and ledges. 3.
**ventricosa* var. *silvicola* (Buch) Jones -- shaded, decayed wood. 1.
**wenzelii* (Nees) Steph. -- moist soil near timberline, 1.

Mylia S. Gray corr. Lindb., nom. et orth. cons.
1. Cuticle verrucose; oil bodies smooth, opaque .... *M. tavlorii*
1. Cuticle smooth; oil bodies coarse, with protuberant globules, hyaline .*M. anomala*

anomala (Hook.) S. Gray -- on Sphagnum in peat bogs. 2.
taylorii (Hook.) S. Gray -- shaded, decayed wood and moist soil. 2.

Nardia S. Gray nom, cons.
1. Leaves shallowly bilobed (1/5-1/6 of their length); underleaves triangular with obtuse apices .... *N. japonica*
1. Leaves entire; underleaves subulate with acute apices ... *N. scalaris*

* *japonica* Steph. -- moist soil. Clallam Co.: Little R. Trail, 82-817. 4.
scalaris S. Gray -- moist soil and wet rocks near small streams. 4.

Tritomaria Schiffn. ex Loeske
**quinquedentata* (Huds.) Buch -- shaded, moist soil and rocks. 1.

GYMNOMITRIACEAE

1. Perianth present; oil bodies present in all leaf cells .... *Marsupella*
1. Perianth absent; oil bodies absent in marginal leaf cells ... *Gymnomitrion*

Gymnomitrion Corda, nom. cons.
1. Leaf-lobes acute; bilobed for 0.20-0.35 of their length; sinus acute and open; trigones bulging into cells; 5-6 mm high .... *G. concinnatum*
1. Leaf-lobes roundish; bilobed for 0.15-0.25 of their length; sinus obtuse and closed; trigones not bulging into cells; 1-2 cm high .... *G. obtusum*

concinnatum (Lightf.) Corda -- acid rocks. Clallam Co.: Boulder L., Svihla 301 (TENN); (Fulford, 1936). Jefferson Co., Queets R., Frye s.n. (F); (Hong 1983a). 5.
obtusum Lindb. -- acid rocks. Jefferson Co.: Mt. Olympus, Queets R. (Clark & Frye, 1928). 1.

Marsupella Dum.
1. Plants minute (0.5-1.0 cm high); trigones conspicuously large and coarse ..

.... *M. commutata*

1. Plants larger (1.0-10 cm high); trigones small and not coarse 2
   2. Paroicous; purplish-brown or blackish to black-brown .... *M. sparsifolia*
   2. Dioicous; color various (green-purplish-brown) 3
3. Leaves divided into 0.1-0.3 of their length; apices of leaf-lobes acute .... *M. emarginata*
3. Leaves divided into 0.3-0.6 of their length; apices of leaf-lobes broadly rounded ... . *M. sphacelata*

commutata (Limpr.) H. Bern. -- moist soil near snow banks. Clallam Co., Badger Valley Trail, 81-900. 1.

emarginata (Ehrh.) Dum. -- moist soil near small strsams. 1.

* *sphacelata* fo. *media* (Gieseke ex Lindenb.) Schust. -- moist soil. Clallam Co.: Badger Valley Trail, 83-1075. Moose L. Trail, 85-1155. 1.

sparsifolia (Lindb.) Dum. -- moist soil. Clallam Co.: Badger Valley Trail, 81-894, 83-1077. The color of these specimens is scorched, in contrast to the green-brown color of the typical form of *M. sparsifolia*. 1.

SCAPANIACEAE

1. Leaf-lobes extremely elongate, narrowly lingulate .... *Diplophyllum*
1. Leaf-lobes circular to broadly ovate, never narrowly lingulate ..... *Scapania*

Diplophyllum (Dum. emend. Lindb.) Dum., nom. cons.

1. Leaf margins strongly dentate; leaf-cells strongly collenchymatous .. *D. plicatum*
1. Leaf margins entire or finely denticulate; leaf-cells not or obscurely collenchymatous 2
   2. Leaves with distinct, elongated medial hyaline cells from base to apex; cuticle smooth .... *D. albicans*
   2. Leaves without distinct, elongated medial hyaline cells; cuticle coarsely papillose 3
3. Paroicous; ventral lobes lingulate and broadly rounded at apex; gemmae rare .... *D. obtusifolium*
3. Dioicous; ventral lobes lingulate-elliptical and usually acute or apiculate at apex; gemmae abundant .... *D. taxifolium*

albicans (L.) Dum. -- shaded, decayed wood, soil and rocks. 2.

* *obtusifolium* (Hook.) Dum. -- moist, sandy soil. Clallam Co.: Eagle Point, 84-393. Jefferson Co.: East Fork Trail, 80-259. Graves Cr., 81-1087. 1.

plicatum Lindb. -- shaded, decayed wood and thin soil over rocks. The color of the plants is always pure green. 1.

taxifolium (Wahlenb.) Dum. -- shaded, ledges and humus on rocks. 1.

Scapania (Dum.) Dum., nom. cons.

1. Base of dorsal lobes with coarse teeth 2
1. Base of dorsal lobes entire or with minute teeth 3
   2. Teeth of leaf margins strongly developed with antleroid branching; on earth and on decayed wood .... *S. bolanderi*
   2. Teeth of leaf margins unbranched; on earth and rarely on decayed wood ....*S. americana*
3. Ventral lobes not conspicuously decurrent 4
3. Ventral lobes conspicuously decurrent 6
   4. Lobes pointed; gemmae 2-celled, greenish .... *S. irrigua*
   4. Lobes not pointed; gemmae 1-to 2-celled, brownish to reddish 5
5. Margins of leaves with equally thickened, 2-4 cells rows as a differentiated border .... *S. curta*
5. Margins of leaves with thin walled cells, not forming a differentiated border .... *S. mucronata*
   6. Small plants (less than 1.2 cm in length); ventral lobes 0.5-0.8 times as wide as long; apex sharply pointed; gemmae 2-celled, brownish to reddish .... *S. umbrosa*
   6. Large plants (over 1.2 cm in length); ventral lobes 0.8-1.2 times as wide as long; apex not sharply pointed; gemmae 1-2 celled, color variable ... 7
7. Dorsal lobes arcuately inserted .... *S. uliginosa*
7. Dorsal lobes transversely inserted 8
   8. Plants pale green; dorsal lobes ca. 0.75 the ventral in size ... *S. subalpina*
   8. Plants green, dark green to reddish; dorsal lobes 0.35-0.65 the ventral in size 9
9. Plant body pale green-dark green; leaf-lobes entire to denticulate .... *S. undulata* var. *undulata*
9. Plant body reddish to vinaceously pigmented; leaf-lobes with well developed dentition .... *S. undulata* var. *oakesii*

americana K. Müll. -- moist soil and rocks. 7.

bolanderi Aust. -- barks, decayed wood and soil. 4.

curta (Mart.) Dum. -- moist soil. 1.

* *irrigua* (Nees) Nees -- moist soil. Clallam Co., Moose L. Trail, 85-1173. 1.

* *mucronata* Buch -- moist soil. Clallam Co., Badger Valley Trail, 81-884. 2.

subalpina (Nees ex Lindenb.) Dum. -- wet rocks and sandy soil of stream banks. 1.

uliginosa (Sw. ex Lindenb.) Dum. [= *S. naludosa* (K. Müll.) K. Müll.] -- soil near streams. 1.

umbrosa (Schrad.) Dum. -- shaded, decayed wood and wet soil near streams. 3.

undulata (L.) Dum. -- shaded, decayed wood and wet soil near streams and waterfalls. 3.

undulata var. *oaksii* (Aust.) Buch -- shaded, wet rocks and moist soil near streams. 3.

RADULACEAE

Radula Dum., nom. cons.

1. Subfloral innovations are short; leaf-cells without trigones; rhizoids absent .... *R. obtusiloba* subsp. *polyclada*
1. Subfloral innovations are long; leaf-cells with thickened large trigones; rhizoids present 2
    2. Dioicous; inner margins of leaf-lobes adnate to stem; lobules inflated, rhomboidal-ovate, ca. 1/2-1/3 size of leaf-lobes; gemmae absent .... *R. bolanderi*
    2. Paroicous; inner margins of leaf-lobes not adnate to stem; lobules quadrate to subquadrate, ca. 1/4 size of leaf-lobes; gemmae always abundant .... *R. complanata*

bolanderi Gott. -- bark. Clallam Co.: Ozette R., 87-741. Sam R. Trail, 81-996. 7.

complanata (L.) Dum. -- bark. 4.

obtusiloba subsp. *polyclada* (Evans) Hatt. -- wet rocks and decayed wood. Clallam Co., Boulder Cr., Foster 2826 (US). Deer L. (Schofield, 1968). Olympic Hot Springs, Schofield 19263 (UBC); (Castle, 1925). Jefferson Co.: Mt. Olympus (Clark & Frye, 1928). 7.

PORELLACEAE

Porella L.

1. Ventral lobes long-decurrent, margins strongly reflexed; underleaves 2 times as wide as ventral lobes .... *P. cordaeana*
1. Ventral lobes not or only short-decurrent, margins plane or weakly reflexed; underleaves 1-2 times as wide as ventral lobes 2
    2. Underleaves about as wide as ventral lobes; gametophores glossy to dull; margins of ventral lobes recurved; trigones large (bulging) .. *P. navicularis*
    2. Underleaves about 2 times as wide as ventral lobes; gametophores glossy; margins of ventral lobes entire; trigones small.................. *P. roellii*

cordaeana (Hüb.) Moore -- rock outcrops near streams. 4.

navicularis (Lehm. et Lindenb.) Lindb. -- bark of *Acer*, *Alnus* and *Betula*, decayed wood and humus on rocks. 7.

roellii Steph. -- rocks, more rarely on bark. 7.

roellii fo. *crisoata* Hong -- rocks. Jefferson Co.: Dosewallips Trail, 81-798 (Hong, 1983b). The margins of the underleaves, lobules (ventral lobes) and upper leaves are strongly undulate-crispate, especially on the ventral side of the leaves. 7.

FRULLANIACEAE

Frullania Raddi

1. Lobules helmet-shaped, about as long as broad; perianth triangular and frequently tuberculate .... *F. bolanderi*
1. Lobules club-shaped, 2-3 times as long as broad; perianth trigonous and smooth 2
   2. Apex of dorsal lobe acute to acuminate-apiculate; underleaves bifid 1/4 or less their length, margins strongly recurved; bracts sinus ... *F. nisquallensis*
   2. Apex of dorsal lobe obtuse-rounded; underleaves bifid 1/3 or more their length, margins plane or slightly recurved; bracts entire 3
3. Apex of dorsal lobe broadly rounded, ocelli scattered; underleaves auriculate at base; beak of perianth retuse, 2-3 times as long as wide ... *F. californica*
3. Apex of dorsal lobe obtuse, ocelli in a median row; underleaves narrowed at base; beak of perianth obtusely narrowed, 1-2 times as long as wide ....*F. franciscana*

bolanderi Aust. -- bark of *Acer*. Clallam Co., Boulder L., 79-251. Elwha R. (Fulford, 1936). 4.

californica (Aust.) Evans -- bark of *Acer* and *Alnus*. Clallam Co.: Ozette R., 87-736. Jefferson Co.: N. Fork Trail, 83-1016. Mason Co.: Snoqualmie Trail, 82-727. 7.

franciscana Howe -- bark of *Picea*. Clallam Co.: Ozette L., 88-1834. Ozette R., 87-729. 7.

nisquallensis Sullivant -- on branches and bark, dead wood and humus on rocks. 7.

CODONIACEAE

Fossombronia Raddi

foveolata Lindb. [= *dumortieri* Hüb. & Genth ex Lindb.] -- moist soil. Clallam Co.: Ozette L. (Fulford, 1936). 3.

PALLAVICINIACEAE

Moerckia Gott

1. Thallus wide (5-10 mm wide); rhizoids reddish-brown; lobed bracts present (in summer) .... *M. blyttii*
1. Thallus rather narrow (3-5 mm wide); rhizoids white; lobed bracts lacking .... *M. hibernica*

blyttii (Moerck) Brockm. -- wet rocks. Jefferson Co.: Mt. Olympus (Clark, 1909; Clark & Frye, 1928). 3.

hibernica (Hook.) Gott. [= *flotoviana* (Nees) Schiffn.] -- moist soil. Jefferson Co.: Queets (Clark & Frye, 1928). 3.

PELLIACEAE

Pellia Raddi, nom. cons. prop.

1. Thallus without vertical band-like thickenings on section .... *P. endiviifolia*

1. Thallus with vertical brown colored band-like thickenings on section 2
   2. Dioicous; involucrs forming complete tube .... *P. neesiana*
   2. Paroicous; involucre reduced to semi-cylindrical scalelike flap ... *P. epiohylla*

endiviifolia (Dicks.) Dum. -- wet rocks and soil near streams. 2.
* *epiphylla* (L.) Corda -- moist soil near streams. 3.
neesiana (Gott.) Limpr. -- moist soil near streams. 3.

METZGERIACEAE

1. Both surfaces of the thallus densely pubescent .... *Apometzgeria*
1. Upper surface of thallus without hairs .... *Metzgeria*

Apometzgeria Kuwah.
pubescens (Schrank) Kuwah. -- humus on rocks. 4.

Metzgeria Raddi
conjugata Lindb. -- rocks, decayed wood and bark. 4.

BLASIACEAE

Blasia L.
pusilla L. -- soil. 2.

ANEURACEAE

1. Thallus broad (more than 3 mm), thick and greasy .... *Aneura*
1. Thallus narrow (2 mm or less wide), not thick and greasy .... *Riccardia*

AneuraDum.
pinguis (L.) Dum. -- moist stream banks. 3.

Riccardia S. Gray, nom. cons.
1. Thallus regularly 3-pinnately branched; thallus with a crenulate, transparent unistratose border, 2 cells wide ....*R. multifida*
1. Thallus palmately or irregularly branched; thallus lacking a transparent unistratose border 2
   2. Autoicous; thallus larger (0.5-2.0 mm wide), yellow green; branching irregular-palmate .... *R. latifrons*
   2. Dioicous; thallus minute (0.2-0.4 mm wide), dark green to brownish; branching palmate, ascending .... *R. palmata*

latifrons (Lindb.) Lindb. -- shaded, moist, decayed wood. 4.
multifida (L.) S. Gray -- shaded, moist soil. 2.

* *palmata* (Hedw.) Garruth. -- shaded, decayed wood. 4.

AYTONIACEAE

1. Pseudoperianth present .... *Asterella*
1. Pseudoperianth absent 2
    2. Female receptacles not lobed .... *Cryptomitrium*
    2. Female receptacle distinctlylobed .... *Reboulia*

Asterella R. Beauv.

1. Pseudoperianth white or hyaline; dorsal epidermis of thallus with thin walls; spores yellow, 60-70 μm in diameter .... *A. gracilis*
1. Pseudoperianth purple; dorsal epidermis of thallus with thickened walls; spores dark purple, 60-90 μm in diameter .... *A. lindenbergiana*

gracilis (F. Web.) Underw. [= *A. ludwigii*] -- moist soil. Jefferson Co.: Mt. Olympus Evans 1920; (Clark & Frye, 1928). 5.

lindenbergiana (Corda ex Nees) H. Arn. -- moist soil. Clallam Co.: Elwha R. (Evans, 1920; Fulford, 1936). Jefferson Co., Mt. Olympus (Clark, 1909; Clark & Frye, 1928).

Cryotomitrium Aust.

tenerum (Hook.) Aust. -- moist soil. Jefferson Co.: Mt. Olympus (Clark & Frye 1928). 4.

Reboulia Raddi, nom. cons.

hemisphaerica (L.) Raddi moist soil. Clallam Co., Part Angeles (Clark & Frye, 1928). 4.

CONOCEPHALACEAE

Conocephalum Hill corr. Wiggers, nom. et orth. cons.

conicum (L.) Underw. -- moist soil and wet rocks. 4.

CLEVEACEAE

Athalamia Falconer

hyalina (Sommerf.) Hatt. -- rocks. Jefferson Co.: Mt. Olympus (Clark & Frye, 1928). 1.

MARCHANTIACEAE

1. Thallus not dichotomously branched; female receptacle hemispheric; gemmae cups absent .... *Preissia*
1. Thallus dichotomously branched; female receptacle stellate; gemmae cups present .... *Marchantia*

Preissia Corda
quadrata (Scop.) Nees -- moist soil. 3.

Marchantia L.
polymorpha L. -- wet rocks and soil near streams and waterfalls. 3.

RICCIACEAE

Ricciocarpos Corda
[*natans* (L.) Corda] -- aquatic. Clallam Co.: Dungeness (Clark & Frye, 1928). 4.

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