

A preliminary checklist, with keys, of California liverworts and hornworts
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I've accepted determinations by W. T. Doyle; I've checked all the other specimens that are cited, but many of them not since 1979-80.

Dan Norris tells me that all of his collections that were at HSC in 1979-80 are now deposited at H, and they are so cited. The other (non-Norris) collections I saw at HSC are apparently still there, but I haven't gone up to check this. Most of my collections are represented at CAS, MO, or DAV, but I haven't checked on all of the older ones; in the latter case, I give the herbarium as "atw" in lower case. Specimens from the personal herbarium of W. T. Doyle are "doy," also in lower case. My specimens listed as "tbd" have not yet been distributed, but will be deposited at CAS and MO.

Family definitions in the liverworts are currently in flux. The family treatment adopted here is presented and discussed after the main list, beginning on page 58.

Key to genera:

1. Gametophytes thallose.
2. Thallus with internal air chambers, thick and opaque, pale or bright green (underside often purple).
 3. Air chambers low and broad, packed with filaments.
 4. Pores compound; antheridial receptacles stalked.
 5. Ventral scales in four or six rows, with differentiated oil cells; disk of carpocephalum radiate; brood-body receptacles often present. *Marchantia*
 5. Ventral scales in two rows, lacking oil cells; disk of carpocephalum unlobed; brood-body receptacles absent. *Preissia*
 4. Pores of thallus simple; antheridial receptacles sessile.
 6. Underside of thallus purple; antheridia on short ventral branches; involucre terminating \pm undifferentiated thallus segments. *Targionia*
 6. Underside of thallus green; antheridia on undifferentiated thallus segments, ventral branches usually absent; involucre in stalked carpocephala.
 7. Thalli 40-200 x 8-22 mm; brood bodies absent. *Conocephalum*
 7. Thalli 8-20 x 6-10 mm; brood bodies present. *Lunularia*
 3. Air chambers relatively high and \pm narrow, without filaments.
 8. Epidermis without well-defined pores; ventral scales in one row (sometimes appearing to be 2), without appendages. *Riccia*
 8. Epidermis with well-defined pores; ventral scales either in two rows with well-defined appendages, or in several rows, with poorly-defined appendages.
 9. Ventral scales in several rows, appendages poorly defined; sporophytes in dorsal carpocephala or dorsal on the thallus.
 10. Thallus without a median groove; sporophytes in dorsal carpocephala; terrestrial. *Clevea*
 10. Thallus with a sharp median groove; sporophytes embedded in thalli; aquatic or stranded. *Ricciocarpos*
 9. Ventral scales in two rows, appendages well defined (or scales rudimentary in *Cryptomitrium*); sporophytes in terminal carpocephala.
 11. Thallus very thin and delicate, ventral scales usually \pm rudimentary, \pm disrupted at maturity; carpocephalum discoid, involucre not projecting beyond margin of disk. *Cryptomitrium*
 11. Thallus thicker, firm, ventral scales well developed, intact at maturity; carpocephalum conical to hemispherical, \pm lobed, involucre spreading laterally away from disk.

- 12. Pseudoperianth present, exserted, longitudinally cleft. *Asterella*
- 12. Pseudoperianth absent.
- 13. Usually paroecious, antheridial receptacle well-defined, with compound pores; operculum of sporangium falling in fragments. *Reboullia*
- 13. Never paroecious, antheridial receptacle never with compound pores; operculum of sporangium falling intact. *Mannia*
- 2. Thallus without internal air chambers, thick and opaque or thin and translucent, if thick then dark green (underside always concolorous).
 - 14. Chloroplasts 1-2 per cell; underside of thallus with stomates, prominent *Nostoc* colonies developing inside thallus; capsule cylindrical.
 - 15. Upper surface of thallus with ridge- or flap-shaped outgrowths; thalli ± radiate, with internal mucilage cavities, margins finely lobulate; spores dark brown. *Anthoceros*
 - 15. Upper surface of thallus smooth; thalli often ± strap-shaped, without internal mucilage cavities, margins not lobulate; spores pale yellow.
 - 15'. Thalli with stalked tubers from the ventral midrib. Antheridia solitary. Spores usually ornamented with a large, single raised ring in the center of the outer face. *Phymatoceros*
 - 15'. Tubers, if present, terminal or marginal, usually sessile. Antheridia several per chamber. Spores papillose or with 8-35 large warts. *Phaeoceros*
 - 14. Chloroplasts many per cell; ventral stomata and *Nostoc* colonies absent; capsule spherical.
 - 16. Thallus laterally compressed, erect; submerged aquatics. *Riella*
 - 16. Thallus dorsiventrally compressed, prostrate; aerial plants.
 - 17. Thalli unistratose for most of their width, pale green.
 - 18. Thallus margins deeply lobed; thallus almost hidden by crowded dorsal involucre; capsules immersed. *Sphaerocarpus*
 - 18. Thallus margins unlobed; involucre small, not hiding thallus; sporophytes exserted.
 - 19. Midrib and wings of thallus not ciliate; thallus with a median conducting strand of narrow, elongate cells (conspicuous in intact thalli by transmitted light). *Pallavicinia*
 - 19. Midrib and wings of thallus densely ciliate; thallus without differentiated conducting tissue. *Metzgeria*
 - 17. Thalli multistratose except sometimes for the extreme margins, dark green.
 - 20. Thallus regularly lobed for about half its width. *Blasia*
 - 20. Thallus not or scarcely lobed.
 - 21. Thalli 0.4-1.7 mm wide, freely branched. *Riccardia*
 - 21. Thalli 3-14 mm wide, sparingly branched.
 - 22. Thallus branching dichotomously; gametangia dorsal on the main thallus; rhizoids purple. *Pellia*
 - 22. Thallus branching laterally; gametangia on very short lateral branches; rhizoids hyaline. *Aneura*
- 1. Gametophytes leafy.
 - 23. Leaves complicate-bilobed (i.e. deeply lobed and sharply folded so that the two lobes are pressed against one another), with an incubous upper lobe and a succubous underlobe (underlobes sometimes resembling extra rows of small leaves).
 - 24. Underlobe at least as large as upper lobe, usually much larger.
 - 25. Leaf lobes lanceolate, acute to acuminate. *Douinia*
 - 25. Leaf lobe oblong to ovate or almost circular, broadly acute to rounded.
 - 26. Gemmae smooth; lobes of leaf mostly ovate to elliptical or almost circular;

- perianth dorsiventrally flattened, smooth. *Scapania*
26. Gemmae stellate; lobes of leaf lingulate, ± parallel-sided; perianth cylindrical, plicate, narrowed to mouth.
- 26'. Leaves strongly decurrent ventrally; shoots 10-40 x 2.5-4.5 mm; walls of cells near leaf margin ± uniformly thickened, in midleaf usually thin-walled with large trigones; gemmae 2-4-celled, ± cubical; cortex of stem well-defined, of 3-4 layers of very thick-walled cells; perianth deeply plicate to base. *Macrodiplrophyllum*
- 26'. Leaves not decurrent ventrally; shoots 8-25 x 1-2.5 mm; walls of leaf cells ± uniformly thickened throughout; gemmae 1-celled, stellate; cortex of stem poorly defined, of 1-2 layers of somewhat thick-walled cells; perianth usually plicate distally and smooth proximally. *Diplophyllum*
24. Upper lobe much larger than underlobe (lobule).
27. Underleaves absent; rhizoids inserted on lobules. *Radula*
27. Underleaves present; rhizoids inserted on stem.
28. Underleaves unlobed; lobules flat, attached to stem but usually not to upper lobe. *Porella*
28. Underleaves bilobed; lobules strongly convex to tubular, attached to upper lobe but not stem. *Frullania*
23. Leaves not complicate-bilobed.
29. Leaves 3-4-lobed for at least half their length.
30. Lobes of leaf all 1-3 cells wide.
31. Underleaves much smaller than leaves; leaf lobes 2-3 cells wide at base. *Kurzia*
31. Underleaves similar to leaves; leaf lobes 1 cell wide to base. *Blepharostoma*
30. Largest lobe of leaf at least 5 cells wide.
32. Underleaves present or absent, if present small, simple or 2-lobed (but margins often ciliate); leaves succubous. *Barbilophozia*
32. Underleaves present, large, 3-4-lobed; leaves incubous.
33. Leaf lobes filiform-acuminate, margins often ciliate; stems branched irregularly and sparingly. *Ptilidium*
33. Leaf lobes acute, margins entire; stems branched pinnately. *Lepidozia*
29. Leaves simple, 2-lobed, or with 3 or more marginal teeth.
34. Leaf insertion incubous.
35. Leaf apex 3-dentate; stems pinnately branched, usually with stolons in axils of underleaves. *Bazzania*
35. Leaves entire or apex 2-dentate; stems sparingly and irregularly branched, without ventral stolons. *Calypogeia*
34. Leaf insertion succubous or transverse.
36. Underleaves large, deeply bilobed; leaf insertion always strongly succubous; rhizoids confined to particular areas (either on underleaf bases or around cushion-shaped masses of differentiated cells on stem).
37. Rhizoids inserted around cushion-shaped masses of differentiated cells on stem; sporophyte in a deep perigynium, perianth absent. *Gyrothyra*
37. Rhizoids inserted on underleaf bases.
38. Underleaves with lateral teeth; perianth present, perigynium absent. *Chiloscyphus*
38. Underleaves without lateral teeth; sporophyte in a deep perigynium, perianth absent. *Geocalyx*
36. Underleaves usually absent, if present then small or unlobed; rhizoids scattered over undifferentiated stem.
39. Leaves unlobed or retuse.
40. Leaves oblong, undulate, irregularly crenate; archegonia and

- sporophytes dorsal on stem.
41. Stems sometimes thickened, but never forming well-defined tubers; capsule exerted on a long seta; elaters with spiral thickenings present; outer face of spore strongly sculptured (ridged or spiny).
Fossombronia
41. Stems arising from well-defined tubers; capsule immersed, seta very short; elaters absent (sterile cells with thin walls present); outer face of spore smooth. *Geothallus*
40. Leaves ovate or circular, flat or concave, entire (or serrate in *Plagiochila*); archegonia and sporophytes terminal on stem.
42. Leaf strongly decurrent antically, antical margin reflexed; leaf margin usually serrate. *Plagiochila*
42. Leaf not or weakly decurrent antically, antical margin plane; leaf margin entire.
43. Underleaves absent (except sometimes near female inflorescence).
44. Leaves lingulate or rectangular, the apex truncate or weakly emarginate; trigones of leaf cells large; perianth smooth, abruptly contracted to a distinct beak. *Liochlaena*
44. Leaves ovate or elliptical, the apex broadly rounded; trigones of leaf cells small or absent; perianth plicate, tapering \pm evenly to mouth, or tapering evenly to a short beak.
- 44'. Leaves ovate to elliptical or cordate, longer than broad (sometimes almost circular and deeply concave in *J. polaris*); rhizoids confined to stem; perianth not beaked. *Jungermannia*
- 44'. Leaves circular to reniform, broader than long; rhizoids sometimes arising from leaf bases as well as stem; perianth distinctly beaked. *Solenostoma*
43. Underleaves present throughout (sometimes very small).
45. Perianth small, hidden by female bracts, sporophyte in a well-developed perigynium; underleaves of sterile shoots minute, less than 0.25 of leaf length; never producing gemmae. *Nardia* (in part)
45. Perianth prominent, projecting beyond bracts, perigynium absent; well-developed underleaves of sterile shoots 0.25-1.0 of leaf length; usually producing gemmae from leaf margins.
46. Perianth bilaterally compressed, mouth broad; leaf cells ca 45-50 x 50-60 μm near midleaf, trigones large, often bulging and knotlike; gemmiparous leaves lanceolate, acute. *Mylia*
46. Perianth 5-angled, mouth contracted; leaf cells ca 25 x 18 μm near midleaf, trigones absent or minute and indistinct; gemmiparous leaves oblong, truncate. *Rivulariella gemmipara*
39. Leaves bilobed 0.2-0.8 of their length.
47. Cortical cells of stem much larger than internal cells, forming a well-marked hyalodermis.
48. Leaves moderately to strongly succubous, often decurrent, about as long as wide, 1/4 to 1/3 bilobed; lobes with uniseriate tips 1-2 cells long. *Fuscocephaloziopsis*
48. Leaves subtransverse, never at all decurrent, longer than wide,

bilobed at least halfway; lobes with uniseriate tips 2-3 cells long.

Cephalozia

- 47. Cortical cells of stem not or scarcely larger than internal cells, never forming a hyalodermis.
- 49. Leaves 0.5-0.8 bilobed; cell walls thin or evenly thickened, without trigones.
 - 50. Underleaves similar to leaves; gemmae never produced; plants whitish. *Anthelia*
 - 50. Underleaves (if present) smaller than leaves and different in form; gemmae often produced; plants green, brown, red, or blackish. *Cephaloziella*
- 49. Leaves 0.2-0.3 bilobed; cell walls with trigones.
 - 51. Perianth exserted, marsupium absent; gemmae often present.
 - 52. Perianth smooth, not beaked, caducous; leaf lobes obtuse or rounded; gemmae absent. *Gymnocolea*
 - 52. Perianth either plicate or beaked, never caducous; leaf lobes acute or acuminate (except in *L. obtusa*); gemmae often present. *Lophozia*
 - 51. Perianth immersed, marsupium present; gemmae absent.
 - 53. Underleaves well developed (our species). *Nardia* (in part)
 - 53. Underleaves absent.
 - 54. Leaves tightly imbricate, shoots julaceous and ± clavate; perianth absent. *Gymnomitrium*
 - 54. Leaves spreading or loosely imbricate, shoots not julaceous nor clavate; perianth present, small. *Marsupella*

BLASIALES

1. Blasiaceae H. Klinggräff

Blasia pusilla L. North coast; on wet shaded soil on banks of creeks and drainages, sea level to 800 m. Howe (1899); Doyle and Stotler (2006).

Representative collections: Blue Lake, Humboldt Co., *Howe 56* (UC); Carlotta, Humboldt Co., *Eastwood s. n.*, Aug. 1924 (CAS); north boundary of Prarie Creek Redwoods State Park, Humboldt Co., *Malachowski s. n.*, 29 Apr. 1972 (CHSC); north end of East Ridge Road, Prarie Creek Redwoods State Park, Humboldt Co., *Jamieson 811* (HSC); ca 1 mile east of Payton Ranch, north of Blocksburg, Humboldt Co., *Norris 48192* (H); Branscomb Road just east of hwy. 1, near 429 1.55 marker, north of Ft. Bragg, Mendocino Co., *Doyle 8047*, (herbarium of W. T. Doyle)

MARCHANTIALES

2. Lunulariaceae H. Klinggräff

Lunularia cruciata (L.) Dumort. Coast Ranges, Cascade Ranges, Sierra Nevada foothills; introduced from the Mediterranean region and now thoroughly naturalized; seasonally dry soil or sometimes rock, upper banks of streams where flooded at high water but dry in the summer, shaded banks, seepy areas, sea level to 600 m. Howe (1899); Frye and Clark (1937-1947); Whittemore (1982); Yurky (1995); Doyle and Stotler (2006).

Note: *Lunularia cruciata* is a well-known weed of greenhouses and nurseries. It was not collected in California prior to the 1890s, when Howe (1899) gave its habitat as "In and around greenhouses," and was reported only from greenhouses and gardens until well into the twentieth century. The oldest collection seen from native vegetation was made in 1976

(*Thomas 18412A*, below). It is now very common along streambanks in undisturbed native vegetation, where the gemmae are apparently dispersed by water, but on shaded roadcuts and trailbanks it is still mostly confined to the vicinity of old (often long-abandoned) gardens. It is often possible to follow the spread of the species in such habitats; first dense populations spread on slopes below old plantings, then as these reach trails, new colonies appear elsewhere along nearby trails where they are spread by foot traffic.

Representative collections: East of Bayside near Jacoby Creek Road, Humboldt Co., *Whittemore & Creek 862* (DAV); Pocket Canyon, 4 miles west of Forestville, Sonoma Co., *Whittemore & Norris 811A* (CAS); West Union Creek, east border of Huddard County Park, Woodside, San Mateo Co., *Whittemore 1336* (DAV); San Francisquito Creek, Jasper Ridge Biological Experiment Area, Stanford University, Palo Alto, Santa Clara Co., *Thomas 18412A* (CAS); old road to abandoned mine, hwy. 49 ca 1 mile south of Forest Hill Road, Placer Co., *Whittemore & Whittemore 3534* (CAS)

3. Marchantiaceae Lindl.

Key to species of *Marchantia*:

1. Ventral scales in four or six rows, with differentiated oil cells; disk of carpocephalum radiate; brood-body receptacles often present. *Marchantia polymorpha*
1. Ventral scales in two rows, lacking oil cells; disk of carpocephalum unlobed; brood-body receptacles absent. *Marchantia quadrata*

Marchantia polymorpha L. s. lat. [*M. aquatica* (Nees) Burgeff, *M. alpestris* (Nees) Burgeff, *M. latifolia* Gray, *M. polymorpha* subsp. *ruderalis* Bischl. & Boisselier, *M. polymorpha* subsp. *montivagans* Bischl. & Boisselier] North and central coast and Coast Ranges, Klamath region, Cascade Range, Warner Mountains, Sierra Nevada, Transverse and Peninsular Ranges; on damp soil, occasionally rock or decaying wood, along streams or in seeps, sea level to 3700 m. Howe (1899); Kingman (1911); Clark and Frye (1936); Frye and Clark (1937-1947); Stark and Whittemore (1992); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Note: European references often divide this species into two or three taxa (*M. polymorpha*, *M. aquatica* (Nees) Burgeff, and *M. alpestris* (Nees) Burgeff, or *M. polymorpha* subsp. *polymorpha*, subsp. *ruderalis* Bischl. & Boisselier, and subsp. *montivagans* Bischl. & Boisselier). Typical *M. polymorpha* has prostrate thalli with the appendages of the median ventral scales crenate or toothed and the dark median line of the thallus weak, interrupted, or absent. Especially striking in Europe is *M. aquatica*, with erect or ascending thalli, appendages of ventral scales entire or nearly so, and the dark median line strong and continuous. Further study of this problem is needed. Some California specimens fit *M. aquatica* (between Crescent City and Adams, Del Norte Co., *Eastwood s. n.* 11 Aug. 1923 [Y]), but others show different combinations of these characters. Reproduction in *M. polymorpha* seems to be predominantly asexual, with spores seldom developed, and it seems likely that there are many apomictic races across its wide range.

Representative collections: Willow Creek, Humboldt Co., *Abrams 7134* (CAS); near inlet stream, Manzanita Lake, Lassen Volcanic National Park, Shasta Co., *Showers 525* (SFSU); Miller's Canyon, vicinity of China Camp, between Jamesburg and Tassajara Hot Springs, Los Padres National Forest, Monterey Co., *Thomas 1305* (CAS); near Giant Forest, Marble Fork Kaweah River, Sequoia National Park, Tulare Co., *Parchim 30 Jan. 1962* (SFSU); near confluence of Doane Creek and French Creek, Palomar Mountain State Park, San Diego Co., *Stark 555B, 673B* (MO)

Marchantia quadrata Scop. [*Preissia quadrata* (Scop.) Nees] Klamath region and high Sierra Nevada; stream banks, seepy calcareous places, or splash zones of creek cascades, 1500 to 3500 m. Whittemore (1987), Christy & Wagner (1996); Doyle and Stotler (2006).

Representative collections: canyon of upper Jaynes Creek, southeast side of Condry Mountain, Siskiyou Mountains, Siskiyou Co., *Norris 48690* (MO); near Big Flat, Siskiyou Co., *Norris 9185* (H); Dinkey Lakes Wilderness trailhead adjacent to Dinkey Creek, end of Forest Road 9S62, Fresno Co., *Shevock 14202* (CAS); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1498A, 1540* (CAS); west of Sixth Lake, Big Pine Lakes, Inyo Co., *Howell 728* (CAS)

4. Conocephalaceae Müller Frib. ex Grolle

Conocephalum conicum (L.) Underw. North and central coast and Coast Ranges, Klamath region, Warner Mountains, Sierra Nevada; wet shaded soil, occasionally rock or wood, along fast-moving streams, commonly where seasonally inundated, or in seepy places, intolerant of drying, common near the coast, uncommon and local in the mountains, sea level to 1900 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Note: *Conocephalum conicum*, as traditionally defined, clearly consists of several ± cryptic species (Szweykowski et al. 2005, Forrest 2006 p. 323). California material has the morphology of European *C. conicum*, although Szweykowski et al. (2005) report differences in isozyme profile between plants from Europe ("L genotype") and western North America ("C genotype"), but they don't provide a species name for the C genotype. None of the California specimens seen shows the characters of *C. salebrosum* Szweykowski, Buczkowska & Odrzykoski ("S genotype"), which is common across most of North America. Further study is needed before a satisfactory taxonomy can be produced. The specimen *Shevock 13769* (along Avalanche Creek, south side of South Fork of King's River, Fresno Co., CAS, MO) is in poor condition and I have not put a species name on it; it was collected at 2800 m, much higher than any other *Conocephalum* in the state.

Representative collections: near Eureka, Humboldt Co., *Howe 959* (UC); Pescadero Creek, San Mateo Co., *Whittemore 7090* (tbd); Jaynes Canyon, Siskiyou Mts., Siskiyou Co., *Wheeler 3204* (UC); Feather River Canyon, 600 m, Butte Co., *Doyle 9716* (UC); East Fork Kaweah River, 1910 m, Tulare Co., *Doyle 7038* (UC).

5. Targioniaceae Dumort.

Key to species of *Targionia*:

1. Epidermal pores (18-)22-56 μm across, cells surrounding pore tangentially elongate (or a minority subdivided into quadrate cells); midrib 0.4-0.6 width of thallus; cell walls in ventral tissue usually distinctly thickened (at least in some cells), locally brown, with elliptical pits usually visible (at least on longitudinal walls near edges of midrib); ventral scales subtending involucre lance-ovate to lanceolate; not Mojave Desert. 1. *Targionia hypophylla*
1. Epidermal pores averaging 10-22 μm across, cells surrounding pore oblong or trapezoidal, not elongate; midrib at least 0.7 width of thallus; cell walls in ventral tissue uniformly thin and hyaline, rarely pitted; ventral scales subtending involucre narrowly lingulate to hemielliptical; Mojave Desert. 2. *Targionia* sp. nov.

Targionia hypophylla L. Klamath region, whole coast and Coast Ranges, Cascade Range foothills, Sierra Nevada, Transverse and Peninsular Ranges; on summer-dry soil, often around rock outcrops, on shaded or north-facing banks, sea level to 1700 m. Howe (1899); Kingman (1911); Evans (1923b); Clark and Frye (1936); Frye and Clark (1937-1947); Clark (1953); Steere (1954); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Along Smith River at Hiouchi Bridge, Del Norte Co., *Norris 9904* (H); Ice Cream Grade 1.6 miles west of junction with Empire Grade, ca 2 miles northeast of Bonny Doon, Santa Cruz Co., *Whittemore & Whittemore 4431* (CAS); 0.4 miles west of Devil's Kitchen, Upper Bidwell Park, Chico, Butte Co., *Griggs 184* (CHSC); along

Dry Creek Road, adjacent to Dry Creek, 7.4 miles north of California hwy. 216, Tulare Co., *Shevock 12800* (CAS); ravines just north of Genessee Avenue, ca 1 mile east of intersection with Interstate 5, San Diego, San Diego Co., *Stark 769* (MO)

Targionia sp. nov. Mojave Desert, on soil, often thin soil over rock, beneath shrubs and around outcrops, 900 to 1500 m.

Representative collections: Mouth of Grapevine Canyon, Death Valley National Monument, Inyo Co., *Norris 10218A* (H); xxx, San Bernardino Co., *Doyle 7086* (herbarium of W. T. Doyle); canyon south of Cottonwood Springs Campground, Joshua Tree National Monument, Riverside Co., *Whittemore 614* (atw)

Excluded species: Schuster (1992b) reports *Targionia lorbeeriana* K. Mueller from California. His determination was evidently based on cell size in the scale appendages, which is supposed to be unreliable. No mention is made of the fine sculpturing of the spore, which recent authors have considered the most reliable character for distinguishing this from *T. hypophylla*. All the North American material I've seen falls into the two species above.

6. Aytoniaceae Cavers

Key to genera:

1. Pseudoperianth present, exserted, longitudinally cleft. *Asterella*
1. Pseudoperianth absent.
 2. Thallus very thin and delicate, ventral scales usually \pm rudimentary; usually paroecious, antheridia in a median row, without a well-defined receptacle; carpocephalum discoid, involucre strongly bilabiate, not projecting beyond margin of disk. *Cryptomitrium*
 2. Thallus thicker, firm, ventral scales well developed; if paroecious then antheridia in a well-defined receptacle; carpocephalum hemispherical, involucre weakly or not bilabiate, spreading laterally away from disk.
 3. Usually paroecious, antheridial receptacle well-defined, with compound pores; operculum of sporangium falling in fragments. *Reboulia*
 3. Never paroecious, antheridial receptacle never with compound pores; operculum of sporangium falling whole. *Mannia*

Key direct to species for sterile Aytoniaceae

1. Ventral scales \pm rudimentary and disrupted; thallus thin, delicate; epidermis densely chlorophyllous; secondary air chambers broad, cavernous, not recovering fully when soaked after dessication; shaded banks at low elevations. *Cryptomitrium tenerum*
1. Ventral scales well formed; thallus firm to leathery; primary or secondary air chambers narrow.
 2. Latero-ventral branching present, usually frequent. Ventral scales each with one (rarely two) narrowly ovate or lanceolate appendages. Mostly below 3000 feet.
 3. Appendages of ventral scales lanceolate, acute or acuminate, entire; oil cells of ventral scales mostly pinkish; cell walls in ventral tissue strongly pitted throughout; antheridia on short ventral branches. *Asterella bolanderi*
 3. Appendages of ventral scales lanceolate or ovate; oil cells of scales hyaline; cell walls of ventral tissue weakly pitted at base of midrib, or smooth; antheridia on main thallus.
 4. Ventral scales near female receptacles with large lanceolate hyaline appendages which project beyond the thallus apex; ventral branches occasional; spores yellow. *Mannia fragrans*
 4. Ventral scales with small pigmented appendages which do not reach the thallus margin; ventral branches abundant; spores black. *Mannia californica*
 2. Latero-ventral branching absent.
 5. Appendages of ventral scales two to four per scale, subulate or narrowly lanceolate

with a long subulate apex; secondary walls of air chambers reaching the epidermis at least in part; thalli 10-25 mm long, 3-6(-9) mm wide.

6. Secondary walls of air chambers partly free from epidermis; appendages two to four per scale; dioicous. *Asterella californica*
6. Secondary walls of air chambers attached to epidermis for their whole width; appendages two, rarely three, per scale; paroicous. *Reboulia hemispherica*
5. Appendages of ventral scales one or two per scale, lanceolate or broader, never with a long subulate apex; secondary walls of air chambers (if present) ending well below epidermis; thalli 5-17 mm long, 1.5-4 mm wide.
7. Air chambers slender, tubular, not subdivided by secondary walls; at least some ventral scales with the appendages \pm ciliate; low elevations. *Asterella palmeri*
7. Air chambers wider, subdivided below by secondary walls that do not reach the epidermis; appendages of ventral scale never ciliate; high montane in California.
8. Epidermis without oil cells; radial walls of cells around pores conspicuously thickened; ventral scales near thallus apex often with large, lanceolate hyaline appendages which project conspicuously beyond the thallus margin; secondary partitions of air chambers usually coarsely dentate. *Mannia fragrans*
8. Epidermis with oil cells; radial walls of cells around pores thin; appendages of ventral scales purple, never projecting conspicuously beyond the thallus margin; secondary partitions of air chambers usually crenate. *Asterella gracilis*

Key to species of *Asterella*:

1. Branching primarily latero-ventral; cell walls of ventral tissue strongly pitted; carpocephalum always on a short latero-ventral branch. *A. bolanderi*
1. Branching dichotomous, ventral branches produced only as an injury response; cell walls of ventral tissue not pitted; carpocephalum on an elongate thallus.
 3. Stalk of carpocephalum naked; paroicous, antheridia in a small circular patch immediately anterior to the carpocephalum; secondary partitions of air chambers either absent or not reaching epidermis, thus primary areoles of epidermis not subdivided.
 4. Spores yellow or golden brown; disk hemispherical; segments of pseudoperianth about six, \pm free. *A. gracilis*
 4. Spores black; disk conic or cylindrical; segments of pseudoperianth ten to 14, strongly adhering at their apices. *A. palmeri*
 3. Stalk of carpocephalum with a cluster of filiform scales at its apex; autoicous or dioicous (or *A. saccata* sometimes paroicous); secondary partitions of air chambers reaching epidermis, thus primary areoles of epidermis subdivided.
 5. Dioicous; thallus robust, 3-6 mm broad; appendages of ventral scales 2 - 4 subulate appendages, never forming a conspicuous hyaline cluster beneath the carpocephalum. *A. californica*
 5. Paroicous or autoicous; thallus smaller, 2-3 mm broad; appendages of ventral scales 1-2, forming a conspicuous hyaline cluster beneath the carpocephalum. *A. saccata*

Asterella bolanderi (Aust.) Underw. [*A. violacea* (Aust.) Underw.] Klamath region, Coast Ranges, Cascade Ranges, Sierra Nevada, Transverse and Peninsular Ranges, but uncommon in Southern California; on summer-dry soil of banks in oak woodland or dry scrub, sometimes beneath shrubs in chaparral or between bunchgrasses in grassland, or around rocks, 60 to 1800 m (but usually below 1200 m). Howe (1899); Clark and Frye (1936); Frye and Clark

(1937-1947); Yurky (1995); Doyle (1998); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Miranda, Humboldt Co., *Tracy 13782* (UC); Oak Run, Shasta Co., *Baker & Nutting, 24 May 1894* (UC); Ice Cream Grade 1.6 miles west of junction with Empire Grade, ca 2 miles northeast of Bonny Doon, Santa Cruz Co., *Whittemore & Whittemore 4430* (MO); west end of Hetch Hetchy Valley, 1 mile north of O'Shaughnessy Dam, Yosemite National Park, Tuolumne Co., *Keck & Clausen 5272* (UC); bank of San Luis Rey River by west entrance to La Jolla Indian Reservation Campground, San Diego Co., *Stark 678B* (MO)

Asterella californica (Hampe) Underw. Klamath region, north and central coast, Coast Ranges, Cascade Range foothills, Great Valley, Sierra Nevada, Transverse and Peninsular Ranges, and western Sonoran Desert; on summer-dry soil or sometimes rock in light shade, on banks and around rock outcrops, mostly in oak woodland, occasionally chaparral, grassland, or desert scrub, mostly 0 to 900 m but up to 2100 m in the southern Sierra Nevada and Transverse Ranges. Howe (1899); Kingman (1911); Evans (1923b); Clark and Frye (1936); Frye and Clark (1937-1947); Clark (1953); Steere (1954); Wolery and Doyle (1969); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Hwy. 96 ca 6 miles north of Hoopa, Humboldt Co., *Whittemore & Norris 1195* (CAS); trail from Rhus Ridge Road to Duveneck Windmill Pasture, border of Rancho San Antonio Open Space Preserve, Palo Alto, Santa Clara Co., *Whittemore & Whittemore 4325* (CAS); along California hwy. 190, 3.4 miles above Wishon road junction, Tulare Co., *Shevock & Tan 13137* (CAS); Palm Springs, Riverside Co., *Parish 3890* (CAS); ravines just north of Genessee Avenue, ca 1 mile east of intersection with Interstate 5, San Diego, San Diego Co., *Stark 768* (MO)

Asterella gracilis (F. Weber) Underw. [*A. ludwigii* auct., non (Schwaegr.) Underw.; *Mannia gracilis* (F. Weber) D. B. Schill & D.G. Long] Klamath Region, Warner mountains, high Sierra Nevada; on damp soil or rock, often on streambanks, in seeps or boggy areas, 500 to 3500 m, but usually above 1200 m. Howe (1899); Frye and Clark (1937-1947); Doyle and Stotler (2006).

Note: *Asterella* is a morphologically heterogeneous group, and recent studies (especially the molecular phylogenies of Long et al. 2000 and Schill et al. 2010) suggest that the traditional delimitation of *Asterella* needs to be modified. Long (2005) proposed a revised sectional classification of *Asterella*, stating that his cpDNA study came to two main conclusions, first "*Asterella* was shown to be paraphyletic," and second, "the molecular clades...supported the five main groups that are now recognized as subgenera." In fact, some of his taxonomic decisions are not at all supported by the chloroplast phylogeny; for instance, Long (2005) puts *Asterella californica* in subg. *Wallichianae*, with *A. wallichiana*, but the two species are completely unrelated in his molecular tree. Other key species were not sampled for the molecular study; he samples only two species of the morphologically diverse subg. *Saccatae*, for instance, and two species of sect. *Brachyblepharis*. He states that, "*Asterella* was shown to be paraphyletic... it was still considered convenient to distinguish *Asterella* as a genus on the basis of its pseudoperianth," but his later transfer of *A. gracilis* to *Mannia* (Schill et al. (2010) negates this by placing a species with an exserted, cleft pseudoperianth in *Mannia*. I have retained the old classification until something more natural can be created to replace it. Such a natural classification will probably remove *A. palmeri* and its relatives from *Asterella* and possibly treat *A. californica* as a distinct genus also, while probably lumping *Mannia* with *Asterella*.

Representative collections: Headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50126, 50130, 50141, 50159* (H); Paine's Lake, east side of Russian Peak, Siskiyou Co., *Norris & Smith 46328* (H); along Gold Lake Road (old road) between Gold Lake and Frazier Falls, Sierra Co., *Whittemore & Whittemore 5375* (tbd); immediately above Eagle Falls on trail from Emerald Bay (Lake Tahoe) to the Desolation Wilderness, El Dorado Co., *Whittemore & Whittemore 5195* (tbd); Eagle Lake

Trail, near Mineral King, Tulare Co., *Howell 618 p. p.* (CAS)

Asterella palmeri (Aust.) Underw. Coast Ranges, Sierra Nevada foothills, Transverse and Peninsular ranges, south coast; on summer-dry soil or rock, sea level to 1200 m. Howe (1899); Kingman (1911); Evans (1923b); Frye and Clark (1937-1947); Steere (1954); Wolery and Doyle (1969); Yurky (1995); Doyle (1998); Jessup et al. (2002); Doyle and Stotler (2006).

Representative collections: University of California Hopland Experiment Station, northeast of Hopland, Mendocino Co., *Langenheim and Tadros s. n.*, 7 Feb. 1954 (UC); Upper Bidwell Park, Chico, Butte Co., *Griggs 61* (CHSC); along California Hwy. 190 between Coffee Campground and road junction to Wishon, Tule River Canyon, Tulare Co., *Shevock & Tan 13093* (CAS); Agua Escondido Springs Road ca 11.9 miles east of junction with Huansa Road, west side of Garcia Mountains east of Arroyo Grande, San Luis Obispo Co., *Doyle 2245* (MO); north-facing slope adjacent to San Vicente Reservoir, midway between San Vicente Dam and parking lot, three miles north of Lakeside, San Diego Co., *Stark 679* (MO)

Asterella saccata (Wahlenb.) Evans High Sierra Nevada: reported from Inyo Co. by Sutcliffe (1947). The report is doubtful, but I have left it in the key so that it may be recognized if collected.

Cryptomitrium tenerum (Hook.) Aust. Coast Ranges, Cascade Range, Sierra Nevada foothills, Transverse and Peninsular ranges, south coast; deeply shaded banks and recesses beneath roots and stones, along intermittent streams and deep in canyons where moist all winter but dry in summer, sea level to 1100 m (but usually below 600 m). Howe (1899); Kingman (1911); Evans (1923a); Frye and Clark (1937-1947); Stark and Whittemore (1992); Yurky (1995); Doyle (1998); Jessup et al. (2002); Doyle and Stotler (2006).

Representative collections: South end of Fisher Road at the north levee of Van Duzen River, between Hydesville and Carlotta, Humboldt Co., *Whittemore 527* (atw); Fern Banks, Upper Bidwell Park, Chico, Butte Co., *Griggs 305* (CHSC); Canyon Trail near north end of Montebello Ridge Open Space Preserve, Palo Alto, Santa Clara Co., *Whittemore & Whittemore 4311* (MO); along Trimmer - Balch Camp Road just west of Kirch Flat Powerhouse above the King's River, Pine Flat Reservoir, Fresno Co., *Shevock, Norris & Barahona 13156* (CAS); within Mission Gorge, just south of the San Diego River, 1 1/2 miles north on Father Junipero Serra Boulevard from Mission Gorge Road, San Diego Co., *Stark 540E* (MO)

Key to species of *Mannia*:

1. Ventral scales with large lanceolate hyaline appendages which project beyond the thallus apex; ventral branches occasional; spores yellow. *M. fragrans*
1. Ventral scales with small pigmented appendages which do not reach the thallus margin; ventral branches abundant; spores black. *M. californica*

Mannia californica (Gott.) L. C. Wheeler [*Grimaldia californica* Gott. ex Underw.] South Coast Ranges, Sierra Nevada, Transverse and Peninsular Ranges, south coast, and Mojave Desert; on exposed summer-dry soil, often around rocks, in areas that dry early in the season, usually 150 to 1500 m, but rarely up to 2700 m. Howe (1899); Frye and Clark (1937-1947); Doyle and Stotler (2006).

Note: The plant from San Bernardino County illustrated under this name by Preston (1939) is actually *Targionia* sp. nov.

Representative collections: 0.9 miles north of Boulder Creek, Santa Cruz Co., *Doyle 904* (herbarium of W. T. Doyle); junction hwy. 49 and Forest Hill Road, at junction North and Middle Forks of the American River, Placer Co., *Whittemore & Whittemore 3532* (CAS); Tollhouse Road between Tollhouse and Mt. Rest Guard Station, Fresno Co., *Doyle 2744*

(MO); between Key Ranch and Barker Dam, Joshua Tree National Monument, Riverside Co., *Norris 50514* (H); Miramar Naval Air Station, San Diego, San Diego Co., *Norris 50698* (H)
Mannia fragrans (Balb.) Frye & L. Clark Klamath region, Modoc Plateau, high Sierra Nevada; dry soil among rocks in open places that dry rapidly after snowmelt, 1400 to 3700 m. Whittemore (1987); Doyle and Stotler (2006).

Collections examined: Along Gold Lake Road (old road) between Gold Lake and Frazier Falls, Sierra Co., *Whittemore & Whittemore 5374* (tbd); north side of Tioga Pass, Tuolumne Co., *Baker 5809* (UC); H. M. Hall Natural Area, Mono Co., *Norris 48446* (H); 2.5 miles north of Tioga Pass, Mono Co., *Norris 48355* (H); Treasure Lake, west of Big Pine, Inyo Co., *Norris 47006* (JE)

Reboulia hemispherica (L.) Raddi Sierra Nevada foothills, deserts; on soil, 100 to 950 m. Howe (1899); Doyle and Stotler (2006).

Collections examined: Southeast side of canyon of North Fork Feather River, ca 300 feet southwest of Grizzly Dome Tunnel, Plumas Co., 39° 52' N 121° 22' W, *Janeway 5468* (MO); Folsom, Sacramento Co., *Brandeggee s. n.* (UC); Wonderland of Rocks, Joshua Tree National Park, San Bernardino Co., *J. C. Brinda 3327* (MO)

Excluded species: According to Evans (1923a), the report of *Mannia triandra* (Scop.) Grolle from Los Angeles by Conklin (1922, as *Neesiella rupestris* (Nees) Schiffn.) is based on a specimen of *Cryptomitrium tenerum*.

7. Cleveaceae Cavers

Key to varieties:

1. Pores of thallus 8-18 μm , radial cell walls near pore usually grossly thickened. *Clevea hyalina* var. *hyalina*
1. Pores of thallus (10-)18-40 μm , cell walls near pore thin or scarcely thickened. *Clevea hyalina* var. *californica*

Clevea hyalina (Sommerf.) Lindb. var. *hyalina* [*Athalamia hyalina* (Sommerf.) S. Hatt.] Klamath Region, Modoc Plateau, Sierra Nevada, Peninsular Ranges?; on shaded soil among rocks, in rather moist to very dry places, 1800 to 3500 m. Howe (1899); Doyle and Stotler (2006).

Representative collections: Near Doctor Rock, S1 T13N R3E, Del Norte Co., *Norris 50303* (H); ca 16 miles east of Medicine Lake, Modoc Co., *Norris 22504* (H); Carson Pass, Alpine Co., *Whittemore 5376* (tbd); Eagle Lake Trail, near Mineral King, Tulare Co., *Howell 618 p. p.* (CAS); Mt. Whitney Trail, Inyo Nat'l Forest, Inyo Co., *Doyle 2664* (herbarium of W. T. Doyle).

Clevea hyalina (Sommerf.) Lindb. var. *californica* M. Howe Coast Ranges, Sierra Nevada, Peninsular Ranges; on shaded, seasonally wet soil or rock, 200 to 900 m. Howe (1899).

Note: Populations found at low elevation in California form a cohesive group having significant genetic differences from the typical *C. hyalina* of high altitudes and latitudes. The characters in the key show some variability. In particular, rare specimens of var. *hyalina* are found in which cell wall thickening around the pores is weak or absent. Further investigation is needed to better characterize this taxon.

Representative collections: San Lorenzo River canyon, 1 mile north of Boulder Creek, Santa Cruz Co., *Hesse 1855* (UC); Adelaide Rd. about 3 miles east of jct. with Cypress Mountain Rd., San Luis Obispo Co., *Doyle 434* (herbarium of W. T. Doyle); Along Forester Rd., between Forester and El Portal, Mariposa Co., *Doyle 2693* (herbarium of W. T. Doyle); Borrego Palm Canyon, San Ysidro Mountains, San Diego Co., *Doyle 7078* (herbarium of W. T. Doyle).

8. Ricciaceae Reichenbach

Key to genera:

1. Ventral scales in several irregular rows, mostly ligulate, toothed; differentiated pores scattered in epidermis; small oil-cells present in all tissues. Air-chambers large, cavernous. *Ricciocarpos*
1. Ventral scales in one row (often splitting longitudinally, thus older scales approximately in two rows), broad, mostly rounded; epidermis without scattered differentiated pores; small oil-cells absent. Air-chambers various, large and cavernous or narrow and inconspicuous. *Riccia*

Key to subgenera of *Riccia*:

1. Air-chambers moderately broad to cavernous, at least always evident in cross section; well-differentiated epidermis present, at least near thallus apex, growing out over chambers, often tearing open over mature chambers; plants of water or seasonally wet soil near water. *Ricciella*
1. Air-chambers very narrow, inconspicuous chinks between cells of chlorenchyma, dorsal layer slightly differentiated as an epidermis, never with cells over chambers. Plants of seasonally moist soil away from bodies of water. *Riccia*

Key to species of *Riccia* subgenus *Ricciella*:

1. Sporophytes bulging strongly through ventral surface of thallus, breaking through ventrally; lobes of thallus oblong-linear to linear, 0.4--1.0 mm wide, 0.10--0.17 mm thick; epidermis of thallus persistent, air chambers remaining enclosed in mature thallus; usually submerged aquatics.
 2. Thallus 0.8--1.1 mm wide; air chambers usually evident in intact thalli, largest chambers 0.2--0.3 mm wide; dorsal surface of thallus plane or with a weak, broad groove at immediate apex; areoles of outer face of spore without central tubercles or blind walls, but spores not yet known from California. *R. fluitans*
 2. Thallus 0.4--0.9 mm wide; air chambers not evident in intact thalli, largest chambers 0.05--0.20 mm wide; dorsal surface of thallus plane or with a sharp groove near apex; some or all areoles of outer face of spore with central tubercles or blind walls. *R. canaliculata*
1. Sporophytes embedded in thallus, not bulging much on either side, breaking through dorsally; lobes of thallus broadly oblong; thalli 0.8--2.4 mm wide, 0.35--0.7 mm thick; epidermis rupturing with age, air chambers gaping on older parts of thallus (except sometimes in *R. frostii*).
 3. Thalli gray-green or purplish, usually linear, 0.8--1.2 mm broad; widest air chambers 0.03--0.06 mm broad; ridges of spore with few anastomoses. *R. frostii*
 3. Thalli yellow-green to pale green or whitish, \pm cordate, 1.2--2.4 mm broad; widest air chambers 0.10--0.20 mm broad; ridges of spore joined to form distinct areoles (sometimes incomplete in center of outer face).
 4. Thalli yellow-green, ageing brown, sometimes tinged with purple; areoles of spore 3--5 across outer face, many irregular or incomplete, the largest 22--37 μ m wide, many areoles enclosing a blind ridge, without spines. *R. cavernosa*
 4. Thalli pale green, ageing white; areoles of spore 8--10 across outer face, always regular and complete, the largest 8--11 μ m wide, never enclosing a blind ridge, with spines at corners. *R. crystallina*

Key to species of *Riccia* subgenus *Riccia*:

1. Ventral scales large, imbricate, reaching the margin or nearly so; cilia absent; dorsal surface with a narrow, sharp sulcus, at least near thallus apex.
 2. Older thallus tissues becoming orange- or red-brown.
 3. Sides and ventral scales solid black-purple; thalli 0.5-1.5 mm wide; spores averaging 68-

- 77 μm in diameter, both faces with a fine, well-formed reticulum. *R. nigrella*
3. Sides and ventral scales colorless or with scattered orange-brown cells, occasionally also with scattered purple cells; thalli 1-3 mm wide; spores averaging 90-112 μm in diameter, areoles of outer face very poorly formed and broken, sculpturing very low on the inner face. *R. campbelliana*
 2. Older thallus tissues becoming whitish.
 4. Ventral scales projecting far beyond thallus margin, covering apical 1-2 mm of dry thallus; thalli to 5-10 mm long, 1.1-3 mm broad, cells of epidermis and scales usually thin-walled. *R. lamellosa*
 4. Ventral scales not projecting significantly beyond thallus margins, not covering apex of dry thallus; thalli to 2-4(-7) mm long, 0.7-1.7 mm broad, cell walls of epidermis and ventral scales thickened. *R. sorocarpa*
 1. Ventral scales small, remote, not approaching thallus margin; cilia usually present and conspicuous (short and peg-like in *R. iodocheila*, often absent in *R. glauca*); sulcus various.
 5. Ventral scales toothed or cleft; sides of thallus merely with short, peg-shaped purple projections ca 60 μm long. *R. iodocheila*
 5. Ventral scales undivided, usually very inconspicuous; cilia (if present) hyaline or yellowish, 90-1000 μm long.
 6. Largest cilia 0.4-1.0 mm long, on sides of thallus and usually on the epidermis over sporophytes; thallus 1.0-1.2 mm wide, dorsal surface with a narrow sharp sulcus near the apex. *R. trichocarpa*
 6. Cilia, if present, 0.1-0.4 mm long, never on the epidermis over sporophytes; thallus 0.7-2.0 mm wide, dorsal surface with a broad, round-bottomed channel.
 7. Spores averaging 57-75 μm in diameter, inner face almost as strongly reticulate as outer face; antheridia without raised ostioles; sides of thallus almost always green, very rarely blotched with purple; cilia always finely granulate. *R. californica*
 7. Spores averaging 75-130 μm in diameter, reticulum of inner face weak or obscure; antheridial ostioles strongly raised; sides of thallus often more or less pigmented with purple; cilia usually smooth, sometimes granulate (often spotty through the accumulation of epiphytes and debris).
 8. Cilia always present, oblong to bluntly lance-oblong, rounded to bluntly acute at apex, never long-tapering; flanks of thallus often swollen, thalli 2-4 times as wide as thick; sides of thallus usually blotched with reddish or brownish purple; spores averaging 76-90 μm in diameter, reticulum of inner faces very low and obscure. Common, 1200 to 3000 m, throughout the mountains of the state. *R. beyrichiana*
 8. Cilia present or absent, if present slender, sharp-pointed, acuminate; flanks of thallus hardly raised, thalli often 4-5 times as wide as thick; sides of thallus green or uniformly black-purple; spores averaging 75-130 μm in diameter, reticulum of inner faces more distinct. Rare, low elevations near the coast. *R. glauca*

Riccia beyrichiana Hampe [*R. lescureana* Aust.] Klamath region, Cascade Range, high inner North Coast Ranges, high Sierra Nevada; on soil, often in seepy areas, 1200 to 3000 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Sutcliffe (1947); Yurky (1995); Doyle and Stotler (2006).

Note: The sole collection reported by Howe (1899) is coastal, and it is probably ciliate *Riccia glauca*.

Representative collections: along Trinity River at Norton Creek, ca 4 miles north of Hoopa, Humboldt Co., *Norris 10449* (H); near summit of Elk Mountain, Lake Co., *Mason s. n., 1 Jan. 1926* (UC); along hwy. 44 ca 24 miles west of Susanville, Lassen Co., *Norris 22594* (H); Cora Lake, Madera Co., *Howell, 10 Aug. 1958* (CAS); Paloma Meadows, Kearn

- Plateau, Tulare Co., *Howell, Fuller & Barbe s. n., 16 July 1980 (CAS)*
- Riccia californica* Aust. North and central coast and Coast Ranges, Cascade Range, Sierra Nevada foothills, Transverse Ranges, south coast, but rare in the southern half of the state; on summer-dry soil, rarely sandstone, usually on banks or by paths, in shrubland, woodland, or grassland, sea level to 500 m. Howe (1899); Frye and Clark (1937-1947); Stark and Whittemore (1992); Yurky (1995); Doyle (1998); Doyle and Stotler (2006).
Note: The report from Alpine County by Howe (1899) is based on a poorly developed specimen of *R. beyrichiana*.
Representative collections: Gualala River 2 miles above Gualala Post Office, Mendocino Co., *Carter 261 (UC)*; Crystal Creek at hwy. 299, Shasta Co., *Malachowski s. n., 29 Apr. 1972 (CHSC)*; Keithly Farm, Rio Linda, Sacramento Co., *Carter 478 (UC)*; back of Stanford University, Santa Clara Co., *Howell 25 May 1933 (CAS)*; western edge of Kearny Mesa, 1/2 mile northwest of the junction of hwy. 805 and 52, San Diego, San Diego Co., *Stark 765 (MO)*
- Riccia campbelliana* M. Howe Central and southern Coast Ranges, Cascade Range, Sierra Nevada foothills, Transverse Ranges, south coast; on summer-dry soil (often thin soil over rock) in openings in shrubland or woodland or in grassland, sea level to 1700 m. Howe (1899); Frye and Clark (1937-1947); Wolery and Doyle (1969); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).
Representative collections: 9 miles east of Bella Vista, Shasta Co., *Norris 47572 (H)*; slope above the parking lot at the hwy. 68 entrance, Toro Regional Park, just west of Salinas, Monterey Co., *Whittemore & Whittemore 2977 (CAS)*; south side of American River, Fair Oaks, Sacramento Co., *Carter 411 (UC)*; vernal pool natural area ca 4 1/2 miles east northeast of Pixley, Tulare Co., *Howell, 30 Apr. 1967 (HSC)*; near hospital, Balboa Park, San Diego, San Diego Co., *Haynes 2832 (CAS)*
- Riccia canaliculata* Hoffm. Northern San Joaquin Valley; floating below surface of streams or lakes, or stranded on wet shaded soil of shoreline, near sea level. Doyle and Stotler (2006).
Representative collections: Modesto Properties Gun Club, 1 mile east of Gustine, Merced Co., *Nobs & Smith 438 p. p. (UC)*; small slough west of Holt, San Joaquin Co., *Carter 240 (UC)*
- Riccia cavernosa* Hoffm. [*R. catalinae* Underw., *R. crystallina* auct., not L.] Cascade Range, Modoc Plateau, Coast Ranges, Great Valley, Sierra Nevada, south coast, Peninsular Ranges; annual on soil which is wet (often submerged) in winter and dry in summer, along streams, in ditches, around seasonal ponds, or in seeps, rarely on seepy rock outcrops, sea level to 2900 m (but usually below 1500 m). Howe (1899); Evans (1923b); Frye and Clark (1937-1947); Steere (1954); Stark and Whittemore (1992); Yurky (1995); Doyle (1998); Doyle and Stotler (2006).
Note: This species was always called *Riccia crystallina* L. until the latter name was lectotypified in 1964. The description and specimens called *R. crystallina* in Howe (1899) and the other pre-1964 papers listed above all belong here.
Representative collections: 1/2 mile south of Ager, Siskiyou Co., *Mason s. n., 10 Aug. 1927 (UC)*; Hood's Mountain, Sonoma Co., *Stason 33 (UC)*; southwest side of Adobe Valley, Mount Hamilton Range, Stanislas Co., *Carter 1150 (UC)*; Salmon Falls Road, 7 1/2 miles from Folsom, El Dorado Co., *Carter 493 (UC)*; along unnamed stream eventually flowing into Oriflame Canyon, Laguna Mountains, ca 10 miles south of Julian, San Diego Co., *Stark 845 (MO)*
Representative collections: Along Loveness Road near hwy. 139, ca 4 miles north of Canby, Modoc Co., *Norris 22247 (H)*; along Anderson to Shingletown Road ca 11 miles east of Anderson, Shasta Co., *Norris 23730 (MO)*; Hilton place, Big Basin Way, Santa Cruz Co., *Hesse 1769 (UC)*; Salmon Falls Road at head of Darlington Trail, Skunk Canyon, north side of the arm of Folsom Lake fed by the South Fork of the American River, El Dorado Co., *Whittemore & Whittemore 4368 (MO)*; Balboa Park, San Diego, San Diego Co., *Haynes*

2718 (UC)

Riccia crystallina L. North and central coast; annual on exposed mineral soil around paths and clearings on bottomland near the coast; below 40 m. Doyle and Stotler (2006).

Note: As noted above, old reports of *R. crystallina* are all based on specimens of *R. cavernosa*.

Representative collections: Bog Trail, east off Calif. 1, Van Damme State Park, south of Mendocino, Mendocino Co., *Doyle 6243* (MO); Tilden property, off Branciforte Drive, Santa Cruz Co., *Doyle 722* (MO); between fee entrance station and Aptos Creek, Forest of Nisene Marks State Park, Santa Cruz Co., *Doyle 6385* (CAS)

Riccia fluitans L. Central Coast Ranges, San Joaquin Valley, northern Sierra Nevada; floating below surface of streams or lakes, or stranded on wet shaded soil of shoreline, sea level to 1200 m. Evans (1923a); Frye and Clark (1937-1947); Sutcliffe (1947); Yurky (1995); Doyle and Stotler (2006).

Representative collections: Lily Lake near Alpine Lake, north side of Mount Tamalpais, Marin Co., *Carter 534* (UC); 1 mile east of Gustine, Merced Co., *Nobs & Smith 438 p. p.* (UC); ca 2 miles south of Greenville, Plumas Co., *Nobs & Smith 1422* (UC); small slough west of Holt, San Joaquin Co., *Carter 241* (UC)

Riccia frostii Aust. Coast ranges, Cascade Range, Great Valley, Sierra Nevada foothills, Owens Valley; annual on damp (often sandy) soil, banks of rivers and lakes, sea level to 2100 m. Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006).

Representative collections: North bank of Russian River at mouth of a small stream, at mile 10.0 on hwy. 116, Sonoma Co., *Whittemore & Norris 809* (herbarium of A. T. Whittemore); Mountain View Cemetary, Oakland, Alameda Co., *Carter 396* (UC); north bank of American River, Fair Oaks, Sacramento Co., *Carter 373, 379* (UC); margin of Lake Success near channel of South Fork Tule River, hwy. 190 between Porterville and Springville, Tulare Co., *Doyle 7042* (MO); floodplain of Walker River ca 0.8 miles north of Coleville, Mono Co., *Doyle 6761* (herbarium of W. T. Doyle)

Riccia glauca L. var. *ciliaris* Warnst. North and central coast and adjacent Outer Coast Ranges; on rather sunny wet soil, sea level to 210 m. Howe (1899); Kingman (1911); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006).

Note: This species has been reported from localities scattered through the state, but it has been confused with *R. beyrichiana* in California, and many specimens named as *R. glauca* are misidentified (usually specimens of *R. beyrichiana* with some eciliate thalli). Further study of the ciliate *Riccia* spp. in California is desirable, and this treatment must be considered tentative.

Representative collections: shore of Lake Mendocino, near hwy. 20, Mendocino Co., *Norris 48271* (H); along hwy. 9 ca 1.5 miles north of Boulder Creek, Santa Cruz Co., *Norris 55577* (H); near junction of Watkins Gate Road and Henneken Ranch Road, south of Marina, old Fort Ord property, Monterey Co., *Doyle 7472* (MO)

Riccia iodocheila M. A. Howe Rocky headland, Santa Catalina Island. Jovet-Ast (1989).

Note: Reported by Steere (1954) as *Riccia violacea* M. Howe; see Jovet-Ast (1989) for the revised determination.

Representative collections: The specimen is missing, and I have not seen it.

Riccia lamellosa Raddi [*R. americana* (M. Howe) M. Howe, *R. austini* Steph.] Central Coast Ranges and coastal Southern California; on summer-dry soil in grassland and chapparral, sea level to 300 (xxx or to 600?) m. Howe (1899); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006).

Representative collections: Serpentine ridge above Dew Falls, ca 3 miles south of Monte Rio, Sonoma Co., *Carter 253* (UC); Route 29 to Napa ca 2 miles south of the hospital, Napa Co., *McLaughlin, 10 Apr. 1965* (UC); Mission Dolores, San Francisco Co., *Howe 508* (CAS); hills east of Mountain View Cemetery, Oakland, Alameda Co., *Carter 759* (UC); western edge of Kearny Mesa, 1/2 mile northwest of the junction of hways. 805 and 52, San

- Diego, San Diego Co., *Stark 761C* (MO)
- Riccia nigrella* DC. Klamath region, Cascade Range, Warner Mountains, Coast Ranges, Sierra Nevada foothills, Transverse and Peninsular Ranges, south coast, western Sonoran Desert; on summer-dry soil in shrubland, grassland or openings in woodland, sea level to 1400 m. Howe (1899); Frye and Clark (1937-1947); Steere (1954); Wolery and Doyle (1969); Weber et al. (1987); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).
- Representative collections:** Crawford Creek, Siskiyou Co., *Norris 10463* (H); vista point immediately north of Edgewood Road on Interstate 280, just west of San Carlos, San Mateo Co., *Whittemore 4215* (MO); 0.6 miles west of the eastern boundary of Upper Bidwell Park, Chico, Butte Co., *Griggs 108* (CHSC); Coffee Campground off of California Hwy. 190, near Tule River, Tulare Co., *Shevock, Norris and Barahona 13014* (CAS); between Key Ranch and Barker Dam, Joshua Tree National Monument, Riverside Co., *Norris 50512* (H); Rincon del Diablo, Escondido, San Diego Co., *Meyer s. n., Mar. 1927* (UC)
- Riccia sorocarpa* Bisch. [*R. minima* L.] Klamath region, Modoc Plateau, Cascade Range foothills, coast, Coast Ranges, Sierra Nevada, Transverse Ranges; on summer-dry soil, usually around paths or among rocks, in shrubland, grassland or openings in woodland, sea level to 3200 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Steere (1954); Stark and Whittemore (1992); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).
- Representative collections:** Near Doctor Rock, S1 T13N R3E, Del Norte Co., *Norris 50362* (H); west side of Goose Lake ca 2 miles north of McGinty Point, Modoc Co., *Norris 23637* (H); upper end of Polly Geraci Trail, Pulgas Ridge Open Space Preserve, west of San Carlos, San Mateo Co., *Whittemore & Whittemore 5122* (MO); vista point on the east side of Carson Pass, immediately south of hwy. 88, Alpine Co., *Whittemore & Whittemore 5377* (tbd); Balboa Park, San Diego, San Diego Co., *Haynes 2745 p. p.* (UC)
- Riccia trichocarpa* M. Howe Klamath region, Modoc Plateau, Cascade Range foothills, central and southern Coast Ranges, Sierra Nevada, Transverse and Peninsular Ranges, south coast; on summer-dry soil in shrubland, grassland or openings in woodland, sea level to 3000 m (but uncommon above 900 m). Howe (1899); Kingman (1911); Evans (1923b); Frye and Clark (1937-1947); Steere (1954); Wolery and Doyle (1969); Weber et al. (1987); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).
- Note:** This species was well known under this name for many years, but it has gone under different names in recent publications. Schuster (1992b) and Hugonnot (2010) have united this species with *R. ciliata* Hoffm., which is a distinct species according to Jovet-Ast (1986, 1994). Jovet-Ast (2000) placed *R. trichocarpa* in the synonymy of *Riccia crinita* Taylor (type from Australia), but Australian and North American specimens do not come out together in the chloroplast DNA phylogeny of Cargill et al. (2016). Until these problems have been sorted out, I retain the name *R. trichocarpa*, the oldest name that unambiguously applies to the North American material.

Excluded species: Schuster (1992b) lists California in the range of *Riccia hirta* (Austin) Underwood, surely by mistake. I haven't seen any material of *R. hirta* from California, and I don't know of any other reports.

- Ricciocarpos natans* (L.) Corda Klamath region, Modoc Plateau, central coast, Coast Ranges, and Sierra Nevada; floating on the surface of lakes or ponds, or on wet soil around the banks of drying pools, sea level to 1500 m. Frye and Clark (1937-1947); Kellman (2003); Doyle and Stotler (2006).
- Representative collections:** Sharber Slough, Trinity Co., *Tracy 7787* (UC); Jack Swamp, north of Canby, Modoc Co., *Stokes s. n., 21 July 1939* (CAS); Laguna Puerca, San Andreas Fault line, north end of San Mateo Co., *Mason, Mason & Duran s. n., 14 Jan. 1933* (UC); ca

2 miles south of Greenville, Indian Valley, Plumas Co., *Nobs & Smith 1400* (UC); near Pine Flat Reservoir, 8 miles east of Trimmer Springs Road on Island Park Road, below Driftwood Trailer Park and Campground, Fresno Co., *Mueller 6905a* (UC)

SPHAEROCARPALES

9. Riellaceae Engler

Key to species of *Riella*:

1. Monoecious; involucre longitudinally winged. *R. heliospora*
1. Dioecious; involucre smooth. *R. americana*

Riella heliospora Segarra-Moragues, Puche, & Sabovljevic. Sacramento Valley and central Coast Ranges; annual on seasonally submerged soil of ponds and lake margins, near sea level. Thompson (1940, 1941); Frye and Clark (1937-1947); Doyle and Stotler (2006), all as *Riella affinis* auct. not M. Howe & Underw.; Segarra-Moragues et al. (2012).

Collections examined: Lake Lagunitas, Stanford University, Santa Clara Co., *R. H. Thompson s. n.*, 1939 (Y), same locality, *R. H. Thompson s. n.*, May 1940 (Y), same locality, *R. H. Thompson s. n.*, June 1940 (Y); on soil cultured from the Cache Creek Settling Basin, near Woodland, Yolo Co., *Yeo s. n.* February 1977 (UBC)

Riella americana M. Howe & Underw. Modoc Plateau; annual on seasonally submerged soil of ponds, 1500 m. Proctor (1972); Doyle and Stotler (2006).

Note: Proctor (1972) provides strong evidence suggesting that most of the North American collections referred to *R. americana*, including the California collection, are distinct from the type collection. However, he does not describe or suggest a more appropriate name for these populations. An annotation by Proskauer, November 1954, says, "Probably synonymous with *R. helicophylla*."

Collection examined: Southwest margin of Big Sage Reservoir, central Modoc Co., *Mason 13468a* (UC)

10. Sphaerocarpaceae Heeg

Key to genera:

1. Gametophyte perennial, forming large tubers; outer face of spore smooth. *Geothallus*
1. Gametophyte annual, without tubers; outer face of spore strongly ridged. *Sphaerocarpus*

Geothallus tuberosus Campb. Peninsular Ranges and adjacent coastal southern California; soil around vernal pools and other wet depressions, sea level to 500 m. Howe (1899); Frye and Clark (1937-1947); Wolery and Doyle (1969); Geissler et al. (1997); Doyle (1998); Doyle and Stotler (2006).

Collections examined: West side of Waterline Road, Santa Rosa Plateau Ecological Reserve, Riverside Co., *Doyle 7295* (herbarium of W. T. Doyle); Balboa Park, San Diego, *Howell 153* (CAS); dirt road north of Mesa Boulevard, west of hwy. 395, north end of Kearney Mesa, San Diego Co., *Doyle & Wolery s. n.*, April 1968 (UC); north side of Miramar Road, between Interstate 805 and Eastgate Mall Road, Kearney Mesa, San Diego Co., *Doyle 6168* (MO)

Key to species of *Sphaerocarpus*:

1. Ridges on outer face of spore not forming areoles or with a few irregular areoles in the middle of the outer face.
 2. Spores separating at maturity; ridges thin, sinuous. *S. cristatus*
 2. Spores permanently united in tetrads; ridges thick, straight. *S. drewei*
1. Ridges on outer face of spore forming regular areoles; spores permanently united in tetrads.
 3. Areoles 18-36 μm wide, 4-6 across width of tetrad, without prominent spines at their

- junctions. *S. texanus*
 3. Areoles 10-14 μm wide, 8-12 across width of tetrad, with prominent spines at their
 junctions. *S. michellii*

Sphaerocarpus cristatus M. Howe Coast Ranges, Sierra Nevada foothills, San Joaquin Valley, Peninsular Ranges, coastal southern California; annual on summer-dry mineral soil, commonly in disturbed areas such as trailbanks, roadsides, gardens, banks of seasonal streams or river floodplains, sea level to 800 m. Howe (1899); Frye and Clark (1937-1947); Clark (1953); Wolery and Doyle (1969); Doyle and Stotler (2006).

Representative collections: Abandoned vineyard southwest of Pleasanton, between Pleasanton and Interstate 680, Alameda Co., *Doyle 790* (MO); Flume Trail by dam of reservoir, Filoli Center, north of Woodside, San Mateo Co., *Whittemore & Noyes 4413* (CAS); Los Altos, Santa Clara Co., *Sutcliffe s. n., April 1931* (CAS); Pine Flat Reservoir, 8 miles east of Trimmer Springs Road on Island Park Road, below Driftwood Trailer Park and Campground, Fresno Co., *Mueller 6903a* (UC); near Horse Creek, south off Calif. hwy. 198 near Kaweah Lake, Tulare Co., *Doyle 5781* (MO); El Monte Road, San Diego Co., *Doyle 788* (herbarium of W. T. Doyle)

Sphaerocarpus dreweae Wigglesw. Peninsular Ranges and adjacent coastal southern California; open areas in chaparral and savanna, 90 to 1300 m. Wigglesworth (1929); Frye and Clark (1937-1947); Wolery and Doyle (1969); Geissler et al. (1997); Doyle (1998); Jessup et al. (2002); Doyle and Stotler (2006).

Representative collections: Near Keane Turnoff hwy. 58, east of Bakersfield, Kern Co., *Doyle 780* (herbarium of W. T. Doyle); Santa Rosa Plateau Ecological Reserve, Riverside Co., *Doyle 7282* (herbarium of W. T. Doyle); Sylvan Meadow Ranch, south side of Clinton Keith Road ca 0.2 miles east of Tenaja Road, Santa Rosa Plateau, Riverside Co., *Doyle 7113* (herbarium of W. T. Doyle); north off Eastgate Road, near top of ravine overlooking Interstate 805, Kearny Mesa, San Diego Co., *Doyle 7193* (MO); Balboa Park, San Diego, San Diego Co., *Howell 152* (CAS)

Sphaerocarpus michellii Bellardi Modoc Plateau; damp soil, ca 1400 m? Doyle (1975); Doyle and Stotler (2006).

Collection: Hwy. 91 ca 18 km west of junction with hwy. 139, Modoc Co., *Doyle 1974* (UC, acc. Doyle 1975, but I didn't find it there)

Sphaerocarpus texanus Aust. [*S. californicus* Aust.] Klamath region, Cascade Range, Coast Ranges, Sierra Nevada foothills, Transverse Ranges, south coast; annual on summer-dry mineral soil, commonly in disturbed areas such as trailbanks, sea level to 1100 m. Howe (1899); Wolery and Doyle (1969); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Wooden Valley Grade, about seven miles northeast of Napa, Napa Co., *Carter 446* (UC); Oak Tree Trail, Pleasanton Ridge Regional Park, north of Sunol, Alameda Co., *Whittemore & Whittemore 4248* (MO); Big Canyon Park, Brittan Avenue, San Carlos, San Mateo Co., *Whittemore 4297* (CAS); New Almaden Trail from jct. Hacienda Trail to serpentine outcrop north of Buena Vista Mine, Almaden Quicksilver County Park, Los Gatos, Santa Clara Co., *Whittemore, Zappacosta, van Seventer, and Casey 5461* (CAS); southern part of the Orestimba Creek Trail, Henry Coe State Park, Stanislas Co., *Whittemore, Briggs & Briggs 6573* (tbd); along Sam Jones Road about 1 km east of Piojo Airstrip, Hunter-Leggett Military Reservation, Monterey Co., *Norris 87217* (UC)

FOSSOMBRONIALES

11. Fossombroniaceae Hazsl.

Key to species of *Fossombronia*:

1. Ridges of spores 5-7(-8) μm apart, 15-26 around edge of spore in face view, 8-11 across side of spore, always continuous. *F. pusilla*
1. Ridges of spores 2.5-4 μm apart, 29-40 around edge of spore in face view, 11-15 across side of spore, usually \pm broken up into short segments or rows of spines. *F. hispidissima*

Fossombronia hispidissima Steph. Klamath region, Coast Ranges, Cascade Range foothills, Sierra Nevada, Transverse and Peninsular Ranges, south coast; on summer-dry soil, 180 to 800 m. Howe (1899); Evans (1923a); Frye and Clark (1937-1947); Steere (1954); Yurky (1995); Doyle (1998); Kellman (2003); Doyle and Stotler (2006).

Note: Many authors, notably Howe (1899), did not distinguish between *Fossombronia pusilla* and *F. hispidissima*. Evans (1923a) separates them on cristate vs. echinate spores, a distinction that does not hold up. The spores that Howe illustrated, and some that Evans described, can be assigned to species; I have used some of these in the distribution statements for *F. pusilla* and *F. hispidissima*. *Fossombronia hispidissima* is very similar to *F. wondraczekii* (Corda) Dumort., differing in that the ridges are usually more or less broken up into short segments; Scott and Pike (1988) say it is "probably just a form of *F. wondraczekii*." Doyle and Stotler (2006) applied the name *F. longiseta* to this taxon; this seems to be an error (see below).

Representative collections: River bluff at Swede Rock, S23 T34N R7E, Trinity Co., Norris 51101 (H); west side of canyon of North Fork Feather River 100 feet above hwy. 70, S7 T22N R5E, Butte Co., Janeway 5373 (MO); trail from Rhus Ridge Road to Duveneck Windmill Pasture, border of Rancho San Antonio Open Space Preserve, Palo Alto, Santa Clara Co., Whittemore & Whittemore 4324 (MO); along Trimmer-Balch Road just west of Kirch Flat Powerhouse above the Kings River, Pine Flat Reservoir, Fresno Co., Shevock, Norris and Barahona 13157 (CAS); alongside the San Luis Rey River within the La Jolla Indian Reservation Campground, hwy. 76 5.7 miles east of Lake Henshaw, San Diego Co., Stark 458 (MO)

Fossombronia pusilla (L.) Dumort. [*F. longiseta* Aust.] Klamath region, north and central coast and Coast Ranges, Cascade Range foothills, Sierra Nevada, Peninsular Ranges; on summer-dry soil, 60 to 1200 m. Howe (1899); Kingman (1911); Evans (1923a, 1923b); Frye and Clark (1937-1947); Wolery and Doyle (1969); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).

Note: *Fossombronia longiseta* was based on a mixture of material belonging to three different species of *Fossombronia*. Schuster (1992a p. 395) lectotypified *F. longiseta* with the specimen of Austin, *Hepaticae Boreali-Americani 118* at H. An SEM of one spore from this specimen was previously published by Scott and Pike (1988 fig. 19) and it is clearly *F. pusilla*. It is not at all clear why Doyle and Stotler (2006) apply the name to *F. hispidissima*.

Representative collections: Bluff above Trinity River along hwy. 96 ca 7 miles north of Hoopa, Humboldt Co., Norris 22278 (H); along Anderson to Shingletown Road ca 11 miles east of Anderson, Shasta Co., Norris 23729 (H); Polly Geraci Trail, Pulgas Ridge Open Space Preserve, San Carlos, San Mateo Co., Whittemore & Whittemore 4468 (CAS); near Ione, Amador Co., Messick 356 (HSC); along Morena Reservoir Road, adjacent to southwest edge of La Morena Reservoir, near Lake Morena, San Diego Co., Stark 826 (MO)

12. Pelliaceae H. Klinggräff

Key to species of *Pellia*:

1. Many mucilage hairs of thallus apex 4-celled, cells elongate; thallus without thickening bands. Inner cells of capsule wall without semiannular thickenings. *P. endiviifolia*
1. Mucilage hairs of thallus apex all 2-celled, cells short; thallus with thickening bands (often few and hard to find). Inner cells of capsule wall with complete semiannular thickenings. *P. neesiana*

Pellia endiviifolia (Dicks.) Dumort. North coast, Klamath region, Cascade Range, Warner

Mountains, high southern Sierra Nevada; shaded creekbanks and wet meadows, 1300 to 2700 m. Doyle and Stotler (2006), Bakalin (2012a).

Note: The report by Clark and Frye (1936) and Frye and Clark (1937-1947) from Hydesville, Humboldt County is based on a specimen, *Frye s. n. 30 July 1933* (UC), that is sterile and depauperate and cannot be identified with certainty.

Representative collections: Forest Service Road 41N14 (Sugar Lake Rd.) ca 2.5 miles from Callahan - Cecilville Rd., Siskiyou Co., *Doyle 5925* (herbarium of W. T. Doyle); county road 14 west of hwy. 395, south of Cedarville, Modoc Co., *Doyle 807* (herbarium of W. T. Doyle); Bear Flat Rd. ca 9.8 miles from Richmond Rd., southwest of Susanville, Lassen Co., *Doyle 1022* (herbarium of W. T. Doyle); Rowell Meadow, Jennie Lakes Wilderness, Tulare Co., *Shevock & York 13707, 13710* (CAS); along forest trail 30E08 between Rowell Meadow and Marvin Pass, Jennie Lakes Wilderness, *Shevock 14580* (CAS)

Pellia neesiana (Gott.) Limpr. North coast, Klamath region, Cascade Range, Warner Mountains, Sierra Nevada; on wet shaded soil near streams, occasionally lakeshores or seeps in forests and meadows, sea level to 3200 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Damnation Creek Trail, Jediah Smith State Park, Del Norte Co., *Roy 212* (SFSU); just south of Landing Aids Experimental Station, on hwy. 101 ca 6 miles north of Arcata, *Nobs 3 May 1950* (UC); Little River, Mendocino Co., *Mason 4991* (UC); Morrell Mine Rd. beyond Larry Flat, Modoc Co., *Doyle 2896* (herbarium of W. T. Doyle); Trout Creek at Boone Meadow Rd., ca 3.3 miles south of Sherman Pass Rd., Tulare Co., *Doyle 6567* (herbarium of W. T. Doyle)

13. Pallaviciniaceae Mig.

Pallavicinia lyellii (Hook.) Gray Reported from the north coast, 100 m (Arcata, Humboldt Co.) by Wilson (1989) and Doyle and Stotler (2006).

METZGERIALES

14. Aneuraceae H. Klinggräff

Key to genera:

1. Thallus segments 3-8 mm broad. *Aneura*
1. Thallus segments 0.4-1.7 mm broad. *Riccardia*

Aneura pinguis (L.) Dumort. [*Riccardia pinguis* (L.) Gray] North and central coast and Coast Ranges, Klamath region, Cascade Range, Warner Mountains, Sierra Nevada, Transverse Ranges; on wet soil or duff on streambanks, seeps, or springs, in conifer forest or montane meadows, sea level to 3300 m. Howe (1899); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Headwaters of a stream, ca halfway between Hoopa and North Trinity Summit, Humboldt Co., *Whittemore & Norris 1216* (CAS); near Kings Creek, Lassen Volcanic National Park, Shasta Co., *Showers 582* (SFSU); lower part of North Fork Trail, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Whittemore & Whittemore 3497* (CAS); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1530* (CAS); Dark Canyon, along Forest Road 24S05 (Jack Ranch Road) just south of White River, Tulare Co., *Shevock 14297* (CAS); Long Valley Creek, Round Valley Trail, San Jacinto Mountains, Riverside Co., *Doyle 7451* (herbarium of W. T. Doyle)

Key to species of *Riccardia*:

1. Branching regularly pinnate; wet banks and seepy spots, on soil or wet rock or wood.
 2. Unistratose margin of thallus broad; epidermal and marginal cells generally without oil bodies; branches ± parallel-sided. *R. multifida*

2. Unistratose margin of thallus narrow; most epidermal and marginal cells with oil bodies; branches somewhat narrowed at base. *R. chamedryfolia*
1. Branching palmate or irregular; on decaying wood.
 3. Monoecious; primary thallus thin, translucent, at least 1.0 mm broad. *R. latifrons*
 3. Dioecious; thallus thicker, opaque, less (usually much less) than 1.0 mm broad. *R. palmata*

Riccardia chamedryfolia (With.) Grolle [*R. major* (Nees) Lindb., *R. sinuata* (Dicks.) Trevis.] North and central coast, Klamath region, Sierra Nevada, Peninsular Ranges; on shaded soil and rotten wood, on streambanks, around springs and seeps, sea level to 2400 m. Howe (1899); Evans (1923a); Clark and Frye (1936); Frye and Clark (1937-1947); Stark and Whittemore (1992); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Along Low Divide Road near Smith River, Del Norte Co., *Thiers 37525* (SFSU); south of Dimmick State Park, Mendocino Co., *Toren 286* (SFSU); mile 15.5 on hwy. 116, in Pocket Canyon 4 miles west of Forestville, Sonoma Co., *Whittemore & Norris 811B* (herbarium of A. T. Whittemore xxx); Laguna de la Puerca, San Francisco Co., *Mrs. T. S. Brandegee s. n., 1891* (CAS); Redwood Creek above California hwy. 180, Monarch Wilderness, Fresno Co., *Shevock & York 12685* (CAS); Lower Doane Valley along Doane Creek, Palomar Mountain State Park, San Diego Co., *Stark 666, 667* (MO)

Riccardia latifrons Lindb. North and central coast, Klamath region, Warner Mountains; on shaded decaying wood or sometimes soil, in wet places, sea level to 1700 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Kellman (2003); Doyle and Stotler (2006).

Representative collections: along coastal trail between Requa and False Klamath Cove, Del Norte Co., *Norris 23996* (H); along hwy. 101 in Prarie Creek State Park, Humboldt Co., *Thiers 37610* (SFSU); near Mendocino, Mendocino Co., *Thiers 10240* (SFSU); ca 4 miles southeast of Fort Bragg, Mendocino Co., *Molseed s. n., 18 Sept. 1962* (UC); near Sisson [now the city of Mount Shasta], Siskiyou Co., *Howe 39* (UC); east of Upper Rush Creek Campground, east of County Road 198, Modoc Co., *Doyle 6673* (herbarium of W. T. Doyle); North Fork of Fall Creek, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Kellman 344* (herbarium of K. Kellman)

Riccardia multifida (L.) Gray [*R. multifida ambrosioides* (Nees) Lindb.] North and central coast, Klamath region, northern Sierra Nevada; on shaded decaying wood and duff, occasionally soil, streambanks and other wet places, sea level to 1500 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Between Crescent City and Adams, Del Norte Co., *Eastwood s. n., 11 August 1923* (CAS); along road to Eight Mile Lookout about 1 mile west of South Fork Mtn. Road about 8 air miles north of Mad River, Humboldt Co., Six Rivers National Forest, *Norris 83863* (UC); 1.8 miles east of South Fork Summit on hwy. 36, Trinity Co., *Boratynski 218* (CHSC); Butte Creek at Centerville Bridge on Humbug Road, Butte Co., *Roy 12* (SFSU); Hood's Peak, near Santa Rosa, Sonoma Co., *Stasson 32a* (UC); in a bog near Abbott's Lagoon, Point Reyes Peninsula, Marin Co., *Howell 696* (CAS); Jamieson Creek Road, San Lorenzo River Drainage, Santa Cruz Co., *Hesse 1737* (UC)

Riccardia palmata (Hedw.) Carruth. Klamath region, north coast (Mendocino Co., according to Howe 1899) and Coast Ranges; on decaying wood, sea level to 1000 m. Howe (1899); Doyle and Stotler (2006), Bakalin (2012a).

Note: I'm sure that Dan Norris collected this once, but I can't find the record of it. The specimen would be at H.

Representative collections: xxx, Humboldt Co., *Doyle 9007* (herbarium of W. T. Doyle); Sisson [now the city of Mount Shasta], Siskiyou Co., *Howe 50* (UC); xxx, Trinity Co., *Doyle*

8654 (herbarium of W. T. Doyle); xxx, Tehama Co., *Doyle 8766* (herbarium of W. T. Doyle)

15. Metzgeriaceae H. Klinggräff

Key to species of *Metzgeria*:

1. Marginal hairs of thallus single; some thalli long-attenuate, bearing gemmae at tip. *Metzgeria violacea*
1. Marginal hairs of thallus mostly paired; all thalli linear, without gemmae. *Metzgeria conjugata*

Metzgeria conjugata Lindb. North coast; on bark and rock, sea level to 200 m. Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: North bank of Smith River, hwy. 197 near Jedediah Smith State Park, Del Norte Co., *Thiers 37447* (SFSU); Hunter Creek, Del Norte Co., *Boratynski 203* (CHSC); hwy. 199 9 miles east of hwy. 101, Del Norte Co., *Roy 192* (SFSU); Big Tree parking lot, north of Prairie Creek, Humboldt Co., *Toren 2339* (SFSU); on road to Petrolia, Humboldt Co., *Norris 10289* (H)

Metzgeria violacea (Ach.) Dumort. Reported from the central coast, below 430 m (ca 2 miles west of Olema, Marin Co.) by Doyle and Stotler (2006) and Yurky (1995, as *Metzgeria temperata* Kuwah).

JUNGERMANNIALES

16. Pseudolepicoleaceae Fulford & J.Taylor

Key to species of *Blepharostoma*:

1. Leaves widely spaced on stem, contorted when dry, 2-3-lobed, lobes often branched, cells thin-walled. *B. arachnoideum*
1. Leaves crowded on stem, not contorted when dry, 3-4-lobed, lobes seldom branched, cells thick-walled. *B. trichophyllum*

Blepharostoma arachnoideum M. Howe North Coast and Sierra Nevada; on decaying logs in damp shaded places; from near sea level to 1400 m. Howe (1899); Frye and Clark (1937-1947); Doyle and Stotler (2006); Wagner (2011).

Representative collections: Prairie Creek Redwoods State Park, Humboldt Co., *Doyle 1338* (herbarium of W. T. Doyle); south end of Young's Valley, T17N R8W S16, Siskiyou Co., *Doyle 2074* (herbarium of W. T. Doyle)

Blepharostoma trichophyllum (L.) Dumort. North and central coast, Klamath region and high Sierra Nevada; on decaying wood, wet rocks, or wet soil, commonly on banks of streams or lakes, sea level to 3500 m. Howe (1899); Clark and Frye (1936); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: along Griffin Creek at Smith River, mile 30.57 on hwy. 199, east of Gasquet, Del Norte Co., *Norris 8834* (H); hwy. 299 10 miles east of hwy. 101, Humboldt Co., *Mauer s. n., 29 Apr. 1972* (CHSC); high above Grizzly Lake, Trinity Co., *Gumber 781021-14b* (HSC); junction of Alpine Road and Heritage Road, immediately south of Heritage Grove County Park, San Mateo Co., *Whittemore & Whittemore 4147B* (atw); South Fork Trail, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Doyle 8867* (herbarium of W. T. Doyle); near Stanford Research Area, H. M. Hall Natural Area, Mono Co., *Norris 48396* (H); banks of Delaney Creek, Tuolumne Meadow, Tuolumne Co., *Howell 660 p.p.* (CAS)

17. Lepidoziaceae

Key to genera:

1. Leaves transverse, lobed almost to base, lobes 1-2 cells wide. *Kurzia*

1. Leaves incubous, lobed less than half of their length, lobes wider.
 2. Leaves 3-4-lobed, pinnately branched, without postical flagella. *Lepidozia*
 2. Leaves 3-toothed, irregularly branched, usually with flagella from axils of underleaves.

Bazzania

Key to species of *Bazzania*:

1. Pale or yellowish green; leaves plane or nearly so, caducous; oil bodies usually 5-6 per cell. *B. denudata*
1. Deep green or brownish; leaves strongly concave, persistent; oil bodies usually 2-4 per cell. *B. tricrenata*

Bazzania denudata (Torr.) Trevis. North coast, on wood, sea level to 70 m. Hong (1988b); Doyle and Stotler (2006).

Representative collection: East side of Howland Summit, Jedediah Smith Redwoods State Park, Del Norte Co., Doyle 7738 (MO); Big Tree Grove, Prarie Creek Redwoods State Park, Humboldt Co., Snodgrass 121 (DAV)

Bazzania tricrenata (Wahlenb.) Trevis. Reported from the north coast (Crescent City, Del Norte Co.) by Clark and Frye (1936) and Frye and Clark (1937-1947); Hong (1988b).

Kurzia sylvatica (A. Evans) Grolle North coast; on decorticated logs and peaty soil, near sea level. Christy & Wagner (1996); Kellman (2003); Doyle and Stotler (2006).

Note: Populations of this species from the Pacific Coast are often treated as a distinct species under the name *Kurzia makinoana* (Steph.) Grolle.

Collections examined: Prarie Creek Redwoods State Park, Humboldt Co., Norris 56814 (H); along Albion - Little River Road south of Mendocino County Airport landing strip, Mendocino Co., Bourell 3605, 3608 (CAS); xxx

Lepidozia reptans (L.) Dumort. North and central coast, Klamath region (north slope of the Siskiyou Mts. only); on decaying wood or occasionally trunks of trees, sea level to 1700 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1988b); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Graves Grove, 10 mi. S of Crescent City, Del Norte Co., Howell 322 (CAS); Big Tree area, Prarie Creek Redwoods State Park, Humboldt Co., Mauer s. n., 30 Apr. 1972 (CHSC); deep shaded ravine ca 1 mile west of White Mountain, near Cook and Green Pass, Siskiyou Co., Norris 50198 (H); on Caspar Little Lake Road ca 1 mile northwest of the junction of 408 and 409, Jackson State Forest, Mendocino Co., Bourell 3705 (CAS); Creek Trail, Butano State Park, San Mateo Co., Whittemore 4013 (MO); North Fork of Fall Creek, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., Kellman 392 (herbarium of K. Kellman)

18. Lophocoleaceae

Key to species of *Chiloscyphus*:

1. Leaves bilobed, lobes acuminate, tips uniseriate. *C. latifolius* [= *Lophocolea bidentata*]
1. Leaves unlobed, or with the lobes rounded.
 2. Shoots 1-1.5 mm wide; paroecious, male bracts saccate; leaves on lower part of stem often bilobed. *C. profundus* [= *L. heterophylla*]
 2. Shoots 2-4 mm wide; autoecious, male bracts plane with a small basal lobe enclosing the antheridia; all leaves truncate or broadly and shallowly emarginate.
 3. Lobes of perianth mouth entire or crenulate; female branches arising far from antheridial sectors of stem; subquadrate cells of apical leaf margin 18-25 μm wide (to 30 μm or more when elongated); oil bodies 2-4 per cell (midleaf). *C. polyanthos*

3. Lobes of perianth mouth toothed or ciliate; female branches usually arising on or near antheridial sectors of stem; subquadrate cells of apical leaf margin 30-35 μm wide; oil bodies 4-12 per cell (midleaf). *C. pallescens*

Chiloscyphus latifolius (Nees) J. J. Engel & R. M. Schust. [*Lophocolea bidentata* (L.) Dumort., *C. cuspidatus* (Nees) J. J. Engel & R. M. Schust., *L. cuspidata* (Nees) Limpr.] North coast, Klamath region, Cascades, northern Sierra Nevada; on mosses growing over bark, logs, rocks or soil, sea level to 1500 m. Howe (1899); Hong (1993); Yurky (1995); Doyle and Stotler (2006).

Note: Often divided into two species, *Chiloscyphus latifolius* (*Lophocolea bidentata*) for dioecious plants and *C. cuspidatus* (*Lophocolea cuspidata*) for autoecious. Other characters are poorly correlated, and it is best to lump them unless reliable grounds for the division are found (Paton 1999).

Representative collections: Damnation Creek Trail, Del Norte Coast Redwoods Redwoods State Park, Del Norte Co., *Norris 46229* (H); along Redwood Creek near the hwy. 299 bridge, Humboldt Co., *Norris 47064* (H); hwy. 1 near Little River, Mendocino Co., *Whittemore B383* (atw); Skyline Blvd. ca 2 miles south of hwy. 92 (ca 4 miles east of Half Moon Bay), San Mateo Co., *Whittemore B198* (atw); near Ox Trail Parking Area, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Kellman 934* (herbarium of K. Kellman); xxx, Yuba Co., *Doyle 9585* (herbarium of W. T. Doyle)

Chiloscyphus profundus (Nees) J. J. Engel & R. M. Schust. [*Lophocolea heterophylla* (Schrad.) Dumort.] North coast, Klamath region, northern Sierra Nevada; on logs, sometimes soil, 70 to 1600 m. Howe (1899); Frye and Clark (1937-1947); Hong (1993); Yurky (1995); Kellman (2003); Doyle and Stotler (2006).

Representative collections: along hwy. 299 ca 2 miles west of Lord Ellis Summit (15 miles east of Arcata), Humboldt Co., *Norris 46189* (H); O'Brien Road between Louise Creek and Indian Creek, east slope of the Little Greyback, west of Happy Camp, Siskiyou Co., *Holmberg 946* (HSC); Phoenix Lake, Marin Co., *Mason 2525* (UC); La Honda Road 1.3 miles northeast of La Honda, San Mateo Co., *Whittemore & Whittemore 4137* (MO); near Boulder Creek, Santa Cruz Co., *Hesse 1798* (UC); xxx, Butte Co., *Doyle 8607* (herbarium of W. T. Doyle)

Chiloscyphus pallescens (Ehrh.) Dumort. [*C. fragilis* (Roth) Schiffn., *C. polyanthos* (L.) Corda var. *pallescens* (Ehrh. ex Hoffm.) Hartm.] Montane; in streams, ca 2000 m. Evans (1923a); Clark and Frye (1936); Hong (1993); Yurky (1995); Doyle and Stotler (2006).

Note: Most or all of the specimens below and in the literature reports were determined on the basis of aspect and size of midleaf cells, and the determinations need to be rechecked.

Collections examined: Idlewyld Campground, ca 10 miles east of Sawyer's Bar, Siskiyou Co., *Norris 11887* (H); near Atwell Mills Campground west of Mineral King, Sequoia National Park, Tulare Co., *Norris 46426* (H)

Chiloscyphus polyanthos (L.) Corda [*C. polyanthos* var. *rivularis* (Schrad.) Nees, *C. rivularis* (Schrad.) Loeske] Klamath region, Coast Ranges, high Sierra Nevada, Transverse and Peninsular Ranges; soil and rocks along streams, 120 to 2800 m. Howe (1899); Evans (1923a); Clark and Frye (1936); Frye and Clark (1937-1947); Stark and Whittemore (1992); Hong (1993); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Note: *Chiloscyphus polyanthos* and *C. pallescens* differ in chromosome number; they are almost invariably sterile, and very difficult to distinguish in this state. Many authors state that they differ in the size of the cells at midleaf, but these cells vary greatly in size and shape, even within one leaf, and Steere and Inoue (1978) found no correlation between cell size and chromosome number. Steere and Inoue do not discuss the quadrate cells along the apical margin, which seem somewhat less variable in size; these are consistently small in those California specimens I have notes on. Inoue (1969) says that the two taxa differ in the position of the perianth relative to antheridial sectors of the stem, but this seems to be based

on a small sample of fertile plants. Smith (1990) mentions the existence of intermediate perianth types. According to Evans (1923a), some of Howe's specimens were actually *C. polyanthos* var. *pallescens*; as noted above, these should be rechecked.

Representative collections: Headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50149* (H); between headquarters and Tiptoe Falls, Portola State Park, San Mateo Co., *Whittemore & Whittemore 4125* (CAS); West Fork of the Carson River by hwy. 88 bridge at Hope Valley Resort, just west of Sorenson's, Alpine Co., *Whittemore & Whittemore 3092* (MO); along Mist Falls Trail less than 0.5 mile above trail junction to Bubbs Creek, South Fork Kings River drainage, Fresno Co., *Shevock & York 14468* (CAS); Lower Doane Valley along Doane Creek, Palomar Mountain State Park, San Diego Co., *Stark 668* (MO)

19. Plagiochilaceae

Key to species of *Plagiochila*:

1. Median leaf cells 25-33 x (28-)30-36 μm , marginal cells 20-28 μm wide; leaves dentate to entire, teeth 1-3 x 1-2 cells; vitta absent. *P. porelloides*
1. Median leaf cells 21-30 x 22-32 μm , marginal cells 17-22 μm wide; leaves usually spinose-dentate, rarely entire, teeth usually 2-5 x 1-4 cells; small vitta present. *P. satoi*

Plagiochila porelloides (Torr. ex Nees) Lindenb. North coast, Klamath region, Cascade Range, and Transverse Ranges (according to Hong 1992); on shaded rock faces, occasionally decaying logs, 180 to 1800 m. Hong (1992); Doyle and Stotler (2006), Bakalin (2012a).

Note: Until recently, *Plagiochila porelloides* was generally included within *P. asplenioides* (L.) Dumort. s. lat., and reports of *P. asplenioides* by Howe (1899), Clark and Frye (1936) and Frye and Clark (1937-1947) are referable to *P. porelloides*.

Representative collections: Along Smith River at hwy. 199 about 9 miles east of jct. with hwy. 101, Del Norte County, Six Rivers National Forest, *Norris 84997, 85014* (UC); Blue Lake, Humboldt Co., *Howe 55* (UC); hwy. 299 ca 10 miles east of hwy. 101, Humboldt Co., *Malachowski s. n., 30 Apr. 1972* (CHSC); trail to Hedge Creek Falls, Shasta Springs, Siskiyou Co., *Eastwood s. n., 8 May 1923* (CAS); Meadow Valley, Plumas Co., *Head s. n., 14 July 1923* (CAS)

Plagiochila satoi S. Hatt. Reported from the north coast by Hong (1992); Christy & Wagner (1996).

Note: According to Wagner (in Christy & Wagner 1996), the characters used by Hong (1992) to distinguish *P. satoi* and *P. porelloides* (size of marginal teeth, presence of vitta) are unreliable. Wagner's preliminary work suggests that *P. satoi* is best distinguished by its fewer, more finely segmented oil bodies and smaller leaf cells. However, he gives no counts or measurements for either species.

20. Cephaloziaceae

Key to genera:

1. Leaves moderately to strongly succubous, often decurrent, about as long as wide, 1/4 to 1/3 bilobed; lobes with uniseriate tips 1-2 cells long. *Fuscocephaloziopsis*
1. Leaves subtransverse, never at all decurrent, longer than wide, bilobed at least halfway; lobes with uniseriate tips 2-3 cells long. *Cephalozia*

Key to species of *Cephalozia*:

1. Dorsal cortical cells of stem 16-32 x 10-16 μm ; cells at base of leaf lobes 16-24 x 14-20 μm .
C. ambigua
1. Dorsal cortical cells of stem 40-160 x 24-60 μm ; cells at base of leaf lobes 30-70 x 20-50 μm .
C. bicuspidata
2. Dorsal cortical cells of stem 40-80 x 24-50 μm ; cells at base of leaf lobes 30-50 x (16-

- 20-36(-42) μm . *C. bicuspidata* var. *bicuspidata*
 2. Dorsal cortical cells of stem 70-160 x (36-)40-60 μm ; cells at base of leaf lobes 30-70 x 30-50 μm . *C. bicuspidata* var. *lammersiana*

Cephalozia ambigua C. Massal. [*Cephalozia bicuspidata* ssp. *ambigua* (C. Massal.) R. M. Schust.] High Sierra Nevada, Cascade Range (according to Hong 1988a); on wet shaded soil, 2700 to 3000 m. Hong (1988a); Doyle and Stotler (2006).

Representative collections: Babcock Creek trail between Lake Merced and Boothe Lake, near diverging trail to Babcock Lake, Yosemite National Park, (*Sutcliffe 18*, CAS); slope above Ranger Lakes at Silliman Pass, King's Canyon National Park, *Norris 46561* (H)

Cephalozia bicuspidata (L.) Dumort. var. *bicuspidata* North and central coast, high Sierra Nevada; on logs, sometimes soil or rock, sea level to 3000 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Big Tree area, Prarie Creek Redwoods State Park, Humboldt Co., *Grade s. n.*, 18 Apr. 1970 (CHSC); in deep canyon of Emerald Creek, east of Orick, Humboldt Co., *Norris 24585* (H); on road halfway from Inverness to Point Reyes, Marin Co., *Howell 445* (CAS); Glen Alpine Springs Canyon, near Lake Tahoe, El Dorado Co., *Conklin 9 p. p.* (CAS); near Stanford Research Area, H. M. Hall Natural Area, Mono Co., *Norris 48402* (H)

Cephalozia bicuspidata var. *lammersiana* (Huebener) Breidl. [*C. lammersiana* (Huebener) Spruce] Reported from the north coast (Del Norte Co.), sea level to 100 m. Sutcliffe (1934, 1947); Doyle and Stotler (2006).

Fuscocephaloziopsis Fulford [*Pleurocladula* Grolle; *Pleuroclada* Spruce 1882, not *Pleurocladia* A. Braun 1855; *Schofieldia* Godfrey]

Key to species of *Fuscocephaloziopsis*:

1. Underleaves large. *F. albescens*
1. Underleaves absent.
 2. Hyalodermis of stems weakly differentiated; leaves weakly to moderately decurrent; lobes scarcely connivent.
 3. Cell walls thin; stolons usually present; female bracts bilobed, otherwise entire or with one tooth on each side; perianth mouth not ciliate. *F. pleniceps*
 3. Cell walls usually firm; stolons absent; female bracts bilobed and dentate; perianth mouth ciliate. *F. catenulata*
 2. Hyalodermis of stems well differentiated; leaves strongly decurrent, lobes quite connivent.
 4. Leaf cells large, mostly 35-40 μm across; perianth mouth ciliate; rare. *F. connivens*
 4. Leaf cells smaller, mostly 20-30 μm across; perianth mouth crenate (cilium-like outgrowths <1 cell long); common.
 5. Dioecious. *F. lunulifolia*
 5. Autoecious. *F. affinis*

Fuscocephaloziopsis affinis (Lindb. ex Steph.) Vána et L.Söderstr. [*Cephalozia affinis* Lindb. ex Steph.] Doubtfully distinct from *F. lunulifolia*. Evans (1923a); Frye and Clark (1937-1947); Yurky (1995).

Distribution: Marin (Yurky 1995) Sisk (Evans 1923a)

Fuscocephaloziopsis albescens (Hook.) Vána et L.Söderstr. [*Pleurocladula albescens* (Hook.) Grolle, *Pleuroclada albescens* (Hook.) Spruce] Reported from the high Sierra Nevada (Tulare Co.), 3000 to 3300 m. Sutcliffe (1941, 1947); Hong (1988a).

Fuscocephaloziopsis catenulata (Huebener) Vána et L.Söderstr. [*Cephalozia catenulata* (Huebener) Spruce] Sierra Nevada; on soil, high elevations. Hong (1988a).

Note: Hong maps this for the Bay Area; no specific localities are cited.

Representative collections: Tuolumne River, Tuolumne Co., *no collector*, 16 Sept. 1923 (CAS)

Fuscocephaloziopsis connivens (Dicks.) Vána et L.Söderstr. [*Cephalozia connivens* (Dicks.) Lindb.] North coast and northern Sierra Nevada; on rotting logs, 150 to 1800 m. Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: About 1 mile east of Ashfield Butte, Humboldt Co., *Norris 52926* (H); Prarie Creek Redwoods State Park, Humboldt Co., *Norris 7903* (H); Roberts Meadows, Salmon Lake Resort, Sierra Co., *Sutcliffe 34* (CAS)

Fuscocephaloziopsis lunulifolia (Dumort.) Vána et L.Söderstr. [*Cephalozia lunulifolia* (Dumort.) Dumort.; *Cephalozia media* Lindb.] North and central coast and Klamath region; on logs, 80 to 2000 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Carlotta, Humboldt Co., *Eastwood 15 Aug. 1923* (CAS); Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12410* (H); Peninsula at Point Reyes, near swamp, Marin Co., *Howell 280 p. p.* (CAS); junction of Alpine Road and Heritage Road, immediately south of Heritage Grove County Park, San Mateo Co., *Whittemore & Whittemore 4148B* (MO); lower part of North Fork Trail, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Whittemore & Whittemore 3489* (CAS)

Fuscocephaloziopsis pleniceps (Austin) Vána et L.Söderstr. [*Cephalozia pleniceps* (Aust.) Lindb.] Klamath region, Warner Mountains, Cascade Range, high Sierra Nevada; on rock, soil or wood, banks of streams and lakes and seepy places, 1300 to 3300 m; also reported from the central coast at ca 100 m (Mill Valley, Marin Co., Yurky 1995). Howe (1899); Yurky (1995); Doyle and Stotler (2006).

Representative collections: Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12354* (H); along Grizzly Creek, 4 miles below Grizzly Lake, Trinity Co., *Norris 9536* (H); Modoc County Road 2 ca 0.15 miles east of turnoff to Lilly Lake, Warner Mountains, Modoc County, *Doyle 8643* (herbarium of W. T. Doyle); hwy. 120 in meadow on east side of Tioga Pass, Mono Co., *Whittemore 1547* (herbarium of A. T. Whittemore); bank of Eagle Creek, Mineral King Trailhead, Tulare Co., *Doyle 7808* (herbarium of W. T. Doyle)

21. Cephaloziellaceae

Key to species of *Cephaloziella*:

1. Underleaves none on sterile stems.
 2. Leaves spinose-dentate; gemmae angular. *C. turneri*
 2. Leaves entire; gemmae smooth.
 3. Lobes of leaves 3-5 cells wide, cells 8-12 μm wide; usually paroecious. *C. cf. rubella* var. *sullivantii*
 3. Lobes of leaves 6-9 cells wide, cells 12-15 μm wide; autoecious. *C. hampeana*
1. Underleaves present on sterile stems; gemmae smooth.
 4. Leaves divided 0.75-0.8 of their length, lobes 2-4 cells wide, cells elongate. *C. spinigera*
 4. Leaves divided 0.5-0.7 of their length, lobes 5-9 cells wide, cells \pm isodiametrical.
 5. Leaf lobes mostly 4-6 cells wide, cells 12-18 μm wide; usually paroecious; underleaves small, usually subulate or lanceolate. *C. stellulifera*
 5. Leaf lobes mostly 4-9 cells wide, cells 9-15(-17) μm wide; usually auto- or dioecious; underleaves large, laminate. *C. divaricata*
 6. Leaves with prominent cellular projections on the dorsal surface, margins often serrate [see also *C. patulifolia* below]. *C. divaricata* var. *scabra*
 6. Leaves smooth, entire.
 7. Dioecious, underleaves small to rather large; widespread. *C. divaricata*

var. *divaricata*

7. Autoecious, underleaves always small; high Sierra Nevada only. *C. varians*

Cephaloziella divaricata (Sm.) Schiffn. [*Cephalozia divaricata* (Sm.) Dumort., *Cephalozia divaricata* var. *scabra* M. Howe, *Cephaloziella byssacea* (Roth) Warnst., *Cephaloziella divaricata* (Sm.) Schiffn. var. *scabra* (M. Howe) Schljakov, *Cephaloziella papillosa* (Douin) Schiffn.] Klamath region, Coast Ranges, Sierra Nevada, south coast, Transverse and Peninsular Ranges; in dry places on soil or sometimes rotting logs, rock or mosses, 200 to 3000 m. Howe (1899); Kingman (1911); Evans (1923a); Frye and Clark (1937-1947); Hong (1986); Stark and Whittemore (1992); Yurky (1995); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Note: Schuster (1980) finds the sexuality of California members of *C. divaricata* s. lat. to be variable, and hints at, but does not formally publish, an alternate taxonomy. He restricts *C. divaricata* to dioecious plants, and reports it from Humboldt, Mendocino, Sonoma, Marin, and San Francisco Counties; he finds similar plants that are autoecious and refers them to a new species, probably *C. howei* R. M. Schust. nom. nud.; he also mentions paroecious specimens, which he calls *C. conduplicata* R. M. Schust. nom. nud. According to Schuster, the lectotype (not then designated!) of *Cephalozia divaricata* var. *scabra* is autoecious; he calls specimens of *C. divaricata* with cellular outgrowths *C. divaricata* var. *asperifolia* (Taylor) Macvicar. However, Söderström et al. (2012) lectotypify *Cephalozia divaricata* var. *scabra* with a dioecious specimen. In the absence of supporting documentation, I retain the traditional taxonomy. Like Smith (1990), I find that the papillose form (var. *scabra* or *C. papillosa* of authors) intergrades with smooth-leaved plants too completely to deserve recognition, even as a variety.

Representative collections: Shasta Springs, Siskiyou Co., *Eastwood s. n.*, May 1923 (CAS); path from fishermen's parking lot to falls, Gray's Falls, Trinity Co., *Whittemore 516* (atw); valley of Putah Creek between Winters and Beryessa Dam, Solano Co., *Weber 75-28* (DAV); Monument Trail and adjacent Northern Heights Route, just north of headquarters, Henry W. Coe State Park, Santa Clara Co., *Whittemore & Whittemore 4271* (CAS); northwest side of canyon of North Fork Feather River, 0.1 miles north of mouth of Rock Creek, S30 T24N R6E, Plumas Co., *Janeway 5391* (CHSC); along Trimmer-Balch Camp Road at Secata Ridge above Pine Flat Reservoir, Fresno Co., *Shevock, Norris & Barahona 13163* (MO); north-facing slope within Mission Gorge, just south of the San Diego River, 1 1/2 miles north on Father Junipero Serra Boulevard from Mission Gorge Road, San Diego Co., *Stark 831* (MO); between Lake Henshaw and Parayne Hill, Palomar Mountains, San Diego Co., *Stark 634* (MO)

Cephaloziella hampeana (Nees) Schiffn. On soil. Evans (1923a); Hong (1986); Yurky (1995); Doyle and Stotler (2006).

Distribution: Marin Co. (Yurky 1995) Mendocino Co. (Bourell in herb.) Ventura Co. (Evans 1923a, Hong 1986)

Cephaloziella patulifolia Warnst. On soil. Evans (1923a), Frye and Clark (1937-1947).

Note: Known only from the type, with the locality given merely as "California." The species has been described by Stephani xxx [Bull. Herb. Boissier II. 8: 509], Douin xxx [Mém. Soc. Bot. France 29: 70. 1920], and Frye and Clark (1937-1947). They describe a plant similar to *C. divaricata* var. *scabra* in having serrate leaves with broad lobes and prominent cellular projections on the dorsal surface and prominent underleaves, but with the female bracteole scarcely united with the bracts. The species is autoecious according to Douin, dioecious according to Frye and Clark. Schuster (1980) places it in his subsect. *Phyllacanthae*, which he characterizes as having the female bracteole scarcely united with the bracts, the leaf lobes ending in an elongate cell, and the leaf generally lacking cellular projections on the dorsal surface. The latter disagrees with all other descriptions of the species. Until the type has

been described adequately, it is impossible to evaluate the status of the species or put it into the key.

Distribution: Unknown.

Cephaloziella rubella (Nees) Warnst. var. *sullivantii* (Aust.) Müll. Frib. Central Coast Ranges and (according to Hong 1986) coastal southern California; well-rotted log in redwood forest, 300 m. Hong (1986); Ellyson and Sillett (2003; not named to variety); Doyle and Stotler (2006).

Note: The single specimen seen is sterile, and the identification needs to be confirmed from fertile collections.

Collection examined: Picnic area along Opal Creek, ca 1 mile north of the ranger station, Big Basin State Park, Santa Cruz Co., *Whittemore & Whittemore 3302* (CAS)

Cephaloziella spinigera (Lindb.) Jörg. [*Cephaloziella subdentata* Warnst.] North coast in Mendocino Co., elev. xxx. Hong (1986); Christy & Wagner (1996); Doyle and Stotler (2006).

Collection examined: xxx, Mendocino Co., *Bourell xxx* (CAS)

Cephaloziella stellulifera (Taylor) Schiffn. Central Coast Ranges, reported from the high Sierra Nevada; on shaded soil, sea level to 120 m (much higher for the localities mapped by Hong). Evans (1923a); Sutcliffe (1947); Hong (1986); Yurky (1995); Doyle and Stotler (2006).

Note: Evans (1923a), Sutcliffe (1947), and Yurky (1995) reported this as *C. stellulifera* var. *gracillima* Douin (syn. *C. limprichtii* Warnst.).

Representative collections: along Sylvan Trail near spur to Sylvan Way, Edgewood County Park, Redwood City, San Mateo Co., *Whittemore & Sommers 5256* (CAS); xxx, Santa Cruz Co., *Whittemore & Doyle s. n., 16 Apr. 1997* (atw)

Cephaloziella turneri (Hook.) Müll. Frib. [*Cephalozia turneri* (Hook.) Lindb., *Prionolobus turneri* (Hook.) Spruce] North and central coast and Coast Ranges, Klamath region, Sierra Nevada, and Peninsular Ranges; on soil, occasionally rock or wood, most common on cliffs and roadbanks, sea level to 1200 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1986); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Along trail to Elkhorn Ridge above junction with trail to Wright's Memorial, Northern California Coast Range Preserve, 7 miles northeast of Branscomb, Mendocino Co., *Bourell 3797* (MO); Anderson Springs, near Sulfur Hot Spring, Lake Co., *Toren 7252* (MO); Ice Cream Grade 1.6 miles west of junction with Empire Grade, ca 2 miles northeast of Bonny Doon, Santa Cruz Co., *Whittemore & Whittemore 4433* (MO); Folsom Lake/Rattlesnake Bar Rd. ca 1.6 miles west of hwy. 49, El Dorado Co., *Doyle 8305* (herbarium of W. T. Doyle); north-facing slope adjacent to San Vicente Reservoir, midway between San Vicente Dam and parking lot at south entrance, three miles north of Lakeside, San Diego Co., *Stark 585* (MO)

Cephaloziella varians (Gottsche) Steph. Reported from the high Sierra Nevada by Bakalin (2012a).

22. Scapaniaceae

Key to genera of Scapaniaceae:

1. Leaves sharply folded along the midline, ventral half of leaf insertion succubous, dorsal half clearly incubous.
 2. Leaf lobes lanceolate, acute to acuminate. *Douinia*
 2. Leaf lobe oblong to ovate or almost circular, broadly acute to rounded.
 3. Gemmae smooth; lobes of leaf mostly ovate to elliptical or almost circular; perianth dorsiventrally flattened, smooth. *Scapania*
 3. Gemmae stellate; lobes of leaf lingulate, \pm parallel-sided; perianth cylindrical, plicate, narrowed to mouth.
 4. Leaves strongly decurrent ventrally; shoots 10-40 x 2.5-4.5 mm; walls of cells near leaf margin \pm uniformly thickened, in midleaf usually thin-walled with

large trigones; gemmae 2-4-celled, ± cubical; cortex of stem well-defined, of 3-4 layers of very thick-walled cells; perianth deeply plicate to base.

Macrodiphyllum

4. Leaves not decurrent ventrally; shoots 8-25 x 1-2.5 mm; walls of leaf cells ± uniformly thickened throughout; gemmae 1-celled, stellate; cortex of stem poorly defined, of 1-2 layers of somewhat thick-walled cells; perianth usually plicate distally and smooth proximally. *Diplophyllum*

1. Leaves plane or concave but never sharply folded, dorsal half of leaf insertion succubous or transverse.

5. Leaves 3-4-lobed. *Barbilophozia*

5. Leaves 2-lobed.

6. At least dorsal half of leaf leaf transversely inserted.

7. Leaves entire, small, apices of lobes inflexed. *Anastrophyllum*

7. Leaves toothed, large, apices of lobes plane; stems very fleshy, 0.2-0.6 mm thick. *Lophozia* (*L. incisa* and *L. opacifolia* only)

6. Leaf insertion succubous throughout, apices of lobes plane.

8. Lobes of leaves rounded; gemmae absent; perianth smooth, easily detached.

Gymnocolea

8. Lobes of leaves acute; gemmae often present; perianth plicate, persistent.

Lophozia (in part)

Anastrophyllum minutum (Schreb.) R. M. Schust. [*Sphenolobus minutus* (Schreb.) Berggr.] Reported from the western Siskiyou Mountains in Del Norte Co.; soil and rock in seepy places in recesses and beneath overhangs, bases of north-facing cliffs, 1700 m. Jessup (2001); Doyle and Stotler (2006).

Key to species of *Barbilophozia*:

1. Cells of cilia at ventral leaf base strongly elongated. *B. hatcheri*

1. Cells of cilia at ventral leaf base quadrate. *B. sp. nov.?*

Barbilophozia hatcheri (A. Evans) Loeske [*Lophozia hatcheri* (A. Evans) Steph.] Klamath region; on rock of cliffs and scree slopes, occasionally soil in rocky places, 1000 to 1800 m. Evans (1923a); Doyle and Stotler (2006).

Representative collections: Near Doctor Rock, S1 T13N R3E, Del Norte Co., *Norris 50309* (H); headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50094, 50112, 50114* (H); vicinity of Trinity Summit, Humboldt Co., *Whittemore & Norris B525* (CAS); steep north-facing slope below Eaton Lake, ca 10 miles southeast of Etna on hwy. 3, Siskiyou Co., *Zinman 48a* (HSC); along Duck Lake Creek at road 8, S7 T40N R9W, Siskiyou Co., *Norris 23287* (H); ridge on west side of Big Flat, Trinity Co., *Norris 8991* (H); Shasta Springs, Siskiyou Co., *Eastwood s.n., 18 May 1923* (CAS)

Barbilophozia (Orthocaulis) sp. nov.? High Sierra Nevada; on north-facing cliff in snowmelt, 3200 m.

Collection examined: Vicinity of Heart Lake on trail from Onion Valley to Kearsage Pass, Inyo Co., *Norris 46824* (H)

Key to species of *Diplophyllum*:

1. Paroecious; ventral lobes of leaf mostly 1.6-2.3 times as long as wide. *D. obtusifolium*

1. Dioecious; ventral lobes of leaf mostly 2.0-2.5 times as long as wide. *D. taxifolium*

Diplophyllum obtusifolium (Hook.) Dumort. North coast and Klamath region; on rock and soil, sea level to 2000 m. Clark and Frye (1936); Frye and Clark (1937-1947); Sutcliffe (1947);

Doyle and Stotler (2006).

Representative collections: near Monumental, Del Norte Co., *Eastwood s. n.*, 6 Aug. 1923 (CAS); Graves Grove, 10 mi. S of Crescent City, Del Norte Co., *Howell 309* (CAS); east side of hwy. 101, opposite W. M. Garland Memorial Grove, north of Orrick, Humboldt Co., *Doyle 1383* (herbarium of W. T. Doyle); slopes above Big Duck Lake, S19 T40N R9W, Siskiyou Co., *Norris 23348* (H); talus slope near South Sugar Lake, S30 T40N R9W, Siskiyou Co., *Norris & McGrew 45614* (H)

Diplophyllum taxifolium (Wahlenb.) Dumort. Reported from the north coast, near sea level (Crescent City, Del Norte Co.) by Frye and Clark (1937-1947); Doyle and Stotler (2006).

Douinia ovata (Dicks.) H. Buch [*Lophozia ovata* (Dicks.) M. Howe] North coast; on rock, sea level to 1500 m; also epiphytic acc. Ellyson and Sillett (2003). Howe (1899); Christy & Wagner (1996); Ellyson and Sillett (2003); Doyle and Stotler (2006).

Representative collections: Big Flat Road near Gordon Mountain, S5 T16N R10W, Del Norte Co., *Norris 7847* (H); along Smith River at Hiouchi Bridge, Del Norte Co., *Norris 9902* (H); deep canyon along Covello Road ca 3.1 miles east of Longvale, Humboldt Co., *Norris 21714* (H); vicinity of Trinity Summit, east of Hoopa, Humboldt Co., *Whittemore & Norris B527* (TEX); near Cazadero, Sonoma Co., *Howe 54* (UC); same locality, *Howe s. n.*, *Underwood & Cook's Hepaticae Americanae 193* (UC)

Gymnocolea inflata (Huds.) Dumort. [*Lophozia inflata* (Huds.) M. Howe] Reported from the high Sierra Nevada, above 3000 m (Mt. Dana, Mono Co.) by Howe (1899), and from *Sphagnum* bogs in Mendocino Co. by Kellman (2003). Doyle and Stotler (2006)

Key to species of *Anastrophyllum*, *Barbilophozia*, *Gymnocolea*, and *Lophozia* (Scapaniaceae) and *Mesoptychia* (Jungermanniaceae):

1. Underleaves present.
 2. Leaves 3-4-lobed. *Barbilophozia*
 3. Cells of cilia at ventral leaf base strongly elongated. *B. hatcheri*
 3. Cells of cilia at ventral leaf base quadrate. *B. sp. nov.?*
 2. Leaves 2-lobed.
 4. Gemmae present.
 5. Gemmae stellate, on tips of lobes of undifferentiated leaves; cuticle smooth. *Lophozia cf. heteromorpha*
 5. Gemmae smooth, on tips of small appressed leaves on ascending shoot tips; cuticle verrucose. *Mesoptychia heterocolpos*
 4. Gemmae none; cuticle verrucose.
 6. Paroecious. *Mesoptychia gillmani*
 6. Dioecious.
 7. Leaves (0.8-)1.2-2.0 mm long, bilobed ca 0.15 of their length, midleaf cells (24-)28-44 μm wide. *Mesoptychia bantriensis*
 7. Leaves 0.5-1.3 mm long, bilobed ca 0.2(-0.3) of their length, midleaf cells 20-32 μm wide. *Mesoptychia collaris*
 1. Underleaves absent.
 8. Lobes rounded.
 9. Dark green or brown; female bracts smaller than leaves; perianth smooth, easily detached. *Gymnocolea inflata*
 9. Light green; female bracts larger than leaves; perianth plicate distally, persistent. *Lophozia obtusa*
 8. Lobes acute.
 10. Distal leaves 3-5-lobed, often toothed, insertion succubous ventrally, transverse dorsally; stems very fleshy, 0.2-0.6 mm thick.

- 11. Distal leaves spinose-dentate, 1-2-stratose near base. *Lophozia incisa*
- 11. Distal leaves entire or bluntly dentate, 3-5-stratose near base. *Lophozia opacifolia*
- 10. Leaves all 2-lobed, never toothed (erose only where gemmae have been attached), insertion completely succubous; stems less fleshy, 0.05-0.3 mm thick.
 - 12. Perianth smooth; gemmae absent. *Mesoptychia polymorpha*
 - 12. Perianth plicate distally; gemmae usually present.
 - 13. Leaf insertion transverse dorsally, oblique ventrally. *Anastrophyllum minutum*
 - 13. Leaf insertion oblique throughout.
 - 14. Gemmae red or purple.
 - 15. Plants brownish, not fleshy, not shrivelled when dry; gemmae reddish orange or red-brown; leaf cells usually with trigones; dioecious; male bract without a basal tooth. *Lophozia sudetica*
 - 15. Plants deep green, rather fleshy, often somewhat shrivelled when dry; gemmae purple or purple-brown; trigones small or absent; male bract with a basal tooth.
 - 16. Leaves bilobed 0.2-0.25(0.3); gemmae sharply stellate; paroecious. *Lophozia excisa*
 - 16. Leaves bilobed (0.2-)0.3-0.4(-0.5); gemmae bluntly angulate; usually dioecious. *Lophozia propagulifera*
 - 14. Gemmae green.
 - 17. Leaves concave, bilobed 0.2. *Lophozia wenzelii*
 - 17. Leaves plane or canaliculate, bilobed 0.25-0.3.
 - 18. Leaves plane, leaf insertion very oblique throughout; many oil bodies with a large central droplet surrounded by numerous small segments (biconcentric).
 - 19. Oil-bodies fewer than 20 per cell, most of them biconcentric; midleaf cells mostly less than 29 μm wide. *Lophozia silvicola*
 - 19. Oil-bodies more than 20 per cell, no more than half of them biconcentric; midleaf cells mostly more than 29 μm wide. *Lophozia savicziae*
- 18. Leaves trough-shaped, leaf insertion very oblique ventrally, scarcely oblique dorsally; oil bodies homogeneous, of numerous small segments.
 - 20. Leaves longer than wide, cells with bulging trigones; mouth of perianth ciliate. *Lophozia guttulata*
 - 20. Leaves wider than long, cells with small to large trigones; mouth of perianth toothed or ciliate. *Lophozia ventricosa*
 - 21. Perianth mouth ciliate (longest cilia 3-4 cells long); leaf cells with large trigones. var. *longiflora*
 - 21. Perianth mouth toothed to short-ciliate (longest cilia 1-2 cells long); leaf cells with small to moderate trigones. var. *ventricosa*

Note: The boundaries of *Lophozia* are very unclear.

Lophozia excisa (Dicks.) Dumort. [*Lophozia excisa* (Dicks.) Konstant. & Vilnet] Central coast, evidently with mosses and lichens on leaf litter, ca 200 m. Evans (1923a); Sutcliffe (1947); Yurky (1995); Doyle and Stotler (2006).

Collection seen xxx: Lake Lagunitas, Marin Co., *Campbell s. n.*, 3-7-22 (CAS) xxx note: pencil 53 on label, too

Representative collections: headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50157* (H); headwaters of Tish Tang a Tang Creek, near Trinity Summit, Humboldt Co., *Norris & Whittemore 52381* (H); Roberts Meadows, Salmon Lake, Sierra Co., *D. C. Sutcliffe 36* (CAS); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1533* (CAS); valley above Robinson Lake, south of Onion Valley, Inyo Co., *Norris 46634* (H)

Lophozia guttulata (Lindb. et Arnell) A. Evans Reported from the high Sierra Nevada by Bakalin (2012a).

Lophozia cf. heteromorpha R. M. Schust. Klamath region, high Sierra Nevada; on rock, soil, or rotten wood, at least often near streams, 1800 to 2700 m.

Note: I have never compared this with material from Greenland (the type locality). The California material needs to be compared further with *L. ventricosa*. In *Whittemore 5379*, I found a single large underleaf in ca 10 stems examined. In most features, this material seems to fit *L. ventricosa* quite well.

Representative collections: On upper reaches of Scott Camp Creek Basin S23 & 26 T39N R5W, Siskiyou Co., *Norris 53091* (H); Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12355* (H); vista point on the east side of Carson Pass, immediately south of hwy. 88, Alpine Co., *Whittemore & Whittemore 5379* (tbd); off of Rock Creek Road along Rock Creek, a tributary to Dinkey Creek, North Fork Kings River drainage, Fresno Co., *Shevock & York 13948* (CAS); off of 4WD road between West Lake and Sand Flat, San Joaquin River drainage, Fresno County, *Shevock 14176* (CAS)

Lophozia incisa (Schrad.) Dumort. ssp. *incisa* [*Schistochilopsis incisa* (Schrad.) Konstant.] North coast, Klamath region; on soil, decaying logs, or bases of shrubs, sea level to 2000 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: along French Flat Trail, near Gasquet, Del Norte Co., *Norris 9604* (H); hwy. 299 ca 10 miles east of hwy. 101, Humboldt Co., *Malachowski s. n.*, 29 Apr. 1972 (MO); Big Tree area, Prarie Creek Redwoods State Park, Humboldt Co., *Mauer s. n.*, 30 Apr. 1972 (MO); hwy. 96 ca 6 miles north of Hoopa, Humboldt Co., *Whittemore & Norris 1198* (atw); Soames Bar - Etna Road ca 9.6 miles northwest of Forks of Salmon, Salmon Mountains, Siskiyou Co., *Doyle 9178* (herbarium of W. T. Doyle)

Lophozia obtusa (Lindb.) A. Evans [*Leiocolea obtusa* (Lindb.) H. Buch, *Obtusifolium obtusum* (Lindb.) S.W. Arnell] Sierra Nevada; evidently on soil, 3000 m. Sutcliffe (1942, 1947) and Frye and Clark (1937-1947).

Lophozia opacifolia Culm. ex Meyl. [*Lophozia incisa* ssp. *opacifolia* (Culm. ex Meyl.) R. M. Schust., *Schistochilopsis opacifolia* (Culm. ex Meyl.) Konstant.] High Sierra Nevada, on rotten wood and soil, streambanks, seeps, and around rock outcrops; 2200-3500 m. Doyle and Stotler (2006)

Representative collections: Meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1511B* (herbarium of A. T. Whittemore); south side of Mt. Whitney Trail between Mirror Lake and Trail Camp, Inyo Co., *Doyle 8836* (herbarium of W. T. Doyle); hwy. 120 at trailhead of Mono - Parker Pass Trail, Tuolumne Co., *Doyle 6787* (herbarium of W. T. Doyle); Harrison Pass Trail, Fresno Co., *Howell 509* (CAS); Eagle Lake Trail, just before trail fork to Mosquito Lake, Tulare Co., *Doyle 7005* (herbarium of W. T. Doyle)

Lophozia propagulifera (Gott.) Steph. [*L. jurensis* Meyl. ex Müll. Frib., *L. latifolia* R. M. Schust., *Lophozia propagulifera* (Gott.) Konstant. & Vilnet] Klamath region; on soil or rock,

- 1500-3500 m. Doyle and Stotler (2006).
Representative collections: On north-facing slopes near Prescott Cabin, S2 T16N R4E, Del Norte Co., *Norris 47883* (H); ca 2 miles east of Seiad Valley, S17 T46N R11W, Siskiyou Co., *Norris 10544* (H); Sky Blue Lake, Tulare Co., *Howell 784* (CAS)
- Lophozia savicziae* Schljak. Reported from the high Sierra Nevada by Bakalin (2012a).
Lophozia silvicola H. Buch [*Lophozia ventricosa* var. *silvicola* (H. Buch) E. W. Jones ex R. M. Schust.] Klamath region, on base of stump, 2000 m.
Collection examined: Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12318* (H)
- Lophozia sudetica* (Nees) Grolle [*L. alpestris* auct., *Pseudolophozia sudetica* (Nees ex Huebener) Konstant. & Vilnet] Klamath region and high Sierra Nevada; on rock, soil or sometimes wood, 1200 to 3500 m. Frye and Clark (1937-1947); Sutcliffe (1947); Doyle and Stotler (2006), Bakalin (2012a).
Representative collections: On north-facing slopes near Prescott Cabin, S2 T16N R4E, Del Norte Co., *Norris 8119* (H); headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50125* (H); slopes above Big Duck Lake, S19 T40N R9W, Siskiyou Co., *Norris 23357* (H); crest of ridge above East Weaver Lake, S10 T34N R10W, Trinity Co., *Norris 9390* (H); slope above Ranger Lake at Silliman Pass, Kings Canyon National Park, Fresno Co., *Norris 46586, 46591* (H); valley above Robinson Lake, south of Onion Valley, Inyo Co., *Norris 46663, 46667* (H); strand of Fourth Lake, Big Pine Lakes, Inyo Co., *Howell 733β* (CAS)
- Lophozia ventricosa* (Dicks.) Dumort. var. *ventricosa* Klamath region, Cascade Range, high Sierra Nevada; on soil, rock or sometimes wood, often along streams or beneath logs, roots, boulders, or overhangs, 1400 to 3500 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Doyle and Stotler (2006), Bakalin (2012a).
Representative collections: On north-facing slopes near Prescott Cabin, S2 T16N R4E, Del Norte Co., *Norris 47871* (H); Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12320* (H); hwy. 50 at Pyramid Creek turnoff, Twin Bridges, El Dorado Co., *Whittemore & Whittemore 4004* (MO); Tioga Junction Campground, hwy. 120 2.5 miles north of Tioga Pass, Mono Co., *Norris 48342* (H); slope above Ranger Lakes at Silliman Pass, Kings Canyon National Park, Fresno Co., *Norris 46550* (H); slope above Treasure Lake, west of Big Pine, Inyo Co., *Norris 46948* (H)
- Lophozia ventricosa* var. *longiflora* (Nees) Macoun [*Lophozia longiflora* (Nees) Schiffn., *L. porphyroleuca* (Nees) Schiffn.] Reported from Mount Lassen Volcanic National Park, Shasta Co. by Clark and Frye (1936) and Frye and Clark (1937-1947); Doyle and Stotler (2006).
- Lophozia wenzelii* (Nees) Steph. Klamath region, high Sierra Nevada; on shaded soil or rock, often near streams or lakes, 1200 to 3500 m; Doyle and Stotler (2006).
Collections examined: On north-facing slopes near Prescott Cabin, S2 T16N R4E, Del Norte Co., *Norris 8136* (H); shore of Sanger Lake, Del Norte Co., *Norris 7762, 7764* (H); Tioga Junction Campground, hwy. 120 2.5 miles north of Tioga Pass, Mono Co., *Norris 48335* (H); vicinity of Heart Lake on trail from Onion Valley to Kearsage Pass, Inyo Co., *Norris 46785* (H); on talus slope above Golden Trout Lake, northwest of Onion Valley, Inyo Co., *Norris 46701* (H)
- Macrodiplrophyllum plicatum* (Lindb.) Perss. [*Diplophyllum plicatum* Lindb., *Scapania plicata* (Lindb.) Potemkin, *Douinia plicata* (Lindb.) Konstant. et Vilnet] North coast; on base of a redwood, 150 m. Doyle and Stotler (2006).
Note: The status of the genus *Macrodiplrophyllum* is very much in dispute.
Collection examined: Howland Summit, Jedediah Smith Redwoods State Park, Del Norte Co., *Doyle 7729* (MO)

Key to species of *Scapania*:

1. Leaf base sheathing, keeled only near sinus; well-developed leaves decurrent ventrally; dorsal lobe squarrose. *S. cuspiduligera*
1. Leaf keeled from sinus to base, base not sheathing.
 2. Leaves not decurrent ventrally.
 3. Plants over 2 mm wide; ventral lobes 1-1.2 times as long as wide. *S. irrigua*
 3. Plants 0.5-2.2 mm wide; ventral lobes 1.2-2 times as long as wide.
 4. Marginal cells of leaves undifferentiated.
 5. Plants red or purple in sun; ventral lobe broadly rounded; perianth mouth toothed. *S. scandica*
 5. Plants brownish in sun; ventral lobe obtuse; perianth mouth short-ciliate. *S. mucronata*
 4. Marginal cells of leaves with walls uniformly thickened.
 6. Ventral lobe rounded; keel 0.5-0.6 as long as ventral lobe. *S. curta*
 6. Ventral lobe rounded, obtuse, or apiculate; keel 0.35-0.45 as long as ventral lobe. *S. parvifolia* var. *grandiretis*
 2. Leaves strongly decurrent ventrally.
 7. Base of dorsal lobe ciliate, cilia often branched; teeth of dorsal lobe much larger and more widely spaced than teeth of ventral lobe. *S. bolanderi*
 7. Base of dorsal lobe entire or toothed; teeth of dorsal and ventral lobes similar in size and spacing.
 8. Plants 0.6-1.2(-2.2) cm long, 1-2.5 mm broad; lobes acute, strongly dentate; on rotten wood. *S. umbrosa*
 8. Plants at least 2 cm long, 2-5 mm broad; at least ventral lobe rounded, entire to strongly dentate; on various substrates.
 9. Lobes almost equal in size. *S. subalpina*
 9. Lobes strongly unequal.
 10. Gemmae green or brown; insertion of dorsal lobe usually transverse, sometimes curved; cortex continuous around stem, not interrupted ventrally.
 11. Gemmae green; leaves green, becoming purplish in sun; marginal cells of leaves with cell walls uniformly thickened. *S. undulata*
 11. Gemmae brown; leaves brown or blackish; marginal cells of leaves similar to interior cells, cell walls thin with small trigones. *S. obscura*
 10. Gemmae red; insertion of dorsal lobe curved, often decurrent; cortex interrupted by a strongly differentiated strip of thin-walled cells on ventral side of stem.
 12. Cuticle smooth or finely roughened; marginal cells of leaf ca 15 μm wide. *S. americana*
 12. Cuticle covered with coarse verrucae; marginal cells of leaf ca 10 μm wide. *S. granulifera*

Scapania americana Müll. Frib. [*S. bolanderi* var. *americana* (Müll. Frib.) Frye and L. Clark] North and central coast, Klamath region, Sierra Nevada; on rock, soil, or rarely wood in mixed evergreen forest or coniferous forest, sea level to 2200 m. Evans (1930); Frye and Clark (1937-1947); Hong (1980); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Along Smith River at middle fork of the Jones River, Del Norte Co., *Norris 46246* (H); near intersection of Seawood Drive and Patrick's Point Drive, 2 3/4 miles north of Trinidad, Humboldt Co., *Specht 134* (HSC); South Fork of the Eel River,

Branscomb Reserve north of Branscomb, Mendocino Co., *Norris 47235* (H); Underwood Mountain Road, 1 mile south of hwy. 299, Trinity Co., *Taylor 68* (CHSC); Cazadero, Sonoma Co., *M. A. Howe 1191* (UC); hills near Boulder Creek, Santa Cruz Co., *V. F. Hesse 1828* (UC); Spring Garden Road ca 3 miles northeast of Foresthill Road, Placer Co., *Doyle 8474* (herbarium of W. T. Doyle)

Scapania bolanderi Aust. North and central coast, Klamath region, Sierra Nevada; on logs or tree bases, rarely soil or rock, in conifer or mixed evergreen forest, 100 to 2800 m, but uncommon above 600 m. Howe (1899); Evans (1930); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Hong (1980); Kellman (2003); Ellyson and Sillett (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Near Smith River on hwy. 199 ca 10 miles east of Gasquet, Del Norte Co., *Norris 8814* (H); hwy. 299 ca 10 miles east of hwy. 101, Humboldt Co., *Malachowski s. n.*, 29 Apr. 1972 (CHSC); one mile west of White Mountain near Cook and Green Pass, S1 T47N R11W, Siskiyou Co., *Norris 50194* (H); junction of Alpine Road and Heritage Road, immediately south of Heritage Grove County Park, San Mateo Co., *Whittemore & Whittemore 4147A* (MO); sides of huge fallen tree, "The Fallen Monarch," above warden's office, Big Basin State Park, Santa Cruz Co., *Carter 385* (UC); trail to Franklin Lake, Mineral King Trailhead, Tulare Co., *Doyle 7846* (herbarium of W. T. Doyle)

Scapania curta (Mart.) Dumort. Cascade Range (Lassen Park, acc. Frye and Clark 1937-1947) and high Sierra Nevada; on soil along streams, 2600 to 3500 m. Evans (1936); Clark and Frye (1936), Frye and Clark (1937-1947); Doyle and Stotler (2006).

Note: The report of *S. curta* from Siskiyou Co. by Howe (1899) was based on a collection of xxx (Evans xxx).

Representative collections: along Pacific Crest Trail south from Echo Summit Ski Area to Benwood Meadows, El Dorado Co., *Whittemore & Whittemore 4177* (MO); below Kearsage Pass, South Fork Kings River drainage, Fresno Co., *Shevock 14326* (CAS); along trail between Wet Meadow and Spanish Lake, John Muir Wilderness, Fresno Co., *Shevock 14155* (CAS); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1537B* (CAS); vicinity of Heart Lake on trail from Onion Valley to Kearsage Pass, Inyo Co., *Norris 46774* (H); xxx, Tulare Co., *Shevock 14575* (CAS)

Scapania cuspiduligera (Nees) Müll. Frib. [*S. bartlingii* (Hampe) Nees] Reported from the high Cascades and Sierra Nevada by Sutcliffe (1947) and Doyle and Stotler (2006).

Scapania granulifera A. Evans Described from the North Coast (near Gasquet, Del Norte Co.) by Evans (1930); Clark and Frye (1936); Frye and Clark (1937-1947); Sutcliffe (1947); Doyle and Stotler (2006).

Note: Stotler and Crandall-Stotler (1977) list *S. granulifera* as a synonym of *S. americana*. The documentation for this has never been published.

Scapania irrigua (Nees) Gott. High Sierra Nevada; on soil along streams, ca 3000 m. Doyle and Stotler (2006), Bakalin (2012a).

Note: Also found at 1800 m in the Klamath region in Curry Co., Oregon (*Norris 52454*, H).

Collections seen: Pacific Crest Trail immediately south of Interstate 80, Donner Summit, Nevada Co., *Whittemore & Whittemore 4159* (MO); hwy. 120 in meadow on east side of Tioga Pass, Mono Co., *Whittemore 1557* (CAS)

Scapania mucronata H. Buch Reported from the Klamath region and Modoc Co. by Doyle and Stotler (2006).

Scapania obscura (Arnell & C.E.O. Jensen) Schiffner Reported from the high Sierra Nevada by Bakalin (2012a).

Scapania parvifolia Warnst. var. *grandiretis* Schljakov Reported from the high Sierra Nevada by Bakalin (2012a).

Scapania scandica (Arnell & H. Buch) Macvicar Klamath region; on wet rocks, logs or soil, 1500 to 2000 m. Doyle and Stotler (2006).

Note: As I recall, I had a lot of trouble deciding if these collections are *Scapania scandica* or

S. mucronata H. Buch; they were never checked against authentic material, as we had none and the group was not part of my thesis. This needs to be checked, as Hong seems to suggest that *S. mucronata* is commoner and more widespread in western North America.

Representative collections: Bear Basin Butte, Del Norte Co., *Norris 8105* (H); steep slope above Tish-Tang-a-Tang Creek near Grogan's Hole, Humboldt Co., *Norris 47842* (H); around Bingham Lake, S31 T40N R9W, Siskiyou Co., *Norris & McGrew 45698* (H)

Scapania subalpina (Nees) Dumort. [*S. perlaxa* Warnst.] High Sierra Nevada, south to Tulare Co. (Evans 1923a); on rocks in streams, 1800 to 3000 m. Evans (1923a); Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: Along Lee Vining Creek at Lee Vining Campground, Mono Co., *Norris 48381* (UC); near Stanford Research Area, H. M. Hall Natural Area, Mono Co., *Norris 48394* (UC); Mono (UC); between Pigeon Flat Campground and Columns of the Giants Geological Site, 1.5 miles east of Dardanelles, Tuolumne Co., *Whittemore 1469B* (CAS)

Scapania umbrosa (Schrad.) Dumort. North and central coast and western Klamath region; on logs, sometimes rocks, soil, and tree bases, mesic forests, 70 to 450 m. Howe (1899); Yurky (1995); Doyle and Stotler (2006).

Note: *Scapania glaucocephala* (Taylor) Aust. was reported from the north coast, near sea level (Russian Gulch, Mendocino Co.) by Howe (1897) and Hong (1980). I agree with Howe (1899) that this collection is actually depauperate *S. umbrosa*.

Representative collections: Along Hunter Creek 4 miles east of hwy. 199, Del Norte Co., *Norris 9928* (H); hwy. 299 ca 10 miles east of hwy. 101, Humboldt Co., *Mauer s. n., 29 Apr. 1972* (CHSC); Emerald Creek at junction with Redwood Creek, Redwood National Park, Humboldt Co., *Norris 45831* (UC); near Brannen Creek on Three Creek Road, near Willow Creek, Humboldt Co., *Nelson 89* (HSC); Quarry Bend Road, off Empire Grade, north of Santa Cruz, Santa Cruz Co., *Doyle 370* (herbarium of W. T. Doyle); along New River between Denny and Mills Creek, Trinity Co., *Norris 23961* (H)

Scapania undulata (L.) Dumort. [*S. heterophylla* M. Howe, *S. oakesii* Aust., *S. undulata* var. *oakesii* (Aust.) H. Buch] North coast (south to Mendocino Co., Howe 1899), Klamath region, Warner Mountains, high Sierra Nevada, Transverse Ranges; on rocks or sometimes wood or soil, in wet places or submerged in streams, sea level to 3200 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1980); Doyle and Stotler (2006), Bakalin (2012a).

Note: Some specimens from the southern Sierra Nevada have the dorsal lobe obliquely inserted and \pm decurrent, thus approaching the related *Scapania uliginosa* (Sw. ex Lindenb.) Dumort. However, these plants evidently represent a form of *S. undulata*, since the insertion may vary from oblique and decurrent to transverse and nondecurrent on different stems of the same colony, and leaves with obliquely inserted dorsal lobes may be strongly serrate (leaves of *S. uliginosa* are always entire or nearly so).

Representative collections: Deep canyon of Emerald Creek, east of Orick, Humboldt Co., *Norris 24604* (H); Haypress Meadow, Marble Mountain Wilderness Area, Siskiyou Co., *Norris 12381* (H); trail from Donner Flat Rest Area (on westbound interstate 80) and Summit Lake, Nevada Co., *Whittemore & Whittemore 3052* (CAS); along FS trail 34E04 to Cliff Camp below Wishon Reservoir, North Fork Kings River, Fresno Co., *Shevock & York 13572* (CAS); along stringer of Weston Meadow off of FS road 14S02, Ten Mile Creek watershed, Kings River drainage, Tulare Co., *Shevock & York 13649* (CAS); Long Valley Creek along Round Valley Trail, San Jacinto Mountains, Riverside Co., *Doyle 7450* (herbarium of W. T. Doyle)

Excluded species: The reports of *Scapania nemorosa* (L.) Dumort. by Howe (1899) were based on specimens of *S. americana* according to Müller (xxx) and Evans (1930). The report of *S. evansii* Bryhn by Clark and Frye (1936) needs to be reinvestigated; *S. evansii* has been listed

as a synonym of *S. nemorosa* or *S. undulata*.

23. Myliaceae

Mylia anomala (Hook.) Gray North coast; on *Sphagnum* in bogs, near sea level. Whittemore (1987); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Big Lagoon County Park, Humboldt Co., *Norris 48316* (H);
xxx

24. Calypogeiaceae

Key to species of *Calypogeia*:

1. Underleaves entire or retuse, if retuse then 7-14 cells from center of sinus to rhizoid-initial region.
 2. Some marginal cells of some or all leaves tangentially elongated; only marginal and submarginal cells with oil bodies. *C. neesiana*
 2. Marginal cells of leaves never tangentially elongated; oil bodies present throughout leaf. *C. integristipula*
1. Underleaves bilobed, 1-6 cells from center of sinus to rhizoid-initial region.
 3. Cells small, in midleaf 36-40(-60) μm long, along midline of underleaf 30-40 μm long. *C. suecica*
 3. Cells larger, in midleaf 40-80 μm long, along midline of underleaf 40-80 μm long.
 4. Leaves longer than wide, often acute or bidentate; underleaves divided within 1-3 cells of rhizoid-initial region, often laterally angulate or with one large tooth.
 5. Most or all leaves bidentate; epidermal cells of capsule without nodular thickenings; spores 14-16 μm across. *C. fissa*
 5. Most leaves on well developed shoots acute; epidermal cells of capsule with nodular thickenings; spores 12.5-14 μm across. *C. neogaea*
 4. Leaves at least as wide as long, rounded or obtuse; underleaves divided within 2-6 cells of rhizoid-initial region, seldom laterally angulate or toothed.
 6. Oil-bodies dark blue; underleaves divided within 2-4 cells of rhizoid-initial region. *C. trichomanes*
 6. Oil-bodies colourless; underleaves divided within 4-6 cells of rhizoid-initial region. *C. muelleriana*

Calypogeia fissa Raddi Reported from the Klamath Region and the central Coast Ranges by Hong (1990).

Calypogeia integristipula Steph. Reported from the Klamath Region by Hong (1990) and Sierra Nevada by Doyle and Stotler (2006) and Bakalin (2012a).

Calypogeia muelleriana (Schiffn.) Müll. Frib. North and central coast, Cascade Range (according to Hong 1990), Sierra Nevada (according to Bakalin 2012a); on rotten logs, sea level to 400 m. Hong (1990); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Old Kneeland Road 3.5 miles east of Old Arcata Road, Humboldt Co., *Norris s. n.*, 23 October 1971 (H); Corkscrew Tree area, Prarie Creek Redwood State Park, Humboldt Co., *Mauer s. n.*, 30 Apr. 1972 (CHSC); Big Tree Grove, Prarie Creek Redwood State Park, N of Orick, Humboldt Co., *Bourell 3686* (CAS); same locality, *Norris 46018* (H); near the ridge on Inverness to Point Reyes Road, Marin Co., *Howell 81* (CAS); North Fork Fall Creek, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Kellman 394* (herbarium of K. Kellman)

Calypogeia neesiana (C. Massal. & Carestia) Müll. Frib. High Sierra Nevada, Bay Area (Marin Co. according to Yurky 1995); soil of streambanks, 1800 to 3200 m. Hong (1990); Yurky (1995); Doyle and Stotler (2006).

Collections examined: Deer Lake, Sierra Co., *Sutcliffe 37 p. p.* (CAS); Gaylor Lakes,

- Tuolumne Co., *Howell 663 p. p.* (CAS); xxx, Mono Co., *Doyle 7975* (herbarium of W. T. Doyle); xxx, Mariposa Co., *Doyle 1479* (herbarium of W. T. Doyle); along trail between Wet Meadows and Spanish Lake, John Muir Wilderness, Fresno Co., *Shevock 14158* (CAS)
- Calypogeia neogaea* (R. M. Schust.) Bakalin [*Calypogeia fissa* Raddi ssp. *neogaea* R. M. Schust.] North and central coast and Coast Ranges, Klamath region, Sierra Nevada, Peninsular Ranges; on soil of shaded banks, occasionally on rotten logs, sea level to 2000 m (but commonest below 500 m). Hong (1990); Stark and Whittemore (1992); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).
- Representative collections:** Grave's Grove, 10 miles south of Crescent City, Del Norte Co., *Howell 306* (CAS); China Creek Trail about three miles above Summerville, Siskiyou Co., *Norris 9516* (H); Fern Canyon, near Bootjack Trail, Muir Woods National Monument, Marin Co., *Hermann 17516* (CAS); Tributary of Redwood Creek at Truss Bridge, Filoli Center, north of Woodside, San Mateo Co., *Whittemore & Noyes 4409* (MO); bank of stream, Big Basin State Park, Santa Cruz Co., *Sutcliffe 283* (CAS); Glen Alpine Spring Canyon, near Lake Tahoe, El Dorado Co., *Conklin 9 p. p.* (CAS); near confluence of Doane Creek and French Creek, Palomar Mountain State Park, San Diego Co., *Stark 548* (MO)
- Calypogeia suecica* (Arnell & J. Perss.) Müll. Frib. Reported from the north coast and the Sierra Nevada; Hong (1990); Clark and Frye (1936); Frye and Clark (1937-1947).
- Calypogeia trichomanes* (L.) Corda [*C. azurea* Stotler & Crotz] North coast, Warner Mountains and Sierra Nevada; wet soil or organic debris, meadows and streambanks, sea level to 2200 (or to 2600?) m. Hong (1990); Doyle and Stotler (2006).
- Note:** Hong maps this species through the Coast Ranges south through the Bay Area. Doyle (*in litt.*) suggests that specimens from the north coast may be a different species xxx. The report of *Kantia trichomanes* (L.) Gray by Howe (1899) was based on specimens of *C. neogaea*; other early reports, as by Clark and Frye (1936) and Frye and Clark (1937-1947), are questionable.
- Representative collections:** Between parking area and Agate Beach, Patrick's Point State Park, Humboldt Co., *Whittemore 1267* (tbd); Modoc County Road 2 about 0.15 mile east of turnoff to Lilly Lake, Warner Mts., Modoc National Forest, Modoc Co., *Doyle 8638* (MO); off of Ross Crossing Road (10S24), tributary of Bull Creek near Cabin Meadow, Fresno Co., *Shevock & Ertter 13505* (CAS); along Rock Creek Road at Glen Meadow Creek, Dinkey Creek Watershed, North Fork King's River drainage, Fresno Co., *Shevock & Bourell 13970, 13977* (CAS); Stringer Meadow along Forest Road 10S66 above Bear Creek road, North Fork King's River drainage, Fresno Co., *Shevock & Bourell 14003* (CAS)

25. Jungermanniaceae

Key to genera:

1. Leaves lingulate or rectangular, the apex truncate or weakly emarginate; sometimes producing erect gemmiparous shoots bearing transverse leaves and large underleaves; perianth various.
 2. Leaf cells 18-25 μm , trigones absent or minute; gemmae multicellular; perianth plicate, not beaked. *Rivulariella*
 2. Leaf cells 32-48 μm , trigones distinct, often bulging; perianth smooth, abruptly contracted to a distinct beak. *Liochlaena*
1. Leaves ovate to elliptical or cordate, longer than broad (sometimes almost circular and deeply concave in *J. polaris*); erect gemmiparous shoots produced only in *Mesoptychia heterocolpos*, gemmae absent in other species.
 3. Leaves bilobed; small underleaves present or absent; perianth smooth, abruptly contracted to a distinct beak. *Mesoptychia*
 3. Leaves entire; underleaves absent on sterile shoots; perianth plicate, not beaked.
 4. Leaves ovate to elliptical or cordate, longer than broad (sometimes almost circular and deeply concave in *J. polaris*); rhizoids confined to stem; perianth not beaked. *Jungermannia*

4. Leaves circular to reniform, broader than long; rhizoids sometimes arising from leaf bases as well as stem; perianth distinctly beaked. see Gymnomitriaceae (*Solenostoma*)

Key to species of *Jungermannia*:

1. Plant often blackish; leaves cordate, clasping stem, about as long as broad; very large aquatic plants (2-7 cm), stem with few rhizoids, attached only at base. *J. exsertifolia*
1. Plant yellow-green to brownish green or reddish; leaves cordate to circular or reniform, not clasping stem, distinctly broader than long; smaller terrestrial plants (to 4 cm), stem with abundant rhizoids, attached to substrate for most of its length.
 2. Dioicous; leaves ovate, striations of cuticle weak or absent. *J. atrovirens*
 2. Paroicous; leaf shape various, striations of cuticle weak or strong.
 3. Leaves elliptical to ovate; perianth fusiform, tapered to mouth. *J. pumila*
 3. Leaves cordate to almost circular; perianth ± ellipsoidal, rounded to the mouth. *J. polaris*

Jungermannia atrovirens Dumort. [*J. riparia* Taylor, *J. tristis* Nees] North coast, Klamath region, Sierra Nevada, and Transverse Ranges; on wet rock or sometimes soil of seeps and streambanks, 150 to 1800 m. Evans (1923a); Frye and Clark (1937-1947); Sutcliffe (1947); Doyle and Stotler (2006).

Representative collections: Along Hardscrabble Creek at Smith River, S23 T17N R1E, Del Norte Co., *Norris 10886* (H); Adams Station on Smith River, Del Norte Co., *Eastwood 8 Aug. 1923* (CAS); hwy. 299 ca 3 miles west of Willow Creek, Humboldt Co., *Norris 12025* (H); near small lake at headwaters of Preston Creek, S26 T17N R6E, Siskiyou Co., *Norris 23266* (H); along New River between Denny and Mills Creek, Trinity Co., *Norris 23976* (H); Glen Alpine Springs Canyon, Lake Tahoe, El Dorado Co., *Conklin 1* (CAS); off of Rock Creek Road along Rock Creek, a tributary to Dinkey Creek, North Fork Kings River drainage, Fresno Co., *Shevock & York 13943* (CAS) Dollar Lake Trail, San Bernardino Mountains, San Bernardino Co., *Howell 719* (CAS)

Jungermannia exsertifolia Steph. ssp. *cordifolia* (Dumort.) Vana Klamath region, high Sierra Nevada; on rocks or soil in streams where frequently submerged, 1000 to 3000 m. Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: Moist canyon along Jaynes Creek to headwaters, S13 T47N R3W, Siskiyou Co., *Norris 48685* (H); along trail from Onion Valley to Robinson Lake, west of Independence, Inyo Co., *Norris 46677* (H); Beasore Creek near Swartzet's Camp, east of Bass Lake, Madera Co., *Doyle 4522* (herbarium of W. T. Doyle); Cedar Creek at Cedar Creek Campground, east of Glennville, Kern Co., *Doyle 7522* (herbarium of W. T. Doyle)

Jungermannia exsertifolia Steph. ssp. *cordifolia* (Dumort.) Vana var. *pendletonii* (Pearson) Vana [*Aplozia pendletonii* Pearson, *J. pendletonii* (Pearson) Evans] Klamath region, in slow running water, 1200 m; known only from the type locality, Sisson (now the city of Mount Shasta), Siskiyou Co. Pearson (1920a, b); Evans (1923a); Frye and Clark (1937-1947).

Representative collections: West side of Mount Shasta, 4 miles from Sisson, Siskiyou Co., *Pendleton 8 May 1910*, *Haynes' American Hepaticae 90* (UC)

Jungermannia polaris Lindb. [*J. schiffneri* (Loitl.) A. Evans] High Sierra Nevada, north to Sierra Co. (Sutcliffe 1947); near streams, 3000 to 3500 m. Sutcliffe (1947); Doyle and Stotler (2006).

Note: The compact alpine form, with leaves almost circular and deeply concave (*Solenostoma polaris* fo. *cavifolia* R. M. Schust.) occurs at high elevations in the Sierra Nevada (Inyo Co., *Norris 46960*, H)

Collections examined: xxx, Mono Co., xxx; slope above Treasure Lake, west of Big Pine, Inyo Co., *Norris 46960*, (H)

Jungermannia pumila With. High Sierra Nevada; on rocks in or near streams, 2100 to 2600 m. Howe (1899); Doyle and Stotler (2006).

Representative collections: West Fork of the Carson River by hwy. 88 bridge at Hope Valley Resort, just west of Sorenson's, Alpine Co., *Whittemore & Whittemore 3091* (MO); Dinkey Lakes Wilderness trailhead adjacent to Dinkey Creek, end of Forest Road 9S62, Fresno Co., *Shevock 14199* (CAS)

Liochlaena lanceolata Nees [*J. lanceolata* auct., not L. emend Grolle, *Jungermannia leiantha* Grolle] North coast, Klamath region, Warner Mts., Sierra Nevada; on rocks, soil or wood, mesic valleys near coast or streambanks and seeps in mountains, sea level to 3000 m. Evans (1923a); Clark and Frye (1936); Sutcliffe (1947); Doyle and Stotler (2006).

Note: *Syzygiella autumnalis* (DC.) K. Feldberg, Vána, Hentschel & J. Heinrichs (Adelanthaceae) [long known as *Jamesoniella autumnalis* (DC.) Steph.], which is not known but might be expected in California, will key here because of its lingulate or rectangular, truncate or weakly emarginate leaves. It differs in having small trigones and a plicate, tapering perianth.

Representative collections: Deep canyon of Emerald Creek, east of Orick, Humboldt Co., *Norris 24600* (H); ravine ca 1 mile east of Copper Butte, S10 T47N R11W, Siskiyou Co., *Norris 50226* (H); Trailhead of Pine Creek Trail, Warner Mountains, Modoc Co., *Doyle 6683* (herbarium of W. T. Doyle); Big Sandy Road (Forest Service Road 6507) by Big Sandy Campground, Madera Co., *Doyle 4463* (herbarium of W. T. Doyle); Near Eagle Lake, Mineral King Trailhead, Tulare Co., *Doyle 7807* (herbarium of W. T. Doyle)

Key to species of *Mesoptychia*:

1. Underleaves absent. *Mesoptychia polymorpha*
1. Underleaves present.
 2. Gemmae present, smooth, on tips of small appressed leaves on ascending shoot tips.
Mesoptychia heterocolpos
 2. Gemmae none.
 3. Paroecious. *Mesoptychia gillmani*
 3. Dioecious.
 4. Leaves (0.8-)1.2-2.0 mm long, bilobed ca 0.15 of their length, midleaf cells (24-)28-44 μm wide. *Mesoptychia bantriensis*
 4. Leaves 0.5-1.3 mm long, bilobed ca 0.2(-0.3) of their length, midleaf cells 20-32 μm wide. *Mesoptychia collaris*

Mesoptychia bantriensis (Hook.) L. Söderstr. & Vána [*Leiocolea bantriensis* (Hook.) Joerg., *Lophozia bantriensis* (Hook.) Steph., *Lophozia hornschurchiana* (Nees) Schiffn.] High Sierra Nevada; on soil and wood in streams, 2000-3000 m. Evans (1923a); Sutcliffe (1947); Doyle and Stotler (2006).

Representative collections: Lower Salmon Lake, Sierra Co., *Sutcliffe s. n. 10-1-'21 xxx* (CAS); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1537A* (CAS); near Stanford Research Area, H. M. Hall Natural Area, Mono Co., *Norris 48450* (H); Franklin Pass trail, near Mineral King, Tulare Co., *Howell s. n. 18 July 1951* (CAS)

Mesoptychia collaris (Nees) L. Söderstr. & Vána [*Leiocolea collaris* (Nees) Shljak., *Lophozia collaris* (Nees) Dumort., *Leiocolea alpestris* (F. Weber) Isov., *Leiocolea muelleri* (Nees ex Lindenb.) Joerg.] Klamath region, high Sierra Nevada; on soil or rock along streams, 1500 to 3000 m. Sutcliffe (1941); Doyle and Stotler (2006).

Representative collections: Moist canyon along Jaynes Creek to headwaters, S13 T47N R3W, Siskiyou Co., *Norris 48691* (H); Salmon River near Big Flat, Siskiyou Co., *Norris 9187* (H); meadow above Lake Mildred, Convict Creek drainage, Mono Co., *Whittemore 1520* (atw)

Mesoptychia gillmanii (Austin) L. Söderstr. & Vána [*Leiocolea gillmanii* (Aust.) A. Evans, *Lophozia gillmani* (Aust.) R. M. Schust.] Reported from the high Sierra Nevada at 3000 m (East Lake, Tulare Co.) by Sutcliffe (1947) and Doyle and Stotler (2006).

Mesoptychia heterocolpos (Thed.) L. Söderstr. & Vána [*Leiocolea heterocolpos* (Thed.) H. Buch, *Lophozia heterocolpa* (Thed.) M. Howe] Klamath region, Warner Mountains, high Sierra Nevada; shaded rock or soil near streams or in seeps, 1300 to 3500 m. Howe (1899); Doyle and Stotler (2006).

Representative collections: near Badger Lake, Madera Co., 3000 m, *Howell 586* (CAS)

Mesoptychia polymorpha Stotler, Crand.-Stotl. & Bakalin Central coast, on shaded seepy banks, ca 50 m.

Distribution: Limekiln Creek, hwy. 1 south of Lucia, Monterey Co., *Doyle 7474* (herbarium of W. T. Doyle); Aptos Creek, Forest of Nisene Marks State Park, east of Aptos, Santa Cruz Co., *Doyle 7056* (herbarium of W. T. Doyle)

Rivulariella gemmipara (A. Evans) D. H. Wagner [*Chiloscyphus gemmiparus* A. Evans] On rocks in streams, 1830 m. Christy & Wagner (1996), Wagner (2013).

Note: Reported from near Yuba Pass, Sierra Co., *B. Thiers 5403a* (OSC). I haven't seen the specimen.

26. Gymnomitriaceae

Key to genera:

1. Leaves unlobed; perianth projecting far beyond female bracts. *Solenostoma*
1. Leaves bilobed; perianth concealed by female bracts or absent.
 2. Leaves succubous; small underleaves present on sterile shoots. *Nardia*
 2. Leaves transverse or nearly so; underleaves absent on sterile shoots.
 3. Leaves very tightly imbricate, shoots julaceous; cells of leaf margin dead and decolorate at maturity. *Gymnomitrium*
 3. Leaves erect to spreading, not imbricate, shoots never at all julaceous; cells of leaf margin living, not differentiated. *Marsupella*

Key to species of *Gymnomitrium*:

1. Leaf lobes frequently acute, entire or weakly crenulate near apices. *G. concinnatum*
1. Leaf lobes obtuse, crenulate over their whole margin. *G. obtusum*

Gymnomitrium concinnatum (Lightf.) Corda Klamath region; on rock, 1800 m. Doyle and Stotler (2006)

Collection examined: headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50110* (H)

Gymnomitrium obtusum Lindb. Reported for the Klamath region and Sierra Nevada by Doyle and Stotler (2006).

Key to species of *Marsupella*:

1. Paroecious; stems 3-15 mm long; leaves transverse, lobes acute or obtuse.
 2. Leaves suberect, stem 1-7 mm long, leaf lobes usually acute. *M. sprucei*
 2. Leaves spreading, stem 3-15 mm long, leaf lobes usually obtuse. *M. sparsifolia*
1. Dioecious; leaf lobes obtuse to rounded.
 3. Stems 2-6 mm long; leaves of elongate sterile stem sectors weakly succubous. *M. bolanderi*
 3. Stems 5-100 mm long; leaves transverse.
 4. Leaves bilobed 0.1-0.25, antical margin often reflexed. *M. emarginata*
 4. Leaves bilobed 0.3-0.5, antical margin plane. *M. sphacelata*

Marsupella bolanderi (Aust.) Underw. Coast Ranges, Sierra Nevada foothills, south coast, on summer-dry soil or sandstone, sea level to 750 m. Howe (1899); Frye and Clark (1937-1947); Hong (1982); Stark and Whittemore (1992); Yurky (1995); Doyle and Stotler (2006).

Representative collections: mile 8.5 on Bolinas - Fairfax Road, Marin Co., *Doyle 8411* (herbarium of W. T. Doyle); near Lake San Andreas, San Mateo Co., *Howe 1225* (UC); vista point immediately north of Edgewood Road on Interstate 280, just west of San Carlos, San Mateo Co., *Whittemore 4221* (CAS); Newton Road ca 2.3 miles west of hwy. 49, Nevada Co., *Doyle 8339* (herbarium of W. T. Doyle); Old Toll Road ca 0.4 miles west of hwy. 49 at Mt. Bullion, Mariposa Co., *Doyle 8857* (herbarium of W. T. Doyle); north-facing slope adjacent to San Vicente Reservoir, midway between San Vicente Dam and parking lot at south entrance, three miles north of Lakeside, San Diego Co., *Stark 581* (MO)

Marsupella emarginata (Ehrh.) Dumort. var. *emarginata* Klamath region and north and central coast, south to San Mateo County (Howe 1899), Sierra Nevada; on damp rock or soil of cliffs, outcrops, and ephemeral drainages, sea level to 2500 m. Howe (1899); Hong (1982); Yurky (1995); Doyle and Stotler (2006).

Representative collections: Headwaters of Oregon Creek, north of Trinity Summit Guard Station, Humboldt Co., *Norris & Creek 50113* (H); Wilder Ridge, ca 5 miles south of Honeydew, Humboldt Co., *Norris 8051* (H); ca 1 mile east of Copper Butte, S10 T47N R11W, Siskiyou Co., *Norris 50247* (H); mile 8.5 on Bolinas - Fairfax Road, Marin Co., *Doyle 8413* (herbarium of W. T. Doyle); near Lake San Andreas, San Mateo Co., *Howe 46* (UC); Quartz Mountain trailhead, along trail to Chiquito Lake, Madera Co., *Doyle 6949* (herbarium of W. T. Doyle)

Marsupella sparsifolia (Lindb.) Dumort. Reported from the Sierra Nevada (Madera Co.) by Hong (1982) and Christy & Wagner (1996; report from Hong 1982).

Marsupella sphacelata (Giesecke ex Lindenb.) Dumort. [*M. sphacelata* var. *erythrorhiza* (Limpr.) Schiffn., *M. sullivantii* (De Not.) A. Evans] Klamath region, Warner Mountains, Cascade Range, high Sierra Nevada; on damp rock or soil of outcrops, ephemeral drainages, banks of creeks and lakes, 1400 to 2900 m. Evans (1923a); Sutcliffe (1942, 1947); Hong (1982); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: open slope near Paines Lake, S12 T40N R10W, Siskiyou Co., *Norris & Smith 46371, 46372* (H); Mineral Springs, 2 miles south of the Oregon border, Warner Mountains, Modoc Co., *Shevock 12234* (UC); bank of Crystal Lake, Lassen Volcanic National Park, Lassen Co., *Doyle 6778* (herbarium of W. T. Doyle); near south shore of Silver Lake, Amador Co., *Doyle 4386* (herbarium of W. T. Doyle); Forest Service Road 5530 east of Clover Meadow Station, Madera Co., *Doyle 6923* (herbarium of W. T. Doyle); Tioga Junction Campground, hwy. 120 2.5 miles north of Tioga Pass, Mono Co., *Norris 48333* (H); Pilot Ridge, South Fork Tuolumne River drainage, Tuolumne Co., *Shevock 13271* (UC)

Marsupella sprucei (Limpr.) Bernet Reported from the Cascade Range, above 2000 m (West Fork [probably of Hat Creek, Mount Lassen Volcanic National Park], Shasta Co.) by Hong (1982).

Key to species of *Nardia*:

1. Leaves entire or bilobed less than 0.2. *N. geoscyphus*
1. Leaves uniformly bilobed 0.2-0.35.
 2. Lobes of leaves obtuse. *N. insecta*
 2. Lobes of leaves acute. *N. hiroshii*

Nardia geoscyphus (DeNot.) Lindb. Klamath region and high Sierra Nevada (Tuolumne Co. according to Sutcliffe 1947); on damp calcareous soil near streams, 1800 m. Frye and Clark (1937-1947); Sutcliffe (1947); Doyle and Stotler (2006).

Collections examined: Along trail from Big Flat to Yellow Rose Mine, S20 T37N R8W, Siskiyou Co., *Norris 9121, 9128* (H)

Nardia hiroshii Amak. High Sierra Nevada; on damp soil in meadow, 2200 m. Bakalin (2012b).

Collections examined: Pacific Crest Trail immediately south of Interstate 80, Donner Summit, Nevada Co., *Whittemore & Whittemore 4157* (MO).

Nardia insecta Lindb. Reported from the Cascades and Sierra Nevada by Doyle and Stotler (2006).

Key to species of *Solenostoma*:

1. Leaves bordered, marginal cells \pm radially elongate, with thick radial walls, inner cells of leaf usually collenchymatous; bracts usually red at base; dioecious, perianth truncate, deeply 4-5 plicate. *S. rubrum*
1. Marginal cells of leaves not differentiated, leaf cells thin-walled or equally collenchymatous to margin.
 2. At least some rhizoids usually purple; sexuality various; perigynium present or absent.
 3. Dioecious; perianth and bracts arising from a deep perigynium. *S. hyalinum*
 3. Paroecious; perigynium absent or very shallow. *S. pseudopyriflorum*
 2. Rhizoids hyaline or brown; paroecious; perigynium not formed.
 3. Leaves strongly decurrent, concave, insertion almost transverse. *S. confertissimum*
 3. Leaves weakly or not decurrent, \pm flat and spreading, insertion oblique. *S. sphaerocarpum*

Solenostoma confertissimum (Nees) Schljakov [*Jungermannia confertissima* Nees, *J. danicola* Gott. ex Underw., *J. bolanderi* Gott. ex Underw., not (Aust.) Aust.] High Sierra Nevada; on rocks or soil banks along streams, ca 3000 m. Howe (1899); Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: near Stanford Research Area, H. M. Hall Natural Area, Mono Co., *Norris 48448* (H); hwy. 120 in meadow on east side of Tioga Pass, Mono Co., *Whittemore 1549* (CAS)

Solenostoma hyalinum (Lyell) Mitt. [*Jungermannia hyalina* Lyell, *Plectocolea hyalina* (Lyell) Mitt.] Reported from the Sierra Nevada by Doyle and Stotler (2006), Bakalin (2012a).

Solenostoma pseudopyriflorum Bakalin et Vilnet Reported from the high Sierra Nevada by Bakalin (2012a).

Solenostoma rubrum (Gottsche ex Underw) R.M. Schust. [*Jungermannia rubra* Gott., *Nardia rubra* (Gott.) A. Evans] North coast, north Coast Ranges, Cascade Range, Sierra Nevada, south coast; on soil or sometimes rock, often on banks and cliffs, sometimes in reach of salt spray, sea level to 2200 m (but usually below 1000 m). Evans (1919b); Anonymous (1924); Bradshaw (1926); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Doyle (1998); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Note: Material reported by Howe (1899) as *Nardia crenulata* (Sm.) Lindb. (= *J. gracillima* Sm. in Sowerby) is *J. rubra* (Evans 1919b).

Representative collections: along French Flat Trail near Gasquet, Del Norte Co., *Norris 9599* (H); Big Lagoon County Park, Humboldt Co., *Malachowski s. n.*, 29 Apr. 1972 (CHSC); 0.3 miles north of Summit Lake, Mendocino National Forest, Lake Co., *Toren 7183* (MO); headland south of mouth of Caspar Creek, west of hwy. 1, Mendocino Co., *Whittemore 531* (MO); between headquarters and Tiptoe Falls, Portola State Park, San Mateo Co., *Whittemore & Whittemore 4126* (MO); North Fork Campground SSE of Emigrant Gap, Placer Co., *Norris 88233* (UC); Adobe Creek near Ranch House, Santa Rosa Plateau Ecological Reserve, Riverside Co., *Doyle 7336* (herbarium of W. T. Doyle)

Solenostoma sphaerocarpum (Hook.) Stephani [*Jungermannia sphaerocarpa* Hook.] North

Coast Ranges and high Sierra Nevada; on rock, from low elevations to 3000 m. Frye and Clark (1937-1947); Doyle and Stotler (2006).

Representative collections: along Trinity River at Norton Creek, ca 4 miles north of Hoopa, Humboldt Co., *Norris 10450, 10451* (H); Dog Lake Trail at Delaney Creek, north of Tuolumne Meadows, Tuolumne Co., *Howell 714* (CAS); Rock Creek Cañon, Tulare Co., *Howell 776, 777* (CAS)

Excluded names: The report of *Solenostoma obovatum* (Nees) R. M. Schust. by Howe (1899, as *Nardia obovata* (Nees) Lindb.) was misidentified; the specimen is probably *S. sphaerocarpum* Hook., according to Evans (1919a). *Nardia scalaris* (Schrad.) Gray was reported from the north coast by Sutcliffe (1947), but the specimen (*Howell 388*, CAS, originally determined by Brinkman) is *Gyrothyra underwoodiana*.

27. Geocalyceae

Geocalyx graveolens (Schrad.) Nees North and central coast; on logs, bark or soil in coniferous forest, sea level to 1600 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1993); Doyle and Stotler (2006).

Representative collections: Young's Valley Road ca 0.2 miles south of Sanger Lake, Siskiyou Mountains, Del Norte Co., *Doyle 2056* (herbarium of W. T. Doyle); steep south-facing slope above Emerald Creek, east of Orick, Humboldt Co., *Norris 24594* (H); Big Tree Parking Lot, Prarie Creek Redwoods State Park, Humboldt Co., *Norris 72078* (UC); Haypress Meadow Trailhead Road ca 9.6 miles from Somes Bar - Etna Road, Salmon Mts., Siskiyou Co., *Doyle 9169* (herbarium of W. T. Doyle); North Fork of Fall Creek, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Kellman 395* (herbarium of K. Kellman)

28. Gyrothyraceae

Gyrothyra underwoodiana M. Howe North coast, south to Mendocino Co. (to Marin Co. according to Yurky 1995); on spoil (usually mineral soil) on permanently damp well-lit banks, sea level to 1100 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Yurky (1995); Doyle and Stotler (2006).

Representative collections: Damnation Creek Trail, Jedediah Smith State Park, Del Norte Co., *Taylor 98* (CHSC); Corkscrew Tree area, Prarie Creek Redwoods State Park, Humboldt Co., *Malachowski s. n., 30 Apr. 1972* (CHSC); north of Orick on Fern Canyon Rd., ca 4.1 miles south of Fern Canyon, Humboldt Co., *Mueller 6708* (UC); near Eureka, Humboldt Co., *Howe 944* (UC); same locality, *Howe s. n., Underwood & Cook's Hepaticae Americanae 184* (UC); ca 3 miles SE of Fort Bragg, Mendocino Co., *Thomas 5220* (CAS)

29. Antheliaceae

Key to species of *Anthelia*:

1. Dioecious, perianth exerted for ca 0.5 of its length; thickening bands of elaters ca 4 μm wide.
A. julacea
1. Poroecious, perianth \pm completely enclosed in bracts; thickening bands of elaters less than 2 μm wide. *A. juratzkana*

Anthelia julacea (L.) Dumort. Reports from the Sierra Nevada (Sutcliffe 1942, 1947; Frye and Clark 1937-1947) are based on sterile specimens, and must be considered very questionable.

Anthelia juratzkana (Limpr.) Trevis. High Sierra Nevada, on seasonally wet or periodically submerged soil in seeps and on banks of streams and lakes, 2700 to 3500 m. Howe (1899); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Mt. Conness Trail W of Ragged Peak, Tuolumne Co., *Howell*

646 (CAS); southeast shore of Garnet Lake, Madera Co., *Howell 584* (CAS); east of Young Lake, Tuolumne County, *Howell 683* (CAS); off of Taboose Pass Trail, headwaters of the South Fork Kings River, Fresno Co., *Shevock 13864* (CAS); Trail to Sam Mack Lake, by Big Pine Lakes, Inyo Co., *Howell 727* (CAS)

30. Ptilidiaceae

Ptilidium californicum (Aust.) Underw. Klamath region; in conifer forest on bases and trunks of *Abies* and *Pseudotsuga*, rarely standing snags, 1100-1700 m. Howe (1899); Frye and Clark (1937-1947); Christy & Wagner (1996); Doyle and Stotler (2006).

Note: This species was described from the mountains of California, without specific locality, but was apparently not recollected in the state until very recently. Forest Service surveys have located 13 populations from sites scattered through northern and central Siskiyou County. Voucher specimens from these populations will be deposited at UC (Harpel pers. comm.)

Representative collections: Scott River District, Klamath National Forest, 41° 37' N, 123° 08' W, Siskiyou Co., *Harpel 20325* (to be deposited at UC); Scott River District, Klamath National Forest, 41° 36' N, 123° 09' W, Siskiyou Co., *Harpel 20310* (to be deposited at UC)

31. Porellaceae

Key to species of *Porella*:

1. Margins of underleaves and lobules with a narrow revolute margin (ca 2 cells wide) for most of their length, entire or with a few small teeth near base; lobules not or weakly decurrent.
 2. Dry plants glossy; plant not staining with I₂KI; perianth mouth rolled under. *P. navicularis*
 2. Dry plants dull; whole plant staining black with I₂KI; perianth mouth plane (lateral margins sometimes deflexed). *P. platyphylla*
1. Margins of underleaves and lobules plane to irregularly undulate or sometimes reflexed only in part (especially underleaf apices and sides of lobules), repand, dentate, spurred or ciliate below; lobules nondecurrent to strongly decurrent; perianth mouth plane (lateral margins sometimes deflexed).
 2. Dry plants glossy (often becoming yellow-green and mottled); basal margin of underleaf repand or with a broad blunt spur; lobule not or weakly decurrent; fresh plants with a strong peppery taste. *P. roellii*
 2. Dry plants ± dull, green; **either** basal margin of underleaf dentate to ciliate **or** lobule long-decurrent; fresh plants without a strong taste.
 3. Perianth often with 2-3 postical keels, its mouth ciliate; plant not staining with I₂KI; postical base of lobule scarcely to strongly decurrent, always dentate or ciliate. *P. bolanderi*
 3. Perianth without postical keels, its mouth entire to repand; whole plant staining black with I₂KI; postical base of lobule always strongly decurrent, entire to ciliate. *P. cordeana*

Porella bolanderi (Aust.) Pearson Klamath region, throughout the coast, Coast Ranges, Cascade Range, Sierra Nevada foothills, Transverse and Peninsular Ranges; on bark, shaded sides of rocks, and (rarely) soil of shaded banks in oak woodland, sea level to 1200 m. Howe (1899); Kingman (1911); Frye and Clark (1937-1947); Steere (1954); Hong (1983); Stark and Whittemore (1992); Yurky (1995); Piippo and Norris (1996); Doyle (1998); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Road near Doe Spring, about 7 air miles north of Mad River, Humboldt Co., Six Rivers National Forest, *Norris 84073* (UC); along Sylvan Way just north of Glenloch Way, Redwood City, San Mateo Co., *Whittemore & Whittemore 3113* (MO); just above Newt Pond, Garin Regional Park, southeast of Hayward, Alameda Co., *Whittemore & Whittemore 5292* (MO); County Road M-220 at Bear Creek, Tulare County, Sequoia

National Forest, *Norris, Shevock & Barahona 87649* (UC); alongside the San Luis Rey River within the La Jolla Indian Reservation Campground, hwy. 76 5.7 miles east of Lake Henshaw, San Diego Co., *Stark 471* (MO)

Porella cordeana (Huebener) Moore [*P. rivularis* (Nees) Trevis.] North and central coast and Coast Ranges, Klamath region, Cascade Range, Warner Mountains, high Sierra Nevada; on rocks, occasionally bases of trees, usually along streams where subject to inundation, sea level to 2600 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1983); Yurky (1995); Piippo and Norris (1996); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: ca halfway from Hoopa to North Trinity Summit, Humboldt Co., *Whittemore & Norris 1241* (atw); near Ox Trail Parking Lot, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Kellman 572* (herbarium of K. Kellman); canyon of Soda Creek, ca 0.1 mile north of confluence with East Branch North Fork Feather River and hwy. 70, Butte Co., *Janeway 5384* (CHSC); Bridal Veil Falls, hwy. 50 2.8 miles west of Icehouse Road, El Dorado National Forest, El Dorado Co., *Whittemore & Whittemore 3999* (MO); along Ross Landing Road (FS 10S24) at Ross Creek, Kings River Drainage, Sierra National Forest, Fresno Co., *Shevock, Ertter & York 13477* (CAS); Cedar Creek, off of California hwy. 155, 3.6 miles west of Greenhorn Summit, Greenhorn Mountains, Sequoia National Forest, Kern Co., *Shevock & Tan 13088* (CAS)

Porella navicularis (Lehm. & Lindenb.) Pfeiff. North and central coast, western Klamath region; on bark and shaded sides of rocks in mesic forests, sea level to 900 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1983); Yurky (1995); Piippo and Norris (1996); Kellman (2003); Ellyson and Sillett (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Along Smith River at hwy. 199 about 9 miles east of jct. with hwy. 101, Del Norte County, Six Rivers National Forest, *Norris 84990* (UC); along trail from Wilderness Falls toward Doe Flat, Siskiyou Co., Klamath National Forest, *Norris 67798* (UC); northwest-facing slope and hilltop above 5440 Bader, Santa Rosa (just outside Annadel State Park), Sonoma Co., *Whittemore & Whittemore 6705* (tbd); picnic ground near reservoir, Filoli Center, north of Woodside, San Mateo Co., *Whittemore & Noyes 4393* (MO); Canyon Trail near north end of Montebello Ridge Open Space Preserve, Palo Alto, Santa Clara Co., *Whittemore & Whittemore 4306* (CAS); xxx, Monterey Co., *Doyle 6160* (herbarium of W. T. Doyle)

Porella platyphylla (L.) Pfeiff. Reported from the Klamath region (Salyer, Trinity Co.) by Clark and Frye (1936), Frye and Clark (1937-1947) and Hong (1983). Piippo and Norris (1996) state that *P. platyphylla* does not occur in California, but they do not cite the voucher for this report, *Frye 2121*, and did not borrow from WTU, where Frye's herbarium is deposited.

Porella roellii Steph. North and central coast, western Klamath region, and (according to Clark and Frye 1936) Cascade Range; on rock, bark, and soil in mesic mixed conifer-broadleaf forest, sea level to 1700 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Hong (1983); Yurky (1995); Piippo and Norris (1996); Doyle and Stotler (2006).

Representative collections: Hwy. 299 9 1/2 miles east of hwy. 101, just east of Blue Lake, Humboldt Co., *Whittemore 1772* (atw); vicinity of Eel Rock, Humboldt County, April 1950, *Koch 78* (UC); Paul M. Dimmick Wayside Park, ca 5 mi. W of Navarro on hwy. 128, Mendocino Co., *Bourell 3597* (CAS); Monte Rio, Sonoma Co., *Mason 2519* (UC); Mt. Tamalpais, Marin Co., *Mason s. n., 7 Jan. 1925* (UC); near Barlow Flat Campground, Ventana Wilderness, Monterey Co., *Doyle 6499* (herbarium of W. T. Doyle)

32. Frullaniaceae

Key to species of *Frullania*:

1. Lobule about as long as wide.
2. Flagella usually common; underleaf commonly with a lateral tooth on each side; lobules

- always inflated; dioecious. *F. bolanderi*
2. Without flagella; sides of underleaves entire; explanate lobules often present; autoecious.
 3. Dorsal lobes squarrose; perianth tapered to beak; underleaves rhombic, cleft ca 0.5, margins usually unidentate. *F. catalinae*
 3. Dorsal lobes complanate; perianth truncate below beak; underleaves circular or obovate, cleft ca 0.3, margins usually entire. *F. inflata*
 1. Lobule at least twice as long as wide; flagella none.
 4. Underleaves gradually narrowed to base; dorsal lobe with a median row of coloured cells. *F. franciscana*
 4. Underleaf base auriculate; dorsal lobe with coloured cells scattered or absent.
 5. Dorsal lobe of leaf rounded-obtuse; lobules separated from stem by less than half of their width. *F. californica*
 5. Dorsal lobe of leaf acute or acuminate; lobules separated from stem by more than half of their width. *F. nisquallensis*

Frullania bolanderi Aust. Coast Ranges, Klamath region, Cascade Range, Sierra Nevada foothills, Transverse Ranges and south coast; on trunks and limbs of broadleaved trees, rarely on Douglas fir, rocks, soil or rotten wood, sea level to 1800 m. Howe (1899); Kingman (1911); Frye and Clark (1937-1947); Iverson (1963); Hong (1989); Stark and Whittemore (1992); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Forest Glen, Trinity Co., *Howell 385* (CAS); along Fall Creek Road at Dekkas Rock above Shasta Lake, Shasta Co., Shasta National Forest, *Norris 84840* (UC); just above newt pond, Garin Regional Park, southeast of Hayward, Alameda Co., *Whittemore & Whittemore 5297* (CAS); along small stream over serpentine outcrop about 1 mile below Drum Powerhouse, Placer Co., *Norris 82022* (UC); along the San Luis Rey River near San Luis Rey Campground, hwy. 76 2.7 miles east of the town of Lake Henshaw, San Diego Co., *Stark 412* (MO)

Frullania californica (Aust.) A. Evans North and central coast and Klamath region; on bark, logs, and rocks in canyon bottoms, sea level to 900 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Iverson (1963); Hong (1989); Yurky (1995); Kellman (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Between Junction City and Weaverville, Trinity Co., *Duell no. 68/5* (UC); The Cedars north of Cazadero, headwaters of Big Austin Creek, Sonoma Co., *Ertter, Raiche et al. 12856* (UC); just west of Skyline Road in Huddard Park, ca 3 1/2 miles west of Woodside, San Mateo Co., *Whittemore 1094* (DAV); near George's Campground, Forest of Nisene Marks State Park, east of Aptos, Santa Cruz Co., *Whittemore & Whittemore 4048* (MO); Pacific Grove, Monterey Co., *Howe s. n., July 1892* (UC); Black Mountain, Santa Rosa Island, Santa Barbara Co., *Bratt s. n., 9 Nov. 1993* (herbarium of W. T. Doyle)

Frullania catalinae A. Evans South Coast Ranges (north to Monterey Co. according to Hong 1989) and coastal Southern California; tree trunks and rock outcrops, low elevations. Howe (1899); Kingman (1911); Evans (1923b); Steere (1954); Iverson (1963); Hong (1989); Doyle and Stotler (2006).

Representative collections: Prefumo Canyon Road ca 1.1 miles southwest of junction with Los Osos Valley Road, southwest of San Luis Obispo, San Luis Obispo Co., *Doyle 7238* (MO); Hope Ranch, Santa Barbara, Santa Barbara Co., *Haynes 1865* (UC); Ridge Road ca 0.25 miles west of Saucer Canyon Rd., Santa Cruz Island, Santa Barbara Co., *Tucker 35851* (herbarium of W. T. Doyle); hwy. 1 ca 1.2 miles east of road to Jaloma Beach County Park, Santa Barbara Co., *Doyle 8139* (herbarium of W. T. Doyle); canyon above White's Landing, 5 miles north of Avalon, Santa Catalina Island, Los Angeles Co., *W. C. Steere s. n., 2-3 May 1953* (CAS)

Frullania franciscana M. Howe North and central coast; tree trunks, rarely boulders, sea level to 100 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Iverson (1963);

Hong (1989); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Along Pala Road at entrance to Kellogg Beach State Park, Del Norte Co., *Norris 75016* (UC); Crescent City, Del Norte Co., *Parks s. n., Kryptogamie exsiccatae editae a us. Hist. Nat. Vindobon. 3075* (UC); foot of cliff behind Agate Beach, near northern boundary of Patrick's Point State Park, Humboldt Co., *Whittemore 1260* (DAV); north side of Cleone Lake, 2.5 miles north of Pudding Creek, McKerricher State Park, Mendocino Co., *Merrifield 703* (UC); Sweeney Ridge, near old Coast Guard building south of Skyline Junior College, San Mateo Co., *Whittemore & Whittemore 4067* (MO); Old Coast Road east of hwy. 1, between Big Sur and Bixby Creek Bridge, Monterey Co., *Doyle 639* (herbarium of W. T. Doyle)

Frullania inflata Gott. Reported from coastal southern California by Hong (1989). Frye and Clark (1937-1947) considered *Frullania catalinae* to be a synonym of *F. inflata*, and most or all of the California specimens they cite under *F. inflata* are actually *F. catalinae*.

Frullania nisquallensis Sull. North and central coast (south to San Mateo Co. according to Iverson 1963); on trees and shrubs, rarely on rock, sea level to 180 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Iverson (1963); Hong (1989); Yurky (1995); Kellman (2003); Ellyson and Sillett (2003); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Smith River Valley between Crescent City and Gasquet, Del Norte Co., *Duell 226/2* (UC); Big Tree Grove, Prarie Creek Redwoods State Park, Humboldt Co., *Snodgrass 131* (DAV); Fort Bragg, Mendocino Co., *Michener & Bioletti s. n., Feb. 1893* (UC); Point Reyes Headland, Marin Co., *Weber 75-95* (DAV); Clarendon Heights, San Francisco, *Howe s. n., Underwood & Cooke's Hepaticae Americanae 198* (UC)

33. Radulaceae

Key to species of *Radula*:

1. Dioicous; gemmae absent; dorsal lobes attached to stem for most of their length; leaf cells 9-16 μm wide. *R. bolanderi*
1. Paroicous; gemmae often present; dorsal lobes free from and crossing the stem; leaf cells 16-24 μm wide. *R. complanata*

Radula bolanderi Gott. North and central coast and western Klamath region; trunks of smooth-barked trees (especially *Alnus rubra*), occasionally logs and rock, sea level to 1100 m. Howe (1899); Clark and Frye (1936); Frye and Clark (1937-1947); Thompson and Ketchledge (1958); Yurky (1995); Kellman (2003); Ellyson and Sillett (2003); Doyle and Stotler (2006). **Representative collections:** along Smith River at hwy. 199 about 9 miles east of junction hwy. 101, Del Norte Co., Six Rivers National Forest, *Norris 84988, 85021* (UC); along road to Eight Mile Lookout about 1 mile west of South Fork Mtn. Road about 8 air miles north of Mad River, Humboldt Co., Six Rivers National Forest, *Norris 83880* (UC); Indian Creek County Park, hwy. 128 5 miles west of Boonville, Mendocino Co., *Whittemore & Norris 839* (atw); just west of Skyline Road in Huddard Park, ca 3 1/2 miles west of Woodside, San Mateo Co., *Whittemore 1095* (DAV); lower part of North Fork Trail, Fall Creek Unit, Henry Cowell Redwoods State Park, Santa Cruz Co., *Whittemore & Whittemore 3481* (CAS); Little Sur River, Palo Colorado Rd. east of hwy. 1, Monterey Co., *Doyle 6157* (herbarium of W. T. Doyle)

Radula complanata (L.) Dumort. North and central coast and Klamath region; wet rocks and trunks of smooth-barked trees, sea level to 1700 m. Howe (1899); Clark and Frye (1936); Yurky (1995); Doyle and Stotler (2006), Bakalin (2012a).

Representative collections: Near Shasta Springs Hotel, Siskiyou Co., *Eastwood s. n., Sept. 1922* (CAS); Monte Rio, Sonoma Co., *Parks 2966a* (UC); Olema, Marin Co., *Howe 26* (UC); Strawberry Canyon, Berkeley, Alameda Co., *Howe s. n., 18 May 1892* (UC); La Honda Road 1.3 miles northeast of La Honda, San Mateo Co., *Whittemore & Whittemore 4141* (MO); Limekiln Creek, east of hwy. 1 south of Lucia, Monterey Co., *Doyle 7478*

(herbarium of W. T. Doyle)

ANTHOCEROTALES

34. Anthocerotaceae

Note: This is often split into two families.

Key to genera:

1. Spore wall dark brown, translucent; thalli ± radiate, with internal mucilage cavities, margins finely lobulate, dorsal surface with flap-shaped outgrowths. *Anthoceros*
1. Spore wall pale yellow, transparent; thalli often ± strap-shaped, without internal mucilage cavities, margins not lobulate, dorsal surface without outgrowths.
 2. Thalli with stalked, usually glandular tubers from the ventral midrib. Antheridia solitary. Spores usually ornamented with a large, single raised ring in the center of the outer face. *Phymatoceros*
 2. Tubers, if present, terminal or marginal, usually sessile, and almost never glandular. Antheridia several per chamber. Spores papillose or with 8-35 large warts. *Phaeoceros*

Key to species of *Anthoceros*:

1. Sculpturing on inner face of spore consisting of spines connected by a reticulum of narrow ridges, ending well away from triradiate ridge, thus arms of triradiate ridge with broad smooth borders. *A. fusiformis*
1. Sculpturing on inner face of spore a reticulum of broad ridges without spines, extending right up to triradiate ridge, thus arms of triradiate ridge unbordered. *A. punctatus*

Anthoceros fusiformis Aust. Klamath region, coast and Coast Ranges, Sierra Nevada, Transverse and Peninsular Ranges; on summer-dry soil or rarely damp rock, sea level to 2400 m. Howe (1899); Kingman (1911); Clark and Frye (1936); Doyle (1998); Jessup et al. (2002); Kellman (2003); Doyle and Stotler (2006).

Representative collections: Jacoby Creek, south of Arcata, Humboldt Co., *Farr 142* (HSC); south side of Kelsey Creek, 1 mile from Happy Creek Camp along Scott River, Siskiyou Co., *Meyer 87* (MO); near Porter Family Picnic Area, Forest of Nisene Marks State Park, east of Aptos, Santa Cruz Co., *Whittemore & Whittemore 4051* (MO); North Fork of the Middle Fork of the American River at Mosquito Ridge Road, Placer Co., *Whittemore & Whittemore 3983* (MO); along French Creek 1/4 mile from its confluence with Doane Creek, Palomar Mountain State Park, San Diego Co., *Stark 672* (MO)

Anthoceros punctatus L. Central coast, Transverse and Peninsular Ranges; on soil, openings in coastal scrub, sea level to 1400 m. Clark and Frye (1936); Yurky (1995); Doyle (1998); Doyle and Stotler (2006).

Note: Frye and Clark (1937-1947) incorrectly treated *A. fusiformis* as a synonym of this species. Many California reports of *A. punctatus*, including at least some in Frye and Clark (1937-1947), actually belong to *A. fusiformis*. I have followed Proskauer (xxx) in treating this species very broadly; some specimens may be referable to *A. agrestis* Patton, which is doubtfully distinct.

Representative collections: Trail around North Pond, Pescadero Marsh, San Mateo Co., *Doyle 7201* (herbarium of W. T. Doyle); Moro Bay State Park, San Luis Obispo Co., *Doyle 5734* (herbarium of W. T. Doyle); Apple Canyon Road ca 1.2 miles east of hwy. 74, southeast of Hemet, Riverside Co., *Doyle 7311* (herbarium of W. T. Doyle); Santa Rosa Plateau Ecological Reserve, Riverside Co., *Doyle 7449* (herbarium of W. T. Doyle); north side of Eastgate Mall Road overlooking I 805, Kearney Mesa, San Diego Co., *Doyle 7241* (herbarium of W. T. Doyle)

Key to species of *Phaeoceros*:

1. Outer face of spores finely spinose, never warty.
 2. Each inner face of spore with more than 30 verrucae (mean number: more than 40) scattered rather evenly over the whole inner face; dry capsules 6-11 x 0.4-0.5 mm. *P. oregonus*
 2. Each inner face of spore with fewer than 30 verrucae (mean number: 20 or fewer) usually ± clustered toward the middle of the face; dry capsules 20--32 x 0.2-0.3(-0.4) mm. *P. carolinianus*
1. Outer face of spores with low rounded or crescentic warts, otherwise smooth or finely papillose.
 3. Most pseudoelaters unicellular, their cells often isodiametric. Capsules 4-6 mm long, often indehiscent. Cells of thallus each with one plastid. Antheridia 2-4 per chamber. *P. hallii*
 3. Most pseudoelaters 2-4-celled, their cells elongate. Capsules 7-40 mm long, always dehiscent. Internal cells of thallus mostly with 2 plastids. Antheridia 1 per chamber.
 4. Thalli 2.5-5 mm wide, tubers sessile on apex or margin of thallus, flattened, to 2.5 mm across. Monoecious. *P. pearsonii*
 4. Thalli less than 2 mm wide, tubers terminal on very narrow thallus branches, usually almost globose, less than 1 mm across. Dioecious, male thalli much narrower than female. *P. proskaueri*

Phaeoceros carolinianus (Michx.) Prosk. [*P. laevis* (L.) Prosk. ssp. *carolinianus* (Michx.) Prosk., *Anthoceros carolinianus* var. *occidentalis* M. Howe] North and central coast, Coast Ranges, Klamath region, Cascade Range, Sierra Nevada foothills; damp soil or rarely wet rock, in seeps, streambanks, drainages, bases of deep roadcuts, splash zone of waterfalls, sea level to 1200 m. Doyle and Stotler (2006), Bakalin (2012a).

Note: The classification of the *Phaeoceros laevis* complex remains unsatisfactory despite repeated study by different people. California populations fall into two groups, treated here as *P. oregonus* and *P. carolinianus*. The spore distinctions given in the key are those used by Thompson (1996); they are evident on SEM examination, but difficult to use with the light microscope. The spore surface between the verrucae is finely vermiculate and appears granulose under the light microscope, and it is often difficult to distinguish the verrucae from large features of this vermiculate sculpturing. Habitat and capsule size also seem to distinguish the California races of these species, but more work needs to be done with material from outside the state. Many authors have treated all of these taxa as *P. laevis* or *P. carolinianus*; reports in Howe (1899), Clark and Frye (1936), Frye and Clark (1937-1947), Proskauer (1958a), and Yurky (1995) cannot be referred to species with certainty.

Representative collections: Foot of cliff behind Agate Beach, near northern boundary of Patrick's Point State Park, Humboldt Co., *Whittemore 1262* (CAS); Fairfax - Bolinas road 1.7 miles southwest of car bridge (dam) over Alpine Lake, Marin Co., *Mueller 6948* (MO); near George's Campground, Forest of Nisene Marks State Park, east of Aptos, Santa Cruz Co., *Whittemore & Whittemore 4031* (MO); canyon of North Fork Feather River, 0.1 mile north of the mouth of Rock Creek, Plumas Co., *Janeway 5400* (CHSC); hwy. 190 ca 4.4 miles east of Coffee Campground, east of Springville, Tulare Co., *Doyle 9036* (herbarium of W. T. Doyle)

Phaeoceros hallii (Aust.) Prosk. Klamath region, Modoc Plateau, Sierra Nevada foothills; on moist shaded soil, humus, or granite, 200 to 1100 m. Yurky (1995); Doyle and Stotler (2006).

Note: Yurky's reports may refer to other taxa, since *Anthoceros phymatodes* has sometimes been erroneously considered a synonym of *P. hallii* (Proskauer 1951; see above).

Representative collections: Sand Ridge Road ca 4.7 miles west of Buck's Bar Road, El Dorado Co., *Doyle 8258* (herbarium of W. T. Doyle); Oak Grove Road ca 2.3 miles west of Mariposa County border, Madera Co., *Doyle 8271* (herbarium of W. T. Doyle); Oak Grove Road 3.9 miles east of Madera County border, Mariposa Co., *Doyle 8269* (herbarium of W. T. Doyle); Yellow Jacket Springs Road ca 0.8 miles west of road 84, north of hwy. 299 near

Canby Bridge, Modoc Co., *Doyle 7486* (herbarium of W. T. Doyle); Garden Bar Road ca 2.1 miles southwest of Wolf Road, west of Higgins Corner on hwy. 49, Nevada Co., *Doyle 8319* (herbarium of W. T. Doyle); Eastside Road 4.7 miles from jct. Calif. hwy. 3, Trinity Mountains, Trinity Co., *Doyle 9133* (MO)

Phaeoceros oreganus (Aust.) Hässel Klamath Region, Cascade Range, central and southern coast, Coast Ranges, Sierra Nevada, Peninsular Ranges; on soil or occasionally rock in seasonally dry localities, often along seasonal streams and seeps, sea level to 1700 m. Doyle (1998).

Note: As noted under *P. caroliniana*, this complex is in need of much work. It is not clear whether *P. mohrii* (Aust.) Hässel is a synonym of *P. oreganus* or a distinct species. The report of *P. laevis* (L.) Prosk. in Stark and Whittemore (1992) is based on specimens of *P. oreganus*.

Representative collections: Eastside Road ca 4.8 miles east of junction with hwy. 3, Trinity Co., *Doyle 8544* (herbarium of W. T. Doyle); Carberry Flat, south side of hwy. 299 ca 1 mile west of summit of Hatchett Mtn. Pass, Shasta Co., *Doyle 7480* (herbarium of W. T. Doyle); main trail up canyon, Burleigh H. Murray Ranch State Park, San Mateo Co., *Whittemore & Whittemore 5408* (CAS); Sandridge Rd. ca 2 miles east of hwy. 49, El Dorado Co., *Doyle 8461* (herbarium of W. T. Doyle); western edge of Kearny Mesa, 1/2 mile northwest of the junction of hwy. 805 and 52, San Diego, San Diego Co., *Stark 767* (MO)

Phaeoceros pearsonii (M. Howe) Prosk. [*Anthoceros pearsonii* M. Howe] Klamath region, Coast Ranges, Sierra Nevada foothills, south coast, Peninsular and Transverse Ranges; on summer-dry mineral soil in open shade, usually in oak woodland, occasionally savanna, mixed evergreen forest and shrubland, sea level to 400 m. Howe (1899); Kingman (1911); Evans (1923b); Clark and Frye (1936); Frye and Clark (1937-1947); Steere (1954); Yurky (1995); Doyle (1998); Jessup et al. (2002); Doyle and Stotler (2006).

Representative collections: Smith River 16 miles east of Gasquet, Del Norte Co., *Norris 8901* (H); canyon of Sinbad Creek, along Kilkare Road north of Sunol, Alameda Co., *Whittemore & Whittemore 4241* (CAS); North Fork of the Middle Fork of the American River at Mosquito Ridge Road, Placer Co., *Whittemore & Whittemore 3985* (MO); Agua Hedionda Creek area, Dawson - Los Monos Canyon Reserve, south of Buena Vista Park in Vista, San Diego Co., *Rebman 3059* (MO); west side of summit of Santa Rita Road, between Cayucos and Templeton, Santa Lucia Mountains, San Luis Obispo Co., *Doyle 5713* (MO)

Phaeoceros proskaueri Stotler, Crand.-Stotl. & W. T. Doyle in Crand.-Stotl, Stotler, W. T. Doyle, and L. L. Forrest Central coast, Coast Ranges, Sierra Nevada foothills, Transverse Ranges, south coast; damp soil of slopes and roadcuts, sea level to 600 m. Crandall-Stotler et al. (2008).

Note: I have not reviewed my specimens since this species was described.

Phymatoceros bulbiculosus (Bertol.) Stotler, W. T. Doyle, & Crand.-Stotl. [*Anthoceros dichotomous* Raddi, *Anthoceros phymatodes* M. Howe, *Phaeoceros bulbiculosus* (Bertol.) Prosk.] Central and South Coast Ranges, Sierra Nevada foothills; shaded, summer-dry mineral soil, usually exposed hillsides and rock outcrops with rapid water runoff, sea level to 650 m. Müller (1954); Proskauer (1958b); Kellman (2003); Doyle and Stotler (2006).

Note: This species has been separated as a monotypic genus by Stotler et al. (2005).

Representative collections: Miwok Meadow, China Camp State Park, Marin Co., *Doyle 8393* (herbarium of W. T. Doyle); on slope north of Sylvan Trail near its south end, Edgewood County Park, Redwood City, San Mateo Co., *Whittemore & Sommers 5245* (CAS); Huasna Road ca 1.1 miles northwest of Huasna Townsite Road, San Luis Obispo Co., *Doyle 7355* (herbarium of W. T. Doyle); Garden Bar Road ca 2.1 miles southwest of Wolf Road, west of Higgins Corner on hwy. 49, Nevada Co., *Doyle 8320* (herbarium of W. T. Doyle); Old Toll Road ca 0.4 miles west of hwy. 49, near Mt. Bullion, Mariposa Co., (*Doyle 8208A*, herbarium of W. T. Doyle)

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A guide to families of California liverworts and hornworts
Alan T. Whittemore
February 2014

The family treatment of the liverworts and has been mostly stable and natural for many years. However, recent research (primarily molecular gene trees) has clarified some ambiguous points, and revealed a few errors in the confusing group of morphologically similar genera surrounding *Jungermannia* and *Lophozia*, which (it is now clear) represent two unrelated groups that have converged on a similar morphology. In most cases, the redefined families are well-defined morphologically and quite recognizable.

Recent attempts at new family classifications of the liverworts include those of Xiaolan et al. (2006) and Crandall-Stotler et al. (2009). However, further studies have not supported some aspects of their classifications, and I have not followed them in all cases.

This document includes a key to families, followed by family descriptions with brief discussion. Finally, there is an index to genera, giving current family placement, and past family placements where relevant. The order in which the taxa are presented should not be taken to be phylogenetic, although related families are placed together as far as possible. Descriptions refer only to taxa present in California; variation found in taxa outside California is not reflected in the descriptions.

Key to families:

1. Gametophytes thallose.
 2. Thallus with internal air chambers, thick and opaque, pale or bright green (underside often purple).
 3. Air chambers low and broad, packed with filaments.
 4. Pores of thallus compound; antheridial receptacles stalked. 3. Marchantiaceae
 4. Pores of thallus simple; antheridial receptacles sessile.
 5. Underside of thallus deep purple; antheridia on short ventral branches; involucre beneath tips of \pm undifferentiated thallus segments. 5. Targioniaceae
 5. Underside of thallus green; antheridia on undifferentiated thallus segments, ventral branches usually absent; involucre in stalked carpocephala.
 6. Thalli 40-200 x 8-22 mm; brood bodies absent. 4. Conocephalaceae
 6. Thalli 8-20 x 6-10 mm; brood bodies present in crescent-shaped dorsal receptacles. 2. Lunulariaceae
 3. Air chambers relatively high and \pm narrow, without filaments.
 7. Ventral scales in two rows, appendages well defined (or scales rudimentary in *Cryptomitrium*); sporophytes in terminal carpocephala. 6. Aytoniaceae
 7. Ventral scales in either one row or several rows, appendages poorly defined; sporophytes in dorsal carpocephala or embedded in the thallus.
 8. Thallus without a median groove; air pores surrounded by differentiated cells with radial walls thin to strongly thickened; sporophytes in dorsal carpocephala. 7. Cleveaceae
 8. Thallus often with a sharp median groove; cells surrounding air pores not differentiated from other epidermal cells; sporophytes embedded in the thallus. 8. Ricciaceae
 2. Thallus without internal air chambers, thick and opaque or thin and translucent, if thick then dark green (upper and lower surfaces the same colour).
 9. Chloroplasts 1-2 per cell; underside of thallus with stomates, prominent *Nostoc* colonies developing inside thallus; capsule cylindrical. 34. Anthocerotaceae
 9. Chloroplasts many per cell; ventral stomata and *Nostoc* colonies absent; capsule spherical.
 10. Thallus laterally compressed, erect; submerged aquatics. 9. Riellaceae

10. Thallus dorsiventrally compressed, prostrate; aerial plants.
 11. Thallus regularly lobed for about half its width.
 12. Thalli unistratose for most of their width, bright green; thallus almost hidden by crowded dorsal involucre; capsules immersed. 10. Sphaerocarpaceae
 12. Thalli multistratose except sometimes for the extreme margins, bright to dark green, rarely blotched with purple; thallus without crowded dorsal involucre; capsules exerted on a long seta. 1. Blasiaceae
 11. Thallus unlobed, margins often somewhat irregular, but never deeply divided.
 13. Gametangia on short lateral or ventral branches; either branching entirely pinnate or margin of thallus ciliate.
 14. Thallus thick, sometimes tapering gradually to unistratose margins, without hairs; branching terminal, mostly monopodial or palmate; gemmae (if present) 1-2-celled. 14. Aneuraceae
 14. Thallus unistratose except for a slender, well defined midrib, with unicellular hairs at least on the margin and midrib; branching dichotomous or occasionally by ventral innovations; gemmae (if present) discoid and unistratose. 15. Metzgeriaceae
 13. Gametangia dorsal on main thallus; branching entirely dichotomous, margin of thallus without cilia.
 15. Thalli unistratose except for a cord-like midrib, bright green. 13. Pallaviciniaceae
 15. Thalli multistratose except for the extreme margins, dark green. 12. Pelliaceae
1. Gametophytes leafy.
 15. Leaves with a large, incubous dorsal lobe and a much smaller ventral lobe (lobule) folded up beneath it.
 16. Underleaves absent; rhizoids arising from the centers of the lobules. 33. Radulaceae
 16. Underleaves present; rhizoids the underside of the stem.
 17. Underleaves unlobed; lobules flat, attached to stem but usually not to upper lobe. 31. Porellaceae
 17. Underleaves bilobed; lobules strongly convex to tubular, attached to upper lobe but not stem. 32. Frullaniaceae
 15. Leaves not as above: if complicate-bilobed (i.e. deeply lobed and sharply folded so that the two lobes are pressed against one another), then with the underlobe at least as large as upper lobe, usually much larger.
 18. Leaf insertion incubous; underleaves always well developed, rhizoids (if present) from bases of underleaves.
 19. Leaf lobes tapering to long cilia, leaf margins often with cilia; perianth terminal on main stem. 30. Ptilidiaceae
 19. Neither apices nor margins ciliate; gynoecia on short ventral branches.
 20. Sporophyte developing in a subterranean marsupium, perianth absent; valves of capsule linear, spiral. Leaves entire or apex 2-dentate; underleaves deeply 2-lobed; stems sparingly and irregularly branched, without ventral stolons. 24. Calypogeiaceae
 20. Sporophyte developing in a perianth, marsupium absent; valves of capsule elliptical, straight. Leaf apex 3-dentate or leaf deeply 3-4-lobed; underleaves repand or deeply 3-4-lobed; stems pinnately branched, sometimes with stolons in axils of underleaves. 17. Lepidoziaceae
 18. Leaf insertion succubous, transverse, or with an incubous upper lobe and a succubous underlobe; underleaves present or absent; rhizoids arising from stem (except in Lophocoleaceae).

21. Leaves and underleaves divided into 3-4 cilia that are 1 cell wide to base. 16. Pseudolepicoleaceae
21. Leaves and underleaves various (or underleaves absent), if lobed then lobes always at least 2 cells wide.
22. Cortical cells of stem much larger than internal cells, forming a well-marked hyalodermis. 20. Cephaloziaceae
22. Cortical cells of stem not or scarcely larger than internal cells, never forming a hyalodermis.
23. Leaves and underleaves identical in size and form. 29. Antheliaceae
23. Underleaves much smaller than leaves, or absent.
24. Leaves oblong, undulate, irregularly crenate; archegonia and sporophytes dorsal on stem.
25. Plant without crowded dorsal involucre (pseudoperianths few per plant and several mm apart); capsule exerted on a long seta; elaters with spiral thickenings present; outer face of spore strongly sculptured (ridged or spiny). 11. Fossombroniaceae
25. Plant almost hidden by crowded dorsal involucre; capsule immersed, seta very short; elaters absent (sterile cells with thin walls present); outer face of spore smooth. 10. Sphaerocarpaceae
24. Leaves ovate or circular, flat or concave, entire (or serrate in *Plagiochila*); archegonia and sporophytes terminal on stem.
26. Leafy branches erect or ascending, from rhizomes, rhizoids confined to rhizomes; leaves toothed, usually strongly decurrent dorsally; perianth laterally compressed, sharply folded dorsally and ventrally and with a wide mouth. 19. Plagiochilaceae
26. Leafy branches creeping, generally with rhizoids; leaves and perianth not as above.
27. Rhizoids confined to bases of underleaves; perianth sharply trigonous (reduced in some species). 18. Lophocoleaceae
27. Rhizoids scattered along underside of stem (sometimes more frequent near bases of leaves or underleaves, but not confined to these sites); perianth \pm terete or plicate with rounded angles, or reduced or absent.
28. Leaves always 2-4-lobed; gemmae commonly present, smooth or angulate, clustered at the tips lobes of ordinary leaves (and sometimes underleaves) on undifferentiated stems. Perianth well-developed, without a perigynium.
29. Plants filiform to large, ventral part of leaf insertion succubous (either the whole leaf succubous, or the dorsal part of the leaf insertion succubous and the dorsal part transverse or incubous); cell walls generally with small to large trigones. 22. Scapaniaceae
29. Filiform plants with transverse leaves bilobed 0.5-0.8; cell walls thin or evenly thickened, without trigones. 21. Cephaloziellaceae
28. Leaves unlobed or shallowly 2-lobed; gemmae usually absent, if present then smooth and borne on well-differentiated gemmiparous branches, on margins of highly modified leaves. Perianth well-developed, small, or absent, perigynium usually present.
30. Underleaves well developed, divided almost to base into 2 lanceolate lobes; gynoecium a deep marsupium on a

- short ventral branch, perianth small or absent.
31. Leaves shallowly bilobed; rhizoids scattered over ventral stem, sometimes more frequent near underleaves. 25. Geocalycaceae
 31. Leaves unlobed; rhizoids confined to edges of large rhizoidal cushions on ventral stem. 28. Gyrothyraceae
 30. Underleaves present or absent, entire or divided for less than half their length; gynoecium terminal on an ordinary leafy branch, perigynium present or absent, perianth large or small.
 32. Perianth bilaterally compressed, mouth broad; gemmae present on margins of lanceolate, acute leaves. 23. Myliaceae
 32. Perianth if present cylindrical, smooth or plicate, mouth narrow; gemmae usually absent, if present then confined to on erect gemmiparous branches.
 33. Leaves unlobed or apex truncate or weakly emarginate; perianth well-developed, perigynium none. 26. Jungermanniaceae
 33. Leaves unlobed or shallowly bilobed with a narrow sinus; perianth large or small, with a well-developed perigynium (except *Solenostoma*). 27. Gymnomitriaceae

Liverworts

Gametophore thallose or leafy, lacking stomates with 2 guard cells (Marchantiales usually have stomates surrounded by 4 or more differentiated cells in the dorsal epidermis, or (*Riccia*) associated with undifferentiated cells; these are clearly not homologous with stomates in other plant groups), not harbouring *Nostoc* colonies inside the thallus (*Blasia* has *Nostoc* colonies in external ventral domatia). **Plastids** many per cell, never with pyrenoids. **Venter of archegonium** exposed above thallus. **Sporophyte** usually spherical, sometimes cylindrical, usually with a seta, all parts of sporangium differentiating simultaneously, without any meristem at maturity; sporangial wall without stomates or columella. **Spores** ripening simultaneously in the whole capsule; elaters present (none in *Riccia*), with strong spiral thickenings in most taxa, unicellular and separate from one another, occasionally a few elaters attached to capsule wall but never forming a network, elaters when shed 1-celled, very regular in shape.

Blasiales

Gametophore with regular, leaf-like lobes from a broad and flattened or narrow and rib-like axis, branching dichotomous, without dorsal pores and air chambers, with rather inconspicuous scales in two rows on underside of midrib, rhizoids uniform, with thin, smooth walls, with *Nostoc* colonies in ventral domatia; with scale-like brood-bodies several cells thick on dorsal surface and spherical brood-bodies in dorsal long-necked flask-shaped receptacles. **Antheridia** naked, sunken singly in dorsal pits on dorsal surface of main thallus segments; archegonia naked on dorsal surface of thallus. **Capsules** exserted from a tubular pseudoperianth, splitting into valves; sterile cells among spores elongate, with spiral thickenings.

Blasiaceae were traditionally aligned with families now referred to Fossombroniales and Metzgeriales, but DNA sequence data indicate that Blasiaceae are sister to Marchantiales +Sphaerocarpaceae. This relationship had been suggested previously based on ultrastructure of the spermatid (Pass and Renzaglia 1995).

1. Blasiaceae H. Klinggräff

Thalli bright to dark green, rarely blotched with purple, midrib broad and flattened to narrow and rib-like, wing divided into regular, leaf-like lobes that are unistratose except at extreme base, without strong internal cell differentiation, branching dichotomous, underside with rather inconspicuous scales in two rows on midrib and with hood-shaped outgrowths (domatia) containing *Nostoc* colonies at lobe bases, with naked scale-like brood-bodies on dorsal surface of thallus and spherical brood-bodies in dorsal long-necked flask-shaped receptacles. **Dioecious**, male plants smaller than female, gametangia dorsal on main thallus segments; antheridia naked, sunken singly in dorsal pits; archegonia naked; sporophyte protected by a pseudoperianth that is constricted at its apex. **Capsule** elongate, its wall prolonged below summit of seta as a basal collar, splitting into four valves, fixed elaters few, basal; spores unicellular when shed, their walls rather thin and delicate.

The appearance of the thallus is variable. In some cases, the midrib is so narrow and the lobes so deep that *Blasia* can be mistaken for a member of the Jungermanniales. In other cases, the midrib is broad and the lobes so shallow that it appears as a thallose liverwort with shallowly crenate margins.

Marchantiales

Gametophore thallose, branching dichotomous or by adventitious branches from underside of thallus, dorsal part of thallus with air-chambers that open to the outside via pores in the dorsal epidermis, each pore usually bordered by 1-3 rings of differentiated cells, with prominent scales in two to several rows on underside of midrib, rhizoids of two kinds: rhizoids with thin, smooth walls that extend down into the soil, and rhizoids that have thicker walls with peg-shaped thickenings on their inner surface (tuberculate rhizoids), that extend along the underside of the midrib, and form a water-conducting system, without *Nostoc* colonies; gemmae usually absent, seldom with brood-bodies several cells thick in concave receptacles on dorsal thallus surface. **Antheridia** in deep pits, scattered in dorsal thallus or clustered in well-defined, sessile or stalked receptacles; archegonia clustered at thallus apex or embedded in dorsal thallus. **Capsules** enclosed in or short-exserted from tubular or bilabiate involucre that are grouped in stalked receptacles (carpocephala) or singly beneath apex of thallus, or capsules embedded in the thallus, splitting into valves, losing an operculum, or indehiscent, then the spores released by decay of wall and surrounding gametophytic tissues; sterile cells among spores usually elongate, with spiral thickenings, absent in a few taxa.

Marchantiales include the most complex gametophytes in the plant kingdom. Unique features include the dorsal system of air pores and air chambers, the external conducting system of tuberculate rhizoids (McConaha 1941), and the carpocephalum, a unique and complex structure that represents a highly modified branch system. Many taxa are drought-resistant. When the thallus dries out in these taxa, it tends to curl upward so the delicate dorsal epidermis and pores are protected and only the underside, which is often tough and dark purple or blackish, is exposed. Plants survive the summer in this state, then rehydrate when the rains begin in the fall.

A surprising number of references incorrectly call the carpocephalum an "archegoniophore." The carpocephalum is not present when the archegonia are receptive - the whole complex structure develops entirely after fertilization, as the sporophytes are developing. The actual archegoniophore (the structure that bears the archegonia) is a small bump at the apex of the thallus. In most genera, the stalk of the carpocephalum has a furrow along one side containing a strand of pegged rhizoids, which conducts water to the head of the carpocephalum.

Morphological evolution in Marchantiales has been complex, with evolution for seasonally arid habitats causing convergent evolution in different lineages. Evolution of involucre and carpocephalum structure, with multiple losses of the carpocephalum in different lines, suggests that spore dispersal strategy has driven morphological evolution of these structures, but nothing is known about how these spores are dispersed. In most taxa, spores are much too large and heavy to be wind dispersed. There were many detailed studies on the structure and development of various

Marchantiales in the early twentieth century, and relationships within the order were reconstructed very accurately (Goebel 1910, 1930, Kashyap 1919, Evans 1939, Burgeff 1943, and Proskauer 1951, 1962). The literature has been badly confused by poorly conceived treatments published by Müller and Schuster, but DNA sequence data strongly supports the early twentieth century treatments.

2. Lunulariaceae H. Klinggräff

Thalli 8-20 x 6-10 mm, branching dichotomous; upper surface flat, dorsal pores simple, cells adjacent to them with walls never strongly thickened; air chambers much broader than high, densely packed with filaments, primary chambers not subdivided by secondary walls; ventral scales in 2 regular rows, with well-differentiated appendages; brood-bodies produced in concave receptacles on dorsal thallus surface. **Antheridia** in well-differentiated sessile receptacles terminating the short branch of a dichotomy (often appearing lateral). **Capsules** enclosed in involucre that are grouped in stalked carpocephala; foot well developed, seta short, capsule barely exerted from involucre, at maturity splitting into 4 valves; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

3. Marchantiaceae Lindley

Thalli 15-200 x 3-20 mm, branching dichotomous, sometimes also terminal-ventral; upper surface flat, dorsal pores compound or simple, cells adjacent to them with walls never strongly thickened; air chambers much broader than high to isodiametric, with or without filaments, primary chambers not subdivided by secondary walls; ventral scales in 2-6 regular rows, inner 2 rows with well-differentiated appendages; brood-bodies sometimes produced in concave receptacles on dorsal thallus surface. **Antheridia** in stalked receptacles, terminating the main thallus or the short branch of a dichotomy (then often appearing lateral). **Capsules** enclosed in involucre that are grouped in stalked carpocephala; foot well developed, seta short, capsule enclosed in or barely exerted from involucre, at maturity splitting into several irregular valves; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

Unlike all of our other Marchantiales, the carpocephala of *Marchantia polymorpha* develop whether the archegonia are fertilized or not, so sterile carpocephala are often seen in this species.

4. Conocephalaceae Müller Frib. ex Grolle

Thalli 40-200 x 8-22 mm, branching dichotomous; upper surface flat, dorsal pores simple, cells adjacent to them with thin walls; air chambers much broader than high, densely packed with filaments, primary chambers not subdivided by secondary walls; ventral scales in 2 regular rows, with well-differentiated appendages; brood-bodies absent. **Antheridia** in well-differentiated sessile receptacles terminating the short branch of a dichotomy (often appearing lateral). **Capsules** enclosed in involucre that are grouped in stalked carpocephala; foot well developed, seta short, capsule barely exerted from involucre, at maturity splitting into several irregular valves; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

5. Targioniaceae Dumort.

Thalli 9-22 x 1.5-4 mm, branching dichotomous and lateral-ventral; upper surface flat, dorsal pores simple, cells adjacent to them with walls never strongly thickened; air chambers much broader than high, densely packed with filaments, primary chambers not subdivided by secondary walls; ventral scales in 2 regular rows, with well-differentiated appendages; brood-bodies absent. **Antheridia** in well-differentiated sessile receptacles terminating short ventral branches. **Capsules** enclosed in solitary involucre on undersides of thallus apices; foot well developed, seta short, capsule enclosed in involucre, at maturity losing a small operculum, then splitting into several irregular valves; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

The structure of the involucre is typical for many Marchantiales, but their position, at the

thallus apex, is unusual. Published accounts of the spore dispersal mechanism in *Targionia* are not always correct; see Proskauer (1971) for an accurate description.

6. Aytoniaceae Cavers

Thalli 5-60(-90) x 1.5-17 mm, branching dichotomous, often also terminal- or lateral-ventral; upper surface flat or channelled, dorsal pores simple, not strongly raised, cells adjacent to them with thin to moderately thickened walls (rarely radial walls strongly thickened); air chambers much higher than broad, without filaments, primary chambers often partially or completely subdivided by secondary walls; ventral scales in 2 regular rows, with well-differentiated appendages; brood-bodies absent. **Antheridia** scattered, clustered or in well-differentiated, sessile receptacles, on upper surface of thallus or terminating short ventral branches. **Capsules** enclosed in involucre that are grouped in stalked carpocephala; foot well developed, seta short, capsule enclosed in involucre, at maturity losing an operculum; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

7. Cleveaceae Cavers

Thalli 5-20 x 1.5-7 mm, branching dichotomous; upper surface flat, dorsal pores simple, cells adjacent to them with radial walls thin to strongly thickened; air chambers much higher than broad, without filaments, primary chambers not subdivided by secondary walls; ventral scales irregularly scattered over thallus, tapering to slender apices that function as appendages but are not clearly set off from body of scale; brood-bodies absent. **Antheridia** clustered on upper surface of thallus. **Capsules** enclosed in involucre that are grouped in stalked carpocephala; foot well developed, seta short, capsule enclosed in involucre, at maturity splitting into several irregular valves; sterile cells in spore mass forming well developed elongate elaters with spiral wall thickenings.

8. Ricciaceae Reichenbach

Thalli 3-12 x 0.4-9 mm, branching dichotomous, rarely also lateral-ventral; upper surface flat, channelled, or with a narrow median groove, dorsal pores simple, often merely tiny gaps between undifferentiated epidermal cells, cells adjacent to them undifferentiated; air chambers isodiametric or much higher than broad, without filaments, primary chambers not subdivided by secondary walls; ventral scales irregularly scattered or in 1 row (then scales often rupturing behind apex so they appear to be in 2 rows on older parts of thallus), without differentiated appendages; brood-bodies absent. **Antheridia** scattered over upper surface of thallus. **Capsules** embedded in thallus, thallus surface over capsule undifferentiated; foot rudimentary or absent, seta absent, capsule embedded in thallus, at maturity indehiscent, spores released by decay of wall and surrounding gametophytic tissues; sterile cells in spore mass absent.

Sphaerocarpaceae

Gametophore either an erect, bilaterally compressed thallus with a well-defined cordlike rib along the ventral side or a prostrate, dorsiventrally compressed thallus bearing regular, succubous leaf-like lobes, branching dichotomous, without dorsal pores and air chambers, sometimes with small scalelike appendages on rib, rhizoids uniform, with thin, smooth walls without *Nostoc* colonies; sometimes with oblong or spatulate gemmae along ventral rib. **Antheridia** in cavities on margin of thallus or each in a bottle-shaped involucre on dorsal surface of thallus; each archegonium in a bottle-shaped involucre on midrib. **Capsules** remaining enclosed in the involucre, indehiscent, spores released by decay of wall and surrounding gametophytic tissues; sterile cells among spores small, thin-walled, more or less disappearing at maturity.

Unlike most liverworts, which are perennial, most Sphaerocarpaceae are ephemeral annuals of soil that is dry for long periods, persisting through long dry seasons as spores. Only *Geothallus* forms tubers and is perennial. The structure of the gametophores is very different in the two families, but the reproductive structures are similar, with an indehiscent capsule that remains

completely enclosed in the involucre, and sterile cells of the spore mass that do not develop into spiral elaters, but remain thin-walled and more or less break down at maturity.

9. Riellaceae Engler

Submerged aquatics, thalli erect, bilaterally compressed, thallus unistratose except for a well-defined cordlike rib along the ventral side, with small scalelike appendages on rib with small scales along ventral rib, gemmae along ventral rib, oblong or spatulate. **Paroecous or dioecous**. **Antheridia** on main thallus in cavities on margin of thallus. **Female involucre**s on midrib; gametangia not crowded, not concealing thallus.

The structure of the gametophore of *Riella* is unique. It is the only thallose liverwort that is flattened laterally, not dorsiventrally; the wing is on the dorsal side of the axis only, so the thickened rib is not a midrib - it runs down the ventral edge, not the middle, of the thallus. Because of the habitat, *Riella* is seldom collected except by phycologists and limnologists who are in the habit of culturing soil samples from sites that are dry for long periods but seasonally submerged.

10. Sphaerocarpaceae Heeg

Terrestrial, thalli prostrate, dorsiventrally compressed, consisting of a flat multistratose central thallus bearing regular, succubous leaf-like lobes that are unistratose without scales, gemmae none, without. **Dioecious**, male plants smaller than female. **Antheridia** dorsal on main thallus segment each in a bottle-shaped involucre on dorsal surface of male thallus. **Female involucre**s dorsal on main thallus segments; thallus ± concealed beneath crowded involucre.

Sphaerocarpos is a common ephemeral annual in California. Plants grow and fruit rapidly on soil, then persist through unfavorable seasons as spores. The structure of the gametophore in Sphaerocarpaceae is hard to interpret, since the main body of the gametophore is very condensed and almost totally hidden beneath the crowded involucre, but its aspect (a tight cluster of inflated involucre, almost completely hiding the rest of the plant) is very distinctive, and it is easily recognized once its appearance is learned.

Fossombroniales

Gametophore thallose or leafy, with leaves in two ranks, branching dichotomous and by adventitious branches from the underside of the midrib, without dorsal pores and air chambers, without ventral scales, rhizoids uniform, with thin, smooth walls, without *Nostoc* colonies; gemmae absent. **Antheridia** naked, subtended by small unistratose scales, or each in a blister-shaped cavity on dorsal surface of main thallus segments; archegonia on dorsal surface of thallus, scattered and naked or subtended by small unistratose scales or clustered with each cluster surrounded by an involucre. **Capsules** exerted from a tubular pseudoperianth or enlarged calyptra, splitting into valves or irregularly disintegrating; sterile cells among spores elongate, with spiral thickenings.

11. Fossombroniaceae Hazsl.

Codoniaceae H. Klinggräff

Thalli bright green, leafy, with a cord-like, fleshy stem and unistratose leaves in two ranks, without strong internal cell differentiation, branching dichotomous, underside without ventral scales or *Nostoc* colonies, without gemmae. **Paroecous**, gametangia dorsal on main thallus segments; antheridia naked or subtended by small unistratose scales; archegonia naked or subtended by small unistratose scales; sporophyte protected by a unistratose, tubular-campanulate to funneliform pseudoperianth. **Capsule** spherical, dehiscing irregularly, without fixed elaters; spores unicellular when shed, with thick sculptured walls.

12. Pelliaceae H. Klinggräff

Thalli dark green, thallus unlobed, without a well-defined midrib, center of thallus thick, rather opaque, thinning gradually to the rather broad unistratose margins, without strong internal cell

differentiation, branching dichotomous, underside without ventral scales or *Nostoc* colonies, without gemmae. **Paroecous or dioecious**, gametangia dorsal on main thallus segments; antheridia each in a blister-shaped cavity; archegonia clustered, each cluster surrounded by a complete or incomplete tubular involucre; sporophyte protected by a well-developed calyptra, pseudoperianth absent. **Capsule** spherical, splitting into four valves, sessile elaters numerous, basal; spores germinating precociously, multicellular at time of release.

13. Pallaviciniaceae Mig.

Thalli bright green, thallus unlobed, unistratose except for a sharply well-defined, cordlike midrib, with a well-defined central strand of narrow conducting cells, branching dichotomous and by adventitious branches from the underside of the midrib, underside without ventral scales or *Nostoc* colonies, without gemmae. **Dioecious**, gametangia dorsal on main thallus segments; antheridia subtended by small unistratose scales; archegonia clustered, each cluster surrounded by a ring of partially fused scales forming an involucre; sporophyte protected by a long, cylindrical pseudoperianth surrounding an enlarged calyptra. **Capsule** cylindrical, splitting into valves, without fixed elaters; spores unicellular when shed, their walls rather thin and delicate.

Metzgeriales

Gametophore thallose, branching regularly or irregularly pinnate and sometimes also dichotomous, without dorsal pores and air chambers, without ventral scales, rhizoids uniform, with thin, smooth walls, without *Nostoc* colonies; gemmae often present, either 1-2-celled or discoid and unistratose, endogenous, from thallus surface or margins. **Antheridia** naked on dorsal surface of short lateral or ventral branches; archegonia naked on dorsal surface of short lateral or ventral branches. **Capsules** exerted from an enlarged calyptra, splitting into valves; sterile cells among spores elongate, with spiral thickenings.

The order Metzgeriales long included all of the liverworts that are thallose outside of the Marchantiales and Sphaerocarpaceae. This was widely recognized as a paraphyletic or polyphyletic group (Proskauer 1965), but the paucity of morphological characters in the simple thalli and the high levels of morphological homoplasy prevented any agreement on the relationships of the families. DNA sequence data has made it clear that Metzgeriaceae s. lat. are related to Jungermanniales s. lat., Blasiaceae is related to Marchantiales, and the remaining Californian families form a distinct clade, here treated as Fossombroniales. Metzgeriales resemble the related order Jungermanniales s. lat. in the formation of lateral branches in the apical region, the 2-celled or unistratose gemmae, and the small, thin-walled spores.

The gemmae of Metzgeriales have an endogenous (endocellular) origin, with the protoplast of a cell rounding up and forming a new cell wall inside the old wall. In *Riccardia* the gemmae are shed while still 2-celled, while in *Metzgeria* these 1-2-celled gemmae germinate in situ and grow into unistratose discs before they are shed, but the structure is otherwise similar (Evans 1910 p. 299).

14. Aneuraceae H. Klinggräff

Thalli dark green, thallus unlobed, multistratose except for extreme margins, with midrib poorly defined or not defined, without strong internal cell differentiation, branching regularly or irregularly pinnate, underside without ventral scales or *Nostoc* colonies, gemmae often present, endogenous, from thallus surface, 1-2-celled. **Dioecious or autoecious**, gametangia dorsal on short lateral branches; antheridia naked; archegonia naked; sporophyte protected by a massive calyptra. **Capsule** cylindrical, splitting into four valves, each valve with a cluster of fixed elaters at its apex, sometimes on a long or short elaterophore; spores unicellular when shed, their walls thin and delicate.

15. Metzgeriaceae H. Klinggräff

Thalli bright green, thallus unlobed, unistratose except for a sharply well-defined, cordlike

midrib, without strong internal cell differentiation, branching dichotomous and with branches from underside of midrib, underside without ventral scales or *Nostoc* colonies, gemmae often present, endogenous, from thallus margins, discoid and unistratose. **Dioecious or autoecious**, gametangia dorsal on short lateral or ventral branches; antheridia naked; archegonia naked; sporophyte protected by a massive calyptra. **Capsule** cylindrical, splitting into four valves, each valve with a cluster of fixed elaters at its apex, sometimes on a long or short elaterophore; spores unicellular when shed, their walls thin and delicate.

Jungermanniales

Gametophore leafy, with leaves in two or three ranks, branches replacing half of a leaf or underleaf, or with adventitious branches from the sides or underside of the stem, without dorsal pores and air chambers, rhizoids uniform, with thin, smooth walls, without *Nostoc* colonies; gemmae often present, 1-2-celled, rarely discoid and unistratose, on margins of leaves (some exceptions to this outside California). **Antheridia** solitary or clustered in axils of modified leaves; archegonia at apex of stem, surrounded by a tubular structure formed by three fused leaves (perianth). **Capsules** exerted from a tubular perianth or a tubular outgrowth of the stem (perigynium), splitting into valves; sterile cells among spores elongate, with spiral thickenings.

This is by far the largest order in the liverworts. It is a very natural group, but some recent authors have split it into two or more orders (He-Nygrén et al. 2006, Crandall-Stotler et al. 2009).

16. Pseudolepicoleaceae Fulford & J.Taylor

Leaves transverse, plane, divided to base into several uniseriate filaments; underleaves similar to leaves, divided to base into several uniseriate filaments. **Rhizoids** scattered over ventral stem, more frequent near underleaves. **Branches** usually replacing ventral half of a leaf, or sometimes intercalary. **Gemmae** very rare, unicellular, smooth, at apices of leaf segments. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, cylindrical, almost smooth; perigynium absent.

This family is sometimes included in Trichocoleaceae.

17. Lepidoziaceae Limpr. in Cohn

Leaves incubous, plane, 3-4-lobed, entire; underleaves large, lobed. **Rhizoids** scattered over ventral stem. **Branches** either intercalary from axils of underleaves or replacing dorsal or ventral half of a leaf. **Gemmae** absent, asexual reproduction sometimes by caducous leaves. **Gynoeceium** on a short ventral branch; perianth well developed, weakly 3-angled, gradually narrowed to mouth; perigynium absent.

18. Lophocoleaceae Vanden Berghen in Robyns

Leaves succubous, plane, shallowly bilobed, sometimes merely retuse, entire; underleaves large, 2-lobed. **Rhizoids** confined to base of underleaf. **Branches** either intercalary or replacing ventral half of a leaf. **Gemmae** present in some species, usually unicellular, smooth, on margins of ordinary leaves. **Gynoeceium** terminal on an ordinary leafy branch, or on a short lateral branch; perianth well developed, sharply 3-angled, gradually narrowed to mouth; perigynium absent.

This group has been merged with Geocalycaceae by many authors, but recent DNA sequence data indicates that the two groups are not related (Hentschel et al. 2006).

19. Plagiochilaceae Müller Frib. & Herzog in Müller Frib.

Leaves succubous, plane, dorsal margin often reflexed, simple or very shallowly bilobed, spinose-toothed; underleaves absent. **Rhizoids** confined to rhizomes, where they are scattered over ventral stem. **Branches** intercalary, from leaf axils. **Gemmae** absent. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, dorsiventrally flattened, mouth wide; perigynium absent.

20. Cephaloziaceae Mig.

Leaves succubous, plane, bilobed, entire; underleaves large or absent, unlobed. **Rhizoids** scattered over ventral stem. **Branches** either intercalary from stem underside or replacing ventral half of a leaf. **Gemmae** seldom present, unicellular, smooth, at apices of stems and branches. **Gynoecium** on a short or long ventral branch; perianth well developed, cylindrical, weakly 3-angled, mouth only slightly narrowed; perigynium absent.

Recent molecular study (Vilnet et al. 2012) suggests that some adjustment to generic boundaries in the family may be necessary.

21. Cephaloziellaceae Douin

Leaves transverse or weakly succubous, plane or concave, bilobed, entire or toothed; underleaves present or absent, simple, seldom 2-lobed. **Rhizoids** scattered over ventral stem. **Branches** usually intercalary, seldom replacing ventral half of a leaf. **Gemmae** common, 1-2-celled, smooth or angulate, on ordinary leaves and sometimes underleaves. **Gynoecium** terminal on an ordinary leafy branch; perianth well developed, weakly plicate, mouth only slightly narrowed; perigynium absent.

The position of Cephaloziellaceae is uncertain. Until recently, Cephaloziaceae was generally considered a distant relative of Cephaloziaceae, but some chloroplast phylogenies have suggested that Cephaloziellaceae is closely related to Scapaniaceae (Hentschel et al. 2007, de Roo et al. 2007). There are many morphological similarities between Cephaloziellaceae and Scapaniaceae: the leaves are deeply lobed with a tendency for the lobes to be toothed, gemmae are normally 1-2-celled, in clusters from the tips of the lobes of scarcely-modified leaves on normal long shoots, with a tendency for the gemmae to be angulate in some species in both families; gametangia are on undifferentiated long branches, with a well developed perianth and no perigynium, so a possible relationship is plausible. However, the more thorough (chloroplast and ITS) study of Vilnet et al. (2012) places Cephaloziellaceae in an isolated position, sister to neither Cephaloziaceae nor Scapaniaceae.

22. Scapaniaceae Mig.

Lophoziaceae Schleich.

Leaves succubous, sometimes succubous ventrally and transverse or incubous dorsally, plane, concave, or folded, always lobed, entire or toothed; underleaves very rarely present on sterile shoot sectors. **Rhizoids** scattered over ventral stem. **Branches** sometimes intercalary from sides of stem, sometimes replacing ventral half of a leaf. **Gemmae** common, 1-2-celled, usually angulate, sometimes ellipsoidal, on margins of ordinary leaves. **Gynoecium** terminal on an ordinary leafy branch; perianth well developed, cylindrical and smooth or plicate or flattened, mouth wide or somewhat narrowed; perigynium absent.

Scapaniaceae was traditionally aligned with Jungermanniaceae and Gymnomitriaceae, and in fact *Leiocolea* was often considered a subgenus of *Lophozia*, but DNA sequence data indicates that the morphological similarities between these families are due to convergence, not close relationship (Hentschel et al. 2007, Vilnet et al. 2010), and various morphological characters support this alignment.

Scapania, with its complicate-bilobed leaves and strongly compressed perianth, has a very different aspect from *Lophozia* and its relatives. Traditionally, Scapaniaceae was restricted to the complicate-bilobed genera, with the others relegated to a paraphyletic family Lophoziaceae. In fact, the two groups intergrade completely through *Douinia* and *Diplophyllum* (with complicate-bilobed leaves and terete or weakly compressed perianths), and there are no grounds for recognizing two families. Within the broadly defined family, relationships are obscure, and there is no agreement on generic boundaries. Both morphological and DNA characters are conflicting and clearly homoplasious, and it seems unlikely that any natural classification will arrive in the near future.

A possible relationship between Scapaniaceae and Cephaloziellaceae is discussed above. De

Roo et al. (2007) shows Cephaloziellaceae arising from within a paraphyletic Scapaniaceae, but this study shows some very unlikely relationships (two accessions of *Jungermannia exsertifolia* come out in different families [Jungermanniaceae and Gymnomitriaceae] and *Lophocolea bidentata* comes out sister to with *Calypogeia*, very remote from other *Lophocolea* species). Their hypothesis of a paraphyletic Scapaniaceae s. lat. with Cephaloziellaceae arising from it has little statistical support in their study, and is contradicted by other studies (Hentschel et al. 2007, Vilnet et al. 2012, Feldberg et al. 2013). The wholesale erection of new taxa (including a new family Anastrophyllaceae L. Söderstr., De Roo & Hedd. nom. nud.) by Söderström et al. (2010) based solely on de Roo et al.'s chloroplast tree is unwarranted.

23. Myliaceae Schljakov

Leaves succubous, plane, unlobed, entire; underleaves present, undivided. **Rhizoids** scattered over ventral stem, more frequent near leaf and underleaf bases. **Branches** replacing ventral half of a leaf. **Gemmae** present, 1-2-celled, smooth, on margins of lanceolate, acute leaves. **Gynoecium** terminal on an ordinary leafy branch; perianth well developed, bilaterally compressed, mouth broad; perigynium absent.

Mylia was traditionally included in Jungermanniaceae, but DNA sequence data suggests that its position is very isolated.

24. Calypogeiaceae Arnell in Holmberg

Leaves incubous, plane, simple or very shallowly bilobed, entire; underleaves large, 2-lobed. **Rhizoids** confined to base of underleaf. **Branches** either intercalary from axils of underleaves or replacing ventral half of a leaf. **Gemmae** present, 1-2-celled, ellipsoidal, on reduced leaves at attenuated shoot apices. **Gynoecium** on a short ventral branch; perianth absent; perigynium a deep marsupium.

Families 24-29 were not placed together traditionally, but molecular data puts them all on the same clade, and this treatment is supported by morphological characters. Most taxa in these families lack gemmae; when present, gemmae are confined to ascending shoots with highly differentiated leaves. Many members of this clade have a perigynium, formed by fusion of the bracts and perianth, a structure that is not known in other leafy liverworts. Capsules with spiral valves are also known only from this clade. Within the clade, however, relationships among the major groups are poorly resolved (Hentschel et al. 2006, 2007, He-Nygrén 2007, Feldberg et al. 2009), so family definitions are still very much in flux.

25. Geocalycaceae H. Klinggräff

Leaves succubous, plane, shallowly bilobed, entire; underleaves present, divided almost to base into 2 lanceolate lobes. **Rhizoids** scattered over ventral stem, sometimes more frequent near underleaves. **Branches** intercalary from axils of underleaves. **Gemmae** none. **Gynoecium** on a short ventral branch; perianth absent; perigynium a deep marsupium.

Geocalycaceae is a group of only five small genera (*Geocalyx*, *Harpanthus*, *Saccogyna*, *Notoscyphus*, and *Saccogynidium*). In molecular analyses, their position relative to each other and relative to related families is either completely undefined or without statistical support (Hentschel et al. 2006, 2007, He-Nygrén 2007, Feldberg et al. 2009; sequence data is currently available only for *Geocalyx*, *Harpanthus*, and *Saccogyna*). Since these genera have various morphological characters in common, I am tentatively retaining the family, but when adequate data is available these genera may have to be incorporated in Jungermanniaceae or placed in more than one family. Only one species from this group is known from California.

26. Jungermanniaceae Reichenbach

Delavayellaceae R. M. Schuster

Leaves succubous, plane, simple or apex truncate or weakly emarginate, entire; underleaves present or absent, entire or divided for less than half their length. **Rhizoids** scattered over ventral

stem. **Branches** sometimes intercalary from sides of stem, sometimes replacing ventral half of a leaf. **Gemmae** absent in most taxa, when present few-celled, smooth, on erect gemmiparous branches. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, cylindrical, smooth or plicate, mouth very narrow, often abruptly beaked; perigynium absent.

27. Gymnomitriaceae H. Klinggräff

Solenostomataceae Stotler & Crand.-Stotl.

Leaves succubous, plane or concave, simple or shallowly bilobed with a narrow sinus, entire or finely serrulate; underleaves small or absent, . **Rhizoids** scattered over ventral stem. **Branches** sometimes intercalary from sides of stem, sometimes replacing ventral half of a leaf. **Gemmae** none. **Gynoeceium** terminal on an ordinary leafy branch; perianth large or small, cylindrical, usually somewhat plicate distally, mouth narrow; usually with a well-developed perigynium.

28. Gyrothyraeaceae R. M. Schuster

Leaves succubous, plane, simple, entire; underleaves large, 2-lobed. **Rhizoids** confined to edges of cushion-shaped masses of differentiated cells on ventral stem. **Branches** infrequent (except below perianth), intercalary, from sides of stem. **Gemmae** occasionally produced, unicellular, spherical, on erect gemmiparous branches. **Gynoeceium** on a short ventral branch; perianth reduced, tubular, hidden in bracts; perigynium a deep marsupium.

29. Antheliaceae R. M. Schuster

Leaves transverse, concave, bilobed, entire; underleaves similar to leaves, bilobed. **Rhizoids** scattered over ventral stem, more frequent near underleaves. **Branches** usually replacing ventral half of a leaf, or sometimes ventral and intercalary. **Gemmae** absent. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, cylindrical, deeply plicate, mouth broad; perigynium absent.

30. Ptilidiaceae H. Klinggräff

Leaves incubous, plane, unequally 3-4-lobed, ciliate; underleaves large, deeply lobed and ciliate. **Rhizoids** scattered over ventral stem. **Branches** replacing ventral half of a leaf. **Gemmae** absent. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, cylindrical, \pm plicate, narrowed to mouth; perigynium absent.

Families 28-32 are often now segregated as a separate order, Porellales.

31. Porellaceae Cavers

Leaves with dorsal lobe incubous, lobule succubous, lobe plane, with a small lobulefolded under the lobe, lobule attached to stem but not to lobe, lobe entire, lobule often ciliate; underleaves large, unlobed. **Rhizoids** scattered over ventral stem. **Branches** replacing ventral half of a leaf. **Gemmae** absent. **Gynoeceium** on a short lateral branch; perianth well developed, dorsiventrally compressed, sometimes with 2-3 additional keels on ventral face, mouth broad or narrowed; perigynium absent.

32. Frullaniaceae Lorch in G.Lindau

Leaves with dorsal lobe incubous, lobule succubous, lobe plane, with a small tubular or helmet-shaped lobule folded under the lobe, lobule attached to lobe but not to stem, entire; underleaves large, 2-lobed. **Rhizoids** scattered over ventral stem. **Branches** replacing ventral half of a leaf. **Gemmae** absent. **Gynoeceium** terminal on an ordinary leafy branch (often a lateral branch); perianth well developed, dorsiventrally compressed, sometimes with additional keels on ventral face, mouth abruptly contracted to a short beak; perigynium absent.

33. Radulaceae Müller Frib.

Leaves with dorsal lobe incubous, lobule succubous, lobe plane, with a small lobule folded

under the lobe, lobule attached to stem and lobe, entire; underleaves absent. **Rhizoids** confined to center of lobule. **Branches** adventitious from immediately behind the leaf. **Gemmae** present in some species, multicellular, discoid, on margins of ordinary leaves. **Gynoeceium** terminal on an ordinary leafy branch; perianth well developed, dorsiventrally flattened, mouth broad; perigynium absent.

Anthocerotales - Hornworts

Gametophore thallose; underside of thallus having stomates with 2 guard cells opening into mucilage cavities that harbour *Nostoc* colonies. **Plastids** solitary (seldom few) per cell, plastids in some taxa with well-defined pyrenoids. **Venter of archegonium** embedded in thallus.

Sporophyte cylindrical, without a seta, sporangium growing continuously by a basal meristem; sporangial wall having stomates with 2 guard cells; columella present along axis of capsule.

Spores continuously ripening along length of capsule; pseudoelaters without spiral thickenings (in California taxa) forming a network in intact capsules, breaking up into pieces as spores are shed, pseudoelaters when shed 1-several-celled, irregular in shape, sometimes branched.

Hornworts bear a superficial resemblance to liverworts when they are sterile, but the two groups are completely unrelated, and the sporophyte of hornworts is completely different in its structure and development from sporophytes of any other group of plants.

34. Anthocerotaceae Dumort.

Notothyladaceae K. Müll.

Thalli dark green, unlobed or shallowly and irregularly lobulate, without a well-defined midrib, center of thallus thick, rather opaque, thinning gradually, multistratose almost to margin, without strong internal cell differentiation but with internal mucilage cavities, branching dichotomous, underside without ventral scales, with stomates opening into small internal mucilage cavities hosting *Nostoc* colonies, without gemmae. **Paroecous or dioecous**, gametangia dorsal on main thallus segments; antheridia solitary or clustered in blister-shaped cavities; archegonia solitary, embedded in thallus, sporophyte protected by a tubular involucre that develops after fertilization. **Capsule** elongate, hornlike, splitting into two valves, pseudoelaters with smooth walls; spores unicellular when shed, spore walls thin and tough to thick and deeply sculptured.

The hornworts are sometimes divided into two families, with *Anthoceros* remaining in Anthocerotaceae and *Phaeoceros* and *Phymatoceros* removed to a separate family Notothyladaceae (Milde) Müll. Frib. ex Prosk., but the level of morphological and molecular divergence is rather low to justify family recognition.

Indices

Index 1. Alphabetical list of families, with family number:

- Aneuraceae - 14.
- Antheliaceae - 29.
- Anthocerotaceae - 34.
- Aytoniaceae - 6.
- Blasiaceae - 1.
- Calypogeiaceae - 24.
- Cephaloziaceae - 20.
- Cephaloziellaceae - 21.
- Cleveaceae - 7.
- Conocephalaceae - 4.
- Fossombroniaceae - 11.

Frullaniaceae - 32.
 Geocalycaceae - 25.
 Gymnomitriaceae - 27.
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 Jungermanniaceae - 26.
 Lepidoziaceae - 17.
 Lophocoleaceae - 18.
 Lunulariaceae - 2.
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 Myliaceae - 23.
 Pallaviciniaceae - 13.
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 Plagiochilaceae - 19.
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 Ptilidiaceae - 30.
 Radulaceae - 33.
 Ricciaceae - 7.
 Riellaceae - 9.
 Scapaniaceae - 21.
 Sphaerocarpaceae - 10.
 Targioniaceae - 5.

Index 2. Alphabetical list of genera found in California, with current family placement, followed (in parentheses) by placement in earlier versions of Whittemore's checklist, and in Doyle and Stotler (2006), if different:

Anastrophyllum - 22. Scapaniaceae (formerly Lophoziaceae)
Aneura - 14. Aneuraceae (sometimes Metzgeriaceae)
Anthelia - 29. Antheliaceae
Anthoceros - 34. Anthocerotaceae
Asterella - 6. Aytoniaceae
Athalamia - 7. Cleveaceae
Barbilophozia - 22. Scapaniaceae (formerly Lophoziaceae)
Bazzania - 17. Lepidoziaceae
Blasia - 1. Blasiaceae
Blepharostoma - 16. Pseudolepicoleaceae (sometimes Trichocoleaceae)
Calypogeia - 24. Calypogeiaceae
Cephalozia - 20. Cephaloziaceae
Cephaloziella - 21. Cephaloziellaceae
Chiloscyphus - 18. Lophocoleaceae (formerly Geocalycaceae)
"Chiloscyphus" gemmiparus - 26. Jungermanniaceae (formerly Geocalycaceae)
Clevea - 7. Cleveaceae
Conocephalum - 4. Conocephalaceae
Cryptomitrium - 6. Aytoniaceae
Diplophyllum - 22. Scapaniaceae
Douinia - 22. Scapaniaceae
Fossombronia - 11. Fossombroniaceae (formerly Codoniaceae)
Frullania - 32. Frullaniaceae
Geocalyx - 25. Geocalycaceae

Geothallus - 10. Sphaerocarpaceae
Gymnocolea - 22. Scapaniaceae (formerly Lophoziaceae)
Gymnomitrium - 27. Gymnomitriaceae
Gyrothyra - 28. Gyrothyraceae
Jungermannia - 26. Jungermanniaceae
Kurzia - 17. Lepidoziaceae
Leiocolea - 26. Jungermanniaceae (formerly Lophoziaceae)
Lepidozia - 17. Lepidoziaceae
Liochlaena - 26. Jungermanniaceae (sometimes Delavayellaceae)
Lophocolea - 18. Lophocoleaceae (formerly Geocalycaceae)
Lophozia - 22. Scapaniaceae (formerly Lophoziaceae)
Lunularia - 2. Lunulariaceae
Macrodiplophyllum - 22. Scapaniaceae
Mannia - 6. Aytoniaceae
Marchantia - 3. Marchantiaceae
Marsupella - 27. Gymnomitriaceae
Metzgeria - 15. Metzgeriaceae
Mylia - 23. Myliaceae (formerly Jungermanniaceae)
Nardia - 27. Gymnomitriaceae (formerly Jungermanniaceae, sometimes Solenostomataceae)
Pallavicinia - 13. Pallaviciniaceae
Pellia - 12. Pelliaceae
Phaeoceros - 34. Anthocerotaceae (sometimes Notothyladaceae)
Phymatoceros - 34. Anthocerotaceae (sometimes Notothyladaceae)
Plagiochila - 19. Plagiochilaceae
Pleurocladula - 20. Cephaloziaceae
Porella - 31. Porellaceae
Preissia - 3. Marchantiaceae
Ptilidium - 30. Ptilidiaceae
Radula - 33. Radulaceae
Reboulia - 6. Aytoniaceae
Riccardia - 14. Aneuraceae (sometimes Metzgeriaceae)
Riccia - 8. Ricciaceae
Ricciocarpos - 8. Ricciaceae
Riella - 9. Riellaceae
Rivulariella - 26. Jungermanniaceae
Scapania - 22. Scapaniaceae
Solenostoma - 27. Gymnomitriaceae (formerly Jungermanniaceae, sometimes Solenostomataceae)
Sphaerocarpus - 10. Sphaerocarpaceae
Targionia - 5. Targioniaceae

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