

A CHECKLIST AND PRELIMINARY KEY TO THE LIVERWORTS OF NEW MEXICO

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ABSTRACT

A checklist and preliminary key are presented for the 89 species of liverworts that have been reported from New Mexico. It is hoped that this information will serve to stimulate interest in these fascinating little plants.

INTRODUCTION

The bryophyte lineage is comprised of mosses, liverworts, and hornworts. Liverworts, also known as hepaticae due to the superficial resemblance of some of them to the mammalian liver, would seem to be poorly adapted to life in the arid southwest. However, this is only partially true, and this report describes the surprising diversity of liverworts in New Mexico.

There are three basic morphologies of liverworts: leafy, simple thalloid, and complex thalloid (Hicks 1992; Schofield 1985, Vanderpooten & Goffinet 2009). Although leafy liverworts superficially resemble mosses, they can be distinguished by visual and microscopic examination. The leaves of leafy liverworts are basically in the same plane as the stem, whereas in mosses, the leaves are arranged radially around the stem. Liverwort leaves virtually never have a mid-vein (costa); mid-veins are found in a majority of moss leaves. Liverwort leaves are often divided into multiple lobes; this characteristic is rare in mosses. Most leafy liverworts have microscopic oil bodies within their cells, which can be important in species identification; mosses never contain oil bodies. Although oil bodies can be transient and are best examined in fresh specimens, they often persist for months in specimens collected from arid environments.

Thalloid liverworts are comprised of elongate thalli instead of leaves and stems. Simple thalloid liverworts have an undifferentiated thallus which is quite thin, often only one cell thick. Simple thalloid liverworts are very uncommon in New Mexico. Complex thalloid liverworts have thick fleshy thalli whose cross-sections show differentiated layers with air pores. They are generally drought tolerant (Schuster 1992a), and some are widespread in New Mexico.

METHODS

We reviewed the existing literature on New Mexico liverworts (Arsene 1933; Bird 1960; Evans 1922; Frye and Clark 1937-1947; Guerke 1971; Hong 1989; Hong 1992; Ireland et al. 1981; Little 1937; Little 1942; Prior 1969; Romig 2012; Shields 1954; Standley 1915; Standley 1916; Stark & Casstetter 1982, Whittemore 1995; Worthington 2001). Bryophyte databases (Southwest Environmental Information Network, Consortium of North American Bryophyte Herbaria) were searched. We standardized the nomenclature but did not confirm the identity of reported specimens.

The taxonomy of hepaticae currently is in a state of flux. The taxonomy used here is basically that of Doyle and Stotler, 2006, with the exception that the Lophoziaceae are listed as their own family, instead of being included with the Scapaniaceae. The Lophoziaceae are not complex bilobed liverworts, whereas the Scapaniaceae are.

Using species descriptions in the literature, as well as specimens collected by us (most deposited in the Dale

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Botanice est Scientia Naturalis quae Vegetabilium cognitioem tradit.

— *Linnaeus*



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A. Zimmerman Herbarium, SNM, at Western New Mexico University), we developed a dichotomous key to the liverworts reported from New Mexico. A few species which have not been reported from New Mexico, but are expected, have been included. It is noted that this key is at best preliminary, and readers are encouraged to report questions or corrections to the authors.

Pictures or photographs are not presented here. Photographs of the species we have collected are in Allred et al. (2018) and at our website www.gilafloora.com.

RESULTS

A preliminary checklist of the liverworts of New Mexico and the Gila National Forest was presented at the 4th Symposium on the Natural History of the Gila in 2012 (Blisard and Kleinman 2015). At that time, approximately 73 species of liverworts were known from New Mexico. Since then, reference to additional species have been found in the literature, and four species new to the state have been found. A few species have been removed from the list, because they are not currently recognized as distinct taxa (ie *Lophozia confertifolia* Schiff.).

We were able to identify a total of 89 species in 23 families for which there is relatively good evidence that these taxa were collected in New Mexico. These are listed in the checklist (Table 1), along with documentation (literature references, or specimen identity of those taxa listed in digital databases). We have not confirmed the identity of specimens which were not collected by us.

Since the publication of the previous checklist (Blisard and Kleinman 2015), we have collected three species new to the state. *Geocalyx graveolens* (Schrad.) Nees was collected at El Malpais National Monument. *Riccia atromarginata* Levier was collected at Carlsbad Caverns National Park, and also within the city of Carlsbad (Kleinman et al, 2020). It is interesting to note that both of these specimens were collected after a period of seasonal flooding, in areas which had been visited on several other occasions. It is characteristic of *R. atromarginata* that it is inconspicuous when dry, but more obvious when wet. *Fossombronina pusilla* (L.) Nees was finally found in a reproductive state, so could be identified to species from the spores. In addition, a fourth species new to the state (*Frullania mexicana* Lindenb.) was reported by Attwood (2017).

Finally, dichotomous keys to the liverwort families (Table 2) and the liverwort species (Table 3) reported from New Mexico are presented. We have included selected species which are not known to occur in New Mexico, but might be expected here; they are marked with an asterisk (*). At the end are tables of characteristics which are helpful in the identification of the genera *Frullania* (Table 5), *Lophozia* (Table 6), *Scapania* (Table 7), and *Riccia* (Table 8).

DISCUSSION

This checklist shows considerable diversity in the liverwort population of New Mexico. This diversity is perhaps not surprising in view of the size of our state (121,697 square miles) and the rich diversity of habitats. Habitats include Chihuahuan desert scrubland, found in arid regions at lower elevations (860-1676 m, 2840-5500 ft). At moderate elevations (1676-2133 m, 5500-7000 ft), pinon-juniper-oak forests and mixed conifer forests predominate. At higher elevations, Ponderosa pine forest (2133-2743m, 7000-9000 ft) and spruce-fir forests (above 2743 m, 9000 ft) occur. Riparian habitats are located adjacent to water courses, and bogs are found in isolated areas.

Liverwort diversity in New Mexico is higher than that reported from nearby states: we found 89 species in New Mexico by literature review and our own collections. In contrast, 46 species have been reported from Nevada (Brinda et al. 2007), and 60 from Utah (Flowers 1961). The 142 species reported from California (Doyle and Stotler 2006) may represent that state's habitat diversity as well as a greater number of bryologists studying California liverworts. It seems likely that as more people study liverworts in New Mexico (and indeed, the entire southwest), more species will be identified.

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Botany is the natural science that transmits the knowledge of plants.

— *Linnaeus*



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TABLE 1
Updated Checklist of New Mexico Liverworts

Leafy

Blepharostomaceae

Blepharostoma trichophyllum (L.) Dumort. [Arsene 1933]

Cephaloziaceae

Cephalozia bicuspidata (L.) Dumort [Haydock 1905-0818 SIU]

Cephalozia lunulifolia (Dumort.) Dumort. [Shields 1954]

Cephalozia pleniceps (Aust.) Lindb. [Arsene 1933]

Odontoschisma denudatum (Nees) Dumort. [Prior 1969]

Odontoschisma prostratum (Sw.) Trevis [Prior 1969]

Cephaloziellaceae

Cephaloziella divaricata (Sm.) Schiffn. [Shields 1954, Stark & Castetter 1982]

Cephaloziella hampeana (Nees) Schiffn. ex Loeske [Shields 1954]

Cephaloziella rubella (Nees) Warnst. [McGregor 7477 NY]

Geocalyceae/Lophocoleaceae

Chiloscyphus/Lophocolea minor Nees [Arsene 1933]

Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.

[Worthington 25476 NY]

Chiloscyphus polyanthos (L.) Corda [Arsene 19037 NY]

Chiloscyphus rivularis (Schrad.) Hazsl. [Standley 1915, Arsene 1933]

Geocalyx graveolens (Schrad.) Nees [Kleinman & Blisard 2018-12-13-4 SNM]

Jubulaceae

Frullania bolanderi Austin [Standley 1914, Arsene 19021 Yale]

Frullania brittoniae A. Evans [Worthington 22248 UTEP]

Frullania eboracensis Gottsche [Standley 1915, Arsene 1933, Shields, 1954]

Frullania inflata Gottsche [Standley 1916, Arsene 1933, Stark & Castetter 1982]

Frullania mexicana Lindenb. [Atwood 2017]

Frullania pluricarinata Gottsche¹ [Hentschel et al. 2011, Worthington 32194 UNAF]

Frullania riparia Hampe ex Lehm. [Standley 1916]

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Jungermanniaceae

- Gymnocolea inflata* (Huds.) Dumort. [Romig VC144 MO]
Jamesoniella autumnalis (DC.) Stephani [Prior 1969]
Jungermannia atrovirens Dumort. [Romig 2012]
Jungermannia confertissima Nees [Prior 1969]
Jungermannia exsertifolia Stephani [Prior 1969]
Jungermannia hyaline Lyell [Arsene 1933]
Jungermannia leiantha Grolle [Worthington 30657 NY]
Jungermannia pumila With. [Prior 1969]
Jungermannia rubra Gotts. ex Underw. [Worthington s.n. UNM]
Jungermannia sphaerocarpa Hook. [Worthington 32667 UNM]

Lepidoziaceae

- Lepidozia reptans* (L.) Dumort. [Arsene 1933]

Lophoziaceae

- Barbilophozia attenuata* (Mart.) Dumort. [Mahler 8221 BRIT]
Barbilophozia barbata (Schreb.) Loeske [Arsene 1933]
Barbilophozia floerkei (F. Weber & D. Mohr) Loeske [Fry & Clark 1937-1947]
Barbilophozia hatcheri (A. Evans) Loeske [Shields 1954]
Barbilophozia lycopodioides (Wallr.) Loeske [Standley 1916, Arsene, 1933]
Leiocolea badensis (Goff. ex Rabenh.) Joerg [Arsene S3181 Yale]
Lophozia (Leiocolea) collaris (Mart.) Dumort. [Worthington 32621 NY]
Lophozia incisa (Schrad.) Dumort. [Arsene 1933]
Lophozia obtusa (Lindb.) A. Evans [Romig 2012]
Lophozia porphyroleuca (Nees) Schniffn. Evans [Allred 6719 COLO]
Lophozia ventricosa (Dicks.) Dumort.² [Worthington 30706 NYS]
Lophozia wenzelii (Nees) Stephani² [Buck 39716 NY; Worthington 30657 UNM]

Plagiochilaceae

- Plagiochila asplenoides* ssp. *porelloides* (Torr. ex Nees) R.M. Schust.³ [Arsene 1933]

Porrelaceae

- Porella cordaeana* (Huebener) Moore [Worthington 32690 NY]
Porella pinnata L. [Prior 1969]
Porella platyphylla (L.) Pfeiff.⁴ [Standley 1915, Arsene 1933, Stark & Castetter 1982]

Radulaceae

- Radula bolanderi* Gottsche [Guerke 1971]
Radula complanata (L.) Dumort. [Arsene 1933, Stark & Castetter 1982]

Scapaniaceae

- Scapania apiculata* Spruce [Arsene 1933]
Scapania curta (Mart.) Dumort. [Arsene 19080 NY]
Scapania cuspiduligera (Nees) Muell. Frib. [Shields 1954]
Scapania irrigua (Nees) Gott, Lindenb, Nees [Arsene 23334a Yale]
Scapania mucronata H. Buch. [Arsene 21313 Yale]
Scapania subalpina (Nees ex Lindenb.) Dumort. [Arsene 20304 NY]
Scapania undulata (L.) Dumort. [Arsene 1933]

Simple Thalloid

Blasiaceae

- Blasia pusilla* L. [Evans 1922]

Fossombroniaceae

- Fossombronia pusilla* (L.) Nees [Blisard & Kleinman 2018-9-4-1 SNM]

Metzgeriaceae

- Apometzgeria pubescens* (Shrank) Kuwah. [Shields 1954]
Metzgeria conjugata Lindb. [Arsene 1933]

Pelliaceae

- Pellia endiviifolia* (Dicks.) Dumort. [Worthington 32598 NY]
Pellia epiphylla (L.) Corda [Hermann 23958 F]

Complex Thalloid

Aytoniaceae

- Asterella gracilis* (F. Weber) Underw. [Ireland et al. 1981]
Asterella lindenberiana (Corda) Lindb. [Nelson & Porter 11501 RM]
Asterella palmeri (Austin) Underw. [Arsene 1933]
Mannia californica (Gottsche) L.C. Wheeler [Blisard & Kleinman 2012-2-23-1 SNM]
Mannia fragrans (Balb.) Frye & L. Clark [Standley 1916, Arsene 1933]
Mannia paradoxa R.M. Schust. [Schuster 1992b]
Mannia pilosa (Hornem.) Frye & L. Clark [Worthington 6927 NY]
Mannia sibirica (K. Mull.) Frye & Clark [Weber s.n. COLO]
Plagiochasma rupestre (G. Forst.) Stephani [Standley 1915, Arsene 1933, Little 1937, Stark & Castetter 1982]
Plagiochasma wrightii Sull. [Arsene 1933, Stark & Castetter 1982]
Reboulia hemisphaerica (L.) Raddi [Standley 1915, Arsene 1933]

Cleveaceae

- Athalamia hyalina* (Sommerf.) S. Hatt. [Shields 1954]

Conocephalaceae

- Conocephalum salebrosum* Szwedk., Buczkowska & Odrzykoski⁵ [Standley 1915, Arsene 1933]

Marchantiaceae

- Dumotiera hirsuta* (Sw.) Nees [Shields 1954]
Marchantia polymorpha L. [Standley 1915, Arsene 1933, Stark & Castetter 1982]
Pressia quadrata Corda [Cruchfield 587 COLO]

Oxymitraceae

- Oxymitra paleacea* Bisch. [Prior 1969]

Ricciaceae

- Riccia albolimbata* S.W. Arnell [Worthington 34182 NY]
Riccia atromarginata Levier [Blisard, Kleinman & West 2017-9-30-1 SNM]
Riccia campbelliana M. Howe [Worthington 32691 NY]
Riccia cavernosa Hoffm. [Little 1942]
Riccia crystallina L. [Lee 101 Yale]
Riccia frostii Austin [Arsene 1933, Little 1937]
Riccia lamellosa Raddi [Little 1942, Weber B14684 COLO]
Riccia membranacea Gottsche & Lindenb. [Arsene 1933]
Riccia sorocarpa Bisch. [Little 1942]

Targioniaceae

- Targionia hypophylla* L. [Shields 1954]

Notes

¹This species was identified by molecular methods (Hentschel et al. 2009).

²*Lophozia confertifolia* has been deleted, as it appears to



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not be a discrete species but rather a form of *L. ventricosa* or *L. wenzelii*,

³ According to Hong, this is the only subspecies that occurs in NM (Hong 1992).

⁴ *Porella platyphylla* (L.) Pfeiff. and *Porella platyphylloidea* (Schwein.) Lindb. appear to be examples of so-called "cryptic" species, that cannot be differentiated solely on the basis of morphologic characteristics but require molecular studies for species identification (Therrien et al. 1998; Heinrichs et al. 2011). Both these species are being included under *P.*

platyphylla.

⁵ *Conocephalum conicum* L. and *Conocephalum salebrosum* Szweyk., Buczkowska & Odrzykoski have been separated by morphologic criteria and molecular methods. According to these authors, *C. salebrosum* is the species which occurs in North America (Szweykowski et al. 2005).

Where a herbarium name is listed, the information was obtained from CNABH.

TABLE 2
Key to the Liverwort Families of New Mexico

Note: Families with an asterisk (*) have not been documented for New Mexico, but are reasonably expected to be in the state (Aneuraceae, Antheliaceae, Calypogeiaceae, Gymnomitraceae, Lunulariaceae)

Preliminary Key

- 1 Plants leafy, forming stems and leaves, leaves one cell thick, without costa..... **Key A**
- 1 Plants thallose or ribbon-like, not forming stems or leaves
 - 2 Plants ribbon-like with distinct mid-rib and thin lamina, or with ruffled leaf-like lobes and purple rhizoids, or thallose and translucent **Key B**
 - 2 Plants thallose and opaque, multiple cells thick, with air pores, rhizoids and/or scales present on ventral surface **Key C**

Key A. Plants leafy

- 1 Plants simple, not complicate-bilobed (see below)
 - 2 Plants small, leaves divided nearly to base into thin fronds one cell thick **Blepharostomaceae**
 - 2 Plants with other morphology (ovate, lanceolate, lobed, etc.)
 - 3 Leaf insertion incubous, ie the upper (nearer the apex of the shoot) edge of the leaf overlaps the lower edge of the leaf above it
 - 4 Leaves with 4 lobes, underleaves (an accessory leaf attached directly to the stem) with 4 lobes also **Lepidoziaceae**
 - 4 Leaves entire, underleaves present **Calypogeiaceae***
 - 3 Leaf insertion succubous, ie the lower (farther from the apex of the shoot) edge of the leaf overlaps the upper edge of the leaf below it, or leaf insertion transverse
 - 5 Leaves entire or sometimes 2-lobed
 - 6 Underleaves present, bilobed with lateral teeth **Geocalyceaceae**
 - 6 Underleaves vestigial or inapparent
 - 7 Leaves entire, rhizoids dense **Jungermanniaceae**

- 7 Leaf edges toothed, rhizoids scattered **Plagiochilaceae**
- 5 Leaves two, three, or four lobed
 - 8 Plants very small (generally 1.5mm wide or less)
 - 9 Stem cortex with large clear cells (hyalodermis); leaves without oil bodies, ie small opaque intracellular storage bodies **Cephaloziaceae**
 - 9 Stem cortex without hyalodermis; oil bodies present **Cephaloziellaceae**
 - 8 Plants larger (generally larger than 1.5mm wide)
 - 10 Leaves with 2-4 lobes, underleaves inapparent or absent in most species **Lophoziaceae**
 - 10 Leaves with 2 lobes, underleaves present or absent
 - 11 Underleaves present, similar in size and shape to leaves **Antheliaceae***
 - 11 Stems erect, underleaves absent **Gymnomitraceae***
- 1 Plants complicate-bilobed, ie one lobe lying over the other, forming a distinct keel
 - 12 Dorsal lobe smaller, ventral lobe larger **Scapaniaceae**
 - 12 Dorsal lobe larger, ventral lobe smaller
 - 13 Underleaves absent **Radulaceae**
 - 13 Underleaves present
 - 14 Underleaves entire, shoots pinnately branching **Porellaceae**
 - 14 Underleaves bilobed **Jubulaceae**

Key B. Plants ribbon-like or thallose and translucent

- 1 Plants with ruffled thalli, appearing leaf-like, with purple rhizoids **Fossombroniaceae**
- 1 Plants thalloid or ribbon-like
 - 2 Thallus margins ruffled, with colonies of blue-green algae at bases of lobes, and often with flask shaped gemmae receptacles **Blasiaceae**
 - 2 Thalloid margins mostly plain, no blue-green algae or gemmae receptacles
 - 3 Plants linear, ribbon-like, with distinct mid-rib, hair-like rhizoids on margin of thallus **Metzgeriaceae**
 - 3 Plants thalloid, no or indistinct mid-rib

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- 4 Plants very large (as much as 1.5cm wide, 5cm long), with little branching..... **Aneuraceae***
- 4 Plants medium sized (5-10mm wide, 2-4cm long), with extensive lobation **Pelliaceae**

Key C. Plants thallose and opaque

- 1 Thalli ribbon-like, often forming rosettes
 - 2 Thalli forming rosettes, with spongy surface and medial indentations **Ricciaceae**
 - 2 Thalli scattered or aggregated into partial rosettes, lateral ventral scales prominent **Oxymitraceae**
- 1 Plants with fleshy thalli, with or without observable air pores
 - 3 Thalli large (2-4 cm long, 5-10 mm wide, or more
 - 4 Thalli very large with distinctly areolate surface due to prominent white air pores, carpocephalum cone shaped **Conocephalaceae**

- 4 Thalli large, air pores less prominent but still conspicuous
 - 5 Thalli with crescent-shaped gemmae cups **Lunulariaceae***
 - 5 Gemmae cups absent or, if present, round **Marchantiaceae**
- 3 Thalli small to medium (1-2 cm long, 2-5 mm wide)
 - 6 Thalli roll up into tubes when dry, ventral scale usually purple **Aytoniaceae**
 - 6 Thalli do not roll up when dry
 - 7 Ventral scales hyaline and curl around thallus apex, carpocephalum dorsal **Cleveaceae**
 - 7 Thalli with sporangium covered by black involucre at dorsal thallus apex **Targioniaceae**

TABLE 3

Preliminary Key to the Liverwort Species of New Mexico, by Family

Note: The following species are not yet documented for New Mexico, but are included in the keys: *Anthelia julacea/juratzkana* (Limpr.) Trevis., *Anuera pinguis* (L.) Dumort., *Lunularia cruciata* (L.) Dumort., *Riccia beyrichiana* Hampe ex Lehm., *Riccia ciliata* Hoffm., *Riccia dorsiverrucosa* Hassel, *Riccia glauca* L., *Riccia hirta* (Austin) Underw., & *Riccia nigrella* DC

LEAFY LIVERWORTS

Note: Individual species that have not been described in New Mexico are marked (*).

ANTHELIACEAE: A single taxon present in New Mexico: *Anthelia julacea* (*juratzkana* *)

BLEPHAROSTOMACEAE: A single taxon present in New Mexico: *Blepharostoma trichophyllum*

CEPHALOZIACEAE

- 1 Leaves 2-lobed, stems with hyalodermis (large pellucid cells on the outside of the stem)
 - 2 Leaves ovate, divided about 1/2 with two erect acute lobes, gemmae rare *Cephalozia bicuspadata*
 - 2 Leaves orbicular, divided about 1/4, gemmae at apices of short shoots common
 - 3 Plants smaller (0.4-0.6 mm), stolons rare *Cephalozia lunulifolia*
 - 3 Plants more robust (1-1.4 mm), fleshy, stolons common *Cephalozia pleniceps*
- 1 Leaves entire, no hyalodermis, large granular oil bodies
 - 4 Gemmae present on apices of small shoots, cell contours round *Odontoschisma denudatum*
 - 4 Gemmae rare, cell contour irregular *Odontoschisma prostratum*

CEPHALOZIACEAE

- 1 Underleaves present *Cephalozia divaricata*
- 1 Underleaves absent, or scarce
 - 2 Plants with reddish-brown pigmentation, leaf lobes 3-5 cells wide at base *Cephalozia rubella*
 - 2 Plants green, leaf lobes 6-12 cells wide at base *Cephalozia hampeana*

GEOCALYCACEAE/LOPHOCOLEACEAE

- 1 Leaves bilobed, with abundant gemmae *Chiloscyphus (Lophocholea) minor*
- 1 Leaves mostly entire or occasionally bilobed
 - 2 Leaves bilobed, inserted longitudinally, underleaves bilobed *Geocalyx graveolens*
 - 2 Leaves entire or shallowly bilobed, underleaves 2-4 lobed, rhizoids restricted to bases of underleaves
 - 3 Plants yellow-green, cells measure 35-60u, 4-8 oil bodies/cell *Chiloscyphus pallescens*
 - 3 Plants dark green, cells measure 18-35u, 2-4 oil bodies per cell
 - 4 Not aquatic *Chiloscyphus polyanthos*
 - 4 Occurs on submerged stones in streams *Chiloscyphus rivularis*

Note: *C. rivularis* may be just a variant of *C. polyanthos*

JUBULACEAE

- 1 Lobule larger than one-half the size of the lobe, plant very small *Frullania bolanderi*
- 1 Lobule smaller than one-half the size of the lobe
 - 2 Underleaves entire, less than twice the width of the stem *Frullania eboracensis*
 - 2 Underleaves twice the width of the stem or greater
 - 3 Underleaves 3-4 times the width of the stem, plants relatively large *Frullania riparia*
 - 3 Underleaves 2-3 times the width of the stem
 - 4 Cell walls wavy *Frullania brittoniae*

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- 4 Cell walls smooth to slightly wavy
- 5 Proximal lobule not expanded, underleaves deeply divided *Frullania inflata*
- 5 Proximal lobules narrowly triangular, underleaves shallowly bifid *Frullania mexicana*

Note: *Frullania pluricarinata* is determined by molecular methods.

JUNGERMANNIACEAE

- 1 Leaves bilobed *Gymnocolea inflata*
- 1 Leaves unlobed
 - 2 Gynoecial bracts (which are nearly always present) lancinate (irregularly cut into narrow lobes *Jamesoniella autumnalis*
- 2 Bracts (present or absent) not lancinate *Jungermannia*

Jungermannia

- 1 Leaves usually oblong with parallel edges *J. leiantha*
- 1 Leaves various shapes, but not oblong with parallel edges
 - 2 Rhizoids developing only from stem tissue
 - 3 Plants large, median leaf cells large with brown/black cell walls, rhizoids few, hyaline... *J. exsertifolia*
 - 3 Plants smaller, rhizoids numerous
 - 4 Typical plants with broadly ovate leaves, oil bodies 2-3 per cell, dioicous *J. atrovirens*
 - 4 Typical plants with elliptical/ovoid leaves, oil bodies 4-5 per cell, paroicous *J. pumila*
 - 2 Rhizoids developing from both stem tissue and (at least some) leaf bases
 - 5 Leaves long decurrent on stem surface; leaf shape semi-circular with widest part near the base of the leaf *J. hyalina*
 - 5 Leaves not or short decurrent on stem surface; leaf shape circular or reniform, with widest part of leaf near middle
 - 6 Leaves reniform, rhizoids in clusters arising from both stem and leaf bases, clusters closely appressed to the stem *J. confertissima*
 - 6 Leaves nearly circular, rhizoids not in clusters but many oriented perpendicular to the stem *J. sphaerocarpa*

Notes: 1) Key to *Jungermannia* species adapted from Doyle and Stotler (2006). 2) It may be impossible to distinguish vegetative forms of *J. atrovirens* from *J. pumila*.

LEPIDOZIACEAE: A single taxon present in New Mexico: *Lepidozia reptans*

LOPHOZIACEAE

- 1 Leaves mostly 2 lobes *Lophozia*
- 1 Leaves mostly 3-4 lobed
 - 2 Leaves mostly 3 lobed, lobes unequal *Tritomaria**

- 2 Leaves generally 3-4 lobed, lobes equal *Barbilophozia*

Barbilophozia

- 1 Leaves mostly 3 lobed, shoots erect
 - 2 Underleaves prominent *B. floerki*
 - 2 Underleaves inapparent *B. attenuata*
- 1 Leaves mostly 4 lobed
 - 3 Underleaves 2 lobed, with occasional cilia, leaves without apiculi *B. barbata*
 - 3 Leaves with apiculi, underleaves with prominent cilia
 - 4 Leaves with small apiculi, usually with abundant red-orange gemmae *B. hatcheri*
 - 4 Leaves with elongate apiculi, prominent cilia on leaf bases, no gemmae *B. lycopodioides*

Lophozia

- 1 Underleaves generally present, gemmae absent or rare
 - 2 Underleaves small and lanceolate; lobes acute often with small apiculi *L. (Leiocolea) collaris*
 - 2 Underleaves sometimes large, consisting of long narrow lobes; lobes with obtuse apex *L. obtusa*
- 1 Underleaves generally absent
 - 3 Uppermost leaves transversely inserted, crowded, forming a cabbage-like head; leaves three-lobed; lobes asymmetric *L. incisa*
 - 3 Leaves do not form a cabbage-like cluster
 - 4 Bases of rhizoids and leaves reddish-tinged; cells collenchymatous (thick-walled) with bulging trigones; lobes incurved *L. porphyroleuca*
 - 4 Leaves and rhizoids not reddish-tinged, cells not collenchymatous
 - 5 Plants very small (less than 1mm wide), leaf cells relatively large (compared to size of plant), cell walls very thin, trigones essentially absent *L. badensis*
 - 5 Plants larger (greater than 1mm wide), cell walls not thin
 - 6 Leaves saucer-shaped, concave towards stem apex *L. wenzelii*
 - 6 Leaves not incurved or saucer-shaped, green gemmae abundant *L. ventricosa*

Notes. 1) *Lophozia confertifolia*, which has been described in collections from New Mexico, appears not to be a real species, but instead a variant form of *L. wenzelii* or *L. ventricosa* (according to Schuster). 2) This abbreviated key applies ONLY to species which have been described in New Mexico.

PLAGIOCHILACEAE: A single taxon present in New Mexico: *Plagiochila asplenoides* ssp. *porelloides*

PORELLACEAE

- 1 Positive (blue/purple) reaction with iodine potassium-iodide (IKI, Lugol's iodine) *P. cordeana*
- 1 Negative reaction with IKI

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- 2 Underleaves narrow, not decurrent, found on wet rocks subject to inundation*P. pinnata*
- 2 Underleaves wider than stem, with arched line of insertion, decurrent, found on bark and rocks not subject to inundation, very common.....*P. platyphylla*

RADULACEAE

- 1 Dorsal lobe inner margin adnate to stem, apical region does not overlap stem, gemmae absent, rhizoids scarce, single oil body nearly filling the cell lumen *R. bolanderi*
- 1 Dorsal lobe inner margin not adnate to stem, apical region overlaps stem, gemmae often present on leaf margins rhizoids abundant, single oil body filling about half the cell lumen*R. complanata*

SCAPANACEAE - *Scapania*

- 1 Ventral lobe decurrent to stem
 - 2 Dorsal and ventral lobes unequal (dorsal lobe less than 0.65 size of ventral lobe) *S. undulata*
 - 2 Dorsal and ventral lobes subequal (dorsal lobe 0.75 size of ventral lobe, or greater)
 - 3 Plants small (1-2.5mm wide)..... *S. cuspiduligera*
 - 3 Plants large (2-4mm wide)*S. sublpina*
- 1 Ventral lobe not decurrent to stem
 - 4 Plants with distinct border of 1-3 rows of cells with thick cell walls*S. curta*
 - 4 Plants without border; laminal cells generally collenchymatous (have bulging trigones)
 - 5 Plants large (2-4mm wide)*S. irrigua*
 - 5 Plants very small to small (0.6 to 2.5mm wide)
 - 6 Apices of both lobes sharp; oil bodies small
.....*S. apiculata*
 - 6 Apex of ventral lobe obtuse with a single cell at tip (occasionally mucronate).....*S. mucronata*

Note: This abbreviated key applies ONLY to species which have been described in New Mexico. If additional species are found (which seems likely), additional sources, such as Schuster's work, will need to be consulted.

SIMPLE THALLOUS LIVERWORTS

ANEURACEAE: A single possible taxon in New Mexico:
*Aneura pinguis**

BLASIACEAE: A single taxon present in New Mexico:
Blasia pusilla

METZGERIACEAE

- 1 Small green to yellow-green thalli, with hairs singly or in pairs, along margin or on ventral midrib, monoecious, often fertile, with sex organs arising from ventral surface *Metzgeria conjugata*
- 1 Small grayish-green thalli with numerous small hairs on both dorsal and ventral surfaces.....
..... *Apometzgeria (Metzgeria) pubescens*

FOSSOMBRONIACEAE A single taxon present in New Mexico: *Fossombronia pusilla*.

PELLIACEAE

- 1 Thalli with short slime papillae (2 cells) on the ventral surface near apex; thallus cross-sections show thickening bands near the mid-rib*P. epiphylla*
- 1 Thalli with longer slime hairs (4-8 cells) on the apical ventral surface; thallus without thickening bands near mid-rib.....*P. endiviifolia*

COMPLEX THALLOUS LIVERWORTS

AYTONIACEAE

- 1 When dry, thalli do not curl up and thus appear brownish; sporangium arises from dorsal midline not at apical notch..... *Plagiochasma*
- 1 When dry, thalli curl up into blackish tubes; sporangium arises from apical notch
 - 2 Carpocephalum with white or purple pseudoperianth below cap, comprised of thin white linear segments*Asterella*
 - 2 Carpocephalum without such pseudoperianth
 - 3 Carpocephalum noticeably lobed, ventral scales with narrow purple appendages, base and apex of carpocephalum with white filiform scales ...*Reboulia*
 - 3 Carpocephalum not or barely lobed, ventral scales with hyaline appendages*Mannia*

Asterella

- 1 Carpocephalum strongly conical, thallus margin brown-black to purple.....*Asterella palmeri*
- 1 Carpocephalum nearly hemispheric
 - 2 Dorsal surface with red lateral margin; red-purple ventral surface, spores yellow *A. gracilis*
 - 2 Spores purple *A. lindenberiana*

Note: *Asterella gracilis* is considered to be a species of *Mannia* by some authors.

Mannia

- 1 Thalli scarcely branched, not expanded distally; androecia diffuse near terminal end of leading segment
- 2 Thalli with apical cluster of white scales, ventral scales with 2-3 hyaline appendages*M. fragrans*
- 2 Thalli without apical cluster of white scales; ventral scales with 1-2 purplish acuminate appendages.....
..... *M. californica*
- 1 Thalli freely branching, often expanded distally, androecia in the form of circular discs
 - 3 Androecial discs not on ventral branches, carpocephalum stalk with beard of purplish filaments (apparently only known from Carlsbad Caverns Nat. Park).....*M. paradoxa*
 - 3 Androecial discs on ventral branches
 - 4 Air spaces scarcely subdivided, ventral scales without oil bodies*M. pilosa*

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- 4 Air spaces somewhat subdivided, ventral scales with oil bodies.....*M. sibirica*

Plagiochasma

- 1 Thalli bright green, shiny, scales with cordate appendages, pores surrounded by 2-3 concentric rows of cells *P. wrightii*
 1 Thalli glaucous (dull) gray-green, scales with triangular appendages, pores surrounded by single row of cells
*P. rupestre*

Reboulia : A single species in New Mexico: *R. hemispherica*

CLEVEACEAE: A single taxon present in New Mexico: *Athalamia hyalina*

CONOCEPHALACEAE: A single taxon present in New Mexico: *Conocephalum salebrosum*

LUNULARIACEAE: A single taxon present in New Mexico: *Lunularia cruciata** not currently known from New Mexico

MARCHANTIACEAE

- 1 Very large thalli without observable air pores, ventral scales, or gemmae; with white scales on margin
 *Dumortieria hirsuta*
 1 Thalli surface with observable surface air pores
 2 Large thalli with distinct pores and colorless scales, round gemmae cups, and carpocephalum umbrella-like with ray-like arms *Marchantia polymorpha*
 2 Large thalli with purple ventral scales; carpocephalum 4-lobed*Preissia quadrata*

OXYMITRACEAE: A single taxon present in New Mexico: *Oxymitra paleacea*

RICCIACEAE - *Riccia*

- 1 Plants generally grow in a specialized (ie xeric, alluvial, aqueous, see below) environment
 2 Plants generally associated with an aqueous environment
 3 Plants grow in an alluvial environment
 4 Plants annual, growing in rosettes, thallus segments nearly parallel, male plants have red (magenta or purple) pigments in their walls.....
*R. frostii*
 4 Plants annual, short-lived, very thin and flat, nearly translucent..... *R. membranacea*
 3 Plants grow in a seasonally moist environment, and

may be very difficult or impossible to find when they are dry

5 Plants growing in hemi-rosettes, color light gray/green/yellow, dorsal surface spongy . *R. cavernosa*

5 Plants gregarious, color deep blue-green, lateral margins blackish-purple, short straight cilia often numerous on lateral margins and dorsal surface.....
*R. atromarginata*

2 Plants generally grow in a xeric environment

6 Thallus margins densely ciliate *R. ciliata**

6 Thallus margins not densely ciliate

7 Thalli of dry plants roll up into vermiform tubes, margins colored

8 Plants bluish-green, thalli with granular surface, margins chestnut*R. dorsiverrucosa**

8 Plants tiny, deep green, with black/purple margins*R. nigrella**

7 Thalli of dry plants do not roll up, margins whitish

9 Ventral scales extend beyond thallus margin, forming whitish border..... *R. lamellosa*

9 Ventral scales extend beyond thallus margin, encrusted with calcium, chalk white when dry.....
 *R. albolimbata*

1 Plants grow in diverse environments

10 Thalli with short cilia

11 Plants perennial, thalli large and pale green, with crowded short hyaline cilia on margins.....
*R. beyrichiana**

11 Thalli grayish or blue-gray, with sparse apical cilia*R. hirta**

10 Thalli with no short cilia

12 Thalli glaucous green, with short median furrow ...
*R. glauca**

12 Thalli not glaucous green with median furrow

13 Thalli bright green with hyaline margins, surface epidermis often sloughed leaving a granular surface..... *R. sorocarpa*

13 Gray-green thalli showing marked contrast with pink/yellow/orange margins.... *R. campbelliana*

Notes: Although some species of *Riccia* not currently known from New Mexico (marked *) have been included in this key, no attempt has been made to be exhaustive in the list of possible species of *Riccia*. In cases where a new state recorded is suspected, another source will need to be consulted. Also, cross sections are critical, and spore morphology helpful, in the identification of *Riccia* species. Other sources, such as Schuster's excellent work, should be consulted for this information.

TARGIONIACEAE: A single taxon present in New Mexico: *Targionia hypophylla*.



Table 5. Characteristics of *Frullania* species.

Species	Habitat	Color	Size	Lobule	Underleaves	Cell walls	Sex	Perianth	Oil bodies	Other
<i>bolanderi</i>	bark rock (unc)	green brown-black	small 0.5-0.7mm	gal/expl >1/2 lobe	<2x stem few teeth		dioicous		7 to 9	erect branches w/o leaves
<i>brittoniae</i>	bark rock (unc)	dark green brown-geen	medium 0.8-1.5mm	gal/expl l=w <1/2 lobe	2-3x stem dentate	wavy	dioicous	rough	4 to 7	
<i>eboracensis</i>	bark	red-brown green	medium 0.8-1mm	gal/expl l=w <1/2 lobe	<2x stem entire	wavy	dioicous	smooth	2 to 4	
<i>inflata</i>	bark rock	dark green brown-geen	medium 0.8-1.3mm	infl/gal/expl <1/2 lobe	2-3x stem entire	smooth	monoicous		3 to 5	marginal/ medial cells similar size
<i>mexicana</i>	bark	green red-purple- brown	medium 0.8-1.2mm	prox portion narrowly triangular	2-3x stem shallowly bifid	wavy	autoicous	≥8 keels	3 to 5	differentiated marginal/ medial cells
<i>riparia</i>	rock	green dark green	large 1.5-2mm	expl/infl w>l <1/2 lobe	3-4x stem	sl wavy	dioicous		5 to 8	

Abbreviations: unc=uncommon; gal=galeate, hooded lobule; expl=explanate, flat lobule; infl=inflated, expanded lobule.

Table 6. Characteristics of *Lophozia* species.

Species	Size	Insertion	Underleaves	Leaves	Lobes	Cell walls	Oil bodies	Gemmae	Misc
<i>badensis</i>	very small 0.5-0.8 x 3-10	horizontal	none	flat cells relatively large	subequal	very thin no trigones	moderate ellipsoid	none	<i>Leiocolea</i>
<i>collaris</i>	small 1-2 x 8-30	transverse	small, lanceolate	spreading broadly ovate	subequal, acute 2-cell apiculus	thin trigones small	2-5, large, ovoid granular	none	<i>Leiocolea</i>
<i>incisa</i>	very small 1.3-1.6 x 4-10	transverse	none	fleshy, opaque upper leaves crowd- ed crispate head	variable 2-3 asymmetric acute	thin trigones absent	numerous, tiny common	green	upper leaves crowded
<i>obtusa</i>	medium 1.5-2.5 x 20- 50	oblique almost horizon- tal	large	quadrate	ovoid, obtuse	thin small trigones	numerous minute	rare	
<i>porphyroleuca</i>	small 1-1.5 x 10-20	subtransverse	none	oblong, rectangular	incurved triangular	thick collenchyma- tous bulging trigones	few variable size and shape	rare	often reddish tinged on decaying wood often with capsules
<i>ventricosa</i>	variable 0.8-3 x 10-50	oblique	none	variable lobes not incurved	sl subequal bluntly acute	moderately thick bulging trigones	variable	abundant greenish	very variable
<i>wenzelii</i>	small 1.2-1.6 x 10- 40	oblique, dense	none	cupped/saucer shaped concave towards stem	equal, blunt incurved	thin small concave trigones	4-9, variable some large	common pale green	boggy or swampy ground

Table 7. Characteristics of *Scapania* species.

Species	Decurrent	Size of plant	Dorsal vs ventral lobe	Margin	Ventral lobe	Keel length ¹	Oil bodies
<i>apiculata</i>	no	very small 0.6-1.2mm	unequal 0.65-0.75	collenchymatous	leaves entire sharp apex	0.6-0.75	small
<i>cuspiduligera</i>	yes	small 1-2.5mm	subequal	border of thick walled cells	apex rounded	0.6-0.75	large
<i>curta</i>	no	small 1.3-2.5	unequal 0.45-0.65	border of thick walled cells	apex rounded dorsal lobe pointed	0.45-0.65	small
<i>irrigua</i>	no	large 2-4.5	unequal 0.5-0.6	collenchymatous	apex pointed	0.35-0.5	small
<i>mucronata</i>	no	small 1.2-2.5mm	unequal 0.5	collenchymatous	leaves entire obtuse, 1 cell at apex	0.5	large fill lumen
<i>subalpina</i>	yes	large 2-4mm	subequal 0.65-0.8	border of thick walled cells	dentate apex round	0.5-0.65	small
<i>undulata</i>	yes	large 2-4mm	unequal 0.35-0.64	border of thick walled cells	ventral lobe dentate dorsal lobe entire red-purple pigment	0.25-0.5	small

¹compared to ventral lobe



Table 8. Characteristics of *Riccia* species.

Species	Environment	Habit	Rosette	Persistence	Color	Thallus	Thallus	Ventral	Misc
<i>albolimbata</i>	xeric	hemi-rosettes rarely gregarious	15-20mm	perennial	chalk white when dry	deep dorsal sulcus only at apex	1.5-2mm w	large colorless	scales extend beyond thallus margin, Ca-encrusted
<i>atromarginata</i>	seasonally moist	gregarious			deep blue-green	well-defined dorsal groove, lateral margin blackish-purple		small purple	cilia sometimes numerous; often on dorsal surface
<i>beyrichiana</i> *	diverse	large rosettes	18-22mm	perennial vigorous	whitish yellow-green		1.8-3mm 2 2-6mm long	small hyaline	crowded short hyaline cilia on margins
<i>campbelliana</i>	diverse	hemirosettes			green/br margins pink or yellow	strongly divergent angles; surface minutely reticulate deep dorsal sulcus	1-3mm w 2-8mm long	hyaline	scales don't exceed margin
<i>cavernosa</i>	seasonally moist	hemi-rosettes	8-20mm	annual short-lived	light green gray/ yellow	dorsal surface areolate, spongy	1.5-2.5mm w	none	crystallina very similar
<i>ciliata</i> *	xeric	rosettes or gregarious			light to gray-green	margins densely ciliate		small hyaline to dark	unmistakable
<i>dorsiverrucosa</i> *	xeric	gregarious semi-submerged in substrate			bluish-green	sharp dorsal groove chestnut margins	1-1.2mm w 3-8mm l	small hyaline	epidermis collapses granular surface dry plants curl up
<i>frostii</i>	alluvial disturbed	rosettes	7-20mm	annual	gray-green	male plants with red wall pigments	1-2mm w 4-10mm l	none	segments nearly parallel
<i>glauca</i> *	diverse	rosettes			glaucous green	med sulcus short	1.5-2.3mm w 5-10mm ling	colorless delicate	
<i>hirta</i> *	diverse	rosettes to gregarious			grayish blue-gray	med furrow narrow, shallow	1-1.5mm w 2-4mm long	small	apices sparingly hirsute
<i>lamellosa</i>	xeric	gregarious			light	deep dorsal groove	2.5-3.5mm w 5-12mm l	large hyaline	scales extend beyond thallus margin, forming whitish border
<i>membranacea</i>	riverine alluvial	rosettes or gregarious		annual short-lived	translucent	flat, very thin	2-3mm w 3-6mm l	none	submerged sporangium
<i>nigrella</i> *	xeric	rosettes gregarious	5-8mm		deep green black/ purple margins	deep dorsal sulcus	0.6-1.3mm w 2-8mm l	red/purple black	dry plants curl up tiny
<i>sorocarpa</i>	diverse	rosettes (hemi)	<15 mm	perennial	bright green	margins hyaline deep dorsal furrow	0.8-1.8mm w 4-7mm l	hyaline	epidermis collapses