

## Key to British and Irish bryophytes

### Key to Sections

1. a. Plant a thallus (no clear differentiation into stem and leaves)..... Section 1 (thalloids)  
b. Plant foliose (clearly differentiated into stem and leaves).....2 (leafies)
2. a. Leaves irregularly-shaped, arranged in 3 rows with no differentiation into lateral leaves and underleaves; shoots erect from a branched subterranean rhizome; rhizoids absent..... *Haplomitrium hookeri*  
b. Leaves  $\pm$  regularly-shaped, arranged in two opposing lateral rows, with or without an additional row of underleaves; subterranean rhizome absent; rhizoids present.....3.
3. a. Leaves unlobed, with no sign of any flaps, sacs or pockets, but often with marginal teeth ..... 4.  
b. Leaves divided into 2 or more lobes; lobes sometimes asymmetrical, one lobe modified into a flap, a 'sac' or a 'pocket' .....5.
4. a. Plant lacking underleaves..... Section 2.  
b. Plant with underleaves.....Section 3.
5. a. Leaves *deeply* divided (*to near base*) into 2-4(-6) lobes, each lobe only 1-4 cells wide at base, *or* leaf margins with  $\pm$  abundant long cilia, making plant look  $\pm$  fluffy..... Section 4.  
b. Leaves more shallowly divided into 2 or more lobes (3-)4-9 cells wide at base; leaves sometimes toothed, but not ciliate, except sometimes for a few cilia at extreme base.,.....6.
6. a. Leaves  $\pm$  symmetrical, divided into two or more  $\pm$  *similar* lobes, with no modification into a 'pocket' or 'sac' ..... 7.  
b. Leaves asymmetrical, either (i)  $\pm$  complicate-bilobed; leaf lobes very unequal, one clearly smaller than the other, or (ii) very asymmetrically tribobed, or (iii) modified into a 'pocket' or 'sac' .....8.
7. a. Plant lacking underleaves..... Section 5.  
b. Plant with underleaves.....Section 6.
8. a. Plant lacking underleaves..... Section 7.  
b. Plant with underleaves.....Section 8.

## Section 1 - Thallose liverworts & hornworts

### Key to Sections

1. a. Plants forming thin (usually 1 cell thick) rosettes <20mm in diameter, *which are ± covered with conspicuous, very inflated pear-shaped or balloon-like involucre*s; spores permanently united in tetrads; rare, but sometimes locally abundant on cultivated ground..... 2.  
b. Plants forming thicker thallus, *lacking inflated involucre*s; spores usually free (rarely in tetrads); habitat various.....3.
2. a. Spore tetrads with alveolae 10-18(-20) µm wide, and smooth lamellae with spines at the angles..... *Sphaerocarpos michelii*  
b. Spore tetrads with alveolae 16-30 µm wide, and papillose lamellae without spines.....*Sphaerocarpos europaeus*
3. a. Plants forming dark or bright green rosettes or mats on soil; dark spots (colonies of *Nostoc* cyanobacteria) embedded in thallus.....4.  
b. Colour and habitat various; dark spots of *Nostoc* colonies absent.....7.
4. a. Thallus with a poorly-defined costa; stellate gemmae directly on surface and globose gemmae on flask-shaped receptacles; thallus cells with multiple chloroplasts; sporophytes typical of liverworts (capsules ellipsoid splitting into four segments to release spores)..... *Blasia pusilla*  
b. Thallus lacking costa and gemmae; thallus cells each with a single large chloroplast; sporophytes long-cylindrical, lacking a capsule, splitting longitudinally to release spores.....5. (hornworts - Anthocerotales)
5. a. Thallus ± flat, not deeply incised, scarcely translucent; spores yellow..... *Phaeoceros laevis*<sup>1</sup>  
b. Thallus irregularly and deeply lobed and crisped, partially translucent; spores black.....6.
6. a. Thallus usually large, 1-3 cm in diameter; antheridial bodies 60-85 x 104-150 µm; habitat various..... *Anthoceros punctatus*  
b. Thallus usually small, 0.6-1.5 cm in diameter; antheridial bodies 45-56 x 56-88 µm; usually in arable fields..... *Anthoceros agrestis*
7. a. Thallus 'frilly', often looking like miniature lettuces or cabbages because of leaf-like lobes or lamellae.....8.  
b. Thallus ± flat, without leaf-like lobes or lamellae, and not looking like lettuces or cabbages.....16.

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<sup>1</sup> *Phaeoceros carolinianus* is monoicous (*P. laevis* is monoicous), and is a rarer, southern, species.

8. a. Dorsal surface of thallus with numerous wide,  $\pm$  parallel lamellae; usually growing from fleshy underground axes in dune slacks.....*Petalophyllum ralfsii*  
b. Dorsal surface of thallus without wide  $\pm$  parallel lamellae; usually without fleshy underground axes; habitat various.....9.
9. a. Rhizoids hyaline or pale brown.....*Fossombronia husnotii*  
b. Rhizoids purple or dark red.....10.
10. a. Plants small, forming  $\pm$  circular rosettes 2-5 mm in diameter; spores 22-32  $\mu\text{m}$ ,  $\pm$  united in tetrads.....*Fossombronia incurva*<sup>2</sup>  
b. Plants larger, forming circular to elongate straggling rosettes or patches 5-25 mm long; spores 30-64  $\mu\text{m}$ , free.....11.
11. a. Spores with tubercles or papillae; elaters with 3-5 spiral bands.....*Fossombronia caespitiformis*  
b. Spores with lamellae, sometimes reticulate; elaters with 2 spiral bands.....12.
12. a. Spores entirely reticulate.....13.  
b. Spores with lamellae,  $\pm$  parallel-sided in places.....14.
13. a. Spore margin with a  $\pm$  continuous wing 4-8  $\mu\text{m}$  wide; alveolae 8-16  $\mu\text{m}$  wide; south-western, coastal.....*Fossombronia angulosa*  
b. Spore margin with a narrow irregular wing; alveolae 8-12  $\mu\text{m}$  wide; widely distributed on acid soils, particular by water.....*Fossombronia foveolata*
14. a. Spores with numerous thin lamellae, appearing at the margin as 26-35 spines/tubercles.....*Fossombronia wondraczekii*  
b. Spores with fewer, thicker lamellae, appearing at the margin as 15-24 spines/tubercles.....15.
15. a. Spores with 15-19 marginal spines/tubercles; costa slender, not fleshy; generally distributed.....*Fossombronia pusilla*  
b. Spores with 19-24 marginal spines/tubercles; costa thick, fleshy; south-western, coastal.....*Fossombronia maritima*
16. a. Dorsal surface of thallus with pores (appearing as pale spots, often within a reticulate pattern of areolae, at least towards thallus apex or margins) or otherwise perforated with holes<sup>3</sup>.....17.  
b. Dorsal surface of thallus without pores, areolae or perforations,  $\pm$  smooth.....26.

<sup>2</sup> *Fossombronia fimbriata* is also very small, with the 'leaves' deeply dissected and fimbriate, so the thallus looks like a tiny fluffball; it is apparently rare, but probably also overlooked.

<sup>3</sup> The rare oceanic species *Dumortiera hirsuta* has only very rudimentary pores near the apex of the thallus; the dark green thallus is faintly wrinkled/reticulate and has sparse marginal hairs.

17. a. Thallus with ultimate branches < 3 mm wide; either compact, often ± circular patches or rosettes on soil, or aquatic/semi-aquatic straggling plants.....18.  
 b. Thallus with ultimate branches > 3 mm wide; if borderline, then growing in open sunny places on walls, rocks & earth banks.....20.
18. a. Plant straggling, with long slender branches.....*Riccia fluitans*<sup>4</sup>  
 b. Plant forming compact, often ± circular rosettes.....19.
19. a. Ventral scales numerous, persistent, triangular to linear with serrate margins; plant floating free on surface of water, or on damp mud at water's edge.....*Ricciocarpos natans*  
 b. Ventral scales ephemeral, tiny or absent; plant forming compact, often ± circular patches or rosettes on soil, often near water.....*Riccia cavernosa*<sup>5</sup>
20. a. Thallus surface with discoid gemmae in special receptacles..... 21.  
 b. Gemmae lacking.....22.
21. a. Gemmae receptacles crecent moon-shaped.....*Lunularia cruciata*  
 b. Gemmae receptacles circular, cup-shaped.....*Marchantia polymorpha*<sup>6</sup>
22. a. Pores inconspicuous to naked eye, under the microscope with surrounding cells resembling the spokes of a wheel; numerous irregular air chambers in >1 layer, without basal filaments (TS).....*Reboulia hemisphaerica*  
 b. Pores conspicuous to naked eye, under the microscope with surrounding cells not resembling the spokes of a wheel; air chambers in 1 layer, with basal filaments (TS).....23.
23. a. Pores ± cross-shaped, compound, barrel-shaped in TS (pic?); plant not fragrant (but with hot taste!).....*Marchantia (Preissia) quadrata*<sup>7</sup>  
 b. Pores ± circular, simple, not barrel-shaped in TS (pic?); plant strongly fragrant.....24.
24. a. Small bright to grey-green plants with thallus braches usually <5 mm wide, strongly incurved when dry showing blackish undersurface; southern plant of open sunny places on walls, rocks & earth banks.....*Targionia hypophylla*<sup>8</sup>

<sup>4</sup> Two rarer species of *Riccia* may also key out here: *R. rhenana* has areolae 200-400 µm wide (60-200 µm in *R. fluitans*) and epidermal cells 36-56 µm wide (20-34 µm in *R. fluitans*); *R. canaliculata* is areolate only towards the thallus margins, and has the apex of the branches narrowed and covered by a curved ventral scale.

<sup>5</sup> Two rare species of *Riccia* may also key out here: *R. crystallina* is flatter and less divided, differs in spore anatomy, and is ± confined to the Isles of Scilly and West Cornwall; *R. huebeneriana* is usually tinged purple and liberates its spores ventrally (dorsally in *R. cavernosa*).

<sup>6</sup> There are three subspecies of *Marchantia polymorpha*: subsp. *polymorpha* has a ± continuous black line running along the middle of the thallus; subsp. *ruderalis* has the line interrupted or absent, and is a common species of ruderal habitats; subsp. *montivagans* lacks the line and occurs mainly in wet places in the uplands.

<sup>7</sup> *Marchantia polymorpha* lacking gemmae will also key out here, but is larger, usually has a blackish line down the middle of the thallus, and three rows of ventral scales on each side of the costa (only one in *M. quadrata*). There are also differences in habitat and general appearance.

<sup>8</sup> The small delicate thalli of *Clevea hyalina*, known from two sites in the Scottish Highlands, may key out here: it has conspicuously protruding ventral scales.

- b. Large bright green plants with thallus branches usually >5 mm wide, not becoming incurved when dry, not blackish below; common and generally distributed, often by streams or in other damp shaded places.....25.
25. a. Thallus shiny when dry, the lines between the pores inconspicuous, not sunken, so that the pale pores are much more noticeable than the divisions between them.....*Conocephalum conicum*  
 b. Thallus matt when dry, the lines between the pores conspicuous, dark and slightly sunken, much more noticeable than the pores themselves.....*Conocephalum salebrosum*
26. a. Thallus unistratose, with a well-defined multistratose costa, and unicellular marginal hairs; inflorescences on ventral surface of costa; common epiphytic or saxicolous plants.....27. (*Metzgeria*)  
 b. Thallus multistratose (or unistratose only at or towards margins), with costa poorly defined or absent; or, if unistratose with a well-defined costa, then wider (up to 7-12 mm) and lacking marginal hairs; inflorescences dorsal or marginal; habitat various.....32.
27. a. Dorsal surface of thallus densely hairy throughout .....*Metzgeria pubescens*  
 b. Dorsal surface of thallus hairless; hairs confined to margins and ventral surface.....28.
28. a. Thallus with attenuate branches bearing gemmae.....29.  
 b. Thallus without attenuate branches; gemmae, if present, scattered on thallus margins and ventral side of costa.....30.
29. a. Gemmae borne all around attenuate shoot apices, on costa and margins; costa of attenuate branches with 3-6 rows of epidermal cells; dry thallus developing blue colouration.....*Metzgeria violacea*  
 b. Gemmae restricted to margins of attenuate shoot apices; costa of attenuate branches with 2 rows of epidermal cells; dry thallus never developing blue colouration.....*Metzgeria consanguinea*
30. a. Marginal hairs strongly curved, hook-like, usually in pairs; oceanic species.....*Metzgeria leptoneura*  
 b. Marginal hairs  $\pm$  straight, single or in pairs; widespread.....31.
31. a. Thallus to 1.2 mm wide, plane, with marginal hairs single.....*Metzgeria furcata*  
 b. Thallus to 2 mm wide, often recurved at margins, with marginal hairs in pairs..... *Metzgeria conjugata*
32. a. Thallus white (lacking chlorophyll),  $\pm$  subterranean beneath *Sphagnum*, leaf litter, etc..... *Aneura mirabilis*  
 b. Thallus green, terrestrial.....33.

33. a. Plants small; thallus narrow, with ultimate branches <2 mm wide; costa completely absent (but sometimes with median groove running along dorsal surface of thallus)<sup>9</sup>.....34.  
 b. Plants larger; thallus wider, with ultimate branches >2 mm wide; costa ( $\pm$  poorly defined) often present; thallus never grooved dorsally.....42.
34. a. Plants forming small rosettes, dichotomously branched, with short branches, often with a  $\pm$  well developed median groove on the dorsal surface, at least near shoot apices; usually growing on disturbed soil.....35.  
 b. Plants elongate,  $\pm$  pinnately branched, with long slender branches; central groove absent, even at shoot apices; found in a wide variety of habitats.....38.
35. a. Median groove sharply acute and persistent over most of length of thallus.....*Riccia sorocarpa*<sup>10</sup>  
 b. Median groove acute only at extreme apex of thallus.....36.
36. a. Ultimate branches with thin apex and margins, not forming swollen ridges at the sides.....*Riccia glauca*  
 b. Ultimate branches with thick apex and margins, forming swollen ridges at the sides..... 37.
37. a. Ultimate branches 0.8-2.5 mm wide, with swollen lateral ridges 250-500  $\mu$ m wide; median groove often widening suddenly from near apex.....*Riccia beyrichiana*  
 b. Ultimate branches 0.3-1.2 mm wide, with swollen lateral ridges 120-350  $\mu$ m wide; median groove widening gradually from near apex.....*Riccia subbifurca*<sup>11</sup>
38. a. Oil bodies absent from all cells; ultimate branches short and wide with obliquely-oriented dorsal epidermal cells (so giving the impression that the branches are 'splaying out'); usually creeping through *Sphagnum* etc, or on peat.....*Riccardia latifrons*<sup>12</sup>  
 b. Oil bodies present, at least in internal cells of thallus; ultimate branches longer and thinner, with longitudinally-oriented dorsal epidermal cells (no impression of 'splaying out'); habitat various.....35.
39. a. Thallus branches with translucent unistratose margins 2-3 cells wide; oil bodies absent from nearly all marginal and epidermal cells.....*Riccardia multifida*  
 b. Thallus branches with inconspicuous unistratose margins 1-2 cells wide; oil bodies present in nearly all cells.....36.

<sup>9</sup> Beware apical 'autumnal branches' of *Pellia endiviifolia*! These always arise from the apices of much wider thalli, which have a poorly-defined costa. *Riccia fluitans* (and rarer relatives) and *Ricciocarpos natans* may also key out here if the pores on the dorsal surface are not readily visible (see above).

<sup>10</sup> The rare south-western species *Riccia nigrella* has a dark green thallus (pale in *R. sorocarpa*) and persistent and strongly pigmented ventral scales, making the ventral surface look  $\pm$  black, especially when drying out.

<sup>11</sup> *Riccia warnstorffii* has recently been recognised in Britain: it has a very shallow groove, and smaller spores (averaging 84  $\mu$ m v. 92  $\mu$ m in *R. subbifurca*) – see Berg *et al.* 2021 (*Field Bryology* 126). Two rare south-western species also key out here: *R. bifurca* has the thallus turning orange-brown with age; *R. crozalsii* usually has numerous long cilia curling over the very thick apex of the thallus.

<sup>12</sup> It is possible that *Riccia fluitans* and *R. rhenana* may key out here if the branching pattern has been misinterpreted: see below.

40. a. Thallus branches  $\pm$  erect and biconvex (TS); epidermal cells *ca.* 20-30 x 30-50  $\mu\text{m}$ ; on rotting logs and peat soils.....*Riccardia palmata*  
 b. Thallus branches  $\pm$  prostrate or procumbent and convex on upper surface; epidermal cells *ca.* 20-40 x 40-100  $\mu\text{m}$ ; habitat various.....37.
41. a. Thallus sparsely branched; branches canaliculate; thallus cells (TS) all about the same width.....*Riccardia incurvata*  
 b. Thallus richly branched; branches plane to slightly concave; thallus with epidermal cells narrower than internal cells (TS).....*Riccardia chamedryfolia*
42. a. Thallus thick, dark 'greasy' green, brittle, fleshy; no discernible costa present; never any reddish pigmentation present.....*Aneura pinguis*<sup>13</sup>  
 b. Thallus thinner and more delicate in texture, with a central poorly defined costa; some reddish pigmentation sometimes present.....43.
43. a. Costa well to fairly well defined; male and female sex organs all protected by a range of frilly structures (lamellae) on dorsal surface of thallus.....44.  
 b. Costa very poorly defined, the lamina gradually becoming thickened in the middle; sex organs without any protective lamellae, antheridia in numerous small volcano-like pimples, archegonia in a tubular or flap-like involucre.....47.
44. a. Thallus with unistratose lamina *sharply* differentiated from the central costa; costa with central strand (TS) of small thick-walled cells.....*Pallavicinia lyellii*<sup>14</sup>  
 b. Thallus with lamina not *sharply* differentiated from costa; costa lacking central strand (but sometimes with two lateral strands) (TS)..... 45.
45. a. Rhizoids reddish-brown to golden-yellow; lamellae bluntly lobed but not toothed or lacinate; arctic-alpine plant of late-lying snow patches.....*Moerckia blyttii*  
 b. Rhizoids colourless to straw-coloured; lamellae toothed to lacinate; habitat various.....46.
46. a. Costa poorly defined, tapering gradually to lamina, with two lateral strands (TS); male lamellae irregularly scattered on costa; calcicole of dune slacks, base-rich flushes, etc.....*Moerckia flotoviana*  
 b. Costa moderately well-defined, narrowing abruptly to lamina, without lateral strands (TS); male lamellae spaced alternately in two rows on costa; calcifuge of wet slopes in uplands .....*Moerckia hibernica*
47. a. Monoicous; involucre nearly horizontal I flap-like; always calcifuge.....*Pellia epiphylla*  
 b. Dioicous; involucre inclined to erect, tubular; often calcicole.....43.

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<sup>13</sup> *Aneura pinguis* is a very variable species complex comprising several cryptic species, which have not yet been satisfactorily defined.

<sup>14</sup> *Moerckia hibernica* has a moderately well-defined costa but lacks a central strand.

48. a. Involucre irregularly toothed; stalked slime papillae restricted to ventral surface of costa near apex (TS); thallus usually lacking reddish or purplish pigmentation, and with fine broccoli-like branching at apex in autumn; calcicole.....*Pellia endiviifolia*
- b. Involucre subentire or lobed but not toothed; stalked slime papillae on ventral and dorsal surface of costa near apex (TS); thallus often with reddish or purplish pigmentation, with no broccoli-like branching; mainly in  $\pm$  neutral conditions.....*Pellia nessiana*



## Section 2

Leaves unlobed, with no sign of any flaps, sacs or pockets, but sometimes with marginal teeth, and lacking underleaves (or underleaves so small that they are very difficult to detect).

1. a. Leaf margin toothed; antical (dorsal) margin often strongly decurrent<sup>1</sup>..... 2  
b. Leaf margin entire (sometimes there may be modified gemmiferous leaves near the shoot apices, which should be disregarded in this couplet); antical (dorsal) margin not or only slightly decurrent.....11.
2. a. Shoots laterally compressed, the concave and leaves arranged vertically, the two rows pressed against one another; rare plant of oceanic montane habitats  
..... *Plagiochila carringtonii*  
b. Shoots not laterally compressed, the leaves not concave or arranged  $\pm$  horizontally, and not pressed together; habitat various .....3.
3. a. Antical (dorsal) leaf margin long-decurrent..... 4.  
b. Antical (dorsal) leaf margin not, or only very shortly, decurrent<sup>2</sup>..... 10.
4. a. Mid-leaf cells 36-53  $\mu\text{m}$  wide; dorsal epidermal cells of stem 25-40  $\mu\text{m}$  wide; strict calcicole, usually on limestone..... *Plagiochila britannica*  
b. Mid-leaf cells 24-48  $\mu\text{m}$  wide; dorsal epidermal cells of stem 12-24  $\mu\text{m}$  wide; habitat various..... 5.
5. a. Leaves suborbicular to ovate,  $\pm$  entire except for 2(-3) distantly-spaced teeth at apex, and with a border of thicker-walled cells; branches arising ventrally; scarce in oceanic woodland..... *Pseudomarsupidium decipiens*  
b. Leaves variously shaped, usually with 4 or more teeth, and lacking a border of thick-walled cells; branches arising laterally; frequent in a variety of habitats.....6.
6. a. Leaves broadly ovate, oval or suborbicular; trigones small, not bulging; leaf margins dentate with many (usually >20) closely-spaced short teeth..... 7.  
b. Leaves ovate, oval-oblong or oblong; trigones generally well-developed and bulging; leaf margins sharply dentate or ciliate with few (usually > 15) relatively distant long teeth.....8.
7. a. Shoots 5-9 mm wide; leaves 2.5-4.5 x 3.0-4.5 mm..... *Plagiochila asplenoides*  
b. Shoots <6 mm wide; leaves 2.5 x 3 mm.....*Plagiochila porelloides*

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<sup>1</sup> Note that *Plagiochila carringtonii*, with essentially entire leaves that sometimes have a few teeth, keys out here because of its very strongly decurrent leaf margin. *Leptoscyphus cuneifolius* may also key out in this Section if the underleaves have fallen off or been overlooked: it has distinctive oblong cuneiform, caducous leaves and forms dark blackish-green patches, mainly on birch trees in oceanic areas, often with *Plagiochila punctata*. The very rare oceanic *Adelanthus lindenbergianus* resembles a *Plagiochila* but the leaves (uniquely) have a strongly incurved antical margin.

<sup>2</sup> The scarce limestone specialist *Pedinophyllum interruptum* may also key out here if there are leaves with some teeth present.

8. a. Vitta well-defined; antical (dorsal) leaf base *abruptly* decurrent down stem; shoots never leafless; small plants (shoots to 5 cm long), dark olive green or khaki, strongly aromatic..... *Plagiochila bifaria*  
b. Vitta poorly-defined or absent; antical (dorsal) leaf base *gradually* decurrent down stem; shoots often partly leafless; large plants (shoots to 15 cm long), green or yellow-green, weakly aromatic .....9.
9. a. Leaves 1.5-2.5 x longer than wide; marginal teeth broadly triangular, 2-8 cells wide at base (leaves very ragged-looking)..... *Plagiochila heterophylla*  
b. Leaves up to 1.5 x longer than wide; marginal teeth narrowly triangular to spiniform, 1-4 cells wide at base (leaves not ragged-looking).....*Plagiochila spinulosa*
10. a. Leaves broadly ovate to suborbicular, broadly rounded at apex with 2-5 teeth; usually many teeth on ventral (postical) margin; plants yellow-green to dark green..... *Plagiochila punctata*  
b. Leaves narrowly ovate, oval or cuneiform, narrower at apex with 2-3 teeth; 0-3 teeth on ventral (positcal) margin; plants dark green to brown or almost black.....*Plagiochila exigua*
11. a. Leaf cells very large, 45-55  $\mu\text{m}$  wide ..... 12.  
b. Leaf cells smaller, 20-35  $\mu\text{m}$  wide.....14.
12. a. Gemmae borne on modified elongated leaves at shoot apex; oil bodies segmented; usually creeping through *Sphagnum* in bogs..... *Mylia anomala*  
b. Gemmae borne on leaves the same shape as the other leaves or absent; oil bodies granular; habitat various.....13.
13. a. Leaves at shoot apex crowded, resembling the pages of a half-opened book; rudimentary underleaves present towards shoot apex; rhizoids colourless to pale brown; often forming large cushions on banks and in bogs and heath.....*Mylia taylorii*  
b. Leaves at shoot apex not crowded, not resembling the pages of a book; underleaves completely absent: rhizoids purplish-red to violet; forming  $\pm$  thin mats on rocks and detritus, often near water.....*Solenostoma paroicum*
14. a. Leaves not inserted to dorsal (antical) mid-line of stem; leaf-free zone 1-6 cells wide..... 15.  
b. Leaves inserted to dorsal (antical) mid-line, so no leaf-free zone on stem .....18.
15. a. Leaves subquadrate to oblong or semi-ovate; flagella and gemmae absent; scarce plant of limestone rock..... *Pedinophyllum interruptum*  
b. Leaves suborbicular to oval; postical flagella usually present; gemmae sometimes present; frequent in acid habitats.....16.

16. a. Leaves bordered with 1-2 marginal rows of thick-walled cells; cell lumen  $\pm$  rounded; gemmae absent; very common creeping through *Sphagnum* in bogs..... *Odontoschisma sphagni*<sup>3</sup>  
 b. Leaves unbordered; cell lumen  $\pm$  stellate; gemmae often present; habitat various.....17.
17. a. Gemmae usually abundant at apex of attenuated shoots; middle lamella of cell walls indistinct; cuticle usually papillose; peaty soils and rotten wood, frequent..... *Odontoschisma denudatum*  
 b. Gemmae rare, gemmiferous shoots not attenuate; middle lamella of cell walls distinct; cuticle smooth; peaty detritus, especially by water, scarce.....*Odontoschisma elongatum*
18. a. Plant opaque, matt; branching terminal (dichotomous); at least some leaves with reddish pigmentation; rhizoids colourless; slender small-leaved shoots absent; leaves not inserted to ventral (postical) mid-line of stem; on dry rocks, trees and rotten wood<sup>4</sup>..... *Syzygiella autumnalis*  
 b. Plant translucent, shiny; branching lateral-intercalary; leaves green, or if somewhat reddish or purplish, then rhizoids reddish-purple to violet *or* slender small-leaved shoots present or leaves *or* leaves inserted to ventral (postical) mid-line of stem; on wet rocks, soil and detritus<sup>5</sup>.....19.
19. a. Perianth borne on a well-developed perigynium (upper female bracts apparently attached to the perianth about halfway up); rhizoids usually reddish-purple to violet..... 20.  
 b. Perianth free or perigynium not well-developed (upper female bracts attached below the base of the perianth); rhizoids usually hyaline or pale brown.....21.
20. a. Dioicous..... *Solenostoma hyalinum*  
 b. Paroicous.....*Solenostoma obovatum*<sup>6</sup>
21. a. Dioicous..... 22.  
 b. Paroicous.....25.
22. a. Leaf cells small, averaging 16-22  $\mu$ m wide; leaves usually cucullate at apex; scarce montane species..... *Jungermannia borealis*

<sup>3</sup> The very rare *Biantheridion undulifolium* may key out here. It resembles *O. sphagni* superficially, and also occurs in *Sphagnum*, but it lacks a border to the leaf, or flagella, and has more oil bodies per cell; when fertile, the strongly undulate margins of the female bracts are distinctive.

<sup>4</sup> Three very rare species may also key out here; all are unusual among leafy liverworts in having clearly *opposite* leaves, and all are southern plants; *Gongylanthus ericetorum*, a plant of coastal heath in Cornwall and the Channel islands; and two species of *Southbya*, both strong calcicoles in limestone quarries etc: the bright green *S. tophacea* and the dark green/blackish *S. nigrella*.

<sup>5</sup> The rare alpine *Odontoschisma macounii* may key out in this section; it has almost round, concave, imbricate leaves and forms pale green worm-like patches in wet base-rich crevices.

<sup>6</sup> *Solenostoma subellipticum* is doubtfully distinct from *S. obovatum*; it is smaller (shoots 0.4-1.5 mm wide), has weakly pigmented rhizoids, and occurs in base-rich conditions (*S. obovatum*: shoots 1.5-3.0 mm wide, strongly pigmented rhizoids, acid conditions).

- b. Leaf cells larger, averaging 20-28  $\mu\text{m}$  wide; leaves often concave but not cucullate at apex; common in a variety of habitats.....23.
23. a. Leaves  $\pm$  orbicular, usually bordered with a row of distinctly larger cells; slender small-leaved shoots usually present; perianth keeled, abruptly contracted to beaked apex..... *Solenostoma gracillimum*<sup>7</sup>  
 b. Leaves  $\pm$  oval, narrowing to apex, unbordered; slender small-leaved shoots absent; perianth plicate but not keeled, gradually narrowed to apex.....24.
24. a. Plants large, shoots 1.5-5 mm wide and up to 8 cm long,  $\pm$  aquatic; leaves narrowly inserted on stem; cell walls dark brownish/reddish..... *Jungermannia eucordifolia*  
 b. Plants smaller, shoots 0.5-4 mm wide and up to 4 cm long, terrestrial (but often near water); leaves widely inserted on stem; cell walls colourless.....*Jungermannia atrovirens*
25. a. Leaves  $\pm$  orbicular; perianth keeled, abruptly contracted to beaked apex..... *Solenostoma sphaerocarpum*<sup>8</sup>  
 b. Leaves  $\pm$  oval, narrowing to apex; perianth plicate but not keeled, gradually narrowed to apex..... *Jungermannia pumila*<sup>9</sup>

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<sup>7</sup> The very rare *Endogemma caespiticia* will also key out here; it usually has conspicuous gemmae at the shoot apices; the leaves lack a border and have very large leaf cells (28-40  $\mu\text{m}$ ), typically with only one oil body. It is a pioneer species of bare soils and has a curious 'glistening' appearance.

<sup>8</sup> *Solenostoma confertissimum* is a rare montane species with larger leaf cells (averaging 28-36  $\mu\text{m}$  wide vs. 20-28  $\mu\text{m}$ ) and lacks the reddish pigmentation sometimes seen in *S. sphaerocarpum*.

<sup>9</sup> *Jungermannia polaris* is another rare montane species with smaller leaf cells (averaging 16-19  $\mu\text{m}$  wide vs. 18-25  $\mu\text{m}$ ) and a less tapering perianth.

### Section 3

Leaves unlobed, with no sign of any flaps, sacs or pockets, but sometimes with marginal teeth, and having underleaves that are easily seen under the microscope.

1. a. Leaf arrangement incubous<sup>1</sup>..... 2.  
b. Leaf arrangement succubous.....11.
2. a. Most leaves triangular-rectangular, with 3 teeth at apex; if only two or none, then leaf cells with very large trigones..... 3.  
b. Most leaves ovate-oval, entire or with 2 teeth at apex; leaf cells with trigones small or absent .....5.
3. a. Shoots 3-6 mm wide; leaf apex  $\pm$  truncate, with 3 subequal teeth/lobes..... *Bazzania trilobata*  
b. Shoots <2 mm wide; leaf apex oblique, with 2-3 unequal teeth/lobes.....4.
4. a. Antical (dorsal) leaf bases not or hardly crossing stem; underleaves wider than long; trigones mostly concave; frequent in western upland areas..... *Bazzania tricenata*  
b. Antical (dorsal) leaf bases widely crossing stem; underleaves longer than wide; trigones mostly strongly convex; scarce oceanic montane plant.....*Bazzania pearsonii*
5. a. Leaves  $\pm$  opaque; underleaves shallowly bilobed, with 7-14 cells between the sinus and the base..... 6.  
b. Leaves  $\pm$  translucent; underleaves  $\pm$  deeply bilobed, with 2-6 cells between the sinus and the base.....7.
6. a. Large plant (shoots up to 3 mm wide) with leaves distinctly and consistently longer than wide; marginal cells at leaf apex quadrate to rectangular, not forming a continuous border; underleaves not or only slightly decurrent at base with an oval/suborbicular rhizoid zone; usually on sandstone or gritstone rocks or peaty banks..... *Calypogeia integristipula*  
b. Smaller plant (shoots up to ca. 2 mm wide) with leaves not clearly and consistently longer than wide; marginal cells at apex rectangular, forming a continuous border; underleaves decurrent at base with a  $\pm$  linear rhizoid zone; usually on a variety of non-calcareous soils or rotting wood, less often on rock.....*Calypogeia neesiana*
7. a. Plant bluish in colour; oil bodies bright sky blue..... *Calypogeia azurea*  
b. Plant green; oil bodies colourless or greyish.....8.
8. a. Large plants, with shoots often >2mm wide; leaf cells ca. 30-48  $\mu$ m wide; underleaf cells ca. 26-46 x 34-60  $\mu$ m; oil bodies with an average of 4-12 segments..... 9.

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<sup>1</sup> Incubous: when shoots are viewed dorsally, the older leaves towards the base of the shoot overlap the younger leaves. Succubous: the opposite condition, with the younger leaves overlapping the older leaves. In this Section, the only plants with an incubous leaf arrangement are species of *Calypogeia*: note that it is very helpful to examine specimens of this genus *fresh*, as oil body characters are important and the oil bodies soon deteriorate and disappear in herbarium specimens.

- b. Smaller plants with shoots usually <2 mm wide; leaf cells *ca.* 24-34 µm wide; underleaf cells *ca.* 20-40 x 22-40 µm; oil bodies with an average of 2-6 segments.....10.
9. a. Underleaves divided to  $\frac{1}{2}$ - $\frac{2}{3}$ , usually with additional lateral 'shoulders'; leaf apex  $\pm$ acute, obtuse or narrowly rounded ..... *Calypogeia fissa*  
 b. Underleaves divided to  $\frac{1}{3}$ - $\frac{1}{2}$ , usually rounded, without additional lateral 'shoulders'; leaf apex  $\pm$  broadly rounded.....*Calypogeia muelleriana*
10. a. Leaf apex subacute to narrowly rounded; underleaves not or hardly decurrent; usually creeping through *Sphagnum*..... *Calypogeia sphagnicola*  
 b. Leaf apex broadly rounded or truncate; underleaves distinctly decurrent; usually on rotten logs.....*Calypogeia suecica*
11. a. Leaves opposite; common in oceanic areas..... *Saccogyna viticulosa*  
 b. Leaves alternate; oceanic or not.....12.
12. a. Underleaves relatively large (*ca.* 0.5 mm long or more), deeply and clearly bilobed, usually with conspicuous lateral teeth..... 13.  
 b. Underleaves very small (*ca.* 0.2 mm long or less) *and/or* linear/subulate, lateral teeth lacking or insignificant.....16.
13. a. Underleaves large (up to 1 mm long), wider than stem, often connate with the lateral leaves..... *Lophocolea semiteres*  
 b. Underleaves small (up to (up to *ca.* 0.7 mm long), narrower than stem, rarely connate with the lateral leaves.....14.
14. a. Lower leaves bilobed..... *Lophocolea heterophylla*  
 b. All leaves unlobed.....15.
15. a. Leaf apex broadly rounded or sometimes truncate or weakly retuse; leaf cells small (*ca.* 20-30 µm wide); oil bodies 1-4 per cell, rarely more; perianth lobes mostly undivided or with short blunt teeth/lobes; usually in or near streams..... *Chiloscyphus polyanthos*  
 b. Leaf apex more often slightly retuse or truncate than rounded; leaf cells large (*ca.* 26-38 µm wide); oil bodies 2-8(-14) per cell; perianth lobes distinctly toothed/ciliate; usually in marshy ground but less often associated with streams.....*Chiloscyphus pallescens*
16. a. Leaf cells very large, 45-55 µm wide ..... 17.  
 b. Leaf cells smaller, 14-35 µm wide.....18.
17. a. Gemmae borne on modified elongated leaves at shoot apex; oil bodies segmented; usually creeping through *Sphagnum* in bogs..... *Mylia anomala*  
 b. Gemmae borne on leaves the same shape as the other leaves or absent; oil bodies granular; habitat various..... *Mylia taylorii*

18. a. Leaves rather distant, cuneiform, oblong, wider at apex than at base, often caducous; gemmae absent; dark blackish-green tufts, mainly on birch, or occasionally other trees or rocks, in oceanic areas..... *Leptoscyphus cuneifolius*  
 b. Leaves  $\pm$  crowded and orbicular, not caducous; gemmae sometimes present; widespread in various habitats (bogs, bare soil, aquatic, rotten wood) but rarely epiphytic.....19.
19. a. Underleaves  $\pm$  erect, subulate, clearly sticking out from stem when shoot viewed from the side; trigones small, not much bulging, so cell lumen  $\pm$  rounded; gemmae and leaf border of thick-walled cells absent ..... 20.  
 b. Underleaves various shapes and orientations, but usually not sticking out conspicuously as above; trigones often large, bulging, so cell lumen  $\pm$  stellate; gemmae often present; leaves sometimes bordered with 1-2 marginal rows of thick-walled cells.....22.
20. a. Plants large, the shoots up to 12 cm long and strongly compressed laterally, the leaves pressed together; stems with a hyalodermis (TS);  $\pm$  aquatic. .... *Nardia compressa*  
 b. Plants small, the shoots typically only *ca.* 2 cm long and not or weakly compressed laterally, the leaves not or loosely pressed together; stems lacking a hyalodermis (TS); terrestrial.....21.
21. a. Leaf apex usually broadly rounded; oil bodies smooth and glistening; very common..... *Nardia scalaris*  
 b. Leaf apex usually retuse or emarginated; oil bodies granular, not glistening; scarce.....*Nardia geoscyphus*
22. a. Leaves bordered with 1-2 marginal rows of thick-walled cells; cell lumen  $\pm$  rounded; gemmae absent; very common creeping through *Sphagnum* in bogs..... *Odontoschisma sphagni*  
 b. Leaves unbordered; cell lumen  $\pm$  stellate; gemmae often present; habitat various.....23.
23. a. Gemmae usually abundant at apex of attenuated shoots; middle lamella of cell walls indistinct; cuticle usually papillose; peaty soils and rotten wood, frequent..... *Odontoschisma denudatum*  
 b. Gemmae rare, gemmiferous shoots not attenuate; middle lamella of cell walls distinct; cuticle smooth; peaty detritus, especially by water, scarce.....*Odontoschisma elongatum*

#### Section 4

Leaves deeply divided (to near base) into (2-)3-4(-6) lobes 1-4 cells wide at base, or leaf margins with long cilia, making plant look  $\pm$  fluffy; leaves in 3 ranks, the underleaves often  $\pm$  the same size as the lateral leaves, or only a little smaller.

1. a. Leaves with long marginal cilia or spinose teeth, making plants appear  $\pm$  fluffy; if leaf lobes discernible, then leaves bilobed<sup>1</sup>..... 2.  
b. Leaf margins lacking cilia or spinose teeth *or* most leaves with 3 or more lobes.....5.
2. a. Leaves almost completely divided into filaments, so that individual leaves cannot easily be discerned; pale green plants of wet places.....*Trichocolea tomentella*  
b. Individual leaves discernible; olive-green, reddish or purplish plants on rocks, soil or trees.....3.
3. a. Stems 5-12 cm long, with some branches slender and drawn-out; leaves spinose-toothed; uncommon plant of Western Scotland..... *Mastigophora woodsii*  
b. Stems 5-6 cm long at the most, without attenuate branches; leaves long-ciliate; widespread.....4.
4. a. Leaves divided only to mid-leaf, with broadest leaf segment *ca.* 20 cells wide at base; usually on rocks or soil..... *Ptilidium ciliare*  
b. Leaves divided to  $\frac{3}{4}$  leaf length, with broadest leaf segment *ca.* 10 cells wide at base; usually on trees.....*Ptilidium pulcherrimum*
5. a. Leaves divided to base, or nearly so, the leaf lobes very fine and bristle-like..... 6.  
b. Leaves divided to  $\frac{3}{4}$  at most, the shorter, wider leaf lobes resembling the fingers of a hand.....9.
6. a. Leaf lobes only one cell wide to the base..... *Blepharostoma trichophyllum*<sup>2</sup>  
b. Leaf lobes 2 or more cells wide towards base.....7.
7. a. Shoots up to 0.5 mm wide; leaf cells in mid-lobe 16-23  $\mu$ m wide; male bracts with rounded apical cell on lobes; female bracts 3-4-lobed with apical cilia to 6 or more cells long..... *Kurzia pauciflora*  
b. Shoots <0.35 mm wide; leaf cells in mid-lobe 12-16  $\mu$ m wide; male bracts with acute apical cell on lobes; female bracts bilobed with apical cilia 2-3 cells long.....8.
8. a. Plants usually forming extensive spongy cushions, strongly aromatic; female bracts divided to  $<\frac{1}{2}$ ; male bracts divided to *ca.*  $\frac{1}{2}$ - $\frac{2}{3}$ , incurved..... *Kurzia trichoclados*

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<sup>1</sup> *Scapania nimbosa* might also key out here; although it has long teeth on the leaf margins, the plants do not look fluffy; the two leaf lobes are clearly distinguishable, the antical (dorsal) lobe smaller than the postical (ventral) lobe, and folded over it (see Section 7).

<sup>2</sup> *Telaranea europaea*, a tiny and very rare south-western oceanic species, and the two even rarer *Tricholepidozia* species, are superficially similar but the leaf lobes are two cells wide at the base.



- b. Plant usually forming thin mats, not aromatic; female bracts divided to *ca.*  $\frac{1}{3}$ ; male bracts divided to no more than  $\frac{1}{2}$ , straight.....*Kurzia sylvatica*
9. a. Leaf lobes concave on dorsal surface, and often with cilia on margins; rare upland plant..... *Tetralophozia setiformis*<sup>3</sup>  
 b. Leaf lobes flat or convex on dorsal surface; cilia lacking; common.....10.
10. a. Leaves densely imbricate, crossing the stem dorsally; plant forming dense yellowish/whitish-green cushions; mainly western..... *Lepidozia cupressina*  
 b. Leaves not densely imbricate, not or hardly crossing the stem dorsally; plant forming thinner, green cushions or wefts; widespread.....11.
11. a. Stem leaves usually wider than long with lobes  $\frac{1}{3}$ - $\frac{1}{2}$  leaf length; autoicous, with male inflorescences on short postical branches; usually  $\pm$  compact plants in a variety of habitats ..... *Lepidozia reptans*  
 b. Stem leaves usually longer than wide with lobes  $\frac{1}{2}$ - $\frac{2}{3}$  leaf length'; dioicous, with male inflorescences terminal on lateral branches; straggling plants on banks in oceanic districts.....*Lepidozia pearsonii*

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<sup>3</sup> Note that some species of *Barbilophozia* sens. lat. have cilia on the leaves, but these are confined to the extreme leaf base.

## Section 5

Leaves divided into two or more  $\pm$  similar lobes, with no modification into a 'pocket' or 'sac'. Plant lacking underleaves.

1. a. At least some shoots attenuate at apex with closely-pressed gemmiferous leaves; gemmae  $\pm$  red..... 2.  
b. Attenuate gemmiferous shoots absent; gemmae sometimes present, borne on unmodified shoots, various colours.....3.
2. a. Leaves mostly 3-lobed; relatively large plants, non-gemmiferous shoots 0.4-1.8 mm wide; gemmae 1-2-celled..... *Orthocaulis attenuatus*<sup>1</sup>  
b. Leaves 2-lobed; small plants, non-gemmiferous shoots <0.8 mm wide; gemmae single-celled.....*Anastrophyllum hellerianum*<sup>2</sup>
3. a. Most leaves 3-4-lobed, almost longitudinally inserted..... *Barbilophozia barbata*<sup>3</sup>  
b. Most or all leaves 2-lobed.....4.
4. a. Leaves  $\pm$  transversely inserted on stem; plants sometimes very small and threadlike, shoots <0.7 mm wide, leaves <0.3 mm long..... 4.  
b. Leaves clearly obliquely inserted on stem; plants larger, shoots >0.7 mm wide, leaves >0.3 mm long.....22.
5. a. Leaf cells arranged in regular concentric rows, with uniformly thickened walls; leaves erecto-patent (so shoots pectinate), lobes sometimes subequal, the antical lobe slightly smaller than the postical, acutely pointed.....*Sphenolobus minutus*  
b. Leaf cells not arranged in regular concentric rows; walls various; leaves imbricate to patent (shoots pectinate or not), lobes  $\pm$  equal, acutely pointed or not .....6.
6. a. Leaf insertion extending to other side of stem dorsally, so that leaves on opposite sides interlock at the base; plants often large (shoots to ca. 5 mm wide) but sometimes much smaller; gemmae absent..... 7.  
b. Leaf insertion extending to stem mid-line dorsally, so leaves do not interlock; plants always very small and threadlike (shoots <0.7 mm wide); gemmae often present.....18.

<sup>1</sup> *Orthocaulis atlanticus* may key out here if the underleaves are not obvious; it differs in having leaf cells 16-22  $\mu$ m wide (23-28  $\mu$ m in *O. attenuatus*) and less attenuate gemmiferous shoots.

<sup>2</sup> *Sphenolobus minutus* sometimes has modified gemmiferous shoots, but is a larger plant (shoots 0.4-1.4 mm wide), the gemmae are 2-4-celled, and the leaf cells are arranged in concentric rows. The rare *Heterogemma capitata* has smooth (not angular) unicellular gemmae and very large leaf cells (averaging 36-46  $\mu$ m wide vs. 16-23  $\mu$ m).

<sup>3</sup> Note also *Orthocaulis atlanticus*, which has obliquely-inserted leaves and usually has red gemmae (gemmae are absent in *B. barbata*). The leaves of *Schistochilopsis incisa* and *S. opacifolia* (see below) are essentially bilobed and obliquely inserted, but subdivided into irregular sub-lobes and teeth, so they may key out here. The leaves are quite unlike the regularly lobed *B. barbata* and are a characteristic glaucous pale green in colour. Both species of *Schistochilopsis* usually have green gemmae. *Saccobasis polita*, a rather rare plant of upland flushes, has much more obliquely – almost transversely – inserted leaves with blunter lobes.

7. a. Leaves  $\pm$  closely appressed and imbricate, so stems  $\pm$  smoothly cylindrical and catkin-like.....8.  
b. Leaves  $\pm$  spreading so stems not smoothly cylindrical or catkin-like.....9.
8. a. Plants whitish to pale green; cuticle minutely and densely papillose.....9.  
b. Plants dark brownish, reddish or black; cuticle smooth or weakly papillose.....10.
9. a. Leaf lobes obtuse with sinus closed at base; margins regularly crenulate with convex outer walls of cells; plants whitish to greyish..... *Gymnomitrium obtusum*<sup>4</sup>  
b. Leaf lobes acute with sinus open at base; margins not or weakly crenulate; plants yellowish-to light-green.....*Gymnomitrium concinnatum*
10. a. Leaves bordered with elongate, strongly projecting cells..... *Gymnomitrium crenulatum*  
b. Leaves without elongate projecting cells..... *Gymnomitrium adustum*<sup>5</sup>
11. a. Leaves strongly keeled, with lobes folded together; gemmae frequent; oil bodies ca. 3-8..... 12.  
b. Leaves not strongly keeled, lobes not folded together; gemmae absent; oil bodies 2-3.....13.
12. a. Postical (ventral) lobe not or shortly decurrent; leaves not bordered with thick-walled cells; usually on rocks..... *Scapania compacta*  
b. Postical lobe long-decurrent; leaves bordered with 2-3 rows of uniformly thick-walled cells; usually on detritus by water.....*Scapania subalpina*<sup>6</sup>
13. a. Lateral margins of at least some vegetative leaves partially recurved; common..... 14.  
b. Lateral margins of all vegetative leaves plane; relatively scarce.....15.
14. a. Leaves divided  $\frac{1}{5}$ - $\frac{1}{3}$ ; leaves unistratose throughout; plants small (shoots 0.5-2 mm wide); on soil and wet or dry rocks..... *Marsupella emarginata*  
b. Leaves divided to  $\frac{1}{5}$ ; leaves bistratose near base; plants large (shoots 1.1-3.5 mm wide); on wet or submerged rocks.....*Marsupella aquatica*
15. a. Leaf lobes mostly broadly rounded; sinus often closed; hyalodermis present (stem TS)..... *Marsupella sphacelata*<sup>7</sup>

<sup>4</sup> *Gymnomitrium corallioides*, a rare alpine plant, will key out here; it differs in having flattened (rather than cylindrical) shoots and a smooth cuticle (minutely and densely papillose in *G. obtusum*).

<sup>5</sup> Several rare and difficult plants of upland rocks and areas of late snow-lie may key out here, of which *Gymnomitrium adustum* is probably the most widespread; it forms small club-like plants. *G. brevissimum* is often abundant in biotic crusts, forming extensive black mats; *G. apiculatum* is similar but has larger leaf cells (and is very rare); *Marsupella stableri* is usually neat and red, the very thin shoots grooved on the antical (dorsal) surface; *M. condensata* is characterised by the lunate leaf sinus.

<sup>6</sup> The rather rare calcicole *Scapania cuspiduligera* may also key out here; the leaves are  $\pm$  sheathing at the base and only weakly keeled (unlike other *Scapanias*), and it has dark red gemmae (greenish to pinkish or purplish in *S. subalpina*). *S. aequiloba* usually has unequal lobes (Section 7) but sometimes they are almost equal: it can be distinguished by the strongly papillose cuticle.

- b. Leaf lobes mostly acute to obtuse; sinus open; hyalodermis absent.....16.
16. a. Plant shiny; leaves patent or erecto-patent from a markedly sheathing base; leaf cells small, averaging 10-14 µm wide..... *Marsupella alpina*  
 b. Plant dull; leaves without a markedly sheathing base; leaf cells larger, averaging 12-20 µm wide.....17.
17. a. Paroicous; most leaves divided  $\frac{1}{4}$ - $\frac{1}{3}$ ; usually on rocks..... *Marsupella sprucei*<sup>8</sup>  
 b. Dioicous; most leaves divided  $\frac{1}{3}$ - $\frac{1}{2}$ ; usually on soil.....*Marsupella funckii*<sup>9</sup>
18. a. Plants delicate, translucent; stem with large translucent, usually thin-walled cortical cells forming a hyalodermis, and smaller, usually thick-walled medullary cells (TS not usually necessary); usually on peat or *Sphagnum*..... *Cephalozia leucantha*  
 b. Plants more opaque and wiry; stem opaque, hyalodermis obscure or absent; habitat various.....19.
19. a. Leaves ± erect and imbricate; leaf cells ± uniformly thick-walled, lacking oil bodies; gemmae absent; upland calcicole..... *Eremonotus myriocarpus*<sup>10</sup>  
 b. Leaves ± spreading; leaf cells thin to thick-walled, often collenchymatous, with oil bodies; gemmae present or absent; usually calcifuge .....20.
20. a. Gemmae absent; terminal branching frequent; postical (ventral) leaf lobe often spreading more than antical (dorsal) lobe; on rock faces in oceanic areas..... *Sphenolobopsis pearsonii*  
 b. Gemmae usually present; branching mostly intercalary; leaf lobes spreading ± equally; habitat various.....21.
21. a. Gemmae multiangular or tuberculate; leaves strongly toothed; locally frequent on earthy banks in the south-west..... *Cephaloziella turneri*<sup>11</sup>  
 b. Gemmae smooth or absent; leaves usually ± entire; common creeping through *Sphagnum* in bogs..... *Cephaloziella hampeana*<sup>12</sup>

<sup>7</sup> The very rare *Marsupella arctica* may key out here: it has very concave leaves, so the shoots are julaceous, and is so far known only from the Cairngorms.

<sup>8</sup> Two very rare paroicous species may also key out here: *Marsupella profunda*, which has slightly differently-shaped leaves as grows only on and around old china-clay workings in Cornwall; and *M. sparsifolia*, an alpine species with more regularly pectinate shoots.

<sup>9</sup> The very rare alpine *Marsupella boeckii* has filiform shoots with very distant concave leaves.

<sup>10</sup> Several rare and difficult plants of upland rocks and areas of late snow-lie may key out here, of which *Gymnomitrium adustum* is probably the most widespread; it forms small club-like plants. *G. brevissimum* is often abundant in biotic crusts, forming extensive black mats; *G. apiculatum* is similar but has larger leaf cells (and is very rare); *Marsupella stableri* is usually neat and red, the very thin shoots grooved on the antical (dorsal) surface; *M. condensata* is characterised by the lunate leaf sinus.

<sup>11</sup> Some rare *Cephaloziellas* with multiangular/tuberculate gemmae may key out here: the very rare *Cephaloziella dentata* also has toothed leaves but has underleaves; *C. integerrima* and *C. calyculata* have untoothed leaves. The former is usually dark brownish in colour; the latter is green and is unique in having a distinctive 'bract-tube' around the perianth, so looking like a 'double perianth'.

<sup>12</sup> The normally paroicous *Cephaloziella rubella* will also key out here (*C. hampeana* is autoicous); *C. baumgartneri* has shortly pointed female bracts (single cell at tip; two cells in the other species) and is a rare

22. a. Plants small (shoots <1.5 mm wide), delicate, translucent; stem with large translucent, usually thin-walled cortical cells forming a hyalodermis, and smaller, usually thick-walled medullary cells (TS not usually necessary); leaf lobes always sharply pointed; stem with antical (dorsal) leaf-free zone 2 cells wide; gemmae 1-celled; oil bodies absent..... 23.  
 b. Plants usually larger (shoots often >1.5 mm wide), more opaque; stem mostly opaque, hyalodermis obscure or absent; leaf lobes sometime blunt; gemmae mostly 2-celled; oil bodies present.....29.
23. a. Antical (dorsal) leaf insertion  $\pm$  reaching middle of stem, so leaf-free zone 0-1 cell wide; very common in many habitats..... *Cephalozia bicuspidata*<sup>13</sup>  
 b. Antical (dorsal) leaf insertion not reaching middle of stem, so leaf-free zone 2 cells wide; less common, except in bogs and on rotting wood.....24.
24. a. Leaf cells 16-24  $\mu$ m wide, obliquely inserted; antical (dorsal) cortical cells 16-28  $\mu$ m wide; usually on peat or rotting wood..... *Cephalozia catenulata*  
 b. Leaf cells 20-34  $\mu$ m wide, almost longitudinally inserted; antical (dorsal) cortical cells >24  $\mu$ m wide; habitat various.....25.
25. a. Apical cell of leaf lobes with wall not thickened at apex.....*Cephalozia pleniceps*  
 b. Apical cell of leaf lobes with wall thicker at apex than on margins.....26.
26. a. Leaf cells 28-50  $\mu$ m wide.....*Cephalozia connivens*<sup>14</sup>  
 b. Leaf cells 20-38  $\mu$ m wide.....27.
27. a. Walls of medullary cells hyaline (TS); perianth mouth with teeth 1-2 cells long; usually in woodland, on rotting wood or banks, but sometimes in *Sphagnum* bogs..... *Cephalozia lunulifolia*  
 b. Walls of medullary cells yellowish (TS); perianth mouth with cilia up to 6 cells long; always in *Sphagnum* bogs..... 28.
28. a. Most leaf lobes ending in a row of 2-3 uniseriate cells; perianth mouth with cilia 2-6 cells long..... *Cephalozia loitlesbergeri*  
 b. Most leaf lobes ending in a 1-2 cells; perianth mouth with cilia 2-3 cells long.....*Cephalozia macrostachya*<sup>15</sup>

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southern calcicole. However, species boundaries in *Cephaloziella* are very blurred and the genus is in need of revision using molecular techniques.

<sup>13</sup> The very rare *C. ambigua*, a plant of late-lying snow patches in the Scottish mountains, has somewhat smaller leaf cells and cortical stem cells.

<sup>14</sup> The rare oceanic *Cephalozia crassifolia*, confined to western Ireland, has the leaf lobes ending in a uniseriate row of 2-3 cells (1-2 in *C. connivens*).

<sup>15</sup> There are two varieties of *C. macrostachya*: var. *spiniflora* differs in having toothed (vs. untoothed in var. *macrostachya*) male bracts, and female bracts ending in a row of 2-4 short cells (vs. 2-6 narrow elongate cells).

29. a. Leaves strongly asymmetrical with postical (ventral) margin  $\pm$  strongly recurved; shoots long, up to *ca.* 8 cm,  $\pm$  erect, often with clusters of red gemmae at apex..... *Anastrepta orcadensis*  
 b. Leaves  $\pm$  symmetrical, postical margin plane; shoots usually shorter, less erect; gemmae present or not.....30.
30. a. Leaves slightly convex, often caducous; leaf cells with trigones small to large and nodular; gemmae absent; uncommon on rocks and trees in oceanic areas..... *Plagiochila exigua*<sup>16</sup>  
 b. Leaves convex to concave, not caducous; leaf cells with trigones small-medium; gemmae often present; habitat and distribution various.....31.
31. a. Shoots <1.5 mm wide; leaves lacking any additional lobes or teeth; leaf lobes often obtuse and leaf sinus  $\pm$  acute, V-shaped; gemmae absent<sup>17</sup> ..... 32.  
 b. Shoots often >1.5 mm wide; leaves sometimes with additional lobes or teeth; leaf lobes  $\pm$  acute, leaf sinus acute to wide and U-shaped; gemmae usually present.....34.
32. a. Leaves obtuse to rounded; caducous perianths often present; dingy green to blackish plant of wet places, calcifuge..... *Gymnocolea inflata*  
 b. Leaves acute to obtuse; caducous perianths absent; yellowish- to brownish-green plants, calcicole.....33.
33. a. Leaves narrowly inserted, not or hardly decurrent; cells walls  $\pm$  without trigones..... *Mesoptychia turbinata*  
 b. Leaves broadly inserted, leaves antically decurrent: cells walls usually with trigones.....*Mesoptychia badensis*
34. a. Leaf lobes mostly rounded; sinus usually narrow, often gibbous; scarce plant of heathy ground.....*Obtusifolium obtusum*  
 b. Leaf lobes mostly pointed; sinus often wide or very shallow; common.....35.
35. a. Gemmae red/purple<sup>18</sup> ..... 36.  
 b. Gemmae green or absent.....40.
36. a. Gemmae with long-persistent homogenous oil globules; calcicole, rare.....*Olealophozia perssonii*  
 b. Gemmae with fugacious granular oil bodies, usually calcifuges, common.....37.

<sup>16</sup> *Pseudomarsupidium decipiens* might key out here; it looks something like a *Plagiochila* with but the leaves concave antically, with two rather distantly-spaced apical teeth, and a border of thick-walled cells.

<sup>17</sup> Small forms of *Obtusifolium obtusum* (see below) may also key out here, as it has obtuse leaf lobes and a narrow sinus. In western Scotland and Ireland, be aware of *Acrobolbus wilsonii*, which could key out either way at this couplet: it has almost longitudinally inserted leaves, and a characteristic pale green opaque appearance, like that of *Saccogyna*. It is a rare plant, mainly on rocks by streams in humid ravines.

<sup>18</sup> The rare *Heterogemma capitata*, which has single-celled smooth gemmae which are green or pigmented, is distinctive in having very large leaf cells averaging 36-46  $\mu$ m wide.

37. a. Leaves divided to  $<\frac{1}{4}$ , with shallow,  $\pm$  lunate sinus; leaf cells averaging 16-22  $\mu\text{m}$  wide; gemmae 14-24 x 15-25  $\mu\text{m}$ ..... *Barbilophozia sudetica*  
 b. Leaves often divided to  $>\frac{1}{4}$ , with sinus deeper and narrower; leaf cells averaging 20-34  $\mu\text{m}$  wide; gemmae 16-28 x 22-48  $\mu\text{m}$  .....38.
38. a. Leaves with long narrow lobes with gemmae in conspicuous globose clusters at lobe tips; usually epiphytic on birch, rowan, etc; sometimes on peaty soil..... *Lophozia longidens*  
 b. Leaves with short wide lobes; gemmae clusters not conspicuously globose at lobe tips; usually on ground.....39.
39. a. Leaf cells thick-walled; gemmae reddish-yellow to reddish-brown; perianth dentate-ciliate, with cilia 2-5 cells long; plants aromatic..... *Isopaches bicrenatus*  
 b. Leaf cells thin-walled; gemmae purplish or wine-red; perianth usually crenulate to shortly dentate, with teeth 1-2 cells long; plants not aromatic.....*Lophozia excisa*<sup>19</sup>
40. a. Plants often with reddish/purplish secondary pigmentation; leaves mainly without additional irregular lobes and teeth; oil bodies mostly 5-18 per cell..... 41.  
 b. Plants without secondary pigmentation; leaves often with additional irregular lobes and teeth; oil bodies  $>2$ - per cell.....42.
41. a. Leaves  $\pm$  concave, divided *ca.*  $\frac{1}{8}$ - $\frac{1}{4}$  or slightly more; leaf cells averaging 16-22(-24)  $\mu\text{m}$  wide; upland plant..... *Barbilophozia sudetica*  
 b. Leaves flat or hardly concave, divided up to *ca.*  $\frac{1}{4}$  or more; leaf cells averaging 20-30  $\mu\text{m}$  wide; upland or lowland.....*Lophozia ventricosa*<sup>20</sup>
42. a. Leaf margins usually irregularly spinose-dentate; leaf 1-2-stratose at base in middle; upland or lowland..... *Schistochilopsis incisa*  
 b. Leaf margins usually not or sparsely dentate; leaf 3-5-stratose at base in middle; alpine.....*Schistochilopsis opacifolia*

<sup>19</sup> Some forms of *Orthocaulis atlanticus* may also key out here. It is a larger plant, with shoots usually at least 3 cm long ( $<2.5$  cm in *L. excisa*) and usually has at least some leaves with 3 lobes and basal teeth.

<sup>20</sup> The taxonomy of the *Lophozia ventricosa* complex is in a state of flux, with different specialists having different opinions. Therefore this key says nothing about 'var. *silvicola*', *L. wenzelii* or *L. longiflora* until further studies have clarified matters.

## Section 6

Leaves divided into two or more  $\pm$  similar lobes, with no modification into a 'pocket' or 'sac'. Plant with underleaves.

1. a. Most or all leaves divided into 3 or more lobes..... 2.  
b. Most or all leaves divided into 2 lobes.....13.
2. a. Plants pinnately-branched; underleaves similar in shape to lateral leaves but smaller..... 3.  
b. Plants not pinnately-branched; underleaves differently shaped to lateral leaves.....5.
3. a. Leaves densely imbricate, crossing the stem dorsally; plant forming dense yellowish/whitish-green cushions; mainly western..... *Lepidozia cupressina*  
b. Leaves not densely imbricate, not or hardly crossing the stem dorsally; plant forming thinner, green cushions or wefts; widespread.....4.
4. a. Stem leaves usually wider than long with lobes  $\frac{1}{3}$ - $\frac{1}{2}$  leaf length; autoicous, with male inflorescences on short postical branches; usually  $\pm$  compact plants in a variety of habitats ..... *Lepidozia reptans*  
b. Stem leaves usually longer than wide with lobes  $\frac{1}{2}$ - $\frac{2}{3}$  leaf length'; dioicous, with male inflorescences terminal on lateral branches; straggling plants on banks in oceanic districts.....*Lepidozia pearsonii*
5. a. Leaf arrangement incubous; leaves shallowly lobed at apex only..... 6.  
b. Leaf arrangement succubous; leaves deeply lobed.....8.
6. a. Shoots 3-6 mm wide; leaf apex  $\pm$  truncate, with 3 subequal teeth/lobes..... *Bazzania trilobata*  
b. Shoots <2 mm wide; leaf apex oblique, with 2-3 unequal teeth/lobes.....7.
7. a. Antical (dorsal) leaf bases not or hardly crossing stem; underleaves wider than long; trigones mostly concave; frequent in western upland areas..... *Bazzania tricenata*  
b. Antical (dorsal) leaf bases widely crossing stem; underleaves longer than wide; trigones mostly strongly convex; scarce oceanic montane plant.....*Bazzania pearsonii*
8. a. Rhizoids clustered at base of underleaves, which may be connate with the lateral leaves; trigones minute or absent; strongly aromatic.....*Lophocolea fragrans*  
b. Rhizoids scattered on postical surface of stem, not connate with lateral leaves; Trigones small to large; not aromatic.....9.



9. a. Most leaves deeply lobed to *ca.* ½ or more of leaf length; leaf lobes strongly concave abaxially; scarce, usually forming large orange patches in boulder fields in the central and eastern Highlands..... *Tetralophozia setiformis*<sup>1</sup>  
b. Most leaves more shallowly lobed, to <½ of leaf length; leaf lobes flat or convex abaxially; common and widely distributed; habitat various.....10.
10. a. Marginal cilia at postical (ventral) leaf base composed of long, narrow cells mostly >40µm long; leaf lobe apices sharply and spinosely pointed with apical cell 30-70 µm long or more..... 11.  
b. Marginal cilia at postical (ventral) leaf base absent or composed of short almost isodiametric cells mostly *ca.* 20 µm long; leaf lobe apices shortly pointed with apical cell mostly <30 µm long.....12.
11. a. Antical (dorsal) leaf margin extending across stem mid-line; gemmae absent; scarce..... *Barbilophozia lycopodioides*  
b. Antical (dorsal) leaf margin not extending across stem mid-line; gemmae usually present; relatively frequent.....*Barbilophozia hatcheri*
12. a. Marginal cilia at postical (ventral) leaf base well-developed; leaf cells *ca.* 18-25 µm wide; gemmae absent..... *Orthocaulis floerkei*  
b. Marginal cilia at postical (ventral) leaf base absent or reduced to a few cells; leaf cells *ca.* 23-28 µ, wide; gemmae usually present .....*Orthocaulis atlanticus*<sup>2</sup>
13. a. Leaves deeply divided, to much more than ½ leaf length; underleaves almost as large as lateral leaves, and similar in shape..... 14.  
b. Leaves more shallowly divided, to *ca.* ½ leaf length or less; if more deeply divided, then underleaves much smaller than lateral leaves, and differently shaped.....17.
14. a. Plants small, with leaves <0.3 mm long, forming whitish or silvery mats in upland flushes ..... 15.  
b. Plants larger, with leaves >1mm long, forming loose orange or greenish-brown tufts.....16.
15. a. Shoots up to several cm long, with rhizoids sparse and only at base of stems; forming often large conspicuous tufts and cushions in upland flushes.....*Anthelia julacea*  
b. Shoots only a few mm long, with rhizoids abundant all along stems; thin crusts in areas of late snow-lie in the mountains.....*Anthelia juratzkana*
16. a. Predominantly bright orange plants with leaf lobes spreading untidily..... *Herbertus hutchinsiae*<sup>3</sup>

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<sup>1</sup> *Barbilophozia quadriloba* may also key out here: it has deeply 3-4-lobed leaves but, unlike *Tetralophozia* or other *Barbilophozias*, a strongly papillose cuticle. It is a very rare alpine calcicole.

<sup>2</sup> *Orthocaulis attenuatus* has leaf cells 16-22 µm wide and lacks underleaves (see Section 5).

<sup>3</sup> *Herbertus borealis* is a larger plant with neatly falcate leaves, restricted to the Loch Maree area in Western Scotland; *H. norenius* is similar but smaller and paler and restricted to Shetland and Orkney.

- b. Predominantly dingy greenish-brown plants with leaf lobes neatly suberect.....*Herbertus stramineus*
17. a. Leaves  $\pm$  transversely inserted on stem; plants very small and threadlike, shoots  $<0.8$  mm wide, leaves  $<0.4$  mm long..... 18.  
 b. Leaves clearly obliquely inserted on stem; plants usually larger, shoots  $>0.7$  mm wide, leaves  $>0.3$  mm long (if smaller, then leaves clearly obliquely inserted).....21.
18. a. Underleaves almost as large as lateral leaves; leaves always longer than wide; stems soft and translucent with obvious hyalodermis<sup>4</sup>..... *Hygrobiella laxifolia*  
 b. Underleaves much smaller than lateral leaves; leaves longer than wide or not; stems more wiry, opaque, hyalodermis absent.....19.
19. a. Usually dioicous and with underleaves present on all shoots; leaves often loosely complicate, sometimes toothed; very common..... *Cephaloziella divaricata*<sup>5</sup>  
 b. Autoicous/paroicous; underleaves usually absent; leaves not or weakly complicate, entire; less common, except in bogs.....20.
20. a. Autoicous; subinvolucral innovations absent; common creeping through *Sphagnum* in bogs..... *Cephaloziella hampeana*  
 b. Paroicous; subinvolucral innovations often present; habitat various.....*Cephaloziella stellulifera*<sup>6</sup>
21. a. Leaf arrangement incubous; leaves shallowly lobed or notched at apex only..... 22.  
 b. Leaf arrangement succubous; leaves shallowly to deeply lobed.....23.
22. a. Leaf apex widely bilobed with lobes narrow,  $\pm$  divergent, 2-3 uniseriate; underleaves bilobed, with additional well-developed subulate lateral lobes..... *Calypogeia arguta*  
 b. Leaf apex merely notched, with lobes broad and not divergent, 1(-2)-seriate; underleaves bilobed, with additional lateral lobes weak or absent.....*Calypogeia fissa*<sup>7</sup>
23. a. At least some shoots attenuate at apex with closely-pressed gemmiferous leaves; gemmae brownish; rare calcicole.....*Mesoptychia heterocolpos*<sup>8</sup>

<sup>4</sup> *Pleurocladula albescens*, a rare plant of Scottish snow-bed, may also key out near here; it is very pale whitish-green, with very concave suborbicular leaves.

<sup>5</sup> *C. massolongi* and *C. nicholsonii* usually have more strongly toothed leaves and are confined to heavy metal-rich soils and rocks. *C. spinigera* and *C. elachista* are two extremely small, threadlike plants (shoots  $<0.25$  mm wide) of *Sphagnum* bogs, both characterised by having a thumb-like tooth at the base of the leaf. The former has thick-walled leaf cells, the latter thin; both are rare but overlooked. The very rare *C. dentata* has tuberculate gemmae.

<sup>6</sup> *Cephaloziella rubella* is smaller (stems 40-95  $\mu$ m wide, leaf lobes 4-6 cells wide). However, species boundaries in *Cephaloziella* are very blurred and the genus is in need of revision using molecular techniques.

<sup>7</sup> Forms of other species of *Calypogeia* may also key out here, but all the other species have leaves with at most very weakly notched apices; in cases of doubt, see Section 3, where all species of *Calypogeia* except *C. arguta* are included.

<sup>8</sup> *Protolophozia herzogiana*, an extremely rare calcifuge with more angular green to red gemmae, will also key out here.

- b. Attenuate gemmiferous shoots absent; gemmae sometimes present, borne on unmodified shoots, various colours; common in a variety of habitats.....24.
24. a. Plants small (shoots usually <1 mm wide), with abundant postical flagellae; sometimes with gemmae; creeping through *Sphagnum* or on peaty soil..... 25.  
 b. Plants larger (shoots usually > 1 mm wide); postical flagellae and gemmae lacking; habitat various, but not usually creeping through *Sphagnum*.....26.
25. a. Leaf cells *ca.* 24-38 µm wide; gemmae absent; leaves usually distant on long creeping shoots.....*Odontoschisma (Cladopodiella) fluitans*  
 b. Leaf cells *ca.* 16-24 µm wide; gemmae usually present; leaves usually ± crowded on shorter shoots.....*Odontoschisma (Cladopodiella) francisci*
26. a. Underleaves clearly bilobed, and usually with additional marginal teeth or cilia; usually strongly aromatic..... 27.  
 b. Underleaves lanceolate to subulate, not bilobed but often with marginal teeth or cilia; aromatic or not.....30.
27. a. Upper leaves unlobed and entire.....*Lophocolea heterophylla*  
 b. All leaves bilobed.....28.
28. a. Leaves with dentate margins.....*Lophocolea fragrans*  
 b. Leaves with entire margins.....29.
29. a. Small plant (mature shoots *ca.* 2 mm wide); postical (ventral) end of leaf insertion distinctly arcuate; uncommon.....*Lophocolea bispinosa*  
 b. Usually a larger plant (mature shoots *ca.* 2-4 mm wide); postical (ventral) end of leaf insertion not or hardly arcuate; very common.....*Lophocolea bidentata*<sup>9</sup>
30. a. Underleaves with ± ciliate apex, with cilia on margins.....31.  
 b. Underleaves with short to acuminate (not ciliate) apex, entire or with 1-2 lateral lobes.....34.
31. a. Leaves with lobes always pointed; leaf cells *ca.* 30-44 µm wide; male and female bracts all toothed at margins.....*Mesoptychia fitzgeraldiae*  
 b. Leaves with lobes pointed to rounded; leaf cells *ca.* 20-38 µm wide; only female bracts sometimes toothed at margins.....32.
32. a. Paroicous; scarce.....*Mesoptychia gillmanii*<sup>10</sup>

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<sup>9</sup> *Geocalyx graveolens* is structurally similar to *Lophocolea bidentata* but looks quite different in the field because of its opaque appearance (like *Saccogyna*), whereas *L. bidentata* is delicate and translucent. It is also aromatic, but is said to smell of turpentine rather than the 'musty woodland' smell of *Lophocolea*. It is very rare and western.

- b. Dioicous; frequent.....33.
33. a. Plants large (shoots *ca.* 2.5-4 mm wide); leaves  $\pm$  strongly antically (dorsally) decurrent; leaf cells *ca.* 30-38  $\mu$ m wide; most commonly in base-rich rock crevices and relatively dry habitats.....*Mesoptychia bantriensis*  
 b. Plants small (shoots *ca.* 0.5-3 mm wide); leaves not or weakly antically decurrent; leaf cells *ca.* 20-32  $\mu$ m wide; most commonly in base-rich flushes and other wet places<sup>11</sup>.....*Mesoptychia collaris*
34. a. Very small plants (shoots <1.2 mm wide), either very pale whitish-green or almost black; leaves often strongly concave; rare, confined to areas of late-lying snow in the Scottish Highlands.....35.  
 b. Larger plants (shoots 1-3.3 mm wide), green; leaves not or weakly concave; less rare, in upland flushes or on rocks and banks, often in woodland or coastal habitats <sup>12</sup>.....36.
35. a. Plants very pale whitish-green; underleaves relatively large, nearly as long as lateral leaves.....*Pleurocladula albescens*  
 b. Plants dark, often black; underleaves small, much shorter than lateral leaves.....*Nardia breidler*<sup>13</sup>
36. a. Leaves  $\pm$  concave antically; leaf lobes  $\pm$  acute, divided to *ca.*  $\frac{1}{3}$  leaf length; underleaves connate with lateral leaves; rocks and banks.....*Harpanthus scutatus*  
 b. Leaves  $\pm$  convex antically; leaf lobes  $\pm$  rounded, divided to *ca.*  $\frac{1}{3}$  leaf length; underleaves not connate with lateral leaves; upland flushes.....*Harpanthus flotovianus*

<sup>10</sup> Including var. *laxa*, currently known only from one site in Norfolk. *Mesoptychia rutheana*, also very rare and mainly in mires in northern England and southern Scotland, differs in its larger size and much larger and more ciliate underleaves.

<sup>11</sup> But there is considerable overlap in the habitat preferences of *Mesoptychia collaris* and *M. bantriensis*.

<sup>12</sup> Forms of *Nardia geoscyphus* with  $\pm$  bilobed leaves may key out here: it is small, with shoots only *ca.* 0.5-2 mm wide, green, has 1-5 oil bodies in most leaf cells (up to 10-15 in *Harpanthus*), and is a colonist of bare sandy soils.

<sup>13</sup> *Nardia insecta* (confined to a single site in Northumberland and not seen there recently) is a larger plant with larger leaf cells.

## Section 7

Leaves asymmetrical, either (i)  $\pm$  complicate-bilobed; leaf lobes very unequal, one clearly smaller than the other, or (ii) very asymmetrical tribobed, or (iii) modified into a 'pocket' or 'sac'; no underleaves.

1. a. Leaves trilobed or simply and shallowly bilobed to  $< \frac{1}{4}$  length of leaf; no modification of leaf lobes into lobules or sacs.....2.  
b. Leaves  $\pm$  deeply complicate-bilobed to  $> \frac{1}{4}$ , or one lobe modified into a flap-like lobule or a  $\pm$  inflated sac.....7.
2. a. Leaves narrowly triangular (or apparently so), tapering to narrow, pointed apex<sup>1</sup>..... 3.  
b. Leaves  $\pm$  broadly ovate-triangular, with  $\pm$  broad apex.....5.
3. a. Gemmae absent; large purplish-brown alpine plants in boulder scree etc..... *Anastrophyllum donnianum*  
b. Red gemmae nearly always present at shoot tips; small bright green plants on rotting wood and peaty soils, mostly lowland.....4.
4. a. Gemmae 14-22  $\mu\text{m}$  wide, angular; leaf cells *ca.* 19-22  $\mu\text{m}$  wide..... *Tritomaria exsectiformis*  
b. Gemmae 8-12  $\mu\text{m}$  wide, angular; leaf cells *ca.* 10-14  $\mu\text{m}$  wide.....*Tritomaria exsecta*
5. a. Leaves nearly all trilobed, the postical margin usually strongly arched, making the leaves very asymmetrical..... *Tritomaria quinquedentata*<sup>2</sup>  
b. Leaves weakly bilobed, the postical margin not strongly arched.....6.
6. a. Leaves convex antically with postical (ventral) margin  $\pm$  strongly recurved; often with clusters of red gemmae at shoot apex..... *Anastrepta orcadensis*  
b. Leaves concave antically with postical margin plane or incurved; gemmae absent.....*Pseudomarsupidium decipiens*<sup>3</sup>
7. a. Leaf lobes about equal, long-ciliate and decurved at apex; postical part of lamina inflated..... *Cephalozia (Nowellia) curvifolia*  
b. Postical and antical leaf lobes very different in size, not long-ciliate or decurved; postical part of lamina not inflated.....8.
8. a. Postical (ventral) leaf lobe (lobule) smaller than antical (dorsal) lobe..... 9.  
b. Antical (dorsal) leaf lobe smaller than postical (ventral) lobe.....16.

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<sup>1</sup> *Anastrophyllum donnianum* has leaves that appear to be narrower than they actually are, because they are very concave and inrolled, so keys out here.

<sup>2</sup> *Tritomaria quinquedentata* is sometimes confused with species of *Barbilophozia* sens. lat. However, these never have strongly asymmetrical leaves with a strongly arched postical leaf margin, and also often have underleaves, so key out elsewhere.

<sup>3</sup> The rare alpine species *Anastrophyllum alpinum* and *A. joergensenii*, both quite unlike *P. decipiens*, will also key out here. Both have very concave leaves and are similar to (and often grow with) *A. donnianum*, except for leaf shape. *A. joergensenii* is small and matt, while *A. alpinum* is larger and glossy.

9. a. Large (shoots 1.5-4 mm wide) purplish plant on *Sphagnum* and peat in western moorland and bogs..... *Pleurozia purpurea*  
b. Medium-sized to very small (shoots < 2.5 mm wide) usually pale green plants on rocks or trees.....10.
10. a. Plants relatively large (shoots up to ca. 2.5 mm wide); leaves sharply keeled where lobe and lobule are attached; lobule a  $\pm$  quadrate flap, pressed closely against the underside of the antical (dorsal) lobe; oil bodies large, usually 1 per cell..... 11.  
b. Plants very small (shoots < 1/3 mm wide); leaves not sharply keeled; lobule modified into a  $\pm$  inflated sac; oil bodies numerous.....13.
11. a. Plants dull dark green to purplish-brown; leaves with marginal cells thick-walled, not producing gemmae; lobules  $\pm$  inflated..... *Radula aquilegia*<sup>4</sup>  
b. Plants pale green; leaves with marginal cells thin-walled, often producing gemmae; lobules not inflated.....12.
12. a. Paroicous; flattened perianths nearly always present; gemmae present but often less frequent than below; very common, especially as a lowland epiphyte<sup>5</sup>..... *Radula complanata*  
b. Dioicous; perianths rare; gemmae abundant; frequent, especially on upland rocks.....*Radula lindenbergiana*
13. a. Leaf lobe cells strongly mamilliose on antical (dorsal) surface; on limestone and other base-rich rocks..... 14.  
b. Leaf lobe cells  $\pm$  smooth on antical (dorsal) surface; not strongly calcicolous.....15.
14. a. Lobule cells mamilliose..... *Cololejeunea rossettiana*  
b. Lobule cells smooth.....*Cololejeunea calcarea*
15. a. Most leaves long and narrow; perianths scarce, smooth; usually on damp shaded rocks in oceanic districts..... *Cololejeunea (Aphanolejeunea) microscopica*  
b. Leaves suborbicular; perianths abundant, 5-keeled; usually epiphytic; not confined to oceanic districts.....*Cololejeunea minutissima*
16. a. Leaves lingulate, very obtuse at apex; leaf margins crenulate to minutely toothed; leaf cells small, 12-16  $\mu$ m wide; gemmae stellate; oil bodies 2-6 per cell; always calcifuge..... 17.  
b. Leaves broadly ovate or, if narrower, then narrowing to a  $\pm$  acute apex; leaf cells usually larger, ca. 14-28  $\mu$ m wide; gemmae smooth to angular but not stellate; oil bodies various, occasionally only 1 per cell; sometimes calcicole.....18.

<sup>4</sup> *Radula carringtonii* is a very rare oceanic species with the lobule less inflated than in *R. aquilegia*.

<sup>5</sup> *Radula complanata* and *R. lindenbergiana* can really only be reliably separated when fertile, but the other characters given are indicative. *R. voluta* and *R. holtii* are very rare oceanic species. *R. voluta* has the lobules greatly expanded and crossing the stem widely; *R. holtii* has the antical margin of the leaf not crossing the stem, and it usually has long trumpet-shaped perianths.

17. a. Leaf lobes with a band of long narrow cells forming a distinct vitta down the centre; very common..... *Diplophyllum albicans*  
 b. Leaf lobes with  $\pm$  elongated central cells, but these not forming a vitta; less common (but probably overlooked) pioneer species<sup>6</sup>.....*Diplophyllum obtusifolium*
18. a. Leaf lobes all  $\pm$  narrowly lanceolate in outline and sharply acute at apex<sup>7</sup>..... 19.  
 b. Leaf lobes wider, obtuse or, if acute, widely ovate in outline.....20.
19. a. Leaves coarsely toothed; red gemmae often present; plants translucent, not waxy..... *Scapania umbrosa*  
 b. Leaves entire or very obscurely toothed; gemmae absent; plant with characteristically opaque, waxy appearance.....*Douinia ovata*
20. a. Leaves deeply divided to near base, with both lobes closely and strongly toothed; uncommon alpine plants of turf or among rocks on NE-facing slopes..... 21.  
 b. Leaves less deeply divided, with a clear keel  $>\frac{1}{2}$  the leaf length joining the lobes; lobes often toothed but rarely so strongly and closely; habitat various.....22.
21. a. Leaves closely toothed, each lobe with  $>40$  teeth mainly 1-2 cells long,  $\pm$  straight..... *Scapania ornithopodioides*  
 b. Leaves more remotely toothed, each lobe with  $<30$  teeth mainly 1-4 cells long, often curved.....*Scapania nimbosa*
22. a. Cuticle *coarsely* papillose; dark green to brown plants with green gemmae; strongly calcicolous.....23.  
 b. Cuticle smooth or *weakly* papillose; plants and gemmae various colours; not, or weakly, calcicolous.....24.
23. a. Leaf lobes unequal; antical lobe decurrent; gemmae 25-38  $\mu\text{m}$  long; leaves with marginal cells  $\pm$  the same as median cells..... *Scapania aspera*<sup>8</sup>  
 b. Leaf lobes subequal; antical lobe not decurrent; gemmae 20-28  $\mu\text{m}$  long; leaves with marginal cells distinctly smaller than median cells.....*Scapania aequiloba*
24. a. Leaves subequally bilobed, not keeled,  $\pm$  sheathing at base; gemmae red..... *Scapania cuspiduligera*  
 b. Leaves unequally bilobed, the antical lobe much smaller than the postical lobe,  $\pm$  keeled, not sheathing at base; gemmae variously coloured.....25.

<sup>6</sup> *Diplophyllum taxifolium* is a rarer montane plant; it is dioicous and always green or brownish, whereas *D. obtusifolium* is mainly lowland, aroicous and usually has some reddish or purplish colouration.

<sup>7</sup> Some rarer species of *Scapania* may occasionally key out here, but none has the very narrow and coarsely toothed lobes of *S. umbrosa*, or the pale, opaque waxy green texture of *Douinia ovata*.

<sup>8</sup> *Scapania calcicola* is much rarer than either *S. aspera* or *S. aequiloba*; it is bright green with red gemmae, has a clearly smaller but non-decurrent antical lobe, and the leaves have a border of smaller, thicker-walled cells.

25. a. Leaves relatively long and narrow, *ca.* 1.5-2 x as long as wide; leaf lobes not or hardly decurrent..... *Scapania scandica*<sup>9</sup>  
 b. Leaves relatively short and broad, *ca.* 1-1.5 x as long as wide; one or both lobes often clearly decurrent .....26.
26. a. Keel strongly arcuate in all leaves; uncommon.....27.  
 b. Keel straight or weakly arcuate; very common.....29.
27. a. Both postical and antical lobes clearly and  $\pm$  longly decurrent..... *Scapania uliginosa*<sup>10</sup>  
 b. Antical lobe not decurrent; postical lobe not or  $\pm$  shortly decurrent; habitat various.....28.
28. a. Leaves bordered with 2-4 rows of thick-walled marginal cells; marginal teeth 1-3 cells long; calcicole, mainly montane flushes and turf; distribution centred in Scottish Highlands..... *Scapania degenii*  
 b. Leaves unbordered; marginal teeth mostly unicellular; not calcicole, mainly in flushes and other wet ground; distribution centred in Wales.....*Scapania paludicola*<sup>11</sup>
29. a. Postical lobe long-decurrent.....30.  
 b. Postical lobe not, or very shortly, decurrent.....31.
30. a. Plants green, usually with contrasting clusters of brown gemmae at shoot apex; leaves strongly toothed, with antical lobe shortly decurrent; on rocks, banks, rotten wood, etc, not semi-aquatic..... *Scapania nemorea*  
 b. Plants usually strongly tinged purple, with less contrasting green or pinkish gemmae; leaves weakly or not toothed, with antical lobe not decurrent; plant semi-aquatic.....*Scapania undulata*<sup>12</sup>
31. a. Antical lobe usually strongly angled away from postical lobe, and always with teeth at base; *brownish*-green plants of rocks, banks and tree bases, very common in oceanic areas..... *Scapania gracilis*  
 b. Antical lobe  $\pm$  appressed to postical lobe, without teeth at base; pale greenish plants of various habitats, generally common except in eastern England.....*Scapania irrigua*<sup>13</sup>

<sup>9</sup> Several much rarer *Scapanias* will also key out here: *S. gymnostomophila* is distinctive in most leaf cells having a single, large oil body; *S. lingulata* has large leaf cells (*ca.* 20-27  $\mu\text{m}$  wide, vs. *ca.* 14-20  $\mu\text{m}$ ); *S. curta* has slightly larger leaf cells than *S. scandica*, but the leaves are bordered with strongly and almost uniformly thick-walled cells (no clear border in *S. scandica*) – it is rare but probably overlooked in ruderal habitats. Two other similar species, *S. parvifolia* and *S. praetervisa*, are exceedingly rare.

<sup>10</sup> The considerably rarer *Scapania paludosa* will also key out here. It differs in the antical lobe not being strongly convex, the marginal teeth being sharply acute and trigones minute or absent. In *S. uliginosa*, the antical lobe is strongly convex (almost inflated), the marginal teeth are blunt, and the trigones often large.

<sup>11</sup> Some forms of the common *S. irrigua* have the keel rather strongly arcuate in some leaves, but there are usually other leaves where the keel is only weakly arcuate. Also the antical lobes in *S. paludicola* are more appressed than those of *S. irrigua*, with their apex directed more towards the shoot apex; *S. irrigua* is common in a variety of habitats, including ruderal places, whereas *S. paludicola* is rare and habitat-restricted.

<sup>12</sup> Note that *Scapania subalpina* has the leaf lobes almost equal in size, so should key out in Section 5.

<sup>13</sup> *Scapania irrigua* is often the *Scapania* one is left with after all the other possibilities have been exhausted! The rare *Sphenolobus saxicola* will also key out here. It is distinct from *Scapania* in that the postical lobes of



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the apical leaves are concave and fold over the shoot apex. Also the leaf is hardly keeled, the leaves are entire and gemmae are unknown. It is confined to block scree in the Cairngorms and one site in Sutherland.

## Section 8

Leaves asymmetrical, either (i)  $\pm$  complicate-bilobed; leaf lobes very unequal, one clearly smaller than the other, or (iii) modified into a 'pocket' or 'sac'; with underleaves.

1. a. Whole leaf modified into an inflated sac with a long beak; shoots with one underleaf for every lateral leaf (so double the 'leafy liverwort norm'); very small tufted yellow-green plants on shaded rocks and trees ..... *Colura calyptrifolia*  
b. Leaf not inflated with a long beak; shoots with one underleaf for every pair of lateral leaves; plants small to large, habit and habitat various.....2.
2. a. Postical leaf lobe  $\pm$  ovate, plane or concave but not inflated or sac-like..... 3.  
b. Postical leaf lobe inflated, sac-like or helmet-shaped.....7.
3. a. Leaf lobules and underleaves very small, not or scarcely wider than stem, untoothed;  $\pm$  aquatic, locally common in the south-west..... *Porella pinnata*  
b. Leaf lobules and underleaves larger, with at least the underleaves wider than the stem, often  $\pm$  toothed; habitat various but not distinctively aquatic, generally distributed.....4.
4. a. Underleaves and lobules usually  $\pm$  strongly toothed; if entire, then leaf lobes usually acute to acuminate, with the antical margin neatly appressed; plant tasting acid.....*Porella arboris-vitae*  
b. Underleaves and lobules usually entire or with a few teeth at base only; leaf lobes rounded, with antical margin sometimes recurved or elevated; plant not tasting acid.....5.
5. a. Lobules widely ovate and nearly as wide as underleaves,  $\pm$  flat or slightly concave, with margins plane or narrowly recurved; plants glossy..... *Porella obtusata*  
b. Lobules lanceolate to ovate, usually less than half the width of the underleaves,  $\pm$  strongly concave, with  $\pm$  strongly recurved margins; if lobules wider, then plants matt.....6.
6. a. Lobules rounded at apex, usually not or slightly decurrent..... *Porella platyphylla*  
b. Lobules tapering to acute apex, distinctly decurrent.....*Porella cordaeana*
7. a. Lobules helmet-shaped, very narrowly attached to base of antical leaf lobe..... 8.  
b. Lobules  $\pm$  inflated, saccate, broadly attached to antical leaf lobe.....13.
8. a. Leaf lobes acuminate and margins  $\pm$  dentate; uncommon oceanic species..... *Jubula hutchinsiae*  
b. Leaf lobes broadly rounded to acuminate and margins not toothed; common and generally distributed.....9.
9. a. Ocelli (enlarged cells) present in antical leaf lobes..... 10.  
b. Ocelli absent.....12.
10. a. Most leaf lobes acutely pointed; underleaves with (at least partly) recurved margins; plant not aromatic..... *Frullania tamarisci*

- b. All leaf lobes rounded; underleaves with plane margins; plant  $\pm$  strongly aromatic.....11.
11. a. Leaf lobes with cells *ca.* 16-22  $\mu\text{m}$  wide and ocelli scattered, rarely forming a line; underleaves 1.5-3 times wider than stem, usually 'shouldered' and divided to  $<\frac{1}{2}$ .....*Frullania fragilifolia*<sup>1</sup>  
 b. Leaf lobes with cells *ca.* 10-16  $\mu\text{m}$  wide and some ocelli forming a distinct median line; underleaves less than twice as wide as stem, usually not 'shouldered' and divided to *ca.*  $\frac{1}{2}$ .....*Frullania microphylla*
12. a. Leaf lobes rounded; lobule about as long as wide, somewhat smaller than lobe; perianth tuberculate; common and widespread.....*Frullania dilatata*  
 b. Leaf lobes usually acutely pointed; lobule clearly longer than wide, much smaller than lobe; ocelli often present; perianth smooth; common only in oceanic areas.....*Frullania teneriffae*<sup>2</sup>
13. a. Underleaves undivided; medium-sized blackish-green plants on strongly calcareous rocks, occasionally on trees.....*Marchesinia mackaii*  
 b. Underleaves bilobed; small, usually pale green plants on rocks and trees.....14.
14. a. Leaf lobes acutely or acuminate pointed; underleaves with a very wide, obtuse sinus, so lobes widely diverging; strongly oceanic species..... 15.  
 b. Leaf lobes obtuse to broadly rounded; underleaves with a narrow,  $\pm$  acute V-shaped or lunate sinus, lobes not diverging; oceanic or not..... 16.
15. a. Leaf lobes ovate, entire; underleaves with blunt lobes, rounded at apex with no uniseriate row ..... *Harpalejeunea mollerii*  
 b. Leaf lobes ovate-lanceolate, toothed; underleaves with narrow subulate lobes terminating in a row of 2-3 uniseriate cells.....*Drepanolejeunea hamatifolia*
16. a. Plants minute (shoots  $<0.35$  mm wide); lobule nearly as large as lobe ..... *Microlejeunea ulicina*<sup>3</sup>  
 b. Plants larger (shoots up to *ca.* 1.5 mm wide); lobule much smaller than lobe.....17.
17. a. Underleaves large, mostly 2-4 times larger than the lobules; oil bodies small, homogenous and numerous (25 or more per cell), persistent..... *Lejeunea cavifolia*<sup>4</sup>

<sup>1</sup> *Frullania fragilifolia* is nearly always more strongly aromatic than *F. microphylla*. As the name suggests, *F. fragilifolia* always has caducous leaves, which readily detach when prodded (hence the English name 'spotty fingers'); *F. microphylla* can sometimes have caducous leaves (var. *deciduiifolia*).

<sup>2</sup> *Frullania teneriffae* is more likely to be confused with *F. tamarisci*, with which it often grows, but, apart from not having ocelli, is distinctive in the field, with its large 'floppy' underleaves and the leaf lobule often more highly pigmented than, and contrasting with, the lobe.

<sup>3</sup> The rare Irish species *Lejeunea hibernica* might key out here, but it is a little larger than *M. ulicina* and has very variable leaves, with the lobules ranging from very large to very small; the shoots are rather stiff and spiky-looking, and the leaf cells tend to be regularly and uniformly thickened.

b. Underleaves small, mostly less than twice the size of the lobules; oil bodies large, granular and few (usually *ca.* 2-14 per cell), fugacious .....18.

18. a. Lobules strongly inflated, much larger than underleaves, forming an angle of *ca.* 90° at the junction with the lobe..... *Lejeunea patens*  
b. Lobules not strongly inflated, smaller to slightly larger than underleaves, forming an angle of 110-180° at the junction with the lobe.....*Lejeunea lamacerina*<sup>5</sup>

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<sup>4</sup> Two rare oceanic species may key out here: *Lejeunea flava* is a bright yellow-green plant with even larger underleaves that tend to be longer than wide, and few (*ca.* 3-8) granular oil bodies per cell; *L. eckloniana* has leaves much longer in proportion to their width and is usually darker green.

<sup>5</sup> The very rare *Lejeunea mandonii* is smaller with narrower ovate (not orbicular) leaves and a smooth (not 5-angled) perianth. *L. hibernica* may also key out here (see note above, under *Microlejeunea ulicina*).