





HANDBOOK OF LIVERWORTS  
AND HORNWORTS  
OF THE IBERIAN PENINSULA  
AND THE BALEARIC ISLANDS

ILLUSTRATED KEYS TO GENERA AND SPECIES



INSTITUT D'ESTUDIS CATALANS  
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Professor Creu Casas, member of the Biological Sciences Section of the Institute of Catalan Studies since 1978, became an emeritus member of this Institute in 1990.

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*Our colleague, Dr Creu Casas, passed away on 20 May 2007.*

*The remaining authors and collaborators, having now completed this work to which she gave so much of her enthusiasm and dedication, hope the result is what she would have wished.*





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# INTRODUCTION

The present book, devoted to liverworts and hornworts of the Iberian Peninsula and the Balearic Islands, has its basis in volume II, *Hepàtiques i antocerotes*, of *Flora dels Briòfits dels Països Catalans* (2004). By adding about 28% more species we were able to cover all the hepatics of the Iberian Peninsula and the Balearic Islands. We were thus encouraged to prepare this work, for which C. Sérgio and M. Infante joined the team of authors, and we counted on the collaboration of A.R. Perry, E. Ruiz and A. Barrón not only in their respective tasks of translation and illustration but also in the revision of texts and keys.

This handbook comprises identification keys to generic and specific level with corresponding illustrations. The keys are for the use of botanists, students, excursionists and people generally keen on bryology. It is not only of special interest to local people but to foreigners collecting in our area of study, and for the latter we thought that an English version would make its use easier.

At the present time there is no updated flora for identification of hepatics in the Iberian Peninsula and the Balearic Islands. “Sinopse das Briófitas de Portugal” (Machado, 1925) published in *Boletim da Sociedade Broteriana* and *Flora Ibérica, Briófitas (1ª parte) Hepáticas* (Casares-Gil, 1919) published by Museo Nacional de Ciencias Naturales are both very important works but now somewhat outdated.

The study area for the present work is located in the extreme southwest of Europe and includes the Iberian Peninsula (peninsular Spain, Portugal and Andorra), and the Balearic Islands. Biogeographically it covers the Mediterranean and Eurosiberian regions (Fig. 1). There is a noteworthy climate variability and a wide range of altitudes from sea level to summits over 3000 m in the Pyrenees and Sierra Nevada, as well as a rich diversity of soil types. All these circumstances produce very different and often contrasting environments, and, as a consequence, a high bryophyte richness overall. We recognised 286 species, which represent 68% of the European hepatic flora.

The illustrations are from those in volume II of *Flora dels Briòfits dels Països Catalans* with further original drawings for most of the species added.

The following have been consulted during the preparation of this volume, in addition to the previously mentioned work by A. Casares-Gil (1919): *The liverwort flora of the British Isles* by J.A. Paton (1999); *The liverworts of Britain and Ireland* by A.J.E. Smith (1990); *Hepatophyta, Part 1: Marchantiopsida: Marchantiidae* by S.M. Perold, in O.A. Leistner (Ed.) *Flora of Southern Africa* (1999); *Identification keys to the liverworts and hornworts of Europe*



FIGURE 1. Map of the Iberian Peninsula and the Balearic Islands, with the mountains cited in the text.

and Macaronesia. 2<sup>nd</sup> ed. by R. Schumacker & J. Váňa (2005); *Illustrated flora of Nordic Liverworts and Hornworts* by K. Damsholt (2002) and “Les Riccia de la région Méditerranéenne”, in *Cryptogamie, Bryologie Lichénologie*, by S. Jovet-Ast (1986).

This work together with the *Handbook of Mosses of the Iberian Peninsula and the Balearic Islands* (2006), also published by Institut d’Estudis Catalans, supply the needed keys for determination of bryophytes of the Iberian Peninsula and the Balearic Islands.

## PRACTICAL INSTRUCTIONS

**Determination keys.** The artificial key to genera comprises two parts. In the first part, by means of the use of morphological characters, usually of easy interpretation, different groups are delimited. In the second part the genera gathered in these artificial groups are separated. For family classification and order, as well as for most of the generic names and authorities, we followed R. Grolle & D.G. Long (“An annotated check-list of the Hepaticae and Anthocerotae of Europe and Macaronesia”, in *Journal of Bryology*, 2000), K.S. Renzaglia *et al.* (“New insight into morphology, anatomy and systematics of hornworts”, in B. Goffinet & A. J. Shaw (Eds.), *Bryophyte Biology*, 2008) and R.M. Ros *et al.* (“Hepatics and Anthocerotes of the Mediterranean, an annotated checklist”, in *Cryptogamie, Bryologie*, 2007), except for *Leicolea* which is included in the genus *Lophozia*. Genera are arranged alphabetically within each family.

Each genus includes a short morphological description referring only to the species that appear in the present work. In monospecific genera the species name follows the description; if plurispecific a key to species is given. We have tried to base our keys on gametophytic characters as far as possible but in some species and even genera we have found it necessary to refer to fertile material. When sizes are given the first value corresponds to the length and the second to the width.

After the specific name, in addition to the differential characters, information to achieve the correct identification is supplied. After this we mention the growth form, ecology and vegetation zone. Geographical distribution (Fig. 1) is given in the broad sense in the Iberian Peninsula but for more localized species the specific isle or isles of the Balearic Islands, or the mountain ranges where they occur are given. Countries in the Iberian Peninsula are abbreviated: Esp (continental Spain), Prt (Portugal), And (Andorra). For the Balearic Islands (Bl) we specify the different isles: Mallorca (which includes the small isles of Cabrera and Dragonera), Menorca, and Pithyusic Islands (including Eivissa and Formentera).

Specimens used for preparing the keys and drawings are mainly from BCB, LISU and VIT herbaria. Illustrations were made from moist material. When possible, similar details have similar or equal magnifications, although this information is always indicated in the legends.





## ARTIFICIAL KEY TO GENERA

- |   |  |   |    |
|---|--|---|----|
| 1 | Plants thallose ( <i>Fossombronia</i> with wings deeply divided into crisped or undulate lobes looks like a foliose liverwort)                             | 2 |    |
| 1 | Plants leafy, leaves arranged in 2-3 rows along stem   |   |    |
|   | <b>FOLIOSE LIVERWORTS</b>  |   | 19 |
| 2 | Thallus cells usually with single, large chloroplast; capsule cylindrical, dehiscing by 2 valves   |   |    |
|   | <b>HORNWORTS</b>   |   | 25 |
| 2 | Thallus cells with numerous chloroplasts or chloroplasts lacking; capsule globose, ovoid, ellipsoidal or cylindrical, dehiscing by 4 valves or irregularly |   |    |
|   | <b>THALLOID LIVERWORTS</b>   |   | 15 |

### THALLOID LIVERWORTS

It is essential to prepare transverse sections of the thallus for identifying members of this group

- |   |   |                      |    |
|---|---|----------------------|----|
| 1 | Thallus without chlorophyll, subterranean   | <b>Cryptothallus</b> |    |
| 1 | Thallus with chlorophyll, growing above ground  | 2                    |    |
| 2 | Thallus circular, completely covered with clavate involucre on dorsal side  |                      |    |
|   | <b>Sphaerocarpos</b>  |                      | 54 |
| 2 | Thallus not as above or not completely covered with clavate involucre   | 3                    |    |
| 3 | Thallus simple, erect, with single dorsal wing; growing mostly submerged in saline waters   |                      |    |
|   | <b>Riella</b>   |                      | 54 |
| 3 | Thallus simple or furcate, prostrate, lateral wings present or lacking; growing in different types of substrata   | 4                    |    |
| 4 | Dorsal epidermis reticulate or not, with pores or irregular openings and usually with air-chambers; rhizoids dimorphic, smooth or warty; parenchyma and chlorenchyma differentiated | <b>TA</b>            | 16 |

- 4 Dorsal epidermis not reticulate, without pores or air-chambers; rhizoids smooth; parenchyma and chlorenchyma undifferentiated **TB** 17

**TA. Thallus with internal differentiation; dorsal epidermis with pores; rhizoids smooth or warty**

- 1 Dorsal side of thallus with gemma-receptacles **2**
- 1 Dorsal side of thallus without gemma-receptacles **3**
- 2 Gemma-receptacles semilunar **Lunularia** 34
- 2 Gemma-receptacles cup-shaped **Marchantia** 35
- 3 Plants in complete or incomplete rosettes; chlorenchyma with air canals or with air chambers with irregular openings or small pores; capsules totally or partially immersed in thallus **4**
- 3 Plants not in rosettes; chlorenchyma with air chambers with simple or compound pores; capsules not immersed in thallus (in *Corsinia* partially immersed) **6**
- 4 Ventral scales very large, silvery, projecting well beyond margins of thallus; capsules covered by a fleshy, conical or pyramidal involucre, 1-2 mm high **Oxymitra** 38
- 4 Ventral scales not projecting beyond margins of thallus or scales pendent; capsules without involucre or involucre rudimentary **5**
- 5 Ventral scales numerous, pendent, 3-6 mm long, with denticulate margins; plants floating **Ricciocarpos** 40
- 5 Ventral scales lacking or ventral scales small, not pendent, with entire margins; plants terrestrial, rarely floating **Riccia** 40
- 6 Thallus semi-translucent, greasy in appearance, without pores, air chambers or ventral scales, except at apex of lobes, with hairs at margin **Dumortiera** 37
- 6 Thallus opaque, with pores, air chambers or ventral scales, without hairs at margin **7**
- 7 Pores conspicuously elevated; air chambers wide and high, very prominent, vault-shaped or conical, with a pore in the apex **Exormotheca** 37
- 7 Pores slightly elevated or nearly plane; air chambers not as above **8**
- 8 Pores compound, conspicuous **9**
- 8 Pores simple, conspicuous or not **10**
- 9 Ventral scales in 2-3 rows on either side of midrib, the inner one with an orbicular or cordate appendage; female receptacle stalked, discoid, with 9-11 digitiform rays **Marchantia** 35

- 9 Ventral scales in 1 row on either side of midrib, with a small, lanceolate, caducous appendage; female receptacle stalked, hemispherical to conical, 3-4-lobed **Preissia** 35
- 10 Epidermis conspicuously reticulate, with elongate areolae 1 or more mm long **Conocephalum** 32
- 10 Epidermis conspicuously reticulate, with areolae less than 1 mm long or reticulate lacking 11
- 11 Thallus soft-textured, never with red colorations; capsule globose, inside a fleshy, warty calyptra, along the dorsal mid line of thallus **Corsinia** 38
- 11 Thallus not soft-textured, usually with red colorations; capsule not as above 12
- 12 Ventral scales dark purplish or blackish, with acute, triangular, caducous appendage; female receptacle sessile, on the ventral side or at apex of lobes; capsule surrounded by a bivalved, dark involucre **Targionia** 27
- 12 Ventral scales not as above; female receptacle stalked, on the dorsal side of lobes; capsule not surrounded by a bivalved, coriaceous involucre 13
- 13 Ventral scales metallic purple, with 2 filiform appendages; pores prominent, surrounded by 4-5 concentric rings of cells **Reboulia** 28
- 13 Ventral scales pink, purple or nearly hyaline, with 1-2 lanceolate, triangular, orbicular or oblong appendages; pores prominent or not, surrounded by 1-5 concentric rings of cells 14
- 14 Air chambers high, obliquely in 2-3 layers; ventral scales triangular, purplish or hyaline, with a lanceolate appendage **Athalamia** 34
- 14 Air chambers low, vertically in 1-3 layers; ventral scales not as above 15
- 15 Ventral scales with 1 triangular or orbicular appendage constricted at base **Plagiochasma** 28
- 15 Ventral scales with 1-2 lanceolate or oblong appendages not constricted at base 16
- 16 Pseudoperianth around sporophyte lacinate in 4(-8) lanceolate, hyaline segments connate apically **Asterella** 30
- 16 Pseudoperianth lacking **Mannia** 30

**TB. Thallus without internal differentiation; dorsal epidermis without pores; rhizoids smooth**

- 1 Thallus circular or cordate; wings with erect lamellae on dorsal side radially arranged from midrib to margin **Petalophyllum** 69
- 1 Thallus not as above 2

- |   |   |                     |    |
|---|---|---------------------|----|
| 2 | Thallus simple or furcate; wings plane, undulate or crisped; antheridia and perianths covered by lamellae   | 3                   |    |
| 2 | Thallus not as above  | 4                   |    |
| 3 | Midrib with a central strand of narrow, elongate, dark-walled cells   |                     |    |
|   |   | <b>Pallavicinia</b> | 63 |
| 3 | Midrib without central strand   | <b>Moerckia</b>     | 65 |
| 4 | Wing lobulate or deeply divided into crisped or undulate lobes similar to leaves and which are obliquely inserted   | 5                   |    |
| 4 | Wing entire   | 6                   |    |
| 5 | Wing lobulate, lobes crisped near apex; gemmae dimorphic, stellate, about 500 µm wide or gemmae globose or ellipsoidal, produced in flask-shaped receptacles on dorsal surface of thallus   | <b>Blasia</b>       | 65 |
| 5 | Wing deeply divided into crisped or undulate lobes similar to leaves, obliquely inserted, arranged in 2 ranks along the midrib; gemmae lacking  | <b>Fossombronia</b> | 65 |
| 6 | Thallus furcate, to 2 mm wide, with unicellular hairs at margins, on ventral or on both sides, sometimes glabrous; midrib narrow, clearly distinct on the dorsal side; gametangia and sporophytes on small branches on ventral side of midrib | 7                   |    |
| 6 | Thallus simple, furcate, pinnate, palmate or irregularly branched, more than 3 mm wide, glabrous; midrib indistinct or poorly distinct on the dorsal side; gametangia and sporophytes on dorsal side of thallus or on lateral branches        | 8                   |    |
| 7 | Thallus densely hairy on both sides; plants growing on basic substrata  | <b>Apometzgeria</b> | 58 |
| 7 | Thallus with scarce hairs at margins or on ventral side, or glabrous; plants growing on basic or acidic substrata   | <b>Metzgeria</b>    | 56 |
| 8 | Thallus furcate; gametangia on dorsal side of thallus   | <b>Pellia</b>       | 63 |
| 8 | Thallus simple, pinnate, palmate or irregularly branched; gametangia on small lateral branches  | 9                   |    |
| 9 | Thallus simple or irregularly branched; more than 6 oil-bodies in each epidermal cell   | <b>Aneura</b>       | 58 |
| 9 | Thallus 1-4-pinnately branched or palmate; 0-2 oil-bodies in each epidermal cell  | <b>Riccardia</b>    | 60 |

## FOLIOSE LIVERWORTS

1	Leaves laciniate, divided almost to base into filiform segments or leaves with longly ciliate or laciniate margins	FA	19
1	Leaves simple or lobed, without ciliate or laciniate margins	2	
2	Leaves arranged in 3 rows along stem; branches radially symmetrical	<b>Haplomitrium</b>	69
2	Leaves arranged in 2-3 rows along stem; plants with dorsiventral symmetry	3	
3	Leaves simple	4	
3	Leaves lobed	6	
4	Leaves opposite	FB	20
4	Leaves alternate	5	
5	Leaves incubous	FC	20
5	Leaves succubous	FD	20
6	Leaves 3-5-lobed	FE	21
6	Leaves bilobed	7	
7	Leaves conduplicate, ventral lobes sometimes sac-shaped or helmet-shaped	8	
7	Leaves not conduplicate	9	
8	Underleaves lacking	FF	21
8	Underleaves present	FG	22
9	Leaves transversely or subtransversely inserted	FH	23
9	Leaves obliquely or longitudinally inserted	10	
10	Leaves incubous	<b>Calypogeia</b>	24
10	Leaves succubous	FI	

## FA. Leaves laciniate or with longly ciliate or laciniate margins

1	Leaves laciniate, divided almost to base into 3-4 uniseriate segments	2	
1	Leaves divided into 2-5 lobes that are not uniseriate, with longly ciliate or laciniate margins	3	
2	Underleaves similar in size to leaves	<b>Blepharostoma</b>	136
2	Underleaves half or less than length of leaves	<b>Telaranea</b>	128
3	Leaf lamina very reduced	<b>Trichocolea</b>	136
3	Leaf lamina well developed	<b>Ptilidium</b>	138

**FB. Leaves simple, opposite**

1	Underleaves well developed	<b>Saccogyna</b>	105
1	Underleaves lacking	2	
2	Basal cells at ventral margin of leaves 4 times as long as wide; plants calcicolous	<b>Southbya</b>	96
2	Basal cells at ventral margin of leaves 4-6 times as long as wide; plants calcifuge	<b>Gongylanthus</b>	98

**FC. Leaves simple, alternate, incubous**

1	Leaf apex rounded to bilobed; underleaves bilobed, retuse, emarginate or rounded	<b>Calypogeia</b>	133
1	Leaf apex truncate, usually with 1-3 teeth; underleaves simple or with 4-5 small lobes, with sinuose to dentate margins	<b>Bazzania</b>	131

**FD. Leaves simple, alternate, succubous**

1	Underleaves present, conspicuous, bilobed	2	
1	Underleaves lacking, minute or small, rarely bilobed	3	
2	All leaves simple, with rounded or retuse apex	<b>Chiloscyphus</b>	102
2	At least some lower leaves bilobed	<b>Lophocolea</b>	100
3	Leaf margin toothed, at least at apex	4	
3	Leaf margin entire	5	
4	Dorsal margin of leaves incurved	<b>Adelanthus</b>	116
4	Dorsal margin of leaves plane or recurved	<b>Plagiochila</b>	99
5	Leaf cells more than 50 $\mu\text{m}$ wide	<b>Mylia</b>	83
5	Leaf cells less than 50 $\mu\text{m}$ wide	6	
6	Underleaves present, at least on young plants	7	
6	Underleaves lacking or caducous	8	
7	Lower leaves spreading, the apical leaves imbricate, pressed face to face; perianth mouth denticulate or ciliate	<b>Jamesoniella</b>	83
7	Leaves not as above; perianth mouth at most crenulate	<b>Nardia</b>	91
8	Leaves strongly obliquely to longitudinally inserted	9	
8	Leaves transversely to obliquely inserted	10	

- |    |  |                      |     |
|----|--|----------------------|-----|
| 9  | Plants prostrate; rhizoids only at stem apex; leaves plane   | <b>Pedinophyllum</b> | 98  |
| 9  | Plants procumbent or ascending; rhizoids lacking or scarce on underground stems; leaves convex                   | <b>Plagiochila</b>   | 99  |
| 10 | Stems with ventral flagelliform branches or gemmae at stem tips; trigones large, often bulging                   | <b>Odontoschisma</b> | 126 |
| 10 | Stems without ventral flagelliform branches, gemmae usually lacking; trigones minute to large or lacking         | <b>11</b>            |     |
| 11 | Lower leaves spreading, the apical leaves imbricate, pressed face to face; perianth mouth denticulate or ciliate | <b>Jamesoniella</b>  | 83  |
| 11 | Leaves not as above; perianth mouth at most crenulate  | <b>Jungermannia</b>  | 85  |

### FE. Leaves 3-5-lobed

- |   |  |                      |     |
|---|--|----------------------|-----|
| 1 | Leaves succubous   | <b>2</b>             |     |
| 1 | Leaves incubous or nearly transverse   | <b>4</b>             |     |
| 2 | Rhizoids fascicled from the underleaves base                                       | <b>Lophocolea</b>    | 100 |
| 2 | Rhizoids scattered on the stem   | <b>3</b>             |     |
| 3 | Lower leaves bilobed, upper leaves irregularly 3-5-lobed                           | <b>Lophozia</b>      | 74  |
| 3 | All leaves 3-4-lobed   | <b>Barbilophozia</b> | 70  |
| 4 | Underleaves lacking  | <b>Tritomaria</b>    | 81  |
| 4 | Underleaves present, similar to leaves   | <b>5</b>             |     |
| 5 | Lobe margins dentate at base   | <b>Tetralophozia</b> | 69  |
| 5 | Lobe margins entire at base  | <b>6</b>             |     |
| 6 | Leaves transversely inserted, divided almost to base; lobes 2-4 cells wide at base | <b>Kurzia</b>        | 128 |
| 6 | Leaves incubous, divided to 1/4-1/3; lobes more than 4 cells wide at base          | <b>Lepidozia</b>     | 130 |

### FF. Leaves conduplicate; underleaves lacking

- |   |  |                     |     |
|---|--|---------------------|-----|
| 1 | Dorsal lobe larger than ventral lobe                   | <b>2</b>            |     |
| 1 | Dorsal lobe similar in size to ventral lobe or smaller | <b>3</b>            |     |
| 2 | Plants medium-sized                                    | <b>Radula</b>       | 138 |
| 2 | Plants minute  | <b>Cololejeunea</b> | 151 |

3	Dorsal lobe similar in size to ventral lobe	4	
3	Dorsal lobe smaller than ventral lobe	5	
4	Dorsal lobe with median cells 20-24 $\mu\text{m}$ wide, mostly isodiametric; leafy branches with a collar at base	<b>Cololejeunea</b>	151
4	Dorsal lobe with median cells 12-20 $\mu\text{m}$ wide, irregular; leafy branches without a collar at base	<b>Aphanolejeunea</b>	153
5	Lobes ovate-lanceolate, attenuated at apex; cuticle waxy	<b>Douinia</b>	107
5	Lobes lingulate to orbicular, not attenuated at apex; cuticle not waxy	6	
6	Ventral lobe narrowly lingulate, more than twice as long as wide; gemmae when present angulate	<b>Diplophyllum</b>	105
6	Ventral lobe orbicular to widely lingulate, less than twice as long as wide; gemmae when present ovoid to ellipsoidal, rarely angulate	<b>Scapania</b>	107

#### FG. Leaves conduplicate; underleaves present

1	Leaf margin spinosely toothed or ciliate	2	
1	Leaf margin entire or dentate	3	
2	Ventral lobe helmet-shaped, sometimes evolute, much smaller than underleaves	<b>Jubula</b>	146
2	Ventral lobe flat, similar in size to underleaves	<b>Porella</b>	140
3	Ventral lobe joined to dorsal lobe by a short or vestigial keel	4	
3	Ventral lobe joined to dorsal lobe by a conspicuous keel	5	
4	Ventral lobe sac-shaped or helmet-shaped; ocelli usually present in dorsal lobe	<b>Frullania</b>	142
4	Ventral lobe plane or convex; ocelli absent	<b>Porella</b>	140
5	Underleaves simple, rounded	<b>Marchesinia</b>	147
5	Underleaves bilobed	6	
6	Underleaf lobes diverging	7	
6	Underleaf lobes straight or more or less converging	8	
7	Underleaf lobes acuminate, 2 cells wide at base	<b>Drepanolejeunea</b>	147
7	Underleaf lobes rounded, 4-6 cells wide at base	<b>Harpalejeunea</b>	147
8	Plants minute; dorsal lobe of leaves not much larger than ventral lobe	<b>Microlejeunea</b>	151
8	Plants small; dorsal lobe of leaves larger than ventral lobe	<b>Lejeunea</b>	147



**FH. Leaves bilobed, transversely or subtransversely inserted**

1	Underleaves present		2
1	Underleaves lacking or very small		6
2	Underleaves large, similar in size to leaves	<b>Anthelia</b>	126
2	Underleaves smaller than leaves		3
3	Plants filiform or very small; leaves to 0,3 mm long	<b>Cephaloziella</b>	116
3	Plants not filiform, small to large; leaves more than 0,3 mm long		4
4	Underleaves simple	<b>Pleurocladula</b>	125
4	Underleaves usually bilobed		5
5	Plants small; stem with ventral branches; leaves to 0,5 mm long	<b>Cladopodiella</b>	124
5	Plants large; stem without ventral branches; leaves up to 1,5 mm long	<b>Barbilophozia</b>	70
6	Leaves appressed; branches julaceous or dorsiventrally compressed, often clavate		7
6	Leaves not appressed; branches not as above		8
7	Leaf margin crenulate, hyaline, or of cells with thicker walls than median cells	<b>Gymnomitrium</b>	95
7	Leaf margin entire, not hyaline, not of cells with thicker walls than median cells	<b>Marsupella</b>	93
8	Leaves asymmetrical, with ventral margin widely incurved and saccate	<b>Nowellia</b>	124
8	Leaves not or only slightly asymmetrical, with ventral margin not saccate		9
9	Plants filiform, very small; usually ventrally branched	<b>Cephaloziella</b>	116
9	Plants not filiform, small to medium sized; laterally branched		10
10	Leaves channelled or strongly concave		11
10	Leaves not channelled, more or less concave		12
11	Usually with gemmae at margins of upper leaves	<b>Anastrophyllum</b>	81
11	Gemmae lacking	<b>Marsupella</b>	93
12	Usually with gemmae at apex and margins of upper leaves; cortex not translucent, not revealing the medulla	<b>Lophozia</b>	74
12	Usually without gemmae; cortex translucent, revealing the medulla	<b>Cephalozia</b>	121

**FI. Leaves bilobed, longitudinally or obliquely inserted, succubous**

1	Underleaves conspicuous	2	
1	Underleaves lacking or underleaves small, subulate or lanceolate	5	
2	Rhizoids restricted to base of underleaves; underleaves bilobed to 1/2-3/4, with teeth on each side	<b>Lophocolea</b>	100
2	Rhizoids scattered on the ventral surface of stem; underleaves simple or bilobed nearly to base, with entire or irregularly dentate margins	3	
3	Underleaves bilobed to 1/3 or almost to base	<b>Geocalyx</b>	105
3	Underleaves simple	4	
4	Underleaves fused to adjacent leaf	<b>Harpanthus</b>	105
4	Underleaves always free	<b>Lophozia</b>	74
5	Leaves caducous; stem partially or almost totally denudate	<b>Plagiochila</b>	99
5	Leaves persistent; stem not denudate	6	
6	Plants very small, filiform	<b>Cephaloziella</b>	116
6	Plants very small or medium-sized	7	
7	At least some leaves asymmetrical, with one side or lobe longer than the other	8	
7	Leaves symmetrical	9	
8	Leaves concave at base, convex above; lobes irregular, rounded to acute	<b>Anastrepta</b>	74
8	Leaves more or less plane; lobes regular, rounded	<b>Cladopodiella</b>	124
9	Cortex translucent, revealing the medulla	<b>Cephalozia</b>	121
9	Cortex not translucent, not revealing the medulla	10	
10	Plants with gemmae	<b>Lophozia</b>	74
10	Plants without gemmae	11	
11	Underleaves small	12	
11	Underleaves lacking or rudimentary	13	
12	Cuticle smooth	<b>Nardia</b>	91
12	Cuticle papillose	<b>Lophozia</b>	74
13	Plants acidophilous, usually with flagelliform branches	<b>Gymnocolea</b>	81
13	Plants calcicolous, usually without flagelliform branches	<b>Lophozia</b>	74

**HORNWORTS**

- |   |   |                     |     |
|---|---|---------------------|-----|
| 1 | Thallus cavernous, without ventral tubers; spores black or dark brown                 | <b>Anthoceros</b>   | 154 |
| 1 | Thallus solid, with or without marginal or ventral tubers; spores yellow or brownish  | 2                   |     |
| 2 | Spores yellow when completely mature, densely papillose-spinulose on distal face      | <b>Phaeoceros</b>   | 156 |
| 2 | Spores yellow, brownish when completely mature, with 1-3 protuberances on distal face | <b>Phymatoceros</b> | 156 |



## Cl. MARCHANTIOPSIDA (LIVERWORTS)

Plants with dorsiventral symmetry, rarely radial, thallose or leafy. Thallose plants prostrate, usually furcate; leafy plants with erect or prostrate stems and leaves in three ranks, the underleaves usually reduced in size or lacking. Rhizoids unicellular, smooth or warty, or rhizoids absent. Capsule projecting and exposed, immersed or on specialized branches, globose, ellipsoidal or cylindrical, without columella, wall hyaline and without stomata, usually dehiscent by 4 valves; seta short or long, hyaline, delicate, ephemeral. Elaters usually present.

### **O. Marchantiales** **Fam. Targioniaceae**

#### **Targionia L.**

Thalli 0,8-2,5 cm long, simple or furcate; when dry, wings roll up revealing ventral scales and become a black worm-like tube; lobes linear, 1,5-5 mm wide; margin unistratose, of 1-3 rows of cells; female thalli with lobes distally widened. Dorsal epidermis reticulate with regular hexagons; pores simple, hardly elevated, surrounded by 1(2) concentric rings of thin-walled cells. Air chambers in one layer, with basal chlorophyllose filaments. Ventral scales imbricate, in one row on either side of midrib, lunate, dark purple to blackish, with metallic sheen, insertion arcuate-transverse, with caducous, acute, triangular appendages projecting beyond margins at apex of thallus. Male receptacles sessile, nearly circular, at the ends of short ventral branches, surrounded by the pointed apex of several small ventral scales. Female receptacles sessile, globose, on ventral side of lobes apex, capsule solitary, surrounded by a bivalved, carinate involucre of 2 blackish scales. Autoicous or dioicous.

- 1 Lobes 1,5-3 mm wide; fresh plants with a mild cedar oil smell; marginal cells of thallus 13-18  $\mu\text{m}$  wide; median cells of ventral scales 45-60  $\times$  20-23  $\mu\text{m}$ ; spores 50-65  $\mu\text{m}$  (fig. 2, 1-3)  
**T. hypophylla L.**

Plants light green. Pores circular, 80-100  $\mu\text{m}$  in diameter, surrounded by a ring of 6-15 small cells. Forms dense, flat patches on soil at base of slopes, in rock and artificial walls crevices, usually on basic substrata, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, Bl.

- 1 Lobes to 5 mm wide; fresh plants with a mild pear smell; marginal cells of thallus 25-30  $\mu\text{m}$  wide; median cells of ventral scales 75-90  $\times$  25-33  $\mu\text{m}$ ; spores 80-110  $\mu\text{m}$

**T. lorbeeriana** K.Müll

Plants glaucous. Pores ovate, 100-170  $\mu\text{m}$  in diameter, surrounded by 1(2) rings of 5-10 large, elongated, reniform cells. Forms dense patches on earth, in rock and artificial wall crevices, in the lowlands. Distributed throughout the Peninsula, less frequent in the north, and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

## Fam. Aytoniaceae

### *Plagiochasma* Lehm. & Lindenb.

Thalli 1-2 cm long, simple or furcate, ventrally branched; lobes flat, fragile, with retuse apex, 4-7 (8) mm wide. Dorsal epidermis not perceptibly reticulate; pores simple. Air chambers low, in 2-3 irregular, vertical layers, without chlorophyllose filaments. Ventral scales in one row on either side of midrib, large, pink to purplish, with metallic sheen, with terminal appendages basally constricted and usually discoloured, projecting beyond margins at apex of young lobes. Male receptacles circular or reniform, sessile, with numerous antheridia, surrounded by small, lanceolate scales, in mid thallus. Female receptacles in mid thallus, usually asymmetrical; stalk solid, 4-7 mm long, with filiform scales at base and apex. Polyoicous.

- 1 Ventral scales with triangular appendages (fig. 2, 4-6)

**P. rupestre** (J.R.Forst. & G.Forst.) Steph.

Plants glaucous, dull, with purplish borders. Pores nearly flat, surrounded by 1 ring of concentric cells. Base of air chambers in mid thallus 2 cells wide. Male receptacles circular. Forms large, dense, fragile patches on rock ledges, compact earth and in rock crevices, on basic or acidic substrata, in the lowlands. Widespread on coastal areas and near to coastal areas of the Mediterranean region of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Ventral scales with orbicular appendages (fig. 2, 7-11)

**P. appendiculatum** Lehm. & Lindenb.

Plants light green to yellowish green, with light brown to reddish borders. Pores prominent, surrounded by 2-3 rings of concentric cells. Base of air chambers in mid thallus 3-4 cells wide. Male receptacles reniform. Forms large, dense patches in calcareous gorges on very moist walls. Very rare, in Mallorca. Bl.

### *Reboulia* Raddi

Thalli 1-3 cm long, furcate; lobes 4-7 mm wide, with retuse apex; margins sinuose, undulate, unistratose. Dorsal epidermis not perceptibly reticulate; pores simple, prominent, surrounded by 4-5 concentric rings of 6 cells with thickened radial walls. Air chambers without chlorophyllose filaments. Ventral scales in one row on either side of midrib, nearly lunate, violet or metallic purple, large, wide, with 2 terminal, filiform appendages projecting beyond margins at apex of thallus. Male receptacles on dorsal

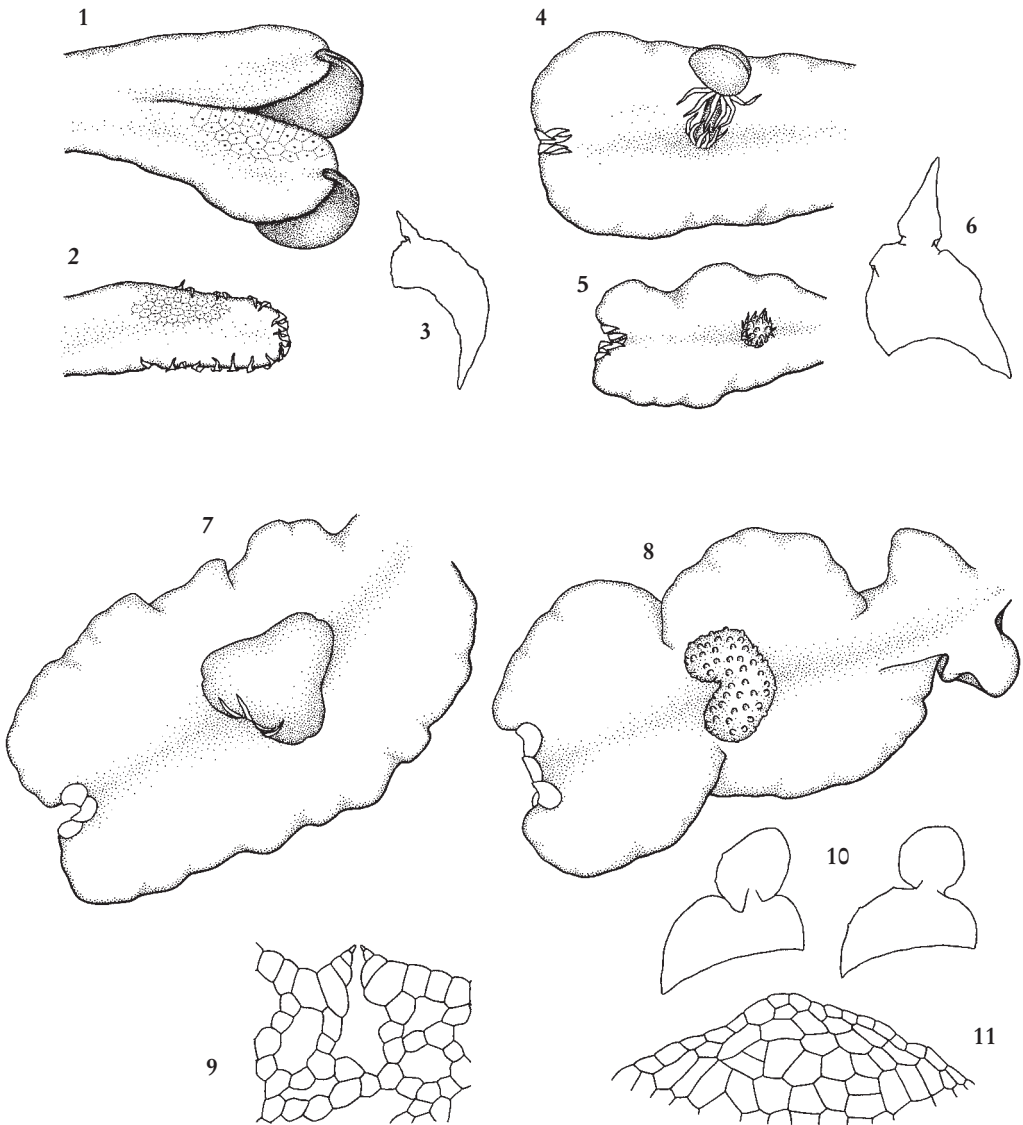


FIGURE 2. 1-3, *Targionia hypophylla*: 1, thallus with involucre; 2, sterile thallus; 3, ventral scale. 4-6, *Plagiochasma rupestre*: 4, thallus with female receptacle; 5, thallus with male receptacle; 6, ventral scale. 7-11, *P. appendiculatum*: 7, thallus with young female receptacle; 8, thallus with male receptacle; 9, pore and air chambers section; 10, ventral scales; 11, appendage apex. 1, 2, 4, 5, 7, 8 ( $\times 5,5$ ); 3, 6, 10 ( $\times 15$ ); 9, 11 ( $\times 160$ ).

surface, near the female receptacle stalk, sessile, lunate, reddish to brownish, surrounded by small filiform scales. Female receptacles hemispherical to conical, warty, with 3-5 lobes; stalk 5-25 mm with filiform scales at base and apex. Spores light brown to yellowish, 65-85  $\mu\text{m}$ , reticulate with alveoli and lamellae. Polyoicous, mainly paroicous (fig. 3, 1-3)

**R. hemisphaerica** (L.) Raddi

Plants light green to dark green, with reddish spots and reddish margins. Forms extensive patches in rock crevices, at slope and rock bases and on soils, in shaded, moist sites, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.

### **Mannia** Opiz

Thalli 1-2,5 cm long, furcate, thick, plane or channelled, light green with purplish margins; lobes 1-2 mm wide, with incurved margins when dry. Dorsal epidermis not perceptibly reticulate; pores simple, small but visible. Air chambers in 1 layer, with abundant, short chlorophyllose filaments or chlorophyllose filaments lacking. Ventral scales in one row on either side of midrib, imbricate, large, lunate, with 1-2 narrow, lanceolate, deciduous appendages. Antheridia immersed in the dorsal side, reddish. Female receptacles warty; stalk (2-)10-20 mm long, at the apex of thallus. Pseudoperianth lacking. Spores with large, spherical papillae on the distal face. Polyoicous.

- 1 Ventral scales and appendages purplish, shortly projecting beyond margins at apex of thallus; stalk of female receptacles without scales or with scales only at base (fig. 3, 4-5)

**M. androgyna** (L.) A.Evans

Spores 65-80  $\mu\text{m}$ ; distal face granulose. Forms small, dense mats on clayey soils, slopes and rock ledges in the lowlands, rarely in montane areas. Widely distributed throughout the Peninsula and in Mallorca. Esp, Prt, Bl.

- 1 Ventral scales purplish, with discoloured, hyaline appendages and margins, longly projecting beyond margins at apex of thallus, especially in female plants; stalk of female receptacles with long scales at base and in the upper part (fig. 3, 6-9)

**M. fragrans** (Balbis) Frye & L.Clark

Plants cedar oil smell. Spores 55-60  $\mu\text{m}$ ; distal face alveolate. Forms dense mats on clayey soils. Rare, in the northeastern part of the Peninsula. Esp.

### **Asterella** P. Beauv.

Thalli 1-2 cm long, simple or furcate, dull; lobes with sinuose, reddish margins, incurved when dry. Pores simple, slightly to strongly prominent. Air chambers in 2 vertical layers, with scarce, short, thin chlorophyllose filaments or filaments lacking. Ventral scales in one row on either side of midrib, purplish, with a lighter appendage not projecting beyond thallus margins. Antheridia irregularly grouped in mid thallus, like small reddish warts behind female receptacle stalk. Female receptacle hemispherical, warty; pseudoperianth lacinate in 4(-8) lanceolate, hyaline segments connate apically until spores mature, surrounding each sporophyte; stalk with small scales at base. Paroicous.



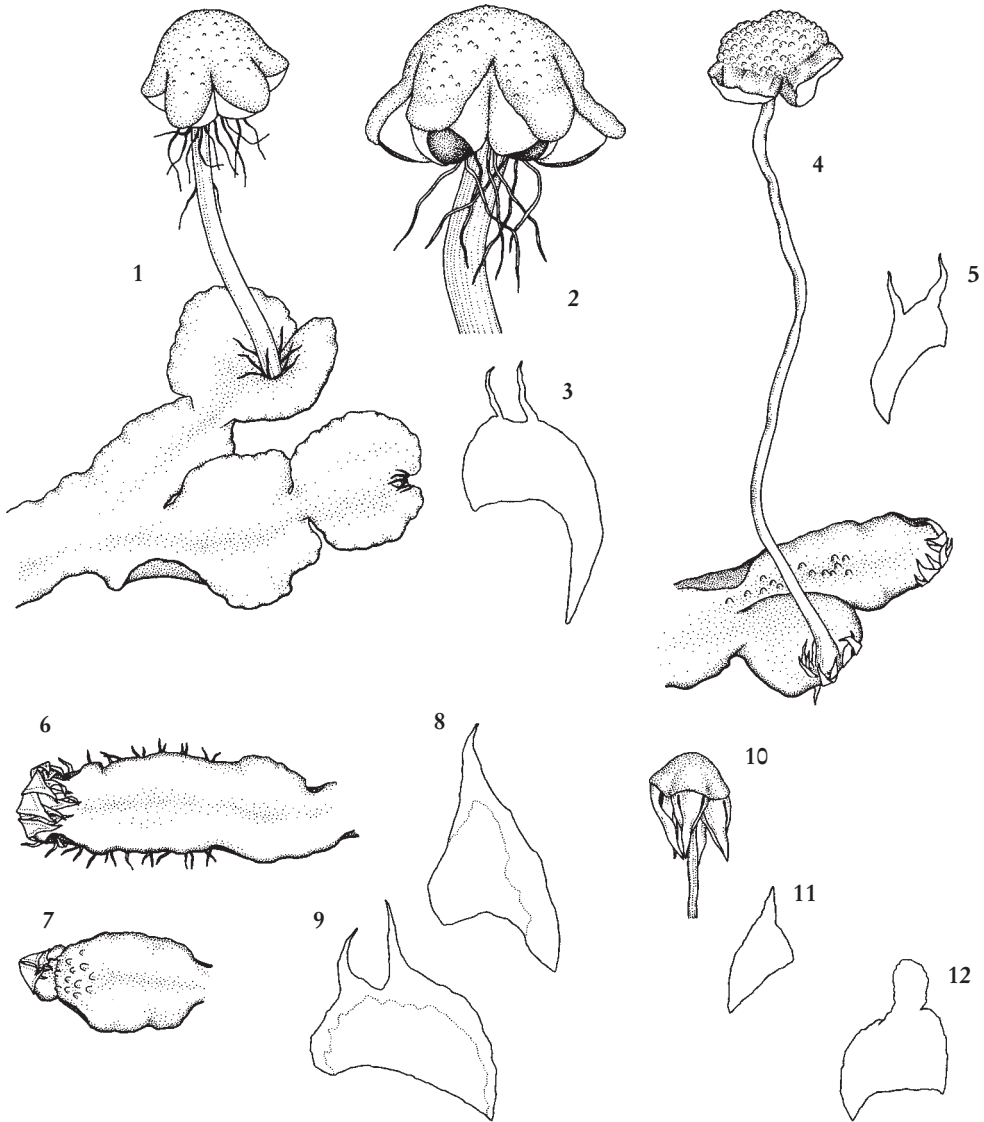


FIGURE 3. 1-3, *Reboulia hemisphaerica*: 1, thallus with female receptacle; 2, female receptacle; 3, ventral scale. 4-5, *Mannia androgyna*: 4, thallus with female receptacle and antheridia; 5, ventral scale. 6-9, *M. fragrans*: 6, female thallus; 7, male thallus; 8, apical scale; 9, ventral scale. 10-11, *Asterella gracilis*: 10, female receptacle; 11, ventral scale. 12, *A. africana*, ventral scale. 1 ( $\times 3,5$ ); 2, 4, 6, 7, 10 ( $\times 6,5$ ); 3, 5, 8, 9, 11, 12 ( $\times 15$ ).

- 1 Lobes 0,15-0,4 mm wide; ventral scales with lanceolate appendage; spores yellowish, 50-60  $\mu\text{m}$  (fig. 3, 10-11) **A. gracilis** (F. Weber) Underw.  
Plants green, aromatic. Chlorenchyma 1/2-2/3 of the thallus thickness at its centre; pores prominent, surrounded by 4-5 concentric rings of 6 cells. Air chambers with scarce, short, thin chlorophyllose filaments, or filaments lacking. Stalk of female receptacle 7-15 mm. Elaters 8-12  $\mu\text{m}$  wide. Forms dense mats on humus, at base of siliceous rocks, near streams, in high mountains. Scattered in the northern half of the Peninsula and in Sierra Nevada. Esp, And.
- 1 Lobes 0,4-0,5(0,8) mm wide; ventral scales with oblong appendage; spores brownish to violet reddish, 60-80  $\mu\text{m}$  (fig. 3, 12) **A. africana** (Mont.) A. Evans  
Plants yellowish green, not aromatic. Chlorenchyma 1/2-2/3 of the thallus thickness at its centre; pores slightly prominent, surrounded by 3-4 concentric rings of (5)6-7 cells. Air chambers without chlorophyllose filaments. Stalk of female receptacle 10-20 mm. Elaters 7-8  $\mu\text{m}$  wide, with light yellow thickenings. Forms dense mats on acidic, seeping soils or rocks, in shaded sites, in the lowlands and montane areas. Rare in the central western part of the Peninsula. Esp, Prt.

## Fam. Conocephalaceae

### Conocephalum Wiggers

Thalli furcate; lobes large, with rounded or emarginate apex; margins slightly sinuose, hyaline, with 1-4 rows of elongated cells; midrib distinct in the dorsal side. Dorsal epidermis perceptibly reticulate, with elongated areolae 1 mm long or more; pores elevated, simple, surrounded by 4-6 concentric rings of 7-8 cells. Air chambers regular, with simple chlorophyllose filaments with an elongated, hyaline distal papilla. Ventral scales in one row on either side of midrib, nearly lunate, hyaline, with sub-terminal appendage. Male receptacles blackish, elliptical, sessile. Female receptacles at the apex of thallus, conical; stalk thin, up to 10 cm. Dioicous.

- 1 Thalli shining on the dorsal surface, 7-20 mm wide; hyaline margin with 3-4 rows of more or less elongated cells; 6-7 air chambers between midrib and thallus margin (fig. 4, 1-5) **C. conicum** (L.) Dumort  
Thallus usually plane or recurved. Outer epidermal cells with flat walls; hyaline apical cells underlying the pores flask-shaped. Ventral scales with a violet appendage. Forms dense and extensive mats on rocks and wet soils, usually in contact with water, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 1 Thalli matt on the dorsal surface, 5-12 mm wide; hyaline margin with 1-2(3) rows of elongated cell; 4-5 air chambers between midrib and thallus margin (fig. 4, 6) **C. salebrosum** Szweykowski, Buczkowska & Odrzykoski  
Thallus incurved or rarely plane. Outer epidermal cells with inflated walls; hyaline apical cells underlying the pores pyriform. Ventral scales with a hyaline appendage violet at margins. Forms dense and extensive mats on rocks and wet soils usually in contact with water, seems to be more tolerant to desiccation than *C. conicum*, in montane areas and high mountains, rare in the lowlands. Distributed in the northern half and the west of the Peninsula, very rare in the southeast. Esp, Prt.

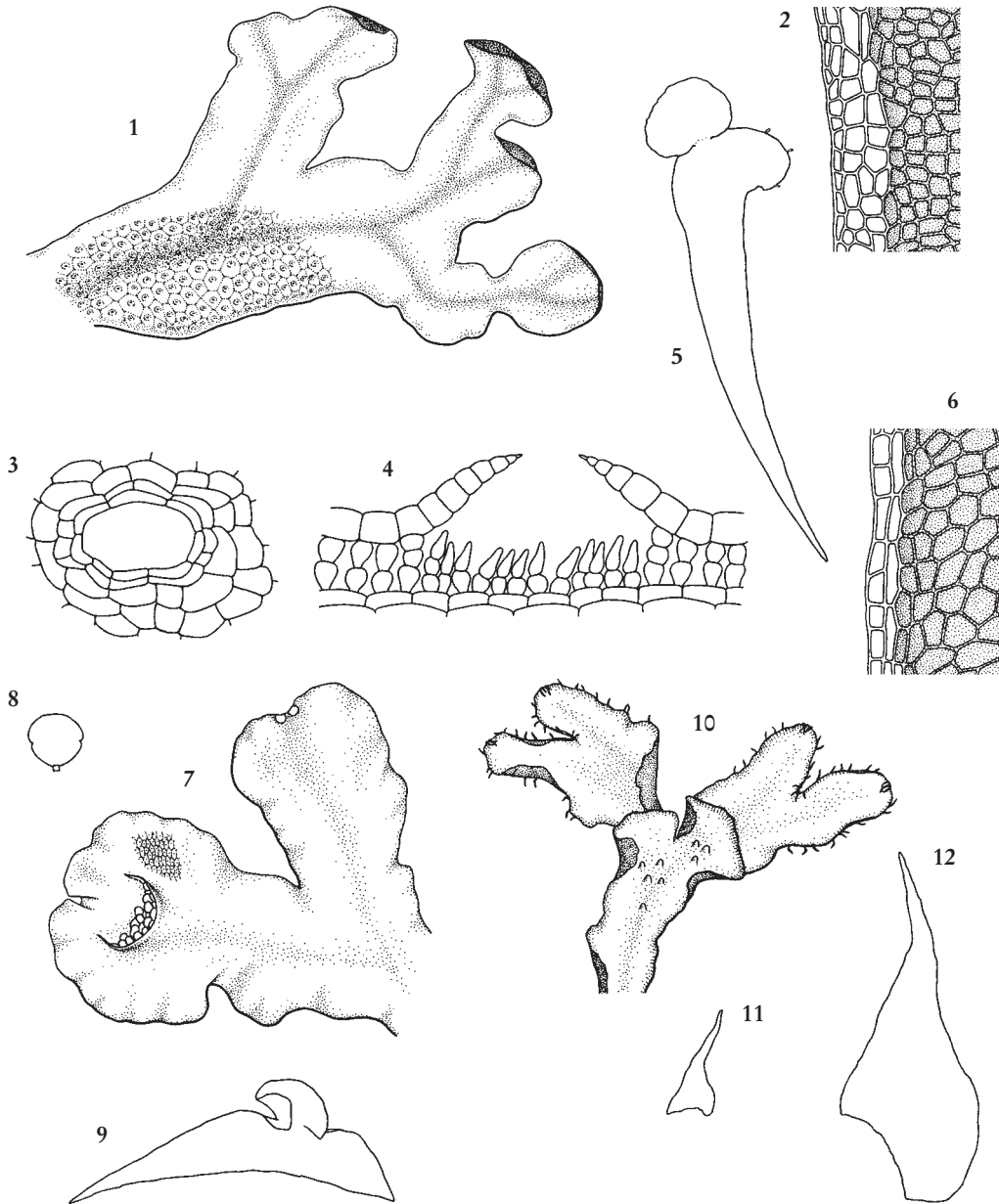


FIGURE 4. 1-5, *Conocephalum conicum*: 1, thallus; 2, thallus margin; 3, pore in surface view; 4, pore and air chamber section; 5, ventral scale. 6, *C. salebrosum*, thallus margin. 7-9, *Lunularia cruciata*: 7, thallus with gemma receptacle; 8, gemma; 9, ventral scale. 10-11, *Athalamia spathysii*: 10, thallus with antheridia; 11, ventral scale. 12, *A. hyalina*, ventral scale. 1 (x2); 7 (x3,5); 10 (x5); 5, 8, 9, 11, 12 (x15); 2, 6 (x100); 3, 4 (x160).

## Fam. Lunulariaceae

### Lunularia Adans.

Thalli 2-4 cm long, furcate; lobes 4-12 mm wide, with sinuose margins, often undulate. Dorsal epidermis distinctly reticulate; pores simple, prominent, with 4-5 concentric rings of 5-7 hyaline, thin-walled cells. Air chambers regular, with simple chlorophyllose filaments. Ventral scales sparse, in one row on either side of midrib, lunate, hyaline, with orbicular to reniform appendages projecting beyond the apex of young lobes. Gemmae discoid, emarginate on each side, green, 0,5 mm wide, attached by 1-celled pedicel and grouped in sessile, lunate receptacles on dorsal surface of midrib. Male receptacles sessile, terminal, becoming apparently lateral with age, ovate, concave, 1,5 mm in diameter, purplish. Female receptacles lateral, firstly sessile and surrounded by a conical involucre of hyaline scales, later raised on stalk 10-20 mm long and the involucre shaped like a cross with 4 horizontal lobes. Dioicous (fig. 4, 7-9)

**L. cruciata** (L.) Lindb.

Plants glossy, light green on both sides. Forms extensive patches on earth, wet rocks and slopes, also very common in gardens and around glasshouses, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

## Fam. Cleveaceae

### Athalamia Falc.

Thalli 0,5-2 cm long, simple or furcate, fleshy; lobes 3-6 mm wide; cells without oil-bodies, not even in ventral scales. Dorsal epidermis distinctly reticulate; pores simple, prominent. Air chambers high, obliquely in 2-3 layers, without chlorophyllose filaments. Ventral scales in one row on either side of midrib, triangular, wide at base, with a lanceolate appendage. Antheridia hardly aggregated, immersed on the dorsal mid thallus. Female receptacle on the dorsal mid thallus, circular, surrounded by small, linear-lanceolate, hyaline scales, at maturity raised on stalk 3-10 mm long. Spores covered by large, hemispherical papillae.

- 1 Ventral scales hyaline, longly projecting beyond margins at apex of thallus; pores surrounding cells with external and radial walls thickened (fig. 4, 12)

**A. hyalina** (Sommerf.) S.Hatt.

Thalli 0,8-1,5(1,8) × 0,4-0,8 cm, glaucous, purplish at margins. Female receptacle stalk to 10 mm long. Dioicous. Forms patches on soils and calcareous rock ledges, in montane areas. Distributed in the north and the south of the Peninsula, rare in the east and in Mallorca. Esp, And, Bl.

- 1 Ventral scales purple, only projecting beyond margins at apex of young parts of thallus; pores surrounding cells with external walls not thickened (fig. 4, 10-11)

**A. spathysii** (Lindenb.) S.Hatt.

Thalli 0,5-1 × 0,3-0,5 cm, green, reddish at margins. Female receptacle stalk 3-6 mm long. Paroicous. Forms patches in small caves, calcareous rock crevices and on soils, in the lowlands

and montane areas. Distributed in the south and southeastern part of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt (Extinct), Bl.

## Fam. Marchantiaceae

### *Preissia* Corda

Thalli to 5 cm long, robust, simple or furcate; lobes to 10 mm wide; margin unistratose, sinuose and undulate. Dorsal epidermis faintly reticulate; pores compound, barrel-shaped in cross-section, external pore circular, very prominent, surrounded by 2 superimposed rings of 4 thin-walled, hyaline cells, inner pore narrower, surrounded by 2-3 rings of cross-shaped cells. Air chambers with chlorophyllose filaments. Ventral scales imbricate, in one row on either side of midrib, large, lunate, purple, with dentate margins and a small, lanceolate, caducous appendage. Male receptacles discoid, warty; stalk reddish, to 2 cm long. Female receptacles hemispherical to conical, stomata numerous, with 3-4 lobes; stalk reddish, to 4 cm long. Dioicous (fig. 5, 1-3)

***P. quadrata*** (Scop.) Nees

Plants dull green, purplish at margins. Forms extensive patches on soils near streams and in wet rock crevices, on calcareous substrata in montane areas and high mountains. Frequent in the north of the Peninsula, rare in the southeastern part. Esp, Prt, And.

### *Marchantia* L.

Thalli to 8 cm long, robust, furcate; margin sinuose, undulate, unistratose. Dorsal epidermis faintly reticulate; pores conspicuous, compound, barrel-shaped in cross-section, external pore circular, slightly prominent, surrounded by 2 superimposed rings of 4 thin-walled, hyaline cells, inner pore narrower, surrounded by 2-3 rings of cross-shaped cells. Air chambers with chlorophyllose filaments. Ventral scales arcuate, obliquely inserted, in 2-3 rows on either side of midrib, purple or hyaline, the inner one lunate with an orbicular or cordate appendage. Gemmae to 0,5 mm, lenticular, emarginate on each side, attached by 1-celled pedicel, in cup-shaped receptacles with membranous, fringed margins. Male receptacles discoid, 6-9 mm in diameter, sinuose at margins; stalk nearly circular in cross section, 1-3 cm long, surrounded by brown scales at base. Female receptacles discoid, 6-9 mm in diameter, disk umbrella-shaped, with 9-11 digitiform rays; stalk subquadrate in cross section, to 5 cm long, surrounded by brown scales at base. Dioicous.

1 Ventral scales in 3 rows on either side of midrib (fig. 5, 4-13) ***M. polymorpha*** L.

Thalli 2-8 × 1-2 cm, with a dark line along the middle on dorsal side, continuous, discontinuous or only present in bifurcations; inner pore wide, more or less cross-shaped. Outer ventral scales small, hyaline, the middle ones wide at base and short, the inner ones lunate, reddish or hyaline and with orbicular appendage. Usually fertile. Forms dark green patches on wet soils and by streams, from the lowlands to high mountains. Scattered throughout the Peninsula. Esp, Prt, And.

subsp. **polymorpha**: Thalli dark green, with continuous median dark line; appendage of the innermost ventral scale crenulate at margins or nearly entire.

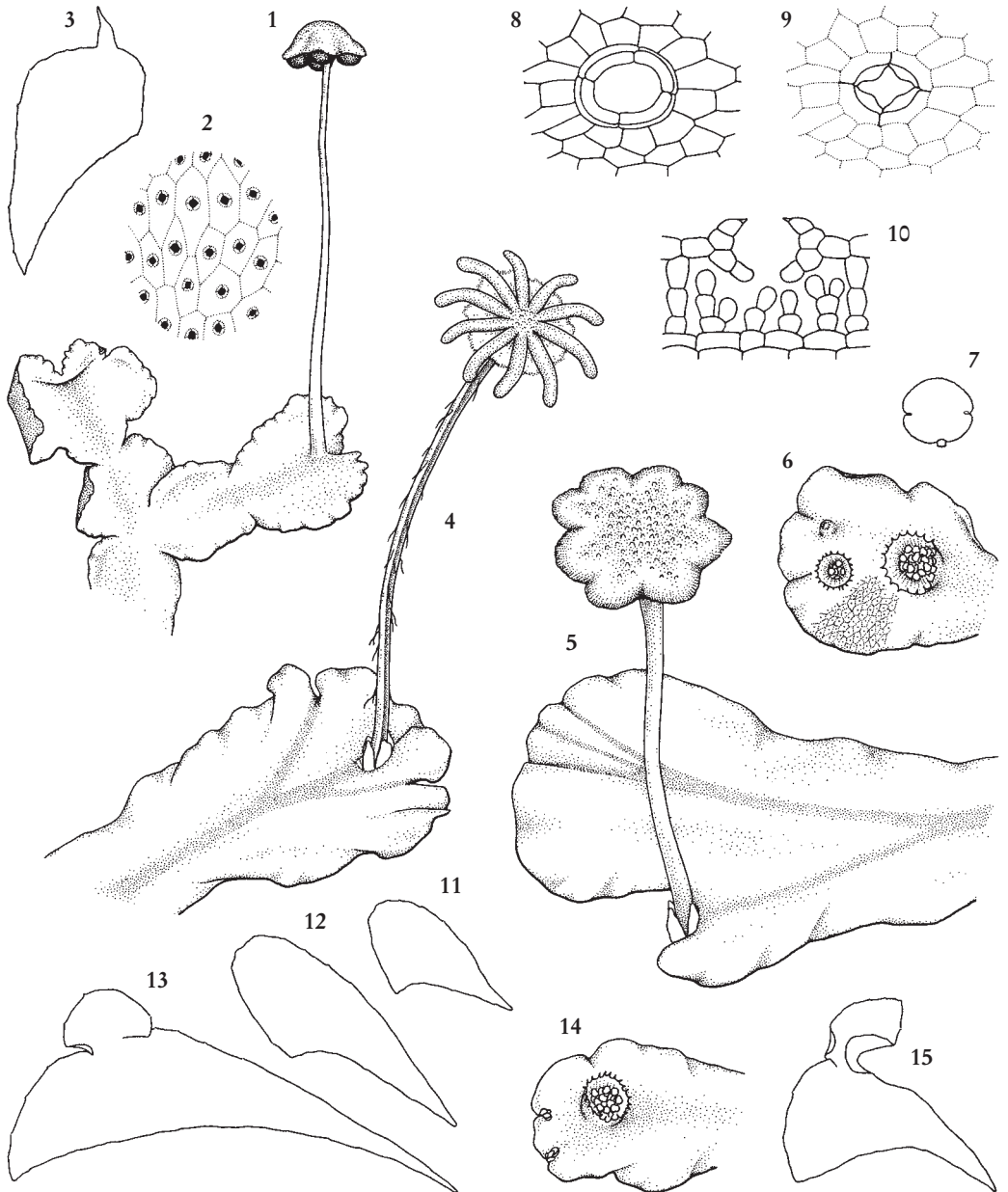


FIGURE 5. 1-3, *Preissia quadrata*: 1, thallus with female receptacle; 2, thallus epidermis; 3, ventral scale. 4-13, *Marchantia polymorpha*: 4, thallus with female receptacle; 5, thallus with male receptacle; 6, thallus with gemma receptacles; 7, gemma; 8, external pore; 9, inner pore; 10, pore and air chamber section; 11-13, ventral scales: 11, marginal; 12, medial; 13, inner. 14-15, *M. paleacea*: 14, thallus with gemma receptacle; 15, inner ventral scale. 1, 4, 5, 6, 14 ( $\times 2.5$ ); 3, 11, 12, 13, 15 ( $\times 15$ ); 2, 7 ( $\times 25$ ); 8, 9, 10 ( $\times 160$ ).

subsp. **montivagans** Bischl. & Boisselier: Thalli yellowish green, without median dark line or only at the bifurcations; appendage of the innermost ventral scale denticulate at margins.

subsp. **ruderalis** Bischl. & Boisselier: Thalli dark green, with faint or discontinuous median dark line; appendage of the innermost ventral scale denticulate at margins.

1 Ventral scales in 2 rows on either side of midrib (fig. 5, 14-15) **M. paleacea** Bertol.

Thalli 2-4 × 0,5-1 cm, with sinuose margins. Inner pore narrowly cross-shaped. Ventral scales purple, the external elliptical, small and caducous, the inner ones imbricate, large with cordate appendage projecting beyond margins at apex of thallus. Usually without sporophytes but with gemma-cups. Forms glaucous green patches, purplish at margins on calcareous substrata on wet soil and rocks, walls of irrigation ditches and by streams, in the lowlands, mainly near coastal areas. Distributed in the north, east and south of the Peninsula and in Mallorca. Esp, Bl.

### Dumortiera Nees

Thalli to 10 cm long, simple or furcate; lobes 1-1,5 cm wide, plane, with scattered, short, yellowish hairs on both sides; margin sparsely hairy. Dorsal epidermis not reticulate, with thin-walled ephemeral cells, only slightly reticulate in young parts; without pores, sometimes with simple, inconspicuous pores surrounded by 1-2 incomplete rings of cells visible at apex of branches. Air chambers without chlorophyllose filaments. Ventral scales in one row on either side of midrib at the apex of thallus, small, laciniate, hyaline. Male receptacles on the dorsal surface of thallus apex, rounded, shortly pedicellate. Female receptacles on the dorsal surface of thallus apex, rounded, plane above or concave when old, with 6-10 lobes; stalk 2-4 cm, with hyaline scales at base and in the upper part. Spores hemispherical, brownish yellow, 28-35 µm. Autoicous or dioicous (fig. 6, 1-2) **D. hirsuta** (Sw.) Nees

Plants dark green. Thallus semi-translucent, greasy in appearance. Mature plants without pores, air chambers or ventral scales. Forms extensive mats in shaded sites, on soils or wet rocks near streams or close by waterfalls, in the lowlands and montane areas, in the north and northwestern part of the Peninsula. Esp, Prt.

## Fam. Exormothecaceae

### Exormotheca Mitt.

Thalli to 3 cm long, simple or furcate, fleshy. Air chambers wide, high, very prominent, conical or vault-shaped, with a simple pore in the apex, with chlorophyllose filaments. Ventral scales in a row on either side of midrib, large, hyaline, with caducous, filiform appendage. Male receptacles oblong, immersed in a groove along the middle of thallus. Female receptacles in the bifurcation of two terminal branches, small, irregular in shape, sessile or subsessile.

1 Thalli 0,5-1 cm long, lobes 1-1,5 mm wide; roof of air chambers conical; chlorophyllose filaments of 5-7 cells (fig. 6, 3-5) **E. pustulosa** Mitt.

Plants silvery glaucous. Spores 50-65 µm. Polyicous. Grows on open, sandy soils and at base of siliceous rocks, in the lowlands. Rare, in northeastern and southwestern part of the Peninsula. Esp, Prt.



- 1 Thalli 1-4 cm long, lobes 2-4 mm wide; roof of air chambers inflated, vault-shaped; chlorophyllose filaments of 2-3 cells **E. welwitschii** Steph.

Plants silvery whitish green. Spores 100-140  $\mu\text{m}$ . Dioicous. Grows on open, temporarily wet, acidic, sandy or clayey soils, in the lowlands. Scattered in the southwestern and central part of the Peninsula, rare in the east. Esp, Prt.

## Fam. Corsiniaceae

### *Corsinia* Raddi

Thalli 1-2 cm long, simple or furcate, fragile, channelled, fleshy, soft-textured, revealing the wide air chambers; lobes 4-6 mm wide, thin and sinuose-undulate at margins, with retuse apex. Dorsal epidermis faintly reticulate; pores simple, surrounded by 2-3 concentric rings of 5-7 thin-walled cells. Air chambers with short, simple chlorophyllose filaments. Ventral scales ephemeral, imbricate, in one row on either side of midrib, hyaline, small, triangular, subulate, projecting beyond margins at apex of young lobes. Male receptacles immersed along the dorsal thallus mid line, oblong, bounded on each side by a lamella. Female receptacles immersed along the dorsal thallus mid line, circular; capsule irregularly dehiscent, globose, inside a fleshy, warty calyptra; involucre rudimentary. Dioicous, autoicous or polyicous (fig. 6, 6-9) **C. coriandrina** (Spreng.) Lindb.

Plants dull, light green, bluish or yellowish, never with reddish spots, with discoloured margins. Forms extensive patches on wet soils and in rock crevices, on acidic or basic substrata, in the lowlands. Mainly distributed in southwestern part of the Peninsula, rare in the northwest and east and in Menorca. Esp, Prt, Bl.

## Fam. Oxymitraceae

### *Oxymitra* Bisch. ex Lindenb.

Plants forming rosettes or incomplete rosettes. Thalli 0,5-1 cm long, simple or furcate, thick, light green to greyish, with reddish spots, with a median, narrow, deep groove; lobes 3-6 mm wide; cells without oil-bodies. Dorsal epidermis with simple, conspicuous pores. Air chambers high, in one layer, without chlorophyllose filaments. Ventral scales in one row on either side of midrib, large, narrowly triangular, acuminate, silvery hyaline, longly projecting beyond margins of thallus. Male receptacles at the bottom of the median groove, surrounded by hairs and small scales at base; antheridia immersed, with prominent walls. Female receptacles in mid thallus; archegonia immersed, covered in the upper part by a fleshy, conical involucre, provided with stomata and air chambers and surrounded by hairs and scales at base (with age the involucre of capsules become pyramidal), in 2 rows 1-2 mm high. Polyicous (fig. 6, 10-11)

**O. incrassata** (Broth.) Sérgio & Sim-Sim

Forms dense mats on clayey or sandy soils and open, calcareous or siliceous ledges, in the lowlands. Mainly distributed in southwestern part of the Peninsula, scattered in the east and in Mallorca. Esp, Prt, Bl.



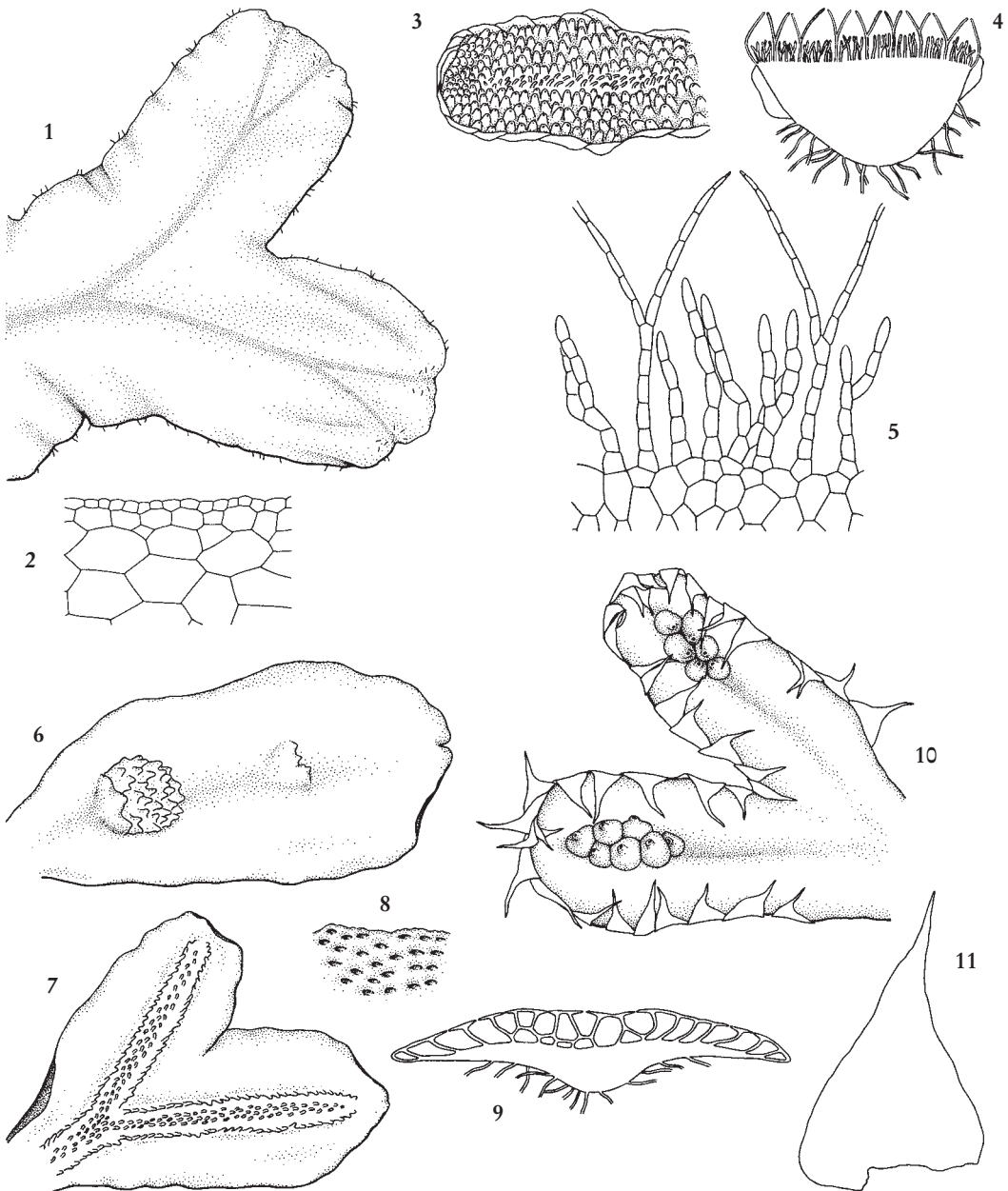


FIGURE 6. 1-2, *Dumortiera hirsuta*: 1, thallus; 2, dorsal portion of thallus section. 3-5, *Exormotheca pustulosa*: 3, thallus with antheridia; 4, thallus section; 5, pore and air chamber section. 6-9, *Corsinia coriandrina*: 6, female thallus; 7, male thallus; 8, thallus epidermis; 9, thallus section. 10-11, *Oxymitra incrassata*: 10, female thallus; 11, ventral scale. 1 ( $\times 2,5$ ); 3, 6, 7, 10 ( $\times 7,5$ ); 4, 8, 9, 11 ( $\times 15$ ); 2, 5 ( $\times 100$ ).

## Fam. Ricciaceae

## Ricciocarpos Corda

Plants in incomplete rosettes. Thalli 0,5-1 cm long, furcate; lobes 4-8 mm wide, green, violet at margins, with a median groove. Dorsal epidermis thinly reticulate with regular hexagons; pores indistinct. Ventral scales numerous, pendent, in 3 rows on either side of midrib, green or violet, 3-6 mm long, lanceolate, denticulate at margins. Rhizoids lacking (fig. 7, 1-2)

**R. natans** (L.) Corda

Forms floating rosettes in slow-flowing or stagnant waters near coastal areas, often in association with *Lemna*. Scattered localities in the southwestern, eastern and central part of the Peninsula. Very rare. Esp.

**Riccia** L.

Plants light green, bluish, whitish or pink to violet, generally forming rosettes. Thalli 3-30 mm long, furcate, fleshy, with or without wings, on the dorsal side flat or with convex flanks, with a narrow or wide and flat median groove or median groove lacking, glabrous or with cilia or papillae on the dorsal side and at margins, usually more abundant in the apical part of lobes; margin acute or rounded. Chlorenchyma dense, composed of parallel columns of chlorophyllose cells, enclosing very narrow air canals, pores with regular openings, or chlorenchyma lax, spongy, of irregular columns of chlorophyllose cells forming air chambers with irregular openings or with small pores ringed by cells; the upper cells of these columns are usually differentiated to form an epidermis. Ventral scales in one row on either side of midrib, fragile, colourless, reddish or violet to almost black, or ventral scales lacking. Rhizoids hyaline. Tubers sometimes present at apex on the ventral side of thallus, globose, pluricellular, occasionally pedicellate. Antheridia and archegonia in usually regular rows immersed along median groove on dorsal side of thallus, with emergent necks. Capsule irregularly dehiscent, globose, immersed in thallus or slightly bulging dorsally or ventrally. Spores black or brownish to yellowish, usually polar, 60-150(200)  $\mu\text{m}$  in diameter. Dioicous, or more frequently monoicous.

- 1 Plants terricolous; chlorenchyma dense, composed of parallel columns of chlorophyllose cells, enclosing very narrow air canals, pores with regular openings, surrounding epidermal cells globose or pyriform; thallus margins glabrous or more often with cilia or papillae (Subgen. **Riccia**) 2
- 1 Plants terricolous or aquatic; chlorenchyma lax, spongy, of irregular columns of chlorophyllose cells forming air chambers with irregular openings or with small pores ringed by cells; thallus margins glabrous (Subgen. **Ricciella**) 22
- 2 Dorsal side of thallus whitish, with calcareous deposits; spores with alveoli only slightly differentiated (fig. 7, 3-6) **R. crustata** Trab.  
Plants in irregular rosettes about 1,5 cm in diameter, bluish green. Thalli 1-2 times as wide as high in section; flanks convex; median groove flat; epidermal cells globose, with calcareous deposits. Spores dark to black, 75-90  $\mu\text{m}$  in diameter; wing lacking; distal face flat, with short

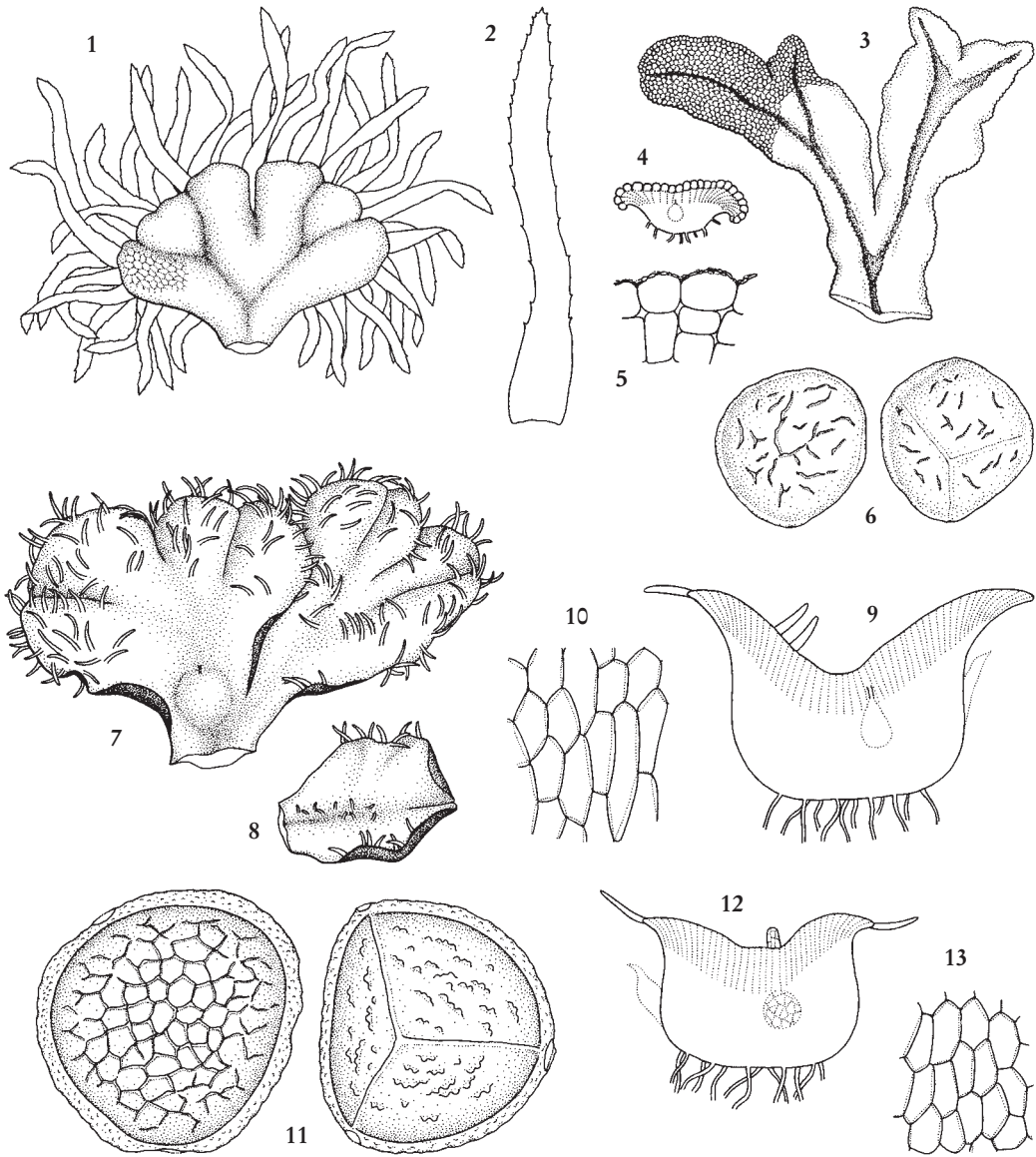


FIGURE 7. 1-2, *Ricciocarpus natans*: 1, thallus; 2, ventral scale. 3-6, *Riccia crustata*: 3, thallus; 4, thallus with capsule in section; 5, epidermal cells section; 6, spores, distal and proximal face. 7-11, *R. gougetiana* var. *armatissima*: 7, thallus with capsule; 8, male thallus; 9, thallus with capsule in section; 10, ventral scale cells; 11, spores, distal and proximal face. 12-13, *R. ciliifera*: 12, thallus with antheridium in section; 13, ventral scale cells. 1 ( $\times 7$ ); 7, 8 ( $\times 8$ ); 2, 3 ( $\times 12$ ); 4, 9, 12 ( $\times 15$ ); 5, 10, 13 ( $\times 100$ ); 6, 11 ( $\times 250$ ).

lamellae or incomplete alveoli; proximal face nearly smooth, with faint trilete mark. Dioicous. Grows on open, gypsiferous or saline, temporarily wet soils, in the lowlands, rarely in montane areas. Widespread in the eastern half of the Peninsula and Pithyusic Islands, very rare in the south of the Peninsula. Esp, Bl.

- 2 Dorsal side of thallus not whitish, without calcareous deposits; spores with regular or irregular alveoli, completely separated or not, at least in the distal face 3
- 3 Lobes with acute margins, usually winged 4
- 3 Lobes with rounded margins, not winged 11
- 4 Lobes winged, usually with cilia on dorsal side or at margins 5
- 4 Lobes not or only slightly winged, cilia lacking 6
- 5 Lobes more than 2,5 mm wide; spores (140)150-180  $\mu\text{m}$  in diameter (fig. 7, 7-11)

**R. gougetiana** Durieu & Mont.

Plants bluish green or greyish. Thalli in the medial part very thick in section; lobes about 10 mm wide, with 2 very well-developed and nearly horizontal wings, ciliate at margins, cilia hyaline, 96-160(230)  $\mu\text{m}$  long. Ventral scales hyaline or pink-violet, visible laterally, with cells 90-200  $\times$  30-70  $\mu\text{m}$ . Spores large, dark brown; wing 5-10  $\mu\text{m}$  wide; distal face with up to 10-12 alveoli across diameter, small and sometimes incomplete; proximal face with irregular tubercles. Dioicous. Grows on open, wet or temporarily waterlogged, sandy, preferentially acidic soils, in the lowlands, rarely in montane areas.

var. **gougetiana**: Thalli glabrous on the dorsal side; margin ciliate. Widespread in the Peninsula and in Menorca. Esp, Prt, Bl.

var. **armatissima** Levier ex Müll. Hal.: Dorsal side of thallus and margin ciliate. Distributed in the southern half of the Peninsula. Esp, Prt.

- 5 Lobes less than 2,5 mm wide; spores 100-150  $\mu\text{m}$  in diameter (fig. 7, 12-13)

**R. ciliifera** Link ex Lindenb.

Plants in incomplete rosettes, bluish green, usually with violet spots at thallus margins. Thalli glabrous on dorsal side; lobes cordate, wider at apex, in section with very well-developed and almost horizontal wings; margin with triangular, hyaline, 100-400  $\mu\text{m}$  long cilia. Ventral scales violet or hyaline, visible laterally, with cells 50-120  $\times$  20-70  $\mu\text{m}$ . Spores large, dark brown; wing about 5-7  $\mu\text{m}$  wide; distal and proximal faces with 5-7 alveoli across diameter, usually incomplete. Dioicous. Grows in glades mostly in pinewoods and cork oak forests, and on temporarily waterlogged soils, in the lowlands and montane areas. Widespread in the Peninsula. Esp, Prt.

- 6 Ventral scales hyaline, projecting above thallus margins (fig. 8, 1-3)

**R. lamellosa** Raddi

Plants usually in complete rosettes, light green or discoloured. Lobes about 2-3 mm wide, lateral wings narrow, hardly distinct, nearly horizontal in old parts. Spores dark brown, 90-100(110)  $\mu\text{m}$  in diameter; wing about 5  $\mu\text{m}$  wide; distal and proximal faces with regular and usually completely apical alveoli, 10-15 alveoli across diameter on the distal face. Monoicous. Grows by roads, on open soils and in open areas in grassland, in the lowlands. Widespread in the Peninsula, but more frequent in the Mediterranean area and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

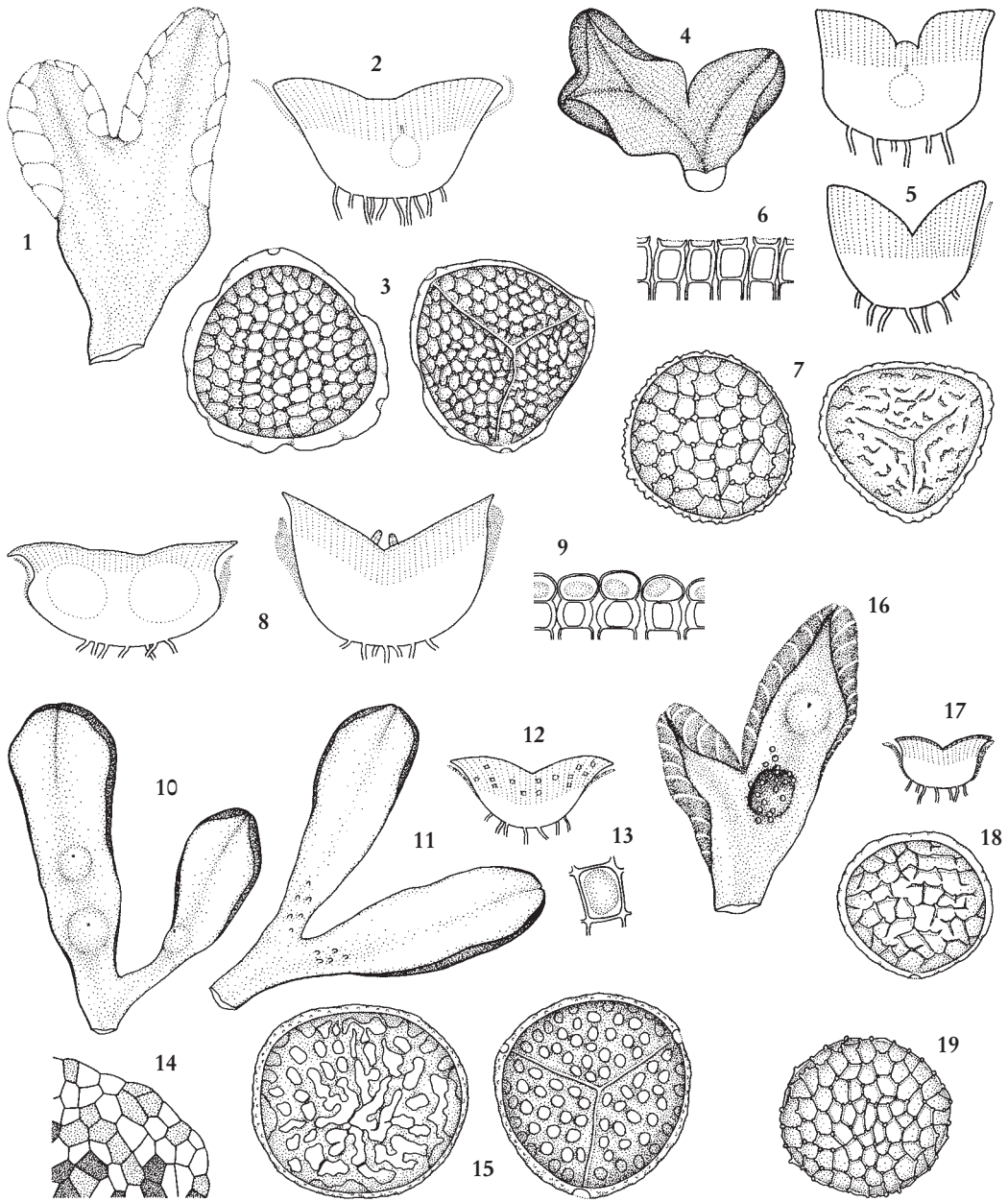


FIGURE 8. 1-3, *Riccia lamellosa*: 1, thallus; 2, thallus section with capsule; 3, spores, distal and proximal face. 4-7, *R. sorocarpa*: 4, thallus; 5, thallus sections with and without capsule; 6, epidermal and subepidermal cells in section; 7, spores, distal and proximal face. 8-9, *R. sommieri*: 8, thallus sections with capsules and antheridia; 9, epidermal and subepidermal cells in section. 10-15, *R. macrocarpa*: 10, female thallus; 11, male thallus; 12, thallus section; 13, cell with oil-body; 14, ventral scale cells; 15, spores, distal and proximal face. 16-18, *R. nigrella*: 16, thallus with capsules and antheridia; 17, thallus section; 18, spore, distal face; 19, *R. trabutiana*, spore, distal face. 10, 11 ( $\times 8$ ); 1, 4 ( $\times 10$ ); 2, 5, 8, 12, 17 ( $\times 15$ ); 16 ( $\times 20$ ); 14 ( $\times 100$ ); 6, 9, 13 ( $\times 150$ ); 3, 7, 15, 18, 19 ( $\times 300$ ).

- 6 Ventral scales hyaline, orange, violet or nearly black, not projecting above thallus margins 7
- 7 Plants deep green or bluish green, never with reddish spots; ventral scales hyaline or light violet (fig. 8, 4-7) **R. sorocarpa** Bisch.  
Plants usually in complete rosettes. Thalli in section 2-3 times as wide as high, reticulate on the dorsal side owing to subepidermal cells with thick, light walls; lobes about 2-3 mm wide; epidermal cells ephemeral. Spores dark brown, (65)70-90  $\mu\text{m}$  in diameter; wing finely crenulate, about 3-5  $\mu\text{m}$  wide; distal face with 8-10 usually regular alveoli per diameter; proximal face granulose, without alveoli, with very short, irregular, lamellae. Monoicous. Grows on open soils and slopes, fields and by road margins, from the lowlands to the high mountains.  
var. **sorocarpa**: Dorsal side of thallus without papillae. Widespread in the Peninsula and in Mallorca, Menorca Pithyusic Islands. Esp, Prt, And, Bl.  
var. **heegii** Schiffn.: Dorsal side of thallus with short, digitiform, straight or curved papillae. Very rare in the southeastern and western part of the Peninsula. Esp, Prt.
- 7 Plants green to reddish or orange; ventral scales violet or nearly black 8
- 8 Thalli more than 1,5 mm wide, cells with oil-bodies scattered in the parenchyma or in the epidermis 9
- 8 Thalli up to 1,5 mm wide, without oil-bodies 10
- 9 Plants coriaceous, reddish or orange; epidermal cells reddish, with a single oil-body; subepidermal cells thick-walled (fig. 8, 8-9) **R. sommierii** Levier  
Plants in incomplete rosettes, green in young parts, reddish or orange in old parts. Lobes medium-sized to large, about 1,5-3 mm wide, 1,5-2,5 as wide as high and v-shaped in section; wings narrow, horizontal, distinct in old parts; epidermal cells globose; subepidermal cells with yellowish walls. Ventral scales violet or nearly black at base, bright, hyaline at margins. Spores brown, 90-110(120)  $\mu\text{m}$  in diameter; wing irregularly crenulate, about 7-8  $\mu\text{m}$  wide; distal face with 8-10 alveoli across diameter, strongly thickened at angles; proximal face with irregular tubercles or lamellae. Dioicous. Grows on open soils, wet ledges in scrub with acidic substrata and in open areas in grassland, in the lowlands. Scattered in southern half of the Peninsula, more frequent in Mediterranean areas. Esp, Prt.
- 9 Plants not coriaceous, yellowish green or orange; epidermal cells hyaline, without oil-bodies; subepidermal cells not thick-walled (fig. 8, 10-15) **R. macrocarpa** Levier  
Plants in incomplete rosettes. Lobes sublinear, 1-1,5 mm wide, 2-3 times as wide as high and v-shaped in section; lateral wings narrow and undulate, well developed in old parts; epidermal cells ephemeral; cells with oil-bodies scattered in the parenchyma. Ventral scales violet, with orange spots. Spores reddish brown, 90-120  $\mu\text{m}$  in diameter; wing crenulate, about 4-5  $\mu\text{m}$  wide; distal face with 8-12 alveoli across diameter, usually irregularly limited and incomplete, with low, inconspicuous lamellae that are strongly thickened at angles; proximal face with high, irregular tubercles. Dioicous. Grows on wet ledges in olive fields, in grasslands, scrubs, in acidic substrata, in the lowlands. Widespread in the western half of the Peninsula, rare in the east and in Menorca. Esp, Prt, Bl.
- 10 Median groove narrow, distinct, along almost all the length of the dorsal side of lobe; lobes v-shaped in section; spores with incomplete, usually irregularly limited alveoli on distal face and with wide wing (fig. 8, 16-18) **R. nigrella** DC.



Plants usually in rosettes, bluish green to reddish brown. Lobes sublinear, about 1 mm wide, 1-2 times as wide as high in section. Ventral scales violet to nearly black, bright, with pink or hyaline margins. Spores 60-80  $\mu\text{m}$  in diameter, brownish; wing crenulate, 3-5(7)  $\mu\text{m}$  wide; distal face with 8-10 alveoli across diameter, the central ones incomplete; proximal face with irregular tubercles. Grows on opens soils, olive fields and by roads, in the lowlands, rarely in montane areas. Widespread in the Peninsula and in Mallorca. Esp, Prt, Bl.

- 10 Median groove only distinct in the apex of the dorsal side of lobe, wide and flat in mid-lobe; lobes v-shaped in section only in the apical part; spores with complete alveoli on distal face, wing lacking or very narrow near germinative pores (fig. 8, 19)

***R. trabutiana* Steph.**

Plants not in complete rosettes, vivid bluish green. Lobes 0,8-1,5 mm wide, at the apex in section as wide as high; margin acute; flanks slightly convex. Ventral scales violet to nearly black, with hyaline margins. Spores 65-80(85)  $\mu\text{m}$  in diameter, dark brown; wing crenulate; distal face with 9-12 alveoli across diameter. Grows on calcareous or rocky soils in pinewoods and oak forests, in the lowlands, rarely in montane areas. Scattered in the east and southern half of the Peninsula and in Mallorca and Pithyusic Islands. Esp, Prt, Bl.

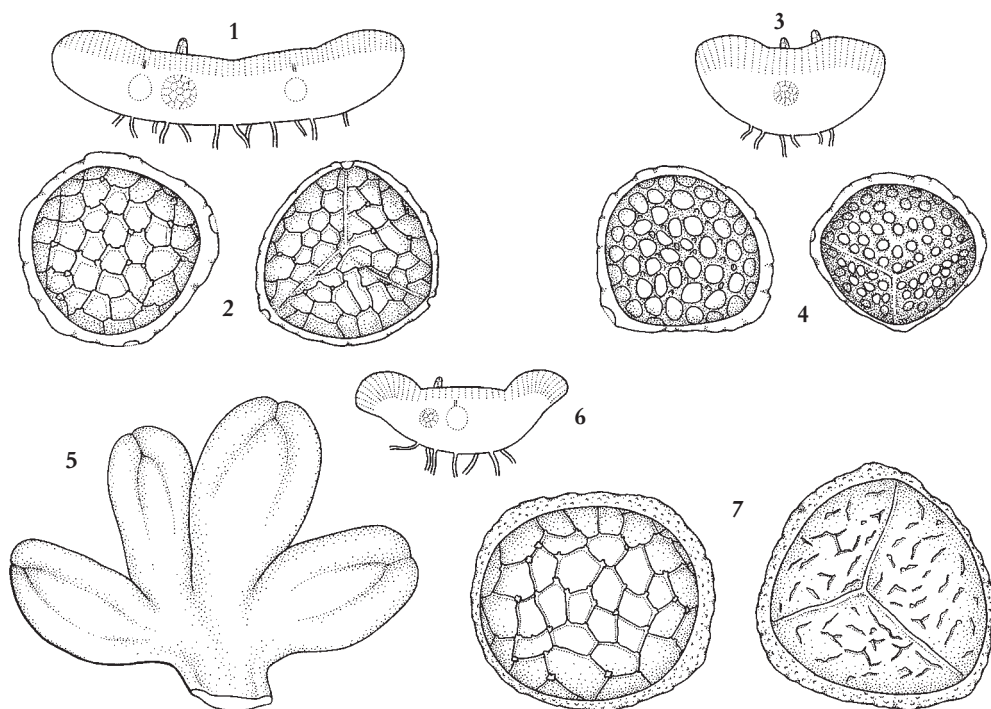


FIGURE 9. 1-2, *Riccia glauca*: 1, thallus section with capsules and antheridium; 2, spores, distal and proximal face. 3-4, *R. bifurca*: 3, thallus section with antheridia; 4, spores, distal and proximal face. 5-7, *R. beyrichiana*: 5, thallus; 6, thallus section with capsule and antheridium; 7, spores, distal and proximal face. 5 ( $\times 8$ ); 1, 3, 6 ( $\times 15$ ); 2, 4, 7 ( $\times 300$ ).

- 11 Lobes 1,5-3 mm wide, 2-5 times as wide as high in section 12
- 11 Lobes 0,4-1,8(2,5) mm wide, (1)1,5-2(2,5) times as wide as high in section 14
- 12 Thalli glaucous; lobes 2-3 mm wide, 4-5 times as wide as high in section (fig. 9, 1-2)  
**R. glauca** L.  
 Plants in rosettes. Lobes with flat and wide median groove; margin usually without cilia; flanks slightly convex. Ventral scales hyaline. Spores 75-100  $\mu\text{m}$  in diameter, dark brown; wing 5-7  $\mu\text{m}$  wide; distal face with 6-8 alveoli across diameter; proximal face with faint alveoli. Monoicous. Grows on wet, clayey soils by streams, in the lowlands and montane areas.  
 var. **glauca**: Margin of lobes without cilia. Widespread in the western half of the Peninsula, rare in the east and in Mallorca. Esp, Prt, Bl.  
 var. **ciliaris** Warnst. (var. *subinermis* (Lindb.) Warnst.): Margin of lobes usually with short, sparse cilia. Rare, in the west of the Peninsula. Esp, Prt.
- 12 Thalli light green to bluish; lobes 1,5-2,2 (2,5) mm wide, 2-4 times as wide as high in section 13
- 13 Plants in complete rosettes, 3-4-branched; median groove narrow at apex of lobes, flat in mid-lobe; flanks slightly convex at least on one side; margin usually glabrous or with short cilia to 300  $\mu\text{m}$  long, in the upper part; spores less than 100  $\mu\text{m}$  in diameter (fig. 9, 3-4)  
**R. bifurca** Hoffm.  
 Plants light green. Thalli 2-4 times as wide as high in section; lobes to 1,5-2 mm wide. Ventral scales hyaline or violet, slightly visible laterally, not projecting above thallus margins. Spores 70-90  $\mu\text{m}$  in diameter, light brown, with thickened lamellae; wing irregularly 5-7  $\mu\text{m}$  wide; distal face with 6-8 alveoli across diameter; proximal face with more or less complete alveoli. Monoicous. Grows on wet, clayey soils in roads and by streams or puddles, in the lowlands and montane areas.  
 var. **bifurca**: Thallus margins without cilia. Scattered in the Peninsula and in Mallorca. Esp, Prt, Bl.  
 var. **subinermis** Heeg: Thallus margins with sparse cilia. In the northeastern and southwestern part of the Peninsula. Esp. Prt.
- 13 Plants in incomplete rosettes; thallus sparsely branched; median groove plane or slightly convex; flanks rounded, swollen; margin usually glabrous or with smooth, hyaline cilia to 200  $\mu\text{m}$  long; spores up to 100-120  $\mu\text{m}$  in diameter (fig. 9, 5-7)  
**R. beyrichiana** Hampe ex Lehm.  
 Plants light green to bluish. Lobes to 1,5-2(2,5) mm wide, with flanks reaching apex; median groove wide. Thalli 2-3 times as wide as high in section. Ventral scales hyaline or violet, inconspicuous. Spores light brown; wing irregularly crenulate and papillose, about 4-7  $\mu\text{m}$  wide; distal face with 6-8 alveoli across diameter; proximal face without alveoli, with irregular high tubercles. Monoicous. Grows on soils in open areas in scrub and by streams, in the lowlands. Widespread in the southern half of the Peninsula, rarer in the north of the Peninsula, Mallorca and Menorca. Esp, Prt, Bl.
- 14 Thalli not papillose, glabrous or with short cilia about 100(200)  $\mu\text{m}$  long 15
- 14 Thalli papillose or with long cilia 200-1100  $\mu\text{m}$  long or with shorter cilia at base of thallus 16



- 15 Thalli bluish green, with lobes wider at apex; spores large, 80-100(110)  $\mu\text{m}$  in diameter, with 8-12(13) alveoli across diameter on the distal face (fig. 10, 1)

**R. subbifurca** Warnst. ex Croz.

Plants in incomplete rosettes. Thalli 1-2 times as wide as high in section; lobes 0,4-1 mm wide, rounded at apex; margin glabrous or with cilia about 100  $\mu\text{m}$  long; flanks rounded, slightly convex; median groove flat. Ventral scales hyaline or light violet, inconspicuous laterally. Spores brown; wing usually regular, about 4-7  $\mu\text{m}$  wide; proximal face with complete alveoli. Monoicous. Grows on wet soils in acidic scrubs, in the lowlands. Scattered in the southern half, northwestern and northeastern part of the Peninsula. Esp, Prt.

- 15 Thalli vivid green, with sublinear lobes; spores 65-85  $\mu\text{m}$  in diameter, with 6-8 alveoli across diameter on the distal face (fig. 10, 2-3)

**R. warnstorffii** Limpr.

Plants in small, usually irregular rosettes. Thalli 1,5-2 times as wide as high in section, with the angle between branches 70-90°; lobes very narrow, 0,4-1 mm wide; margin glabrous or with short cilia about 100  $\mu\text{m}$  long; flanks swollen near apex; median groove flat. Ventral scales hyaline or light violet, inconspicuous laterally. Spores brownish; wing usually regular, about 3-7  $\mu\text{m}$  wide; proximal face with complete alveoli. Monoicous. Grows on open, wet, acidic soils, in the lowlands. Scattered in the Peninsula. Esp, Prt.

- 16 Thalli ciliate; cilia less than 300  $\mu\text{m}$  long, wide at base, 2-3-fused basally, patent to squarrose (fig. 10, 4-5)

**R. bicarinata** Hoffm.

Plants in incomplete rosettes, light green to greyish, dark violet in the upper part and flanks. Thalli regularly branched, 1,5-2 times as wide as high in section; lobes 0,6-1,2 mm wide, with rounded apex; cilia persistent, the high ones finely papillose and the low cilia generally smooth, triangular and usually yellowish; flanks rounded, convex; median groove distinct almost to base. Ventral scales light violet or with hyaline cells. Spores brown to blackish, 85-110(115)  $\mu\text{m}$  in diameter; wing usually narrow, about 4-5  $\mu\text{m}$  wide, visible on both faces; distal face with 8-10 alveoli across diameter. Monoicous or dioicous. Grows on wet soils in scrubs and by roads and temporary puddles, in the lowlands. Scattered in the southwestern part of the Peninsula and in Menorca. Esp, Prt, Bl.

- 16 Thalli papillose or ciliate; cilia 300-1000  $\mu\text{m}$  long, not widened at base, isolated, slightly incurved 17

- 17 Thalli papillose; plants dioicous 18

- 17 Thalli ciliate; plants monoicous or dioicous 19

- 18 Plants light green; lobe margins with pink or light violet scales; spores 60-80  $\mu\text{m}$ , with 5-8 alveoli across diameter on the distal face (fig. 10, 6-9)

**R. papillosa** Moris

Plants in incomplete rosettes. Lobes about 0,5-1,5 mm wide, in section as wide as high at apex; flanks thick, rounded, convex; papillae scattered at margins and upper part of thallus, straight or curved, digitiform, about 100  $\mu\text{m}$  high. Spores dark brown; wing crenulate and narrow or wing lacking. Grows in acidic open areas in scrub, by temporary puddles and roads, in the lowlands. Widespread in the western half of the Peninsula, very rare in the northeast. Esp, Prt.

- 18 Plants bluish light green; lobe margins with dark violet scales; spores 80-120  $\mu\text{m}$ , with 12-18 alveoli across diameter on the distal face (fig. 10, 10-11)

**R. atromarginata** Levier

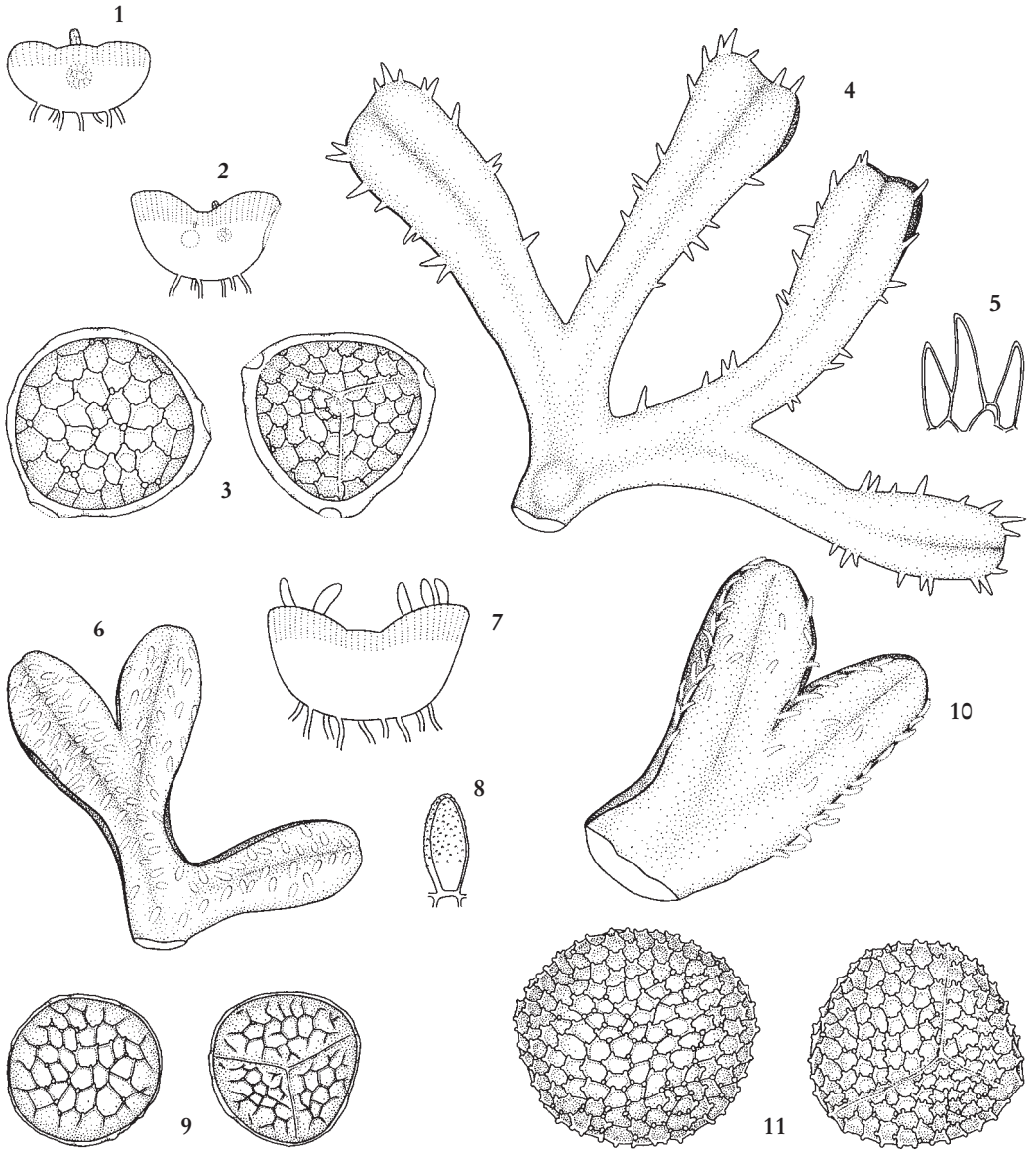


FIGURE 10. 1, *Riccia subbifurca*, thallus section with antheridium. 2-3, *R. warnstorffii*: 2, thallus section with capsule and antheridium; 3, spores, distal and proximal face. 4-5, *R. bicarinata*: 4, thallus with capsule; 5, low cilia. 6-9, *R. papillosa*: 6, thallus; 7, thallus section; 8, papilla; 9, spores, distal and proximal face. 10-11, *R. atromarginata*: 10, thallus; 11, spores, distal and proximal face. 4 ( $\times 17$ ); 6, 10 ( $\times 20$ ); 1, 2, 7 ( $\times 30$ ); 5, 8 ( $\times 100$ ); 3, 9, 11 ( $\times 300$ ).

Plants in incomplete rosettes. Lobes about 1-1,8 mm wide, in section 1-1,5 times as wide as high at apex; margin rounded; flanks thick, convex to swollen; papillae scattered on flanks and upper part of thallus 70-150  $\mu\text{m}$  high. Ventral scales light violet or with hyaline cells. Spores with crenulate margins; wing lacking. Grows on dry, calcareous ledges in grasslands, pinewoods and olive fields, in the lowlands. Scattered in the east and south of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 19 Cilia 500-1000  $\mu\text{m}$  long, at margins, on the dorsal side and on capsules, regularly distributed along the whole thallus (fig. 11, 1-3)

**R. crinita** Taylor

**R. trichocarpa** M. Howe

Plants regularly branched, rarely in rosettes, glaucous green. Thalli 1-2 times as wide as high in section; lobes 0,7-1,5 mm wide; flanks and median groove rounded, convex; marginal cilia yellowish or hyaline, not papillose. Spores brown, (80)90-120  $\mu\text{m}$  in diameter, with thickened lamellae; wing granulate, usually regular, very narrow, about 2  $\mu\text{m}$  wide; distal face with 8-12 alveoli across diameter; proximal face with complete alveoli, with thinner walls than those of distal face. Monoicous. Grows at road margins, on slopes, on ground and among rocks, in the lowlands. Scattered in the east and southern half of the Peninsula and in Mallorca, more frequent in the Mediterranean area. Esp, Prt, Bl.

- 19 Cilia (200)300-500  $\mu\text{m}$  long, rarely at margins, more abundant at the lobe apex, lacking on the dorsal side and on capsules 20

- 20 Thalli bluish; base of lobes and scales violet, usually very dark; cilia 200-300  $\mu\text{m}$  long (fig. 11, 4-7)

**R. crozalsii** Levier

Plants in incomplete rosettes, very small. Thalli irregularly branched, dark violet on sides and in the upper part, 1,5-2 times as wide as high in section; lobes 0,4-1 mm wide, with rounded apices; cilia from 1/3 to apex of lobe margins, ephemeral, finely papillose; flanks rounded, convex; median groove distinct at apex. Spores brownish, 60-90(95)  $\mu\text{m}$  in diameter; wing irregularly crenulate, visible on both faces, usually narrow; distal face with 8-12 alveoli across diameter. Monoicous. Grows on wet soils, from the lowlands to the high mountains. Widespread in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 20 Thalli light green to glaucous; base of lobes and scales hyaline to light violet; cilia 250-500  $\mu\text{m}$  long 21

- 21 Plants monoicous; cilia finely papillose; spores 70-90  $\mu\text{m}$  in diameter (fig. 11, 8-10)

**R. ciliata** Hoffm.

Plants in incomplete rosettes, green rarely violet. Lobes 0,6-1(1,5) mm wide, as wide as high in section, with rounded apices; cilia from 1/3 to apex of lobe margins, abundant in the upper part, with a globose cell at base; flanks rounded, slightly convex, channelled when dry; median groove plane. Spores brownish, 70-90  $\mu\text{m}$  in diameter; wing usually narrow, wider near germinative pore; distal face with 7-9(10) alveoli across diameter; proximal face with complete alveoli, smaller than those of distal face. Grows on wet soils, by ravine margins, on acidic substrata, in the lowlands. Widespread in the Peninsula and in Menorca. Esp, Prt, And, Bl.

- 21 Plants dioicous; cilia papillose or smooth on the same plant; spores 90-100 (120)  $\mu\text{m}$  in diameter (fig. 11, 11-13)

**R. michelii** Raddi

Plants in incomplete rosettes or isolated, light green with light violet spots. Thalli 3-4 times as wide as high in section; lobes 1,2-1,6 mm wide, narrowed from apex to base; cilia at margins,

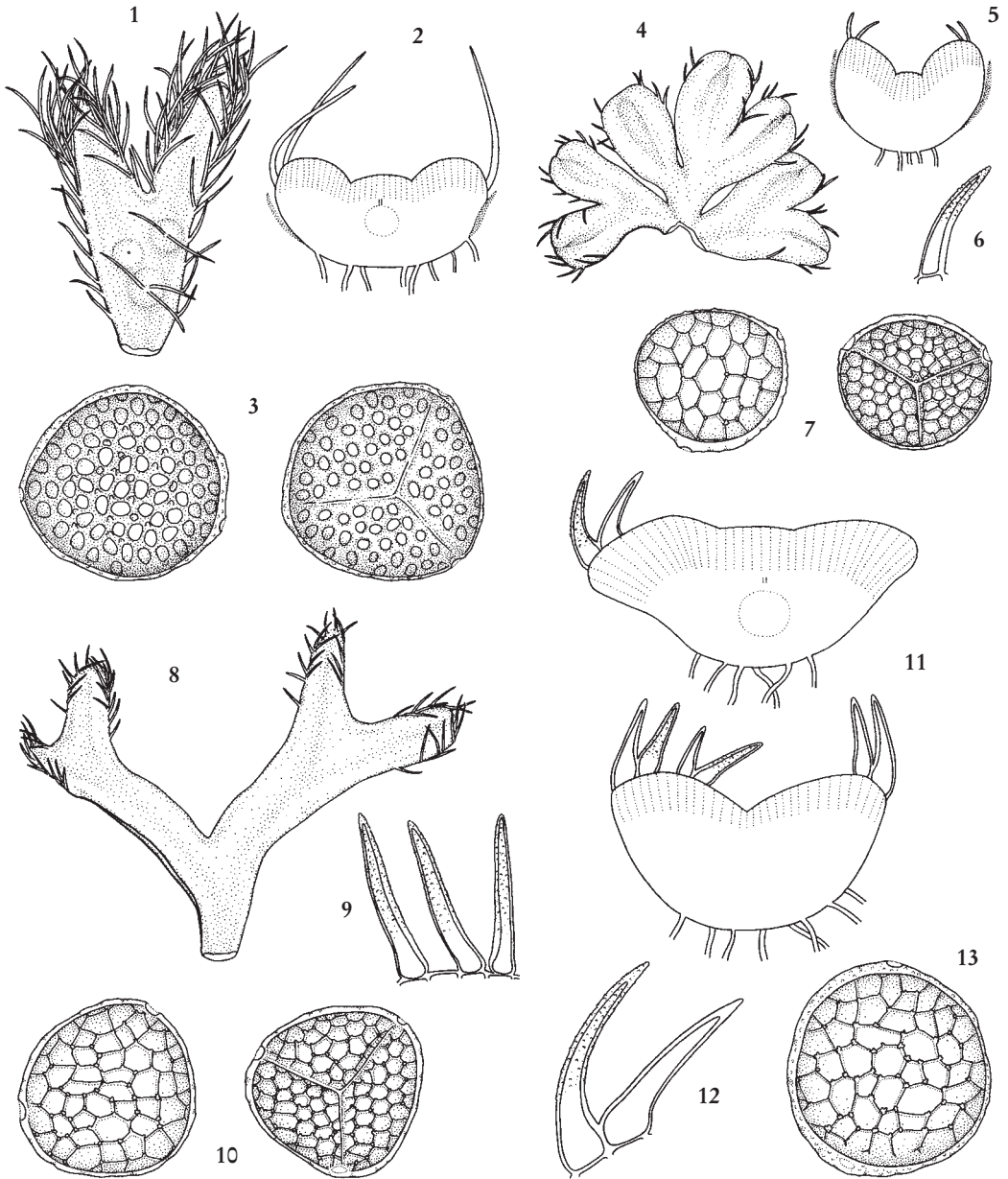


FIGURE 11. 1-3, *Riccia crinita*: 1, thallus with capsules; 2, thallus section with capsule; 3, spores, distal and proximal face. 4-7, *R. crozalsii*: 4, thallus; 5, thallus section; 6, cilium; 7, spores, distal and proximal face. 8-10, *R. ciliata*: 8, thallus; 9, cilia; 10, spores, distal and proximal face. 11-13, *R. michelii*: 11, thallus sections with and without capsule; 12, cilia; 13, spore, distal face. 1, 4, 8 ( $\times 10$ ); 2, 5, 11 ( $\times 30$ ); 6, 9, 12 ( $\times 80$ ); 3, 7, 10, 13 ( $\times 300$ ).

more abundant at apex, in pairs, usually fused at base; flanks convex, specially in the upper part. Spores light brown; wing irregular, 5-7  $\mu\text{m}$  wide; distal face with 7-9 alveoli across diameter, with tuberculate angles. Grows on wet, acidic ledges among rocks, in the lowlands. Rare, scattered in the Peninsula. Esp, Prt.

22 Dorsal side of thallus with spongy appearance and air chambers with irregular openings 23

22 Dorsal side of thallus without spongy appearance and air chambers opening by small pores 27

23 Spores without alveoli on the distal face; plants dioicous (fig. 12, 1-2)

**R. frostii** Austin

Plants in dense rosettes nearly complete, 6-8(10) mm in diameter, bluish green to greyish. Lobes 0,7-1,4 mm wide, truncate, rounded to emarginate; median groove lacking. Capsules abundant along the thalli, immersed or slightly prominent but distinct when dry. Spores brown, 45-52(55)  $\mu\text{m}$  in diameter; wing finely and regularly crenulate, usually narrow, about 2  $\mu\text{m}$  wide; distal face with irregular, undulate lamellae, radiating from centre to distal face; proximal face with distinct trilete mark, without complete alveoli, irregular, undulate lamellae more visible at centre. Grows on wet, alluvial soil at reservoir margins. Rare, in the southwest of the Peninsula. Esp.

23 Spores with totally or irregularly limited alveoli on the distal face; plants monoicous or dioicous 24

24 Plants in incomplete rosettes or isolated; lobes narrow or linear; mature capsules prominent on ventral side of thalli; plants monoicous or dioicous 25

24 Plants in rosettes; lobes cordate or fan shaped; mature capsules immersed or prominent on dorsal side of thalli; plants monoicous 26

25 Thalli yellowish to light green; lobes (1)1,5-3 mm wide, 3-4 times as wide as high in section; terminal tubers present on the ventral side of thallus (fig. 12, 3-5)

**R. perennis** Steph.

Lobe flanks thick, with narrow, undulate, white lateral wings, usually distinct in old parts; median groove distinct, nearly to base at least when dry. Tubers sometimes pedicellate, to 1 mm high. Archegonia in a small hole in mid-thallus. Capsules rare. Spores light yellowish, 110-120  $\mu\text{m}$  in diameter; wing usually about 10  $\mu\text{m}$  wide; distal face with 3-4 alveoli; proximal face with irregular lamellae, alveoli lacking. Dioicous. Grows on soils in open areas in scrub and by streams, in the lowlands. Widespread in the southern half of the Peninsula. Esp, Prt.

25 Thalli light green with light violet spots at sides and on old parts; lobes 0,4-1 mm wide, 1-2 times as wide as high in section; tubers lacking (fig. 12, 6-7)

**R. huebeneriana** Lindenb.

Lobes with median groove visible at apex, reaching the base in dry plants. Capsules prominent on the ventral side, not or only slightly visible on the dorsal side. Spores yellowish to brownish or black, 55-75  $\mu\text{m}$  in diameter; wing irregularly lobed, finely papillose, usually more than 3-5(6)  $\mu\text{m}$  wide; distal face with 6-8 complete alveoli; proximal face with incomplete alveoli. Monoicous. Grows on alluvial soil, on ravine stream and reservoir margins, on acidic

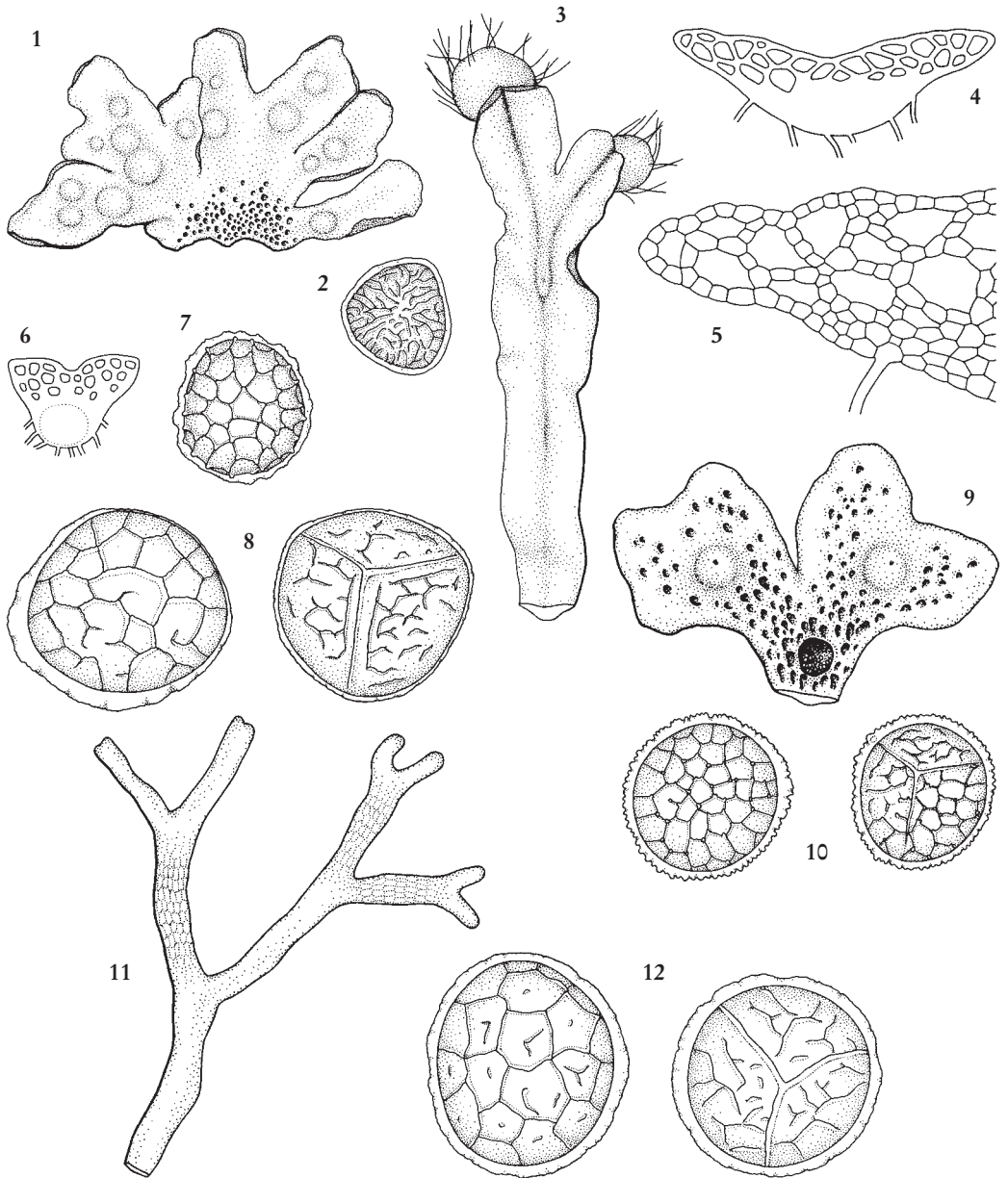


FIGURE 12. 1-2, *Riccia frostii*: 1, female thallus when dry; 2, spore, distal face. 3-5, *R. perennis*: 3, thallus with gemmae; 4-5, thallus sections. 6-7, *R. huebeneriana*: 6, thallus section with capsule; 7, spore, distal face. 8, *R. cavernosa*, spores, distal and proximal face. 9-10, *R. crystallina*: 9, thallus with capsules; 10, spores, distal and proximal face. 11, *R. fluitans*, thallus. 12, *R. duplex*, spores, distal and proximal face. 9, 11 ( $\times 6$ ); 1, 3 ( $\times 10$ ); 4, 6 ( $\times 30$ ); 5 ( $\times 80$ ); 2, 7, 8, 10, 12 ( $\times 300$ ).



substrata, in the lowlands. Scattered in the north and northwestern part of the Peninsula. Esp, Prt.

- 26 Thalli light green with pink or light violet spots; lobes to 2 mm wide, with narrow cavities; spores reddish to brownish with incomplete, usually irregularly delimited alveoli on the distal face (fig. 12, 8) **R. cavernosa** Hoffm.

Plants in large rosettes, to about 3 cm in diameter, light or vivid green. Thalli with irregular perforations on the dorsal side, more visible in old parts; lobes rounded to emarginate; median groove lacking. Capsules immersed or slightly prominent and opening on the dorsal side but showing through the ventral side, more abundant at base. Spores (60)80-100(130)  $\mu\text{m}$  in diameter; wing regularly crenulate, usually to 7  $\mu\text{m}$  wide; distal face with irregularly delimited alveoli; proximal face with distinct trilete mark and irregularly delimited alveoli. Grows on wet soils and sandy rock ledges, in the lowlands, rarely in montane areas. Scattered in the Peninsula and in Mallorca. Esp, Prt, Bl.

- 26 Thalli bluish green, crystalline, usually with pink or light violet spots; lobes 3-10 mm wide, with large cavities; spores yellowish to brownish with complete alveoli on the distal face (fig. 12, 9-10) **R. crystallina** L. emend. Raddi

Plants in dense, large rosettes, more than 1,5 cm in diameter. Thalli with irregular perforations on the dorsal side, more visible in old parts; lobes truncate, rounded to emarginate; median groove lacking. Capsules abundant along the whole thallus, immersed or slightly prominent and opening on the dorsal side but showing through the ventral side. Spores 70-85  $\mu\text{m}$  in diameter; wing regularly crenulate, about 5  $\mu\text{m}$  wide; distal face with 9-10 complete alveoli across diameter; proximal face with distinct trilete mark and complete alveoli mostly irregularly delimited. Grows by roads, on open soils, in open areas in grassland and rocky, sandy sites, mainly in the lowlands, in the southern half of the Peninsula, rare in the north, and in Mallorca and Menorca. Esp, Prt, Bl.

- 27 Thalli translucent, distinctly reticulate; lobes 0,8-1 mm wide, 3-6 times as wide as high in section; plants dioicous; aquatic, rarely growing on soils (fig. 12, 11)

**R. fluitans** L.

Thalli furcate, light green. Lobes to 15 mm long; median groove only visible at apex. Dorsal epidermis with quadrangular pores surrounded by 4 cells. Terminal ventral scale not covering lobe apex. Capsule prominent on the ventral side, not or only slightly visible on the dorsal one. Spores brownish to blackish, 60-75  $\mu\text{m}$  in diameter; wing finely crenulate, about 5  $\mu\text{m}$  wide; distal and proximal faces with incomplete alveoli. Floating in lakes, slow-flowing streams and on wet soils, in the lowlands. Scattered in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 27 Thalli not translucent, not distinctly reticulate; lobes 0,4-0,6(0,8) mm wide, 2,5-3 times as wide as high in section; plants monoicous; terricolous (fig. 12, 12)

**R. duplex** Lorb.

Thalli furcate, light green, slightly bright. Lobes (0,3)0,4 -0,6(0,8) mm wide, up to 8 mm long; median groove faint at apex. Terminal ventral scales covering lobe apex. Capsules prominent on the ventral side, usually covered by violet scales. Spores brownish, 90-100  $\mu\text{m}$  in diameter; wing irregular, finely crenulate, 4-7  $\mu\text{m}$  wide; distal face with 4-5 alveoli across diameter, with a central papilla; proximal face with incomplete alveoli. Grows on wet, acidic ledges by streams and on wet soils, in the lowlands. Scattered in the southwestern part of the Peninsula. Esp, Prt.

## O. Sphaerocarpaceles

### Fam. Riellaceae

#### Riella Mont.

Plants annual, 1-5 cm long. Axes erect or prostrate, simple, with an undulate longitudinal wing on dorsal side, sinuose at margins, unistratose. Ventral scales in one row, small, caducous, usually only evident in the upper part. Rhizoids at base in erect forms, and along the axis in the prostrate forms. Gemmae along the axis, late winter. Antheridia in seriate cavities at the wing margin. Archegonia surrounded by a flask-shaped involucre and grouped near the axis apex. Capsule irregularly dehiscent. Monoicous or dioicous. Elaters lacking. Plants variable in shape and size depending on environmental conditions, growing in clean and sunny aquatic sites, fluctuant, with more or less long dry periods, submerged, semi-submerged or on mud in shallow ponds and in saline pools or marshes.

- 1 Involucres with longitudinal wings; ventral scales spatulate (fig. 13, 1-2) **R. cossoniana** Trab.  
Plants 10-20 mm long. Wings (1)2-3 mm wide. Spores 60-70(80)  $\mu\text{m}$ , with rounded spines 3-5  $\mu\text{m}$  long on the distal face. Dioicous. Grows submerged in pond margins. Distributed in the south, east and central part of the Peninsula. Rare. Esp.
- 1 Involucres without longitudinal wings; ventral scales lanceolate **2**
- 2 Spore surface smooth; distal spines of spores 7-10  $\mu\text{m}$  high, truncate, widened at apex; ventral scales small; dioicous (fig. 13, 3-6) **R. helicophylla** (Bory & Mont.) Mont.  
Plants 10-20 mm long. Spores 80-93  $\mu\text{m}$ . Grows in shallow, brackish water both coastal and inland areas, in periodically waterlogged margins and hollows and in marshes. Scattered in the east, south and central part of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 2 Spore surface papillose; distal spines of spores 4-6  $\mu\text{m}$  high, blunt; ventral scales large, to 0,3 mm long; monoicous (fig. 13, 7) **R. notarisii** (Mont.) Mont.  
Plants 5-10 mm long. Wing margin very sinuose, usually irregularly divided, with 1 or more rows of narrowly rectangular marginal cells. Spores 50-65(70)  $\mu\text{m}$ . Grows in temporary pools, shallow ponds of brackish or saline water. Scattered in the south and east of the Peninsula and in Menorca. Esp, Prt, Bl.

## Fam. Sphaerocarpaceae

### Sphaerocarpos Boehm.

Plants annual or ephemeral. Thalli furcate, circular; lobes 1-1,5 cm in diameter, lobes short, with unistratose margins, erect or undulate. Antheridia and archegonia on the dorsal side of thallus, individually surrounded by the involucres, that almost cover the dorsal surface; male involucre pyriform, female involucre clavate or sub-globose, constricted in the upper part and with a small aperture. Capsule irregularly dehiscent, not exerted. Spores united in tetrads; elaters lacking. Dioicous.



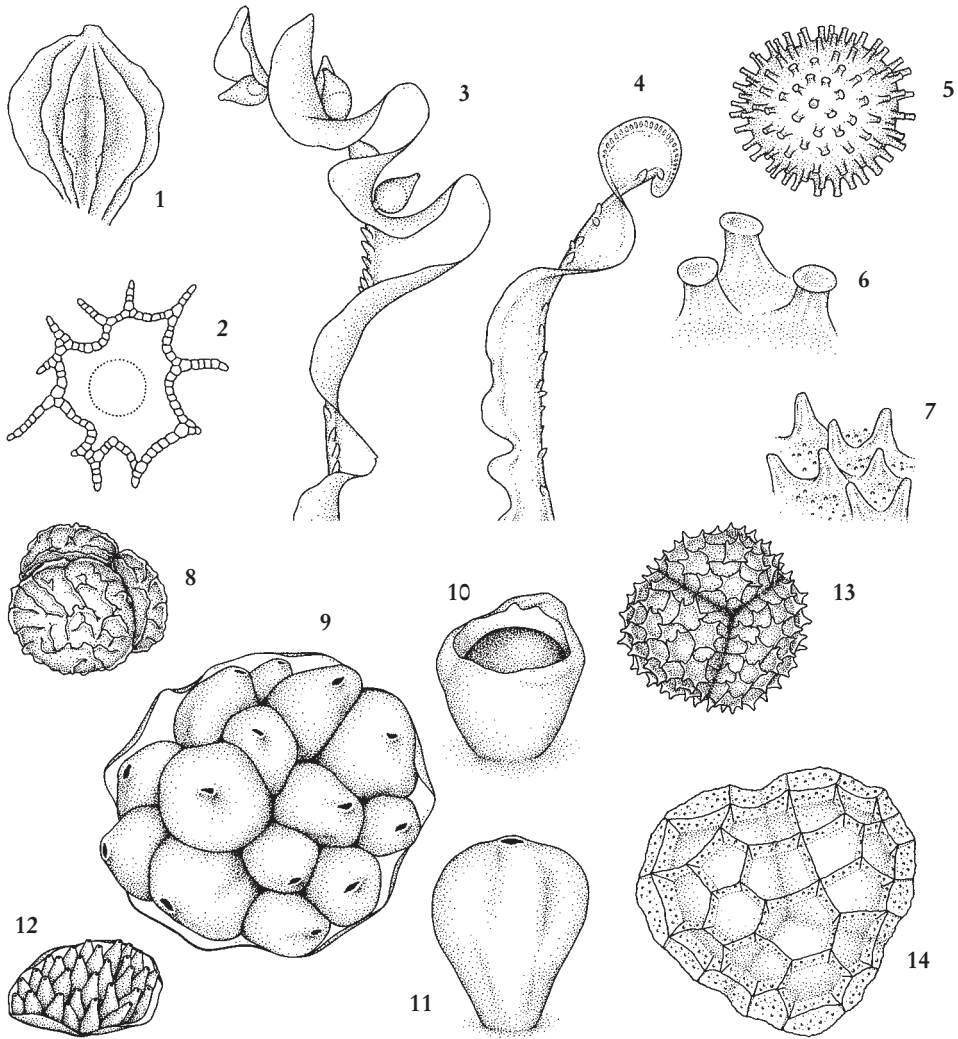


FIGURE 13. 1-2, *Riella cossoniana*: 1, involucre; 2, involucre section. 3-6, *R. helicophylla*: 3, female thallus; 4, male thallus; 5, spore, distal face; 6, spore spines. 7, *R. notarisii*, spore spines. 8, *Sphaerocarpos stipitatus*, spore tetrad. 9-13, *S. michelii*: 9, female thallus; 10, involucre and capsule; 11, involucre; 12, male thallus; 13, spore tetrad. 14, *S. texanus*, spore tetrad. 3, 4 ( $\times 5$ ); 1, 9, 10, 11, 12 ( $\times 15$ ); 2 ( $\times 55$ ); 5, 8, 13, 14 ( $\times 250$ ); 6, 7 ( $\times 900$ ).

- 1 Distal face of spores without well-defined alveoli and with irregular lamellae; female involucre 2-stratose, stalked (fig. 13, 8) *S. stipitatus* Bisch. ex Lindenb.  
Forms small, green patches on soil, in arable fields and in gardens, in the lowlands. Rare, in the western part of the Peninsula. Prt.
- 1 Distal face of spores with well-defined alveoli; female involucre unistratose, sessile 2

- 1 Spore tetrads dark brown, 90-110  $\mu\text{m}$ ; 8-10 alveoli across the distal surface of the spore; lamellae smooth, 2,5-5  $\mu\text{m}$  high, with spines at the angles (fig. 13, 9-13)

***S. michelii*** Bellardi

Forms small, light green patches on moist soils, in gardens and arable fields, in the lowlands. Distributed in the western half and east of the Peninsula, rare in the north and in Mallorca and Menorca. Esp, Prt, Bl.

- 1 Spore tetrads reddish brown, 135-170  $\mu\text{m}$ ; 4-6 alveoli across the distal surface of the spore; lamellae papillose, 10-12,8  $\mu\text{m}$  high, without spines at the angles (fig. 13, 14)

***S. texanus*** Austin

Similar to *S. michelii*. Forms small, light green patches on moist soils, in gardens and arable fields, in the lowlands. Distributed in the east and western half of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

## O. Metzgeriales Fam. Metzgeriaceae

### *Metzgeria* Raddi

Thalli prostrate, furcate, usually with ventral branches arising from midrib, rarely from margins; wings unistratose, translucent, commonly with scarce, short, hyaline, unicellular hairs on ventral side and at margins, or lacking; midrib narrow. Gemmae, when present, on wing margins or on the ventral side of midrib, discoid to oblong, ovoid or ellipsoidal, pluricellular, unistratose, sometimes with hairs. Antheridia on small branches on ventral side of midrib, inside a globose sac (inrolled male branchlet). Archegonia on small branches on ventral side of midrib, hidden under a thallus flap (female branchlet or involucre). Autoicous or dioicous.

- 1 Marginal hairs in pairs; plants autoicous; gemmae lacking (fig. 14, 1-2)

***M. conjugata*** Lindb.

Thalli 14-25  $\times$  0,8-1,6 mm, weakly convex, sometimes recurved at margins, with simple hairs on ventral side. Forms yellowish green mats on shaded, acidic rocks, slopes and wet soils or corticolous, from the lowlands to high mountains, in northern part of the Peninsula, rare in the western part. Esp, Prt, And.

- 1 Marginal hairs single or lacking; plants dioicous; sometimes with gemmae

2

- 2 Thalli plane, without attenuate branches (fig. 14, 3-4)

***M. furcata*** (L.) Dumort.

Thalli 20-25  $\times$  0,5-1(2) mm, sometimes with abundant marginal branches, with single hairs on the ventral side and at margins or lacking; midrib with 2 rows of epidermal cells on dorsal side. Gemmae sometimes present on wing margins or on ventral side of midrib, without hairs. Forms green or yellowish flat green mats on bark of trees or on wet, shaded rocks, from the lowlands to high mountains. Widely distributed in the northern half of the Peninsula and in Mallorca and Menorca, scattered in the southern half. Esp, Prt, And, Bl.

- 2 Thalli convex, with attenuate gemmiferous branches

3

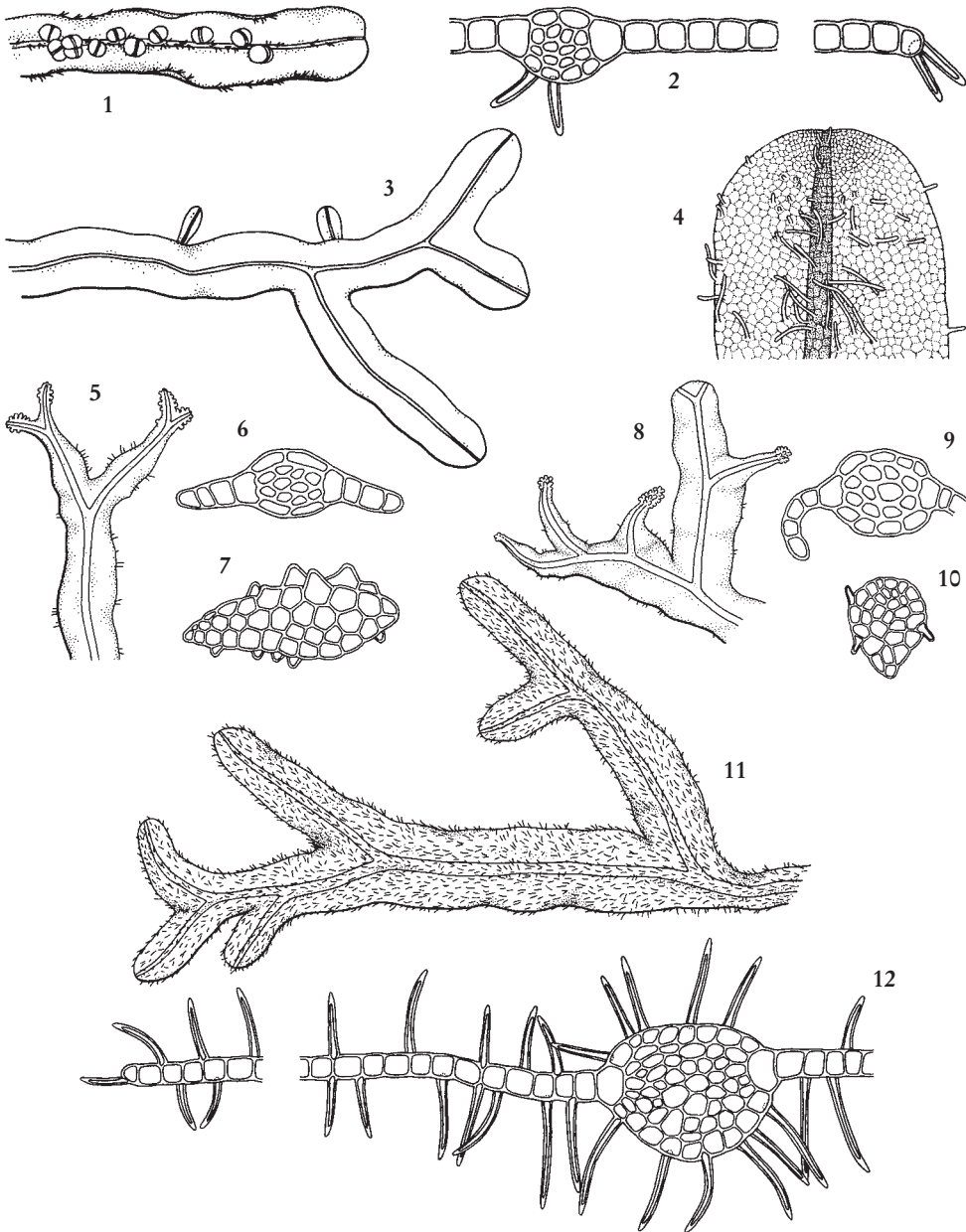


FIGURE 14. 1-2, *Metzgeria conjugata*: 1, thallus with antheridia, ventral view; 2, thallus section. 3-4, *M. furcata*: 3, thallus; 4, thallus apex on ventral side. 5-7, *M. temperata*: 5, thallus; 6, attenuated branch in section; 7, gemma. 8-10, *M. violacea*: 8, thallus; 9, attenuated branch in section; 10, gemma. 11-12, *Apometzgeria pubescens*: 11, thallus; 12, thallus section. 11 ( $\times 7$ ); 1, 3, 5, 8 ( $\times 10,5$ ); 4 ( $\times 50$ ); 7, 10, 12 ( $\times 100$ ); 2, 6, 9 ( $\times 125$ ).

- 3 Gemmae only on wing margins; midrib of branches with 2 rows of epidermal cells; thalli never with bluish coloration (fig. 14, 5-7) **M. temperata** Kuwah.  
Thalli  $20 \times 0,5-1,5$  mm, with ascending, attenuate gemmiferous branches and marginal hairs. Gemmae with 1-several conical cells, with or without hairs. Forms yellowish green mats, pale yellow or whitish when long-dried, corticolous, in wet, shaded sites, in the lowlands. Distributed in the north of the Peninsula. Esp.
- 3 Gemmae on margins, apex and both sides of wing; midrib in attenuate branches with 3-6 rows of epidermal cells; thalli gradually becoming blue (fig. 14, 8-10)  
**M. violacea** (Ach.) Dumort.  
**M. fruticulosa** (Dicks.) A.Evans  
Thalli  $10(15) \times 0,6-1$  mm, turquoise blue or dark blue at least at apex or when long-dried, with ascending, dark blue gemmiferous branches; hairs on the ventral side scarce or lacking, rarely with hairs in pairs at margins. Gemmiferous branches attenuate, often reduced to midrib, with cluster of dark blue gemmae at apex, gemmae with rounded cells, with or without hairs. Corticolous or growing on rotting trunks, in wet, shaded sites, in the lowlands and montane areas. Distributed in the northern part of the Peninsula. Esp.

### **Apometzgeria** Kuwah.

Thalli to about 3,5 cm long, procumbent or ascending, irregularly branched, whitish green or glaucous owing to the dense covering of hyaline hairs on both sides of thallus; lobes about 2 mm wide; wings unistratose; midrib prominent in the dorsal side, quite wide at the lobe base, narrower at apex. Antheridia on small branches on ventral side of midrib, inside a globose sac (inrolled male branchlet). Archegonia on small branches on ventral side of midrib, hidden under a thallus flap (female branchlet or involucre). Dioicous (fig. 14, 11-12) **A. pubescens** (Schrank) Kuwah.  
Forms lax patches on shaded, wet, calcareous rocks, in montane areas and high mountains. Distributed in the Pyrenees and north of the Peninsula. Esp, And.

## **Fam. Aneuraceae**

### **Aneura** Dumort.

Thalli ascending, prostrate or procumbent, fleshy, rigid, translucent or not, light green, more or less channelled, simple or irregularly branched; margin plane, undulate or sinuose, with border of 1-4 unistratose rows of cells; midrib poorly or clearly differentiated. Oil-bodies more than 6, in epidermal cells, ephemeral, finely granulose. Rhizoids hyaline, in the middle of the ventral side in prostrate or procumbent thalli and at base in the ascending ones. Antheridia and archegonia on small, lateral branches. Capsule ellipsoidal. Dioicous.

- 1 Thallus translucent; midrib (5)6-9(10) cells thick (fig. 15, 1-2) **A. pseudopinguis** (Herzog) Pócs  
Thallus  $2-5(7) \times 0,4-0,6$  cm, very thin, green, plane to concave in section, gradually tapered towards margin; midrib incipient; wings scarcely differentiated, weakly undulate to flattened,

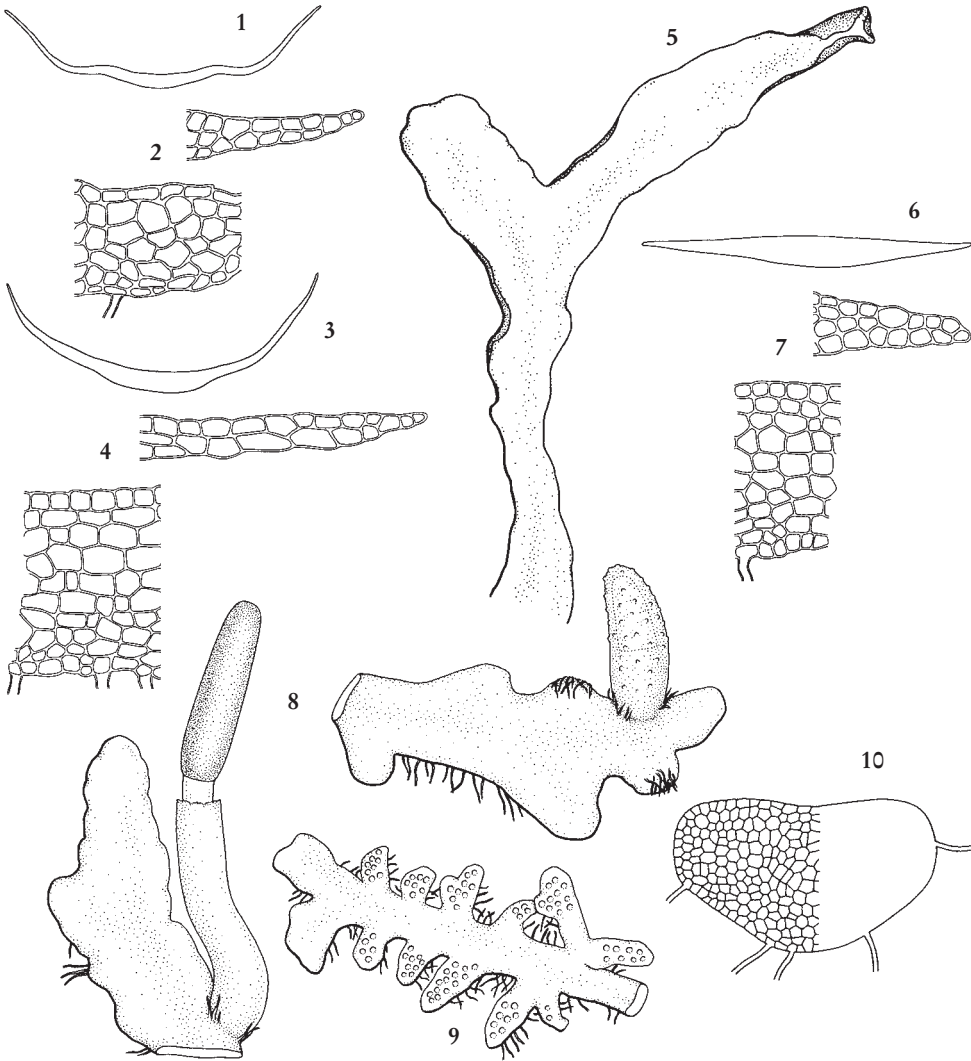


FIGURE 15. 1-2, *Aneura pseudopinguis*, thallus sections. 3-4, *A. maxima*, thallus sections. 5-7, *A. pinguis*: 5, thallus; 6-7, thallus sections. 8-10, *Cryptothallus mirabilis*: 8, female thalli, with sporophyte with capsule and enclosed by calyptra; 9, male thallus with antheridia; 10, thallus section. 5, 8, 9 ( $\times 6$ ); 1, 3, 6 ( $\times 9$ ); 10 ( $\times 30$ ); 2, 4, 7 ( $\times 70$ ).

totally 2-4-stratose close to the margin to near the central part; margin acute, narrowly bordered by 2-4 unistratose rows of cells; epidermal cells in section rectangular, irregular, with flexible, collapsed walls. Grows on shaded granitic rocks, near streams or sources, mainly in the lowland and montane areas, in the northwest of the Peninsula. Esp, Prt.

1 Thallus opaque or translucent only at margins; midrib (8)10-12(15) cells thick 2

- 2 Thallus translucent at margins, with distinct midrib; wings 20-25 or more cells wide (fig. 15, 3-4) **A. maxima** (Schiffn.) Steph.

Thallus 4-7 × 0,7-1(1,2) cm, light green plane to concave in section, abruptly tapered towards margin; wings weakly incurved, undulate-crisped, 2-4-stratose close to the margin to near the central part; margin acute, bordered by 2-4 unistratose rows of cells; epidermal cells quadrangular in section, isodiametric, with firm, non-collapsed walls; midrib (8)10-12(14) cells thick. Grows on wet rocks or wet banks, from the lowlands to high mountains in northern half of the Peninsula, rare in the southeast. Esp, Prt, And.

- 2 Thallus opaque, with indistinct midrib; wings less than 10 cells wide (fig. 15, 5-7) **A. pinguis** (L.) Dumort.

Thallus 3-6(7) × 0,2-0,8 cm, pale green, yellowish green to dark green, with greasy lustre, plano-convex to biconvex in section; wings 2-4-stratose close to the margin; margin obtuse to acute, flat or nearly so, bordered by 1-2 unistratose rows of cells; epidermal cells quadrangular in section, isodiametric, with firm walls, not collapsed; midrib (9)10-13(15) cells thick, gradually tapered towards margin. Forms lax, fragile patches on earth by streams, occasionally submerged, mainly on neutral or basic substrata, in montane areas and high mountains in the north and northwestern part of the Peninsula, scattered in the east. Esp, Prt, And.

### **Cryptothallus** Malmb.

Plants 2-3(5) cm long, colourless or creamy white, non-photosynthetic, epiparasitic on ectomycorrhizal fungi. Thalli fleshy, horizontal, subterranean, simple or pinnate, with short, ascending branches; in section biconvex or plano-convex, 16-20 cells thick in the central part; margin rounded, elevated; cells without chlorophyll; epidermal cells large, polygonal, with 6-12 oil-bodies or oil-bodies lacking; midrib indistinct. Rhizoids scattered, mostly on ventral and lateral sides. Male shoots *ca* 1/5 of length of female plants. Antheridia on lateral branches, arranged in 2(3) rows. Archegonia grouped at apex of lateral branches, surrounded by abundant hairs. Capsule cylindrical; calyptra fleshy, clavate, elongated; spores spherical, alveolate, 22-25(30) μm in diameter, remaining in tetrads. Dioicous (fig. 15, 8-10) **C. mirabilis** Malmb.

**Aneura mirabilis** (Malmb.) Wickett & Goffinet

Grows on very humid, acidic soils, generally in *Pinus pinaster* Ait. plantations, in the northwestern part of the Peninsula. Prt.

### **Riccardia** Gray

Thalli fragile, pinnate, palmate or irregularly branched, with emarginate or truncate apex; lobe margins usually unistratose, 1-3 cells wide; midrib poorly differentiated from wings, for a thickness of (4)5-8(9) cells in the middle of thallus. Oil-bodies in epidermal cells 1-2, usually ephemeral, or lacking. Rhizoids on the ventral side and also very often at margin of thallus, hyaline, light brown. Gemmae often present on the dorsal side, near thallus apex, 2-celled. Antheridia and archegonia on small, lateral branches; archegonia and sporophytes surrounded by clavate involucre. Capsule ellipsoidal. Autoicous or dioicous.

- 1 Ultimate lobes with translucent margins, 2-3 cells wide; oil-bodies present only in internal cells (fig. 16, 1-3) **R. multifida** (L.) Gray  
Plants to 2,5 cm long, dark green. Thalli pinnate; lobes plane, 0,5-1,5 mm wide, lobes very branched, ultimate ones linear; midrib asymmetrically biconvex, 4-6 cells thick in the middle; epidermal cells smaller than internal cells. Autoicous. Grows on wet slopes, on rotten trunks in forests and on wet rocks, in montane areas and high mountains, rarely in the lowlands. Distributed in the northern half of the Peninsula and in the south. Esp, Prt.
- 1 Ultimate lobes with opaque margins, 1(2) cells wide; oil-bodies present in most cells or lacking 2
- 2 Thalli concave in cross section; plants dioicous (fig. 16, 4-5) **R. incurvata** Lindb.  
Thalli 0,5-1 mm wide, irregularly branched; lobes channelled, poorly branched; epidermal and internal cells similar in width. Forms lax patches, semi-submerged or on soil, by streams, in montane areas and high mountains. Rare, in the Pyrenees and north of the Peninsula. Esp.
- 2 Thalli plano-convex or biconvex in cross section; plants autoicous or dioicous 3
- 3 Thalli palmate; plants dioicous (fig. 16, 6-7) **R. palmata** (Hedw.) Carruth.  
Plants small, to 1 cm long, dark green or reddish brown at base. Thalli 0,5 mm wide, prostrate but with erect lobes, biconvex in section, (4)6-9 cells thick in the middle; epidermal cells less than 1/2 of internal cells size. Oil-bodies 1-2 in internal cells, lacking in epidermal cells. Male branches with incurved margin. Grows on rotten wood, in montane areas and high mountains. Distributed in the north of the Peninsula and in the Pyrenees, rare in the Central and Iberian Ranges. Esp, And.
- 3 Thalli furcate, pinnate or irregularly branched; plants autoicous 4
- 4 Thalli furcate or irregularly branched, prostrate, with erect branches; epidermal cells similar in size to inner cells; oil-bodies present or not in internal cells, lacking in epidermal cells **R. latifrons** (Lindb.) Lindb.  
Plants to 1,5 cm long, pale green. Lobes to 2 mm wide; epidermal cells 30-50 ? 60-100  $\mu$ m. Grows on rotten trunks, in montane areas and high mountains, rarely in the lowlands. Rare, in the north, west of the Peninsula, in the Pyrenees and in Algeciras Mountains. Esp, Prt, And.
- 4 Thalli pinnate, prostrate; epidermal cells 1/2 or 1/3 narrower than internal cells; 1-4 oil-bodies in internal cells, 1 large oil-body in epidermal and marginal cells (fig. 16, 8-9) **R. chamedryfolia** (With.) Grolle  
Plants to 3-4 cm long, pale green or yellowish. Lobes to 2 mm wide; margin in male branches erect but not incurved. Forms small patches on soil and rotten wood, by or in streams, in the lowlands and montane areas. Distributed in the western and northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.



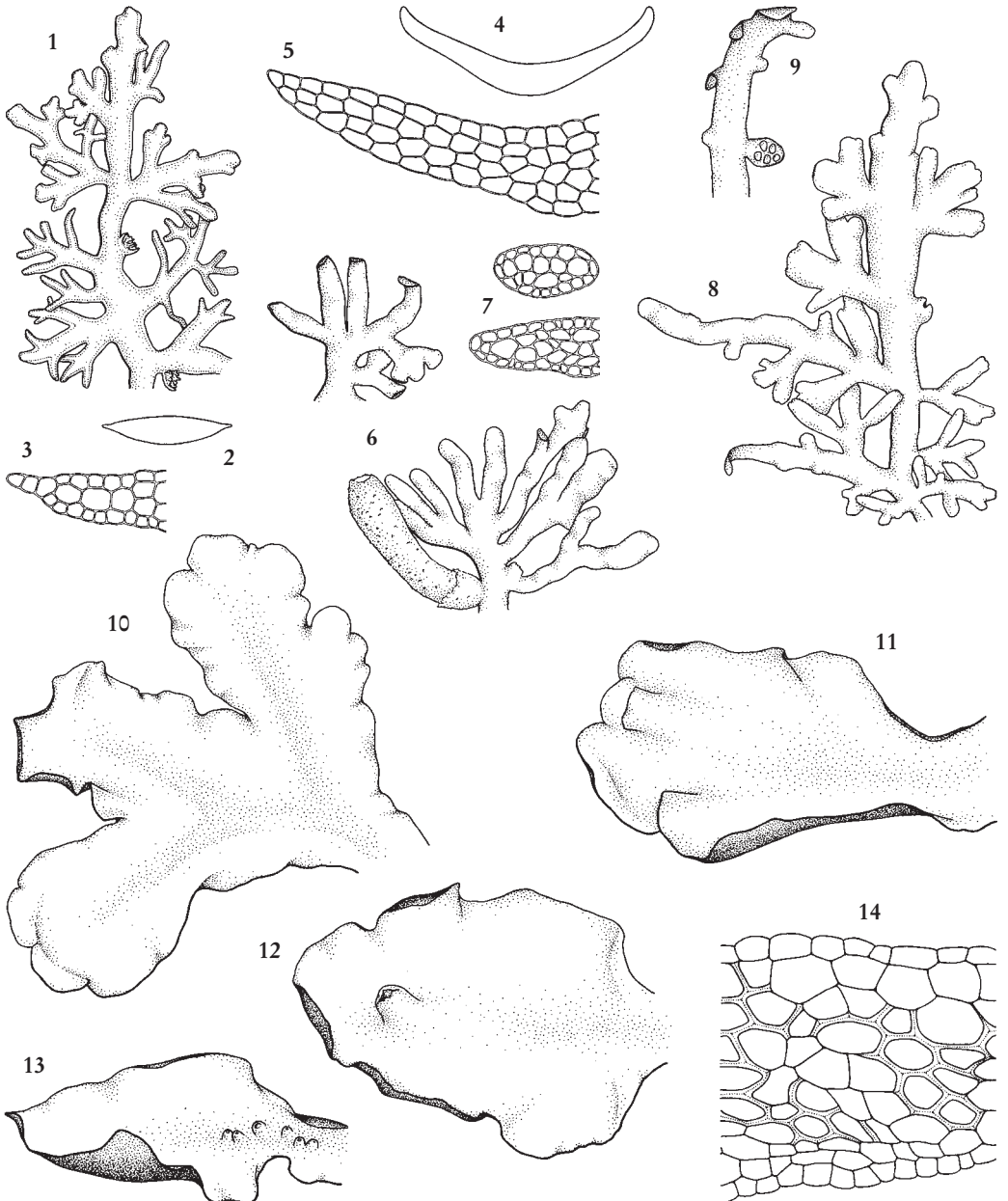


FIGURE 16. 1-3, *Riccardia multifida*: 1, female thallus; 2-3, thallus sections. 4-5, *R. incurvata*, thallus sections. 6-7, *R. palmata*: 6, thalli, sterile and with involucre; 7, thallus sections. 8-9, *R. chamedryfolia*: 8, thallus; 9, thallus with antheridia. 10, *Pellia endiviifolia*, thallus. 11, *P. epiphylla*, female thallus. 12-14, *P. neesiana*: 12, female thallus; 13, male thallus; 14, thallus section. 10, 11, 12, 13 ( $\times 4$ ); 1, 8 ( $\times 5$ ); 6, 9 ( $\times 10$ ); 2, 4 ( $\times 30$ ); 3, 5, 7 ( $\times 70$ ); 14 ( $\times 100$ ).



## Fam. Pelliaceae

## Pellia Raddi

Thalli furcate, to 1 cm wide, with retuse apex and mucilaginous hairs in the upper part of ventral side or on both sides; wings undulate at margins, 1-3 cells thick; midrib 6-15 cells thick, poorly distinct on the dorsal side. Rhizoids abundant on the midrib ventral side. Antheridia almost immersed in mid dorsal side, in 2-3 irregular rows. Archegonia grouped at thallus apex, surrounded by an involucre, without perianth. Capsule globose.

- 1 Cells in mid thallus with regularly thickened walls in section; mucilaginous hairs only in the apical part of lobes on the ventral side, with 1 mucilaginous cell and 2-5 basal cells; involucre erect; calyptra immersed; plants growing on basic or neutral substrata (fig. 16, 10) **P. endiviifolia** (Dicks.) Dumort.

Plants dark green. Lobes channelled; marginal cells 20-50 ? 40-80  $\mu\text{m}$ . Vegetative propagation by means of small lobes of branches at apex of thallus. Involucre cylindrical, laterally compressed, 3-5 mm long, dentate or ciliate at mouth. Dioicous. Forms patches by streams, at base of wet slopes or submerged, in the lowlands and montane areas. Distributed throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Cells in mid thallus with irregularly thickened walls in section; mucilaginous hairs in the upper part of lobes on both sides, with 1 mucilaginous cell and 1 basal cell; involucre horizontal or erect; calyptra exserted; plants growing on acidic substrata 2

- 2 Paroicous; involucre horizontal, reduced to a small, convex scale, with almost entire margin; thallus 10-15 cells thick in the middle (fig. 16, 11) **P. epiphylla** (L.) Corda  
Plants scarcely aromatic, dark green. Lobes plane; marginal cells 70-90  $\times$  35-50  $\mu\text{m}$ ; midrib dark green, sometimes reddish. Forms patches on moist earth and by streams, in the lowlands and montane areas. Distributed throughout the Peninsula. Esp, Prt, And.

- 2 Dioicous; involucre erect or nearly so, shortly cylindrical, to 3-4 mm long, with crenulate margin; thallus 6-10 cells thick in the middle (fig. 16, 12-14) **P. neesiana** (Gottsche) Limpr.

Plants aromatic, dark green. Lobes plane; marginal cells 52-95  $\times$  35-42  $\mu\text{m}$ ; midrib reddish. Forms patches on moist earth and by streams, in montane areas, rarely in high mountains. Distributed in the north of the Peninsula, rare in the central part. Esp, Prt.

## Fam. Pallaviciniaceae

## Pallavicinia Gray

Thalli 1-3 cm long, delicate, simple or furcate; lobes 1,5-4 mm wide; wings plane, undulate or crisped, unistratose except at base; midrib strong, pale green, 10-14 cells thick, with a central strand of narrow, elongated cells and dark walls; margin entire or papillose. Rhizoids on the midrib, pale brown. Antheridia in 2 rows on each side of midrib, pale orange when mature, covered by small lamellae with lacinate or dentate-lacinate margins.

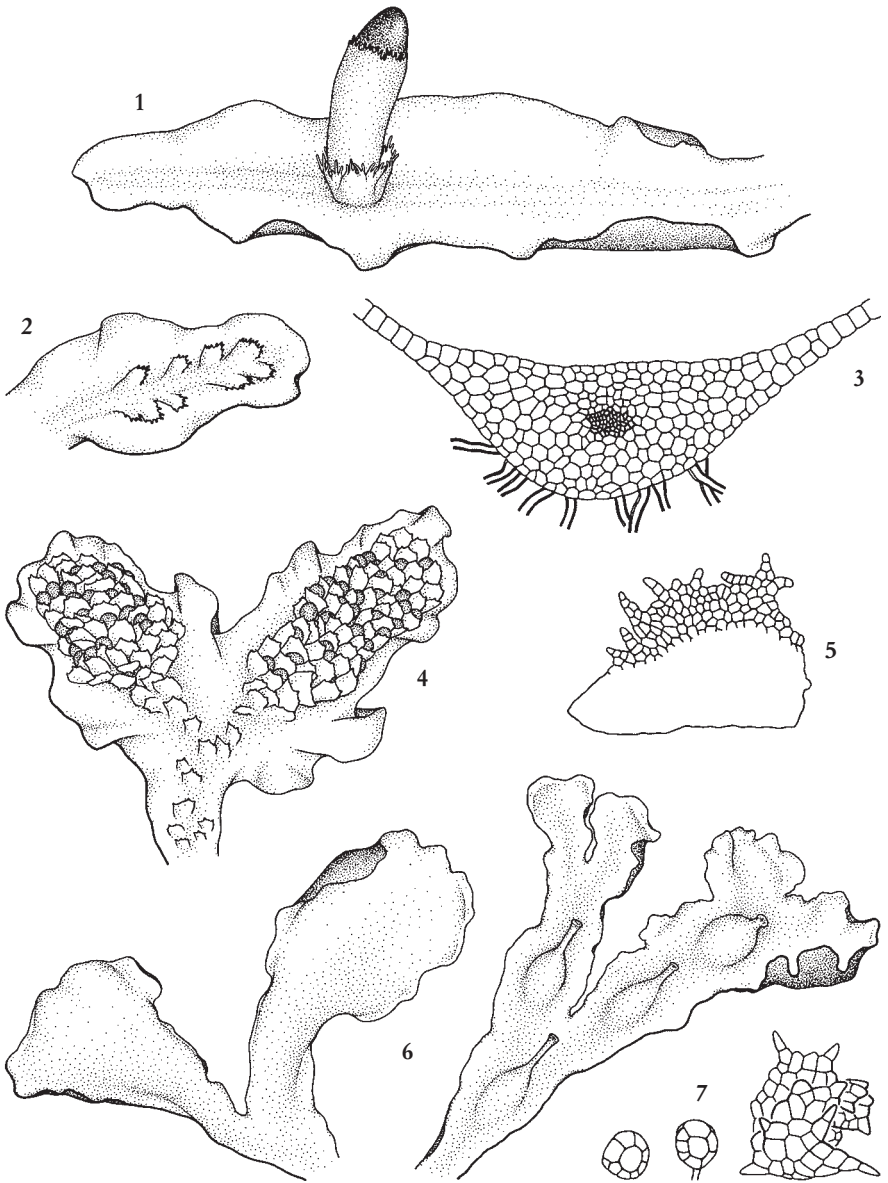


FIGURE 17. 1-3, *Pallavicinia lyellii*: 1, female thallus; 2, male thallus; 3, thallus section. 4-5, *Moerckia hibernica*: 4, male thallus; 5, antheridial lamella. 6-7, *Blasia pusilla*: 6, thalli, sterile and with gemmiferous receptacles; 7, gemmae. 1, 2, 4, 6 ( $\times 7,5$ ); 5 ( $\times 30$ ); 3 ( $\times 50$ ); 7 ( $\times 70$ ).

Archegonia in small groups on the dorsal side of midrib, surrounded by an involucre of lamellae with lacinate margins, fused at base; perianth cylindrical, 3-5 mm long, constricted and ciliate at mouth. Capsule cylindrical to ellipsoidal; spores (20)22-26  $\mu\text{m}$ , with the distal surface reticulate. Dioicous (fig. 17, 1-3) **P. lyellii** (Hook.) Carruth.

Forms lax pale green, translucent and glossy patches in wet sites, by streams, on acidic substrata, in the lowlands and montane areas. Distributed in the west of the Peninsula, rare in the northeastern part. Esp, Prt.

### **Moerckia** Gottsche

Thalli to 3 cm long, furcate, ascending or prostrate, pale green, glossy, partially translucent; lobes 5 mm wide; wings crisped or undulate, unistratose at margins; midrib strong on ventral side. Antheridia sessile, globose, covered by small lamellae dentate at margins. Archegonia on the dorsal side near apex of lobes; perianth cylindrical with lacinate involucre lamellae at base. Dioicous (fig. 17, 4-5)

**M. hibernica** (Hook.) Gottsche

Grows on shaded, calcareous soil, by a forest path, in montane area. Very rare, in the Pyrenees. And.

## **Fam. Blasiaceae**

### **Blasia** L.

Thalli to 2 cm long, furcate, light green; lobes 5 mm wide; wings unistratose; with lobulate margins, crisped near apex; midrib poorly differentiated from wings. Ventral scales ovate, denticulate, in one row on either side of midrib. Rhizoids on ventral side of midrib, colourless. Gemmae dimorphic, either irregularly stellate, about 500  $\mu\text{m}$  wide, on dorsal side of thallus, or gemmae smooth, globose or ellipsoidal, produced in flask-shaped receptacles, on dorsal surface. Dioicous (fig. 17, 6-7) **B. pusilla** L.

Forms patches on shaded, seeping slopes, in montane areas. Distributed in the north and northwest of the Peninsula, rare in the Pyrenees. Esp, Prt.

## **Fam. Fossombroniaceae**

### **Fossombronia** Raddi

Thalli 0,3-2 cm long, forming more or less dense light green rosettes or mats. Stem prostrate. Rhizoids on the midrib. Wings deeply divided into crisped lobes (giving to the plants the appearance of a foliose liverwort), obliquely inserted, arranged in 2 rows along the midrib, as wide as long; margin sinuose, undulate or dentate, seemingly continuously ruffled. Sporophyte surrounded by a pseudoperianth. Spores 30-65(68)  $\mu\text{m}$ ; distal face with spines or more or less high lamellae, branched or not, which sometimes form incomplete or complete alveoli; elaters 2-4-spiral. Monoicous or dioicous.

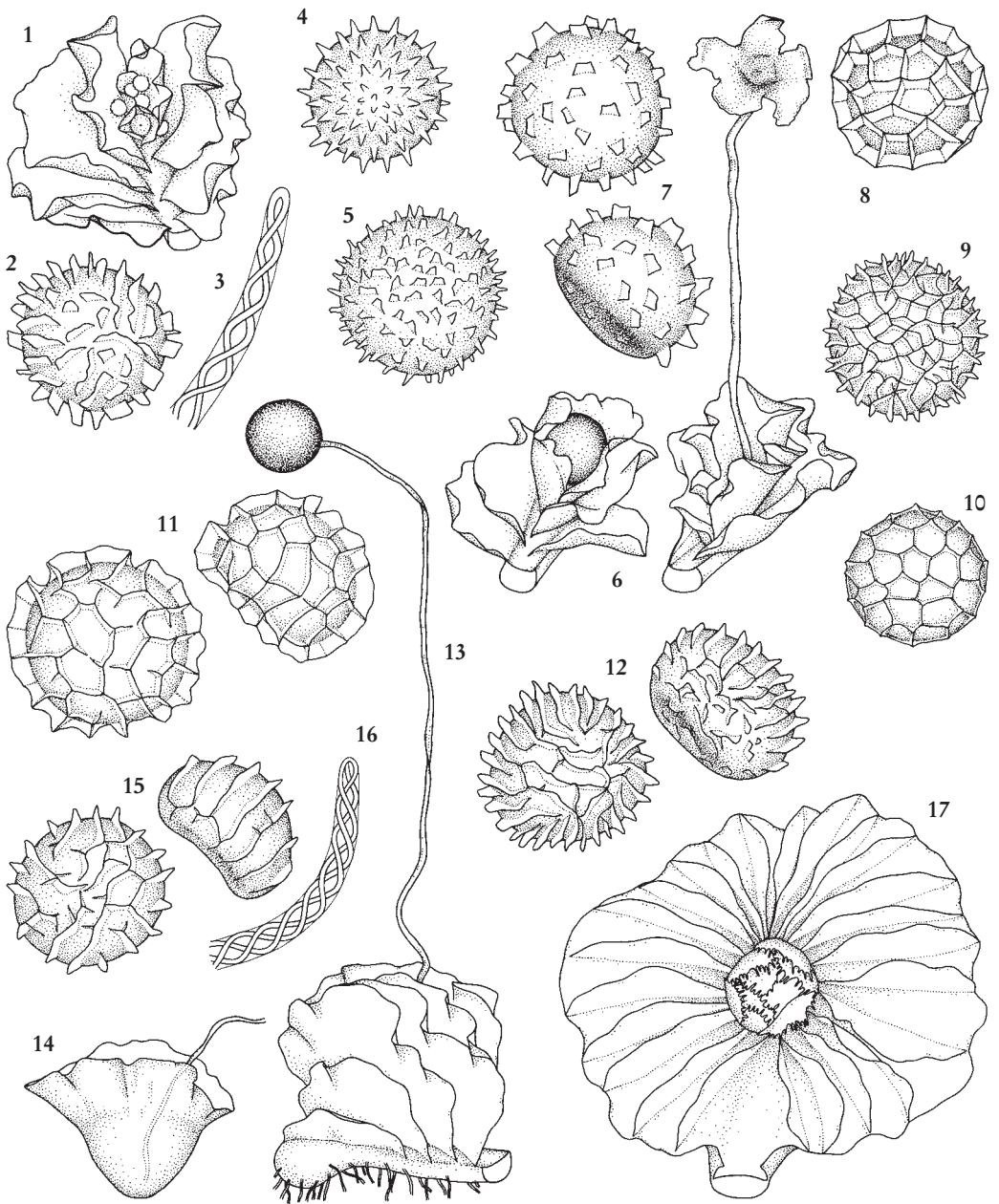


FIGURE 18. 1-3, *Fossombronina caespitiformis* subsp. *multispira*: 1, thallus with antheridia; 2, spore, distal face; 3, elater. 4, *F. echinata*, spore, distal face. 5, *F. leucoxantha*, spore, distal face. 6-7, *F. caespitiformis* subsp. *caespitiformis*: 6, thalli with sporophytes; 7, spores, distal face and in profile. 8, *F. angulosa*, spore, distal face. 9, *F. crozalsii*, spore, distal face. 10, *F. foveolata*, spore, distal face. 11, *F. crista*, spores, distal face and in profile. 12, *F. wondraczekii*, spores, distal face and in profile. 13-16, *F. pusilla*: 13, thallus with sporophyte; 14, pseudoperianth; 15, spores, distal face and in profile; 16, elater. 17, *Petalophyllum ralfsii*, female thallus. 17 ( $\times 7.5$ ); 1, 6, 13, 14 ( $\times 15$ ); 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 15, 16 ( $\times 500$ ).

- 1 Rhizoids colourless or pale brown (fig. 18, 1-3)  
**F. caespitiformis** Rabenh. subsp. **multispira** (Schiffn.) J.R. Bray et D.C. Cargill  
**F. husnotii** Corb.  
 Plants to 1 cm long. Spores 40-65  $\mu\text{m}$ ; lamellae truncate or undulate, low or high, sometimes joining to form irregular alveoli in the centre of the distal face; elaters 2-3(4)-spiral. Monoicous. Grows on soil ledges among stones and in temporarily wet, open, Mediterranean grasslands, in the lowlands. Distributed in the west half of the Peninsula, rare in the north, northeast and in Pithyusic Islands. Esp, Prt, Bl.
- 1 Rhizoids reddish, violet or dark purple 2
- 2 Spores with spines or small lamellae 3
- 2 Spores alveolate or with more or less undulate, elongate lamellae 5
- 3 Spores 30-35(42)  $\mu\text{m}$  in diameter, densely ornamented with narrow, acute spines (fig. 18, 4) **F. echinata** Macvicar  
 Plants to 1 cm long. Rhizoids violet. Spores dark brown; distal face with 9-12 spines across diameter up to 5  $\mu\text{m}$  high; elaters orange brown, 2-3-spiral. Grows on open soils, temporarily wet ledges, in open areas in grassland and scrubs by roads, on calcareous substrata, in the lowlands. Rare, in the southwest of the Peninsula. Esp, Prt.
- 3 Spores 40-65  $\mu\text{m}$  in diameter, with truncate spines or small lamellae 4
- 4 Spores 40-55  $\mu\text{m}$  in diameter, distal face with (10)12-15 truncate spines or small lamellae across diameter; plants dioicous (fig. 18, 5) **F. leucoxantha** Lehm.  
 Plants to 0,6-0,8 cm long. Rhizoids violet. Lobes irregularly dentate. Pseudoperianth irregularly dentate at mouth, with folds bearing toothed projections. Spores dark; distal face with spines or lamellae up to 4-5  $\mu\text{m}$  high; proximal face with conspicuous triradiate marks; elaters orange brown, 2-3-spiral. Grows on wet ledges in olive fields and in grasslands or scrubs with poorly developed, calcareous soils, in the lowlands. Distributed in the southwest of the Peninsula. Prt.
- 4 Spores 42-65  $\mu\text{m}$  in diameter, distal face with 6-8(10) small lamellae across diameter; plants monoicous (fig. 18, 6-7) **F. caespitiformis** Rabenh. subsp. **caespitiformis**  
 Plants to 1 cm long. Rhizoids violet. Lobes subentire. Spores dark; elaters orange brown, 150-300  $\times$  8-10  $\mu\text{m}$ , 2-3-spiral. Grows on ledges in grasslands and roadsides, wet slopes and among usually calcareous rocks, in the lowlands, rarely in montane areas. Widespread in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.
- 5 Spores more or less regularly alveolate on distal and lateral faces 6
- 5 Spores with irregular or divided lamellae forming complete or incomplete alveoli on distal face, lateral faces with parallel lamellae 9
- 6 Spores with 3-4(5) alveoli across diameter on the distal face; plants dioicous, more than 1 cm long (fig. 18, 8) **F. angulosa** (Dicks.) Raddi  
 Plants 1-1,5(2) cm long. Rhizoids violet or purplish. Lobes about 3 mm long. Spores 40-50  $\mu\text{m}$  in diameter; alveoli regular, 8-16  $\mu\text{m}$  wide, lamellae 4-8  $\mu\text{m}$  high, forming a continuous wing

on spore margin; elaters 150-400 × 4-6 µm, 2-3-spiral. Calcifuge, grows on wet, shaded slopes, in the lowlands, rarely in montane areas. Widespread in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

- 6 Spores with more than 5 alveoli across diameter on the distal face; plants monoicous, usually smaller than 1 cm long 7
- 7 Spores with 10-14 more or less regular alveoli across diameter on the distal face, lateral side also alveolate (fig. 18, 9) **F. crozalsii** Corb.  
Plants to 1 cm long. Spores 45-55(60) µm in diameter; distal face with alveoli 3-5 µm wide, with 30-45 spines in profile 2-3 µm high; elaters 2-3-spiral. Grows on slopes and wet soils, in rockrose scrubs with neutral pH. Very rare, in the south of the Peninsula. Esp.
- 7 Spores with 5-9 regular alveoli across diameter on the distal face, lateral side also alveolate 8
- 8 Spores 35-42(-50) µm in diameter, alveoli connected by an irregular wing 1-2 µm high; plants growing on acidic substrata (fig. 18, 10) **F. foveolata** Lindb.  
Plants 0,6-0,8 cm long. Rhizoids violet or purplish. Distal face of spores with 5-7(9) alveoli across diameter, alveoli 5-8(10) µm wide, with a slightly raised wing at angles; proximal face and margins with about 20 low spines; elaters 2-spiral. Grows on alluvial soil, at acidic ravine margins and by slow-flowing streams, usually associated with *Sphagnum* species, in the lowlands, in the west of the Peninsula. Prt.
- 8 Spores 45-60(-65) µm in diameter, alveoli connected by an interrupted wing 4-6 µm high; plants growing on calcareous substrata (fig. 18, 11) **F. crispa** Nees  
Plants 0,5-1 cm long. Rhizoids violet or purplish. Distal face of spores with 5-9 alveoli 7-12 µm wide across diameter; margin with 14-18 spines; elaters 2-spiral. Grows on exposed ledges, by roads, among usually calcareous stones, in sites with xerophytic vegetation, in the lowlands, in the west of the Peninsula. Prt.
- 9 Spores with 10-13 lamellae in profile 3-5 µm apart; distal face of spores with 30-45 spines at margins (fig. 18, 12) **F. wondraczekii** (Corda) Lindb.  
Plants less than 1 cm long. Spores 50-65(68) µm across diameter, with abundant lamellae that usually form complete alveoli in the centre of the distal face; elaters usually 2-spiral. Monoicous. Grows on clayey soils and wet, exposed slopes, in the lowlands. Distributed in the northern half and west of the Peninsula, rare in the southeastern part and in the Pithyusic Islands. Esp, Prt, Bl.
- 9 Spores with 5-9 lamellae in profile 6-10 µm apart; distal face of spores with 15-28 spines at margins (fig. 18, 13-16) **F. pusilla** (L.) Nees  
Plants about 1 cm long. Stem usually apically thickened. Spores 45-62 µm in diameter; lamellae often joining to form several alveoli in the centre of the distal face; elaters 3-spiral frequent. Monoicous. Grows on wet, shaded, acidic slopes and soils, in the lowlands and montane areas. Widespread in the Peninsula, rare in Mallorca and Menorca. Esp, Prt, Bl.  
Under this species is included **F. maritima** Paton.

### **Petalophyllum** Nees & Gottsche ex Lehm.

Thalli 0,5-1 cm long, simple, rarely furcate consisting of a rhizome-like midrib, prostrate to ascending, semi-subterranean, circular or semi-circular in section and an upper part circular or cordate, 6-7 mm wide, with prostrate wings; wings undulate, unistratose, with erect lamellae on the dorsal side, which are 1-cell thick, erect and radially arranged from midrib to margin, 15-25 cells high in the middle, lower towards margins. Rhizoids in the tuberous part, hyaline. Antheridia scattered in the midrib on the dorsal side, globose. Archegonia grouped in the midrib on the dorsal side, surrounded by small laminae irregular in shape; involucre with dentate or ciliate lobes. Capsule shortly stalked, globose, irregularly dehiscent; spores 40-60  $\mu\text{m}$ , with irregular alveoli. Dioicous (fig. 18, 17)

**P. ralfsii** (Wils.) Nees & Gottsche

Plants light green. Grows on clayey, wet soils in open grasslands and ravines, near the coast. Rare, in the southwestern part of the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Prt, Bl.

### **O. Calobryales** **Fam. Haplomitriaceae**

#### **Haplomitrium** Nees

Plants pale yellowish green. Rhizome hyaline or pale brown, horizontal; branches straight, radially symmetrical. Rhizoids lacking. Leaves transversely inserted, simple, arranged in 3 rows, distant to imbricate, the ventral ones distant, erecto-patent, rhomboidal, ovate-oblong or lingulate, concave, with rounded or acute apex; margin entire or with 2 lateral, small lobes; cells rectangular or hexagonal, 32-35  $\times$  20-25  $\mu\text{m}$ , thin-walled, narrower and longer at base; lower leaves imbricate. Archegonia lateral, scattered on stem or in a group at the shoot apex. Dioicous (fig. 19, 1-2)

**H. hookeri** (Sm.) Nees

Plants scattered on humus-rich soils in sheltered, wet sites, in the high mountains. Very rare, in the Spanish Central Range and in the Pyrenees. Esp, And.

### **O. Jungermanniales** **Fam. Lophoziaceae**

#### **Tetralophozia** (R.M.Schust.) Schljakov

Plants slender, up to 4 cm long; stem simple or branched. Leaves transversely inserted, distant to imbricate, erecto-patent, 4-lobed to near base, lobes widely lanceolate, more than twice as long as wide, dorsally channelled; margin recurved and toothed at base. Underleaves similar to leaves but smaller, bilobed, with spinose-dentate margin at base. Dioicous (fig. 19, 3-6)

**T. filiformis** (Steph.) Urm

Forms brown mats on damp acidic soils, mainly in montane areas. Very rare, in the north of the Peninsula. Esp.



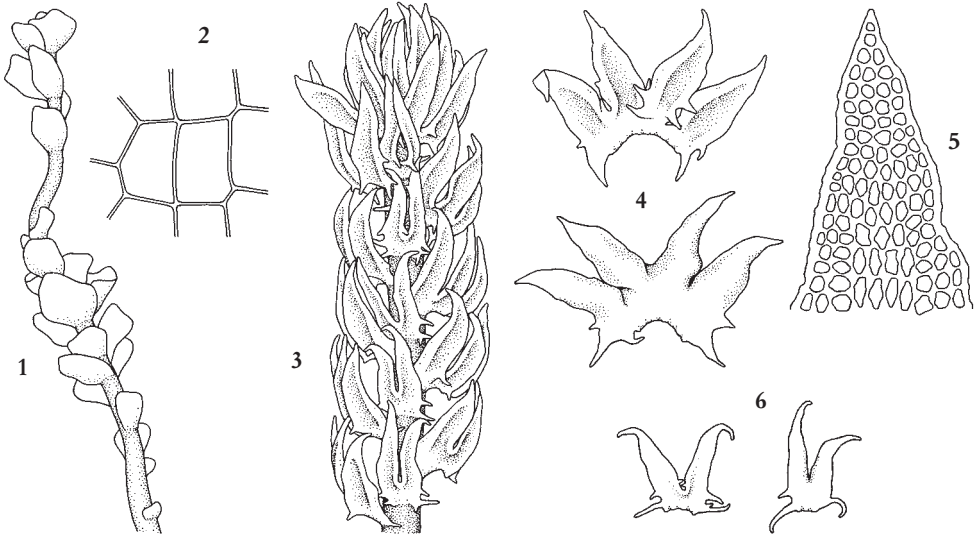


FIGURE 19. 1-2, *Haplomitrium hookeri* (After Geissler, 1990): 1, habit; 2, leaf cells. 3-6, *Tetralophozia filiformis*: 3, habit on ventral side; 4, leaves, dorsal and ventral sides; 5, cells of leaf lobe; 6, underleaves, dorsal and ventral sides. 1 ( $\times 4,4$ ); 3, 4, 6 ( $\times 40$ ); 5 ( $\times 160$ ); 2 ( $\times 300$ ).

### *Barbilophozia* Loeske

Plants medium-sized to large. Stem procumbent, ascending or erect, simple or slightly branched, with abundant colourless rhizoids. Leaves nearly transversely or obliquely inserted, succubous, 2-4-lobed, almost plane or concave, lobes triangular, rounded to acute, apiculate; ventral margin ciliate or not at base; cells with small trigones and 4-9 oil-bodies, 4-9  $\mu\text{m}$  long. Underleaves bifid with laciniate margin or lacking. Gemmae unicellular or 2-celled, angulate or ellipsoidal, borne at margins of apical leaves. Perianth ovoid or pyriform, folded in the upper part, constricted in a ciliate mouth. Dioicous.

1 Leaves mostly bilobed (fig. 20, 1-4)

***B. kunzeana*** (Huebener) Müll.Frib.

Leaves transversely inserted, patent, to 1,5 mm wide, 2-3-lobed to 1/4-1/2 or nearly retuse, lobes rounded or obtuse, sometimes acute, sinus wide, rounded or obtuse, occasionally gibbous; ventral leaf margin sometimes with a small cilium at base; median cells 16-24  $\mu\text{m}$  wide, oil-bodies 2-6, 3-10  $\times$  3-6  $\mu\text{m}$ ; trigones small or large. Underleaves erecto-patent, small, usually divided to base in 2 subulate lobes. Gemmae slightly angulate, light yellowish green, 1-2-celled. Grows on damp or wet soils, in the high mountains, in the Pyrenees and rarer in the Spanish Central Range. Esp, And.

1 Leaves mostly 3-lobed or 4-lobed

2

2 Leaves mostly 3-lobed

3

2 Leaves mostly 4-lobed

6



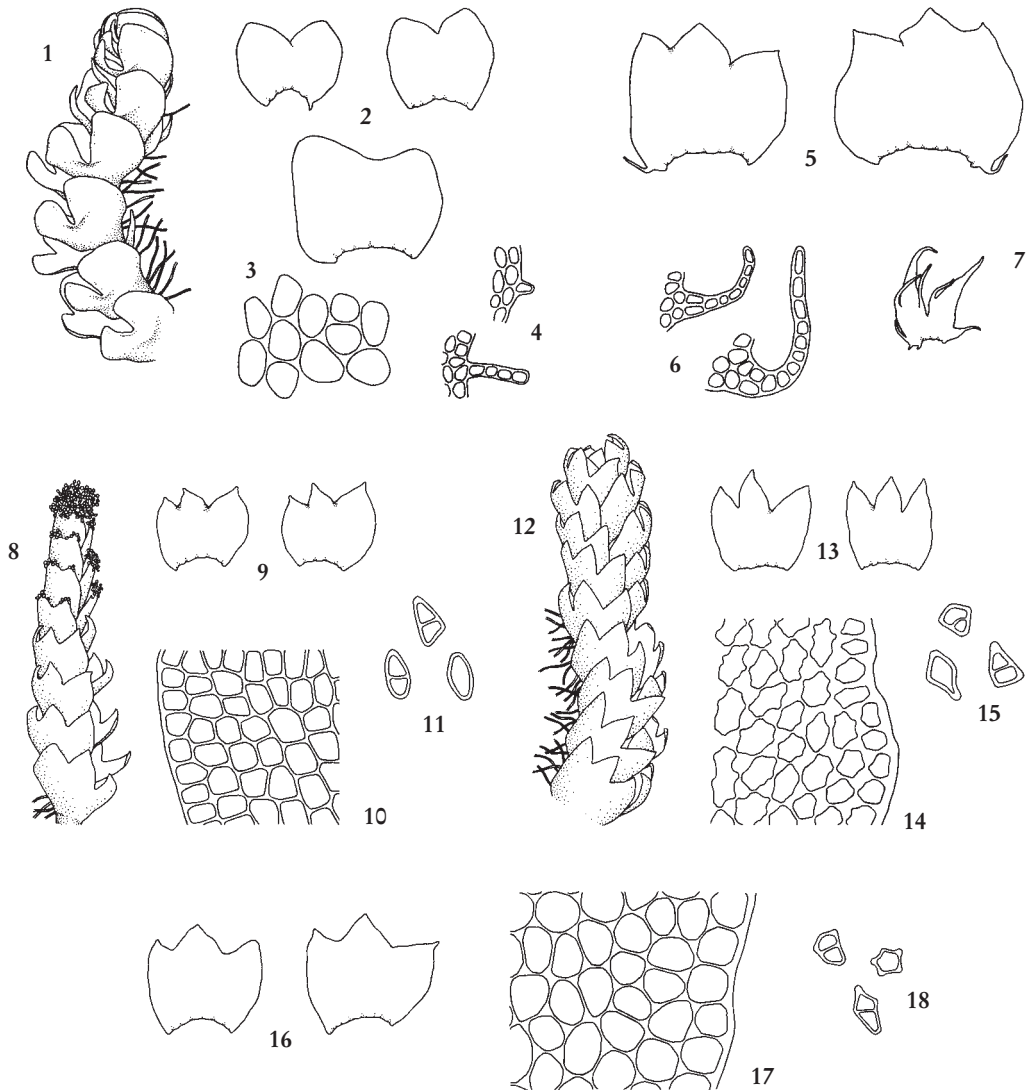


FIGURE 20. 1-4, *Barbilophozia kunzeana*: 1, habit; 2, leaves; 3, leaf cells; 4, basal cilia. 5-7, *B. floerkei*: 5, leaves; 6, basal cilia; 7, underleaf. 8-11, *B. attenuata*: 8, gemmaiferous shoot; 9, leaves; 10, leaf cells; 11, gemmae. 12-15, *B. binsteadii*: 12, habit; 13, leaves; 14, leaf cells; 15, gemmae. 16-18, *B. atlantica*: 16, leaves; 17, leaf cells; 18, gemmae. 1 ( $\times 16$ ); 2, 5, 7, 8, 9, 12, 13, 16 ( $\times 20$ ); 4, 6 ( $\times 120$ ); 3, 10, 11, 14, 15, 17, 18 ( $\times 220$ ).

- 3 Underleaves large, bilobed, ciliate (fig. 20, 5-7)  
**B. floerkei** (F. Weber & D. Mohr) Loeske  
 Leaves more or less concave, 0,8-1,6 mm wide, (2)3(4)-lobed, lobes acute or obtuse; cells with 2-6 oil-bodies, 4-8 × 4-6 μm; cells of marginal cilia 1-2 times as long as wide. Underleaves with subulate lobes. Gemmae rare, slightly angulate. Forms mats on rocks and wet soils, from the lowlands to the high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 3 Underleaves lacking or very small 4
- 4 Leaf cells 13-16(18) μm wide; gemmiferous shoots with reduced leaves common (fig. 20, 8-11)  
**B. attenuata** (Nees) Loeske  
 Plants usually developing almost cylindrical gemmiferous shoots with densely imbricate and appressed leaves. Leaves somewhat obliquely inserted, patent to erecto-patent, concave, 0,5-0,8 mm wide, as wide as long or wider than long, 2-3(4)-lobed to 1/4-1/3, lobes acute; cells with 2-10 oil-bodies, 4-10 × 4-8 μm. Gemmae ellipsoidal or angulate, pale green, 1-2-celled. Grows on humic soils, in montane areas in the north of the Peninsula. Esp.
- 4 Leaf cells (18)20-28 μm wide; gemmiferous shoots rare 5
- 5 Leaves strongly concave; trigones coarse and confluent (fig. 20, 12-15)  
**B. binsteadii** (Kaal.) Loeske  
 Leaves obliquely inserted, patent to erecto-patent, 0,5-0,8 mm wide, as wide as long, 2-3(4)-lobed to 1/3-1/2, lobes subequal, acute; median cells (18)20-23 μm wide. Gemmae angulate, wine-red, 1-2-celled, 23-34 × 18-23 μm. Grows in peat bogs, in the lowlands. Rare, in the northwest of the Peninsula. Esp.
- 5 Leaves not or hardly concave; trigones neither coarse nor confluent (fig. 20, 16-18)  
**B. atlantica** (Kaal.) K. Müller  
 Leaves transversely inserted, patent to erecto-patent, 0,6-0,9 mm wide, as wide as long or wider than long, (2)3(4)-lobed to 1/4, lobes rounded to acute; median cells (20-)25-28 μm wide, 4-10 oil-bodies, 4-10 × 4-8 μm. Gemmae angulate, reddish, 1-2-celled, 23-34 × 16-20 μm. Grows on slopes and wet soils, from the lowlands to high mountains. Distributed in the north of the Peninsula. Esp.
- 6 Ventral margin of leaves not ciliate at base; underleaves lacking or very small, bifid or subulate (fig. 21, 1-2)  
**B. barbata** (Schreb.) Loeske  
 Stem procumbent or ascending. Leaves plane, 1-1,9 mm wide, with (3)4 rounded lobes, unequal, the lateral ones smaller; cells with 2-10 oil-bodies, 3-8 × 3-6 μm. Gemmae rare. Forms mats on soils, slopes, rocks or at base of trees, in montane areas, in the northern half of the Peninsula. Esp, Prt, And.
- 6 Ventral margin of leaves ciliate at base, cilia cells to 4-7 times longer than wide; underleaves large, bilobed or bifid, with ciliate margins 7
- 7 Leaves undulate, 2-3 mm wide; gemmae lacking; dorsal margin exceeding the median line of stem (fig. 21, 3-6)  
**B. lycopodioides** (Wallr.) Loeske  
 Plants 4-8 × 0,3-0,4 cm. Leaves imbricate, obliquely inserted, more or less asymmetrical, lobes apiculate, wider than long; cells with 2-8 oil-bodies, 3-6 × 3-8 μm. Forms extensive mats on wet soils and rocks, in montane areas and high mountains, in the northern part of the Peninsula and in Serra da Estrela. Esp, Prt, And.

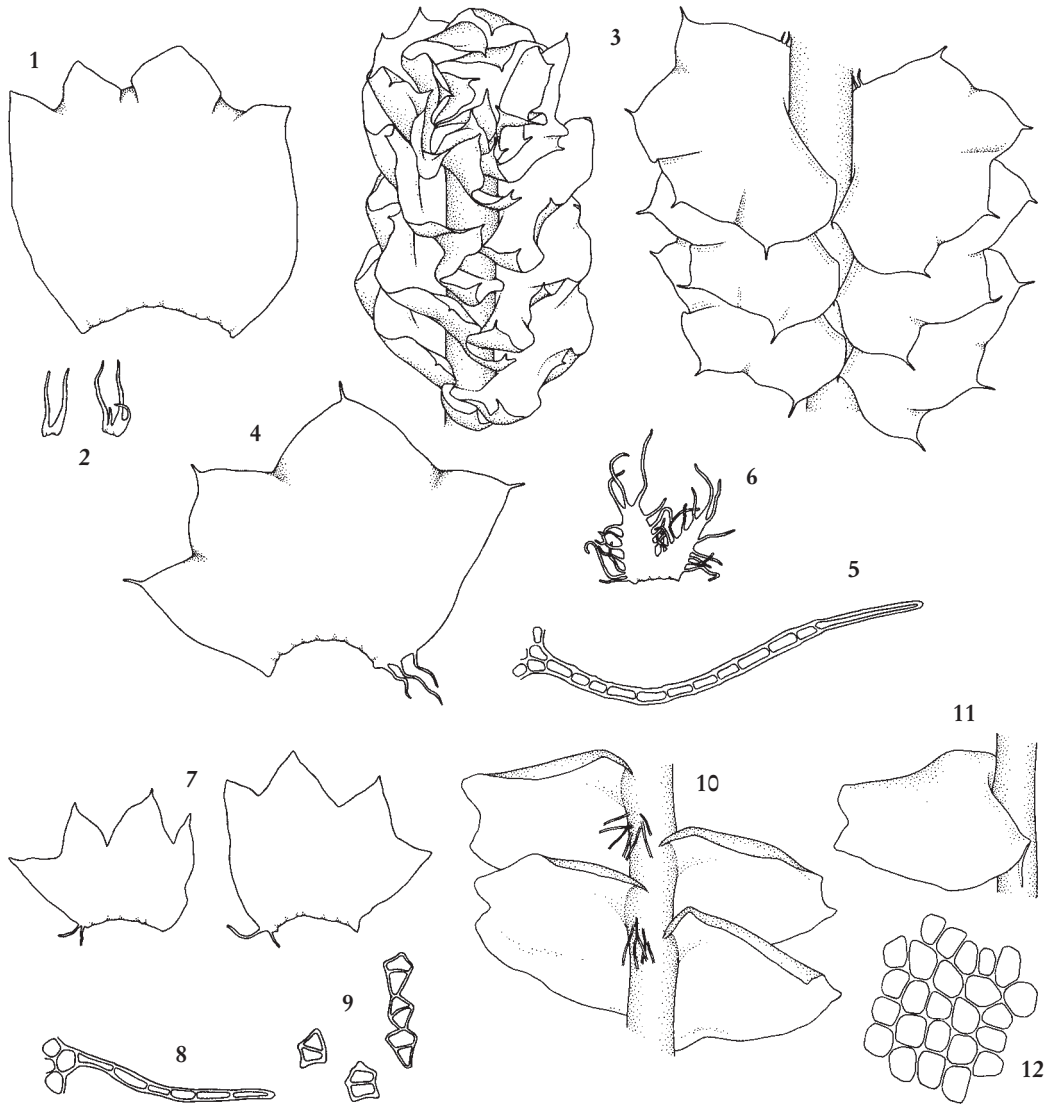


FIGURE 21. 1-2, *Barbilophozia barbata*: 1, leaf; 2, underleaves. 3-6, *B. lycopodioides*: 3, habits; 4, leaf; 5, basal cilium; 6, underleaf. 7-9, *B. hatcheri*: 7, leaves; 8, basal cilium; 9, gemmae. 10-12, *Anastrepta orcadensis*: 10, habit on ventral side; 11, leaf on dorsal side; 12, leaf cells. 3 ( $\times 12$ ); 1, 2, 4, 6, 7, 10, 11 ( $\times 20$ ); 5, 8 ( $\times 120$ ); 9, 12 ( $\times 220$ ).

- 7 Leaves not or only slightly undulate, 1-2 mm wide; gemmae usually present; dorsal margin not exceeding the median line of stem (fig. 21, 7-9)

**B. hatcheri** (A.Evans) Loeske

Plants 2-5 × 0,2-0,3 cm. Leaves more or less asymmetrical, usually only some lobes apiculate; cells with 2-8 oil-bodies, 3-8 × 3-8 μm. Usually with gemmae 1-2-celled, angulate, reddish. Forms mats, usually among other bryophytes, on wet soils and rocks, from the lowlands to the high mountains, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.

### **Anastrepta** (Lindb.) Schiffn.

Plants to 8 cm long, green to reddish brown or brown. Stem erect to procumbent. Leaves alternate, spreading, obliquely inserted, succubous, simple, ovate-cordate, shallowly bilobed, at least some leaves asymmetrical, concave at base, convex above, with one lobe or side longer than the other, longly decurrent dorsally; margin entire, the ventral one recurved; cells more or less quadrate to shortly rectangular, 14-21 μm wide, with trigones. Underleaves lacking. Dioicous (fig. 21, 10-12)

**A. orcadensis** (Hook.) Schiffn.

Forms lax tufts or scattered shoots on wet, humiferous soils over acidic rocks, in montane areas. Very rare, in the north of the Peninsula. Esp.

### **Lophozia** (Dumort.) Dumort.

Plants small to medium-sized. Stem procumbent or erect, often branched; sometimes with dorsiventral medullary differentiation. Leaves almost transversely to obliquely inserted, succubous, orbicular to rectangular, bilobed or the uppermost 3-5-lobed, lobe apex acute to rounded; cells often with trigones. Underleaves very small, lanceolate, simple or bilobed, or lacking. Gemmae mostly angulate, mostly 1-2-celled, at apex of the uppermost leaves, or lacking. Perianth ovoid to cylindrical, smooth or plicate in the upper part, with narrow, ciliate, spinulose or entire mouth. Dioicous or paroicous.

- 1 Leaf lobes rounded, with gibbous sinus (fig. 22, 1-2) **L. obtusa** (Lindb.) A.Evans

Plants up to 4(6) cm long. Leaves obliquely inserted and horizontally spreading, flaccid. Underleaves rudimentary, formed by (1)2-3 cilia. Gemmae occasional, green. Dioicous. Grows on acidic soils in montane areas. Very rare, in Central Pyrenees and Cantabrian Mountains. Esp, And.

- 1 Leaf lobes acute or obtuse, sinus not gibbous 2

- 2 Plants with underleaves, at least on well developed shoots 3

- 2 Plants without underleaves, or with minute ones 4

- 3 Gemmae smooth, spherical or ellipsoidal (fig. 22, 3-4)

**L. heterocolpos** (Thed. ex C.Hartm.) M.Howe

**Leiocollea heterocolpos** (Thed. ex Hartm.) H.Buch

Plants up to 2 cm long. Leaves with acute lobes, divided to 1/4, sinus angular; cells with large, bulging trigones. Gemmiferous branches with elongated, erect leaves and underleaves;

gemmae 1–2-celled. Dioicous. Calcicolous, grows on rocks in very humid environments, sometimes in beech or fir forests, in montane areas and high mountains. Very rare, in Central Pyrenees and Sierra Nevada. Esp, And.

- 3 Gemmae lacking (fig. 22, 5-8) **L. bantriensis** (Hook.) Steph.  
**Leiocolea bantriensis** (Hook.) Jörg.

Plants variable, relatively large, up to 5 cm long, to 4(5) mm wide. Leaf lobes rounded to acute; cells 20–38  $\mu\text{m}$  wide; cuticle papillose. Perianth cylindrical, not or slightly plicate in the upper part, scarcely beaked. Dioicous. Saxicolous, on calcareous substrata, in humid environments, from the lowlands to high mountains. Common and widespread throughout the territory. Esp, And.

Included under this species is **L. collaris** (Nees) Dumort. (*Leiocolea collaris* (Nees) Schljakov): Plants up to 3 mm wide. Leaves with acute or apiculate lobes; cells 20–32  $\mu\text{m}$  wide. Perianth slightly plicate in the distal part, usually beaked.

- 4 Leaf cells thick-walled; stem without dorsiventral medullary differentiation (fig. 22, 9-11) **L. bicrenata** (Schmidel ex Hoffm.) Dumort.

Plants up to 1 cm, fleshy and persistently smelling of cedar oil. Leaves usually as wide as or wider than long. Gemmae angulate, yellowish orange. Female bracts dentate, bigger than leaves. Perianth ovoid, plicate in the upper half, with narrow, spinulose or ciliated mouth. Paroicous, usually sterile. Grows on acidic soils, in the lowland and montane areas. Widespread but scattered in the northern half of the Peninsula. Esp, Prt, And.

- 4 Leaf cells thin-walled; stem with or without dorsiventral medullary differentiation (ventral cells smaller than dorsal) 5

- 5 Upper leaves 2–5-lobed; 20–50 oil-bodies per cell; plants pale bluish green 6

- 5 Leaves bilobed; 2–18(20) oil-bodies per cell; plants never bluish 7

- 6 Leaves 1–1,5 times as wide as long, with spinulose margins; leaf base 1–2-stratose; gemmae 17–23 mm (fig. 22, 12–17) **L. incisa** (Schrad.) Dumort.

Plants to 1 cm long, glaucous to whitish, lacking secondary reddish colours. Stem section ellipsoidal. Leaves imbricate, crisped and undulate at the apex of branches, rosette-like. Gemmae green. Perianth mouth dentate, with 1–3-celled teeth. Dioicous, rarely fertile. Forms dense patches on acidic substrata in montane areas and high mountains. Rare, in Pyrenees, Cantabrian Mountains and northern Iberian Range. Esp.

- 6 Leaves 1,5–2,5 times as wide as long, with scarcely dentate margins; leaf base 3–5-stratose; gemmae 27–33 mm (fig. 22, 18–19) **L. opacifolia** Culm. ex Meyl.

**L. incisa** (Schrad.) Dumort. subsp. **opacifolia** (Culm. ex Meyl.) R.M.Schust. & Damsh. Similar to the previous taxon. Rare in Pyrenees and northeast of the Peninsula. Esp, And.

- 7 Gemmae lacking; stems without dorsiventral medullary differentiation; plants very small, growing on basic substrata 8

- 7 Gemmae usually present; stems with dorsiventral medullary differentiation; plants small or not, mostly growing on acidic substrata 9

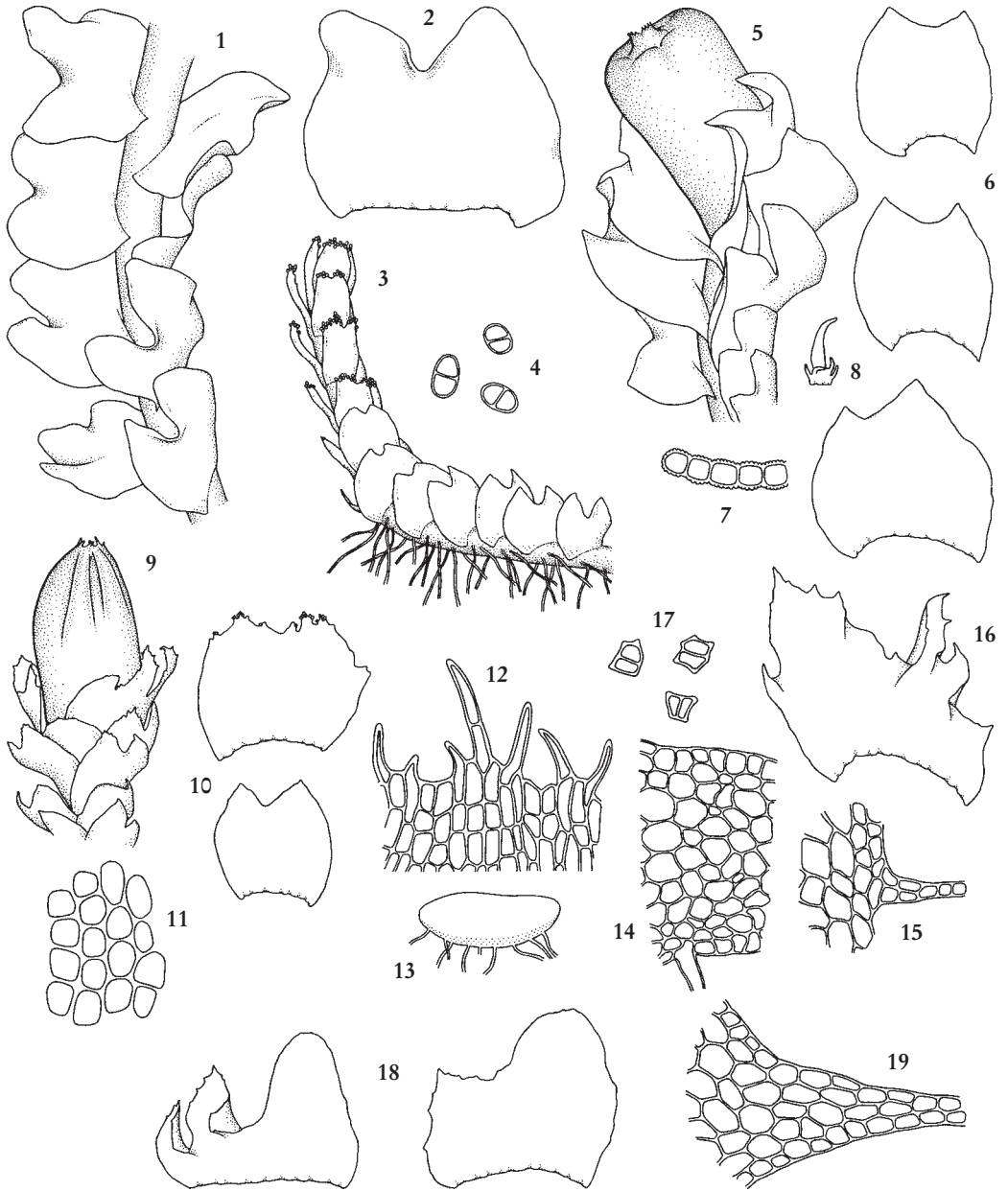


FIGURE 22. 1-2, *Lophozia obtusa*: 1, habit; 2, leaf. 3-4, *L. heterocolpos*: 3, habit; 4, gemmae. 5-8, *L. bantriensis*: 5, plant with perianth; 6, leaves; 7, leaf section; 8, underleaf. 9-11, *L. bicrenata*: 9, plant with perianth; 10, leaves; 11, leaf cells. 12-17, *L. incisa*: 12, perianth mouth; 13-14, stem sections; 15, longitudinal section of leaf at its insertion; 16, leaf; 17, gemmae. 18-19, *L. opacifolia*: 18, leaves; 19, longitudinal section of leaf at its insertion. 1, 3, 5, 9 ( $\times 16$ ); 2, 6, 8, 10, 13, 16, 18 ( $\times 20$ ); 12, 14, 15, 19 ( $\times 100$ ); 7, 11 ( $\times 160$ ); 4, 17 ( $\times 220$ ).

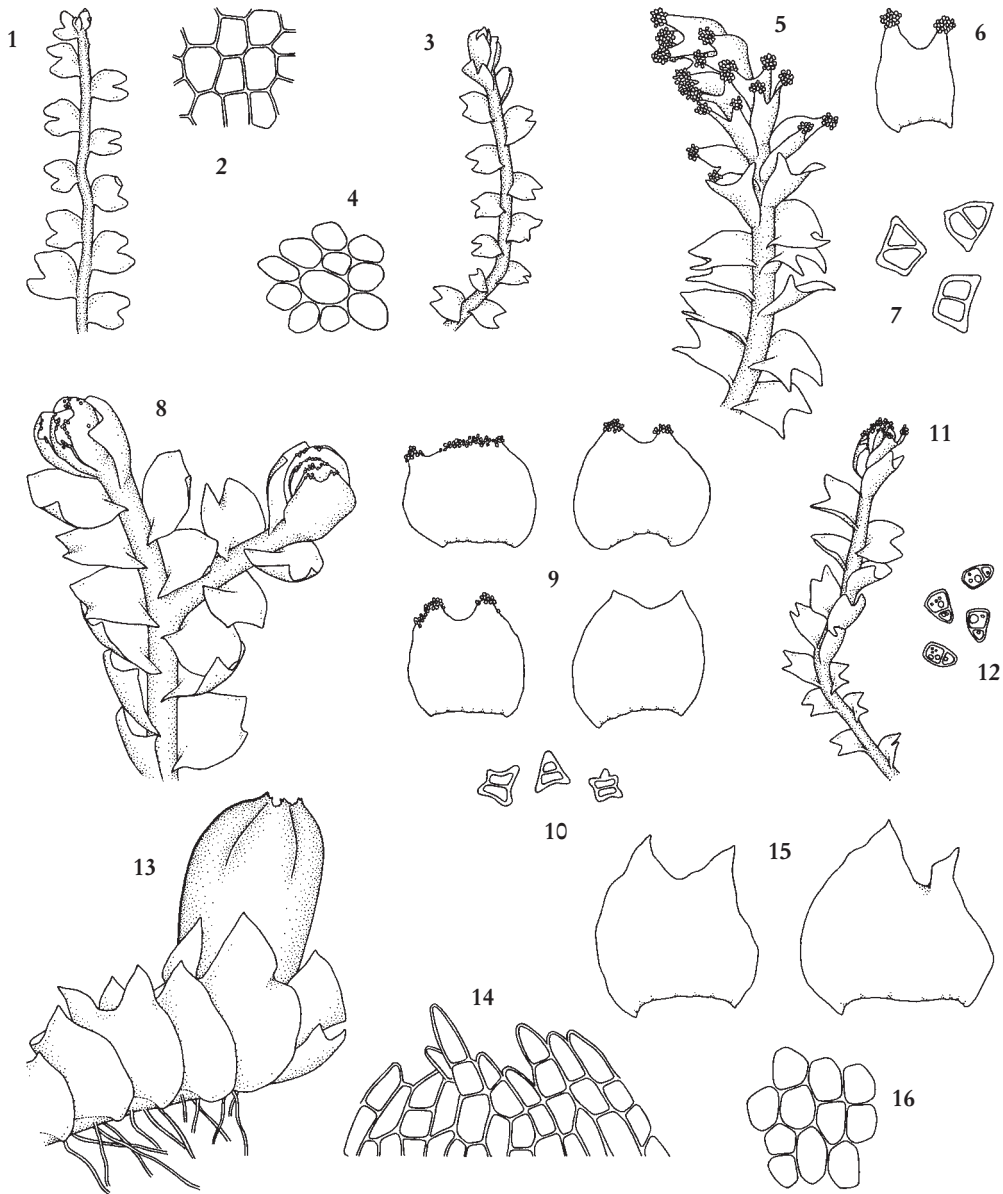


FIGURE 23. 1-2, *Lophozia turbinata*: 1, habit; 2, leaf cells. 3-4, *L. badensis*: 3, habit; 4, leaf cells. 5-7, *L. longidens*: 5, habit; 6, gemmiferous leaf; 7, gemmae. 8-10, *L. sudetica*: 8, habit; 9, leaves with and without gemmae; 10, gemmae. 11-12, *L. perssonii*: 11, habit; 12, gemmae. 13-16, *L. excisa*: 13, plant with perianth; 14, perianth mouth; 15, leaves; 16, leaf cells. 1, 3, 5, 8, 11, 13 ( $\times 16$ ); 6, 9, 15 ( $\times 20$ ); 2, 4, 14, 16 ( $\times 160$ ); 7, 10, 12 ( $\times 220$ ).



- 8 Leaves not or slightly decurrent, shortly inserted, narrowed at base; lobes rounded; cells without trigones (fig. 23, 1-2) **L. turbinata** (Raddi) Steph.

**Leiocolea turbinata** (Raddi) H.Buch

Plants small, to 1 cm long and 1,5 mm wide. Leaves distant, obliquely inserted and horizontally spread. Perianth cylindrical, with crenulate mouth, constricted into a beak. Dioicous, usually with sporophytes. Terricolous or saxicolous, on humid substrata, by streams, on humid slopes and tufa springs, in the lowland and montane areas. Widespread in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 8 Leaves dorsally decurrent, longly inserted and arched in the ventral part; lobes often acute; cells with small trigones (fig. 23, 3-4) **L. badensis** (Gottsche) Schiffn.

**Leiocolea badensis** (Gottsche) Jörg.

Plants very small, similar to the former species. Stem translucent. Dioicous. Grows on soils and basic, wet rocks, in montane areas and high mountains. Very rare, in Central Pyrenees and Central Cantabrian Mountains. Esp, And.

- 9 Mature gemmae reddish or brownish and leaf cells with small trigones or trigones lacking 10

- 9 Mature gemmae green or yellowish green and trigones small to medium-sized, if gemmae lacking, then leaf cells with large, swollen trigones 13

- 10 Plants ascending to erect; leaves almost transversely inserted, often longer than wide; leaf lobes horn-like, with large masses of gemmae at the apex (fig. 23, 5-7)

**L. longidens** (Lindb.) Macoun

Plants to 2 cm long, deep green. Leaves spreading to reflexed; lobes straight or scarcely divergent, lower leaves usually squarrose; cells with small trigones. Gemmae in reddish masses on the upper leaves. Dioicous. Forms lax patches or scattered, on acidic rocks, bark of trees and rotten stumps, in montane areas and high mountains. Uncommon but spread in the northern half of the Peninsula. Esp, And.

- 10 Plants prostrate or ascending; leaves more or less obliquely inserted, as wide as long or wider; leaf lobes not horn-like, with gemmae at leaf margins 11

- 11 Leaf cells (18)20-25 mm, trigones usually well developed (fig. 23, 8-10)

**L. sudetica** (Huebener) Grolle

Plants up to 2 cm long. Leaves often with brownish colour, almost rounded, concave, sinus lunate. Gemmae reddish brown, on the upper margin of leaves, giving them an eroded appearance. Dioicous. Forms prostrate patches on acidic rocks in montane areas and high mountains. Distributed in the northern half of the Peninsula and Sierra Nevada. Esp, Prt, And.

- 11 Leaf cells 20-35 mm, trigones small or lacking 12

- 12 Gemmae angulate, 18-28 mm long, with one cell much bigger than the other and bearing a large, persistent, shiny, simple oil-body filling the whole cell (fig. 23, 11-12)

**L. perssonii** H.Buch & S.W.Arnell

Plants to 5 mm. Leaf cells with small trigones. Gemmae yellowish reddish, at the apex and margins of leaves, 1-2-celled. Dioicous. Grows on wet, open, calcareous soils in montane areas, in the Pyrenees. And.



- 12 Gemmae angulate, 24-37 mm long, with the 2 cells similar and each bearing several small granulose oil-bodies (fig. 23, 13-16) **L. excisa** (Dicks.) Dumort.  
Plants up to 1 cm long. Leaves as wide as long or wider; cells with very small trigones or trigones lacking. Gemmae at leaf apex, vinaceous. Perianth cylindrical, slightly plicate near the mouth, mouth usually crenulate, rarely dentate; cells underneath the mouth elongated and with very thin walls. Paroicous, usually fertile. Forms dense patches on acidic soils, from the lowland to high mountains, in the northern half of the Peninsula. Esp, Prt, And.
- 13 Plants ascending; leaves sub-erect, transversely inserted; lobes horn-like, with big masses of yellowish gemmae at apex (fig. 24, 1-4) **L. ascendens** (Warnst.) R.M.Schust.  
Plants up to 8 mm long, pale green, reddish at base of male bracts and in old parts of plants growing in exposed sites. Leaves ovate to oblong. Oil-bodies simple. Perianth cylindrical, plicate and constricted into a lacinate mouth. Dioicous. Strictly saprolignicolous, in fir and mountain pine forests, in montane areas and high mountains, in the Central Pyrenees. Esp, And.
- 13 Plants not as above **14**
- 14 Leaves very concave, wider than long, lobed to 1/5, with lunate, scarcely incurved lobes (fig. 24, 5-6) **L. wenzelii** (Nees) Steph.  
Plants to 1,5 cm long, procumbent or ascending. Leaves almost transversely inserted. Dioicous. Forms small patches on acidic soils and rocks in the high mountains; in the Pyrenees, Cantabrian Mountains and Serra da Estrela. Esp, Prt, And.
- 14 Leaves flat or scarcely concave, as long as wide, lobed to 1/5-1/2, with incurved lobes **15**
- 15 Gemmae often lacking; leaf cells with large, swollen, usually confluent trigones (fig. 24, 7-10) **L. longiflora** (Nees) Schiffn.  
Plants to 1,1 cm long, reddish on ventral side and basal part. Stem procumbent, with ascending apex. Leaves scarcely concave, with the ventral and basal part reddish. Leaves obliquely inserted, narrow, scarcely concave, with the ventral and basal part reddish. Perianth ovoid, reddish in the lower half, mouth and triangular lobes ending in a cilium 2-4(6) cells long. Dioicous. Saprolignicolous, rarely on other types of organic substrata, in montane areas and high mountains. Distributed in the northern part of the Peninsula. Esp, Prt, And.
- 15 Gemmae always present; leaf cells with small to medium-sized trigones (fig. 24, 11-13) **L. ventricosa** (Dicks.) Dumort.  
Plants 2(2,5) cm long, green, reddish at the rhizoid insertion. Stem procumbent. Leaves obliquely inserted, slightly asymmetrical. Gemmae (1)2-celled, angulate, green. Female bracts with entire margins; perianth mouth with truncate to rounded lobes, sometimes with 1-3-celled teeth. Dioicous. Forms small patches on acidic soils, in montane areas and high mountains.  
var. **ventricosa**: Oil-bodies granulose. Rather frequent in the mountainous areas of the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.  
var. **silvicola** (H.Buch) E.W.Jones: Oil-bodies biconcentric, with a large glistening central globule. Very rare, in montane areas and high mountains in the north of the Peninsula and in the Central Pyrenees. Esp.

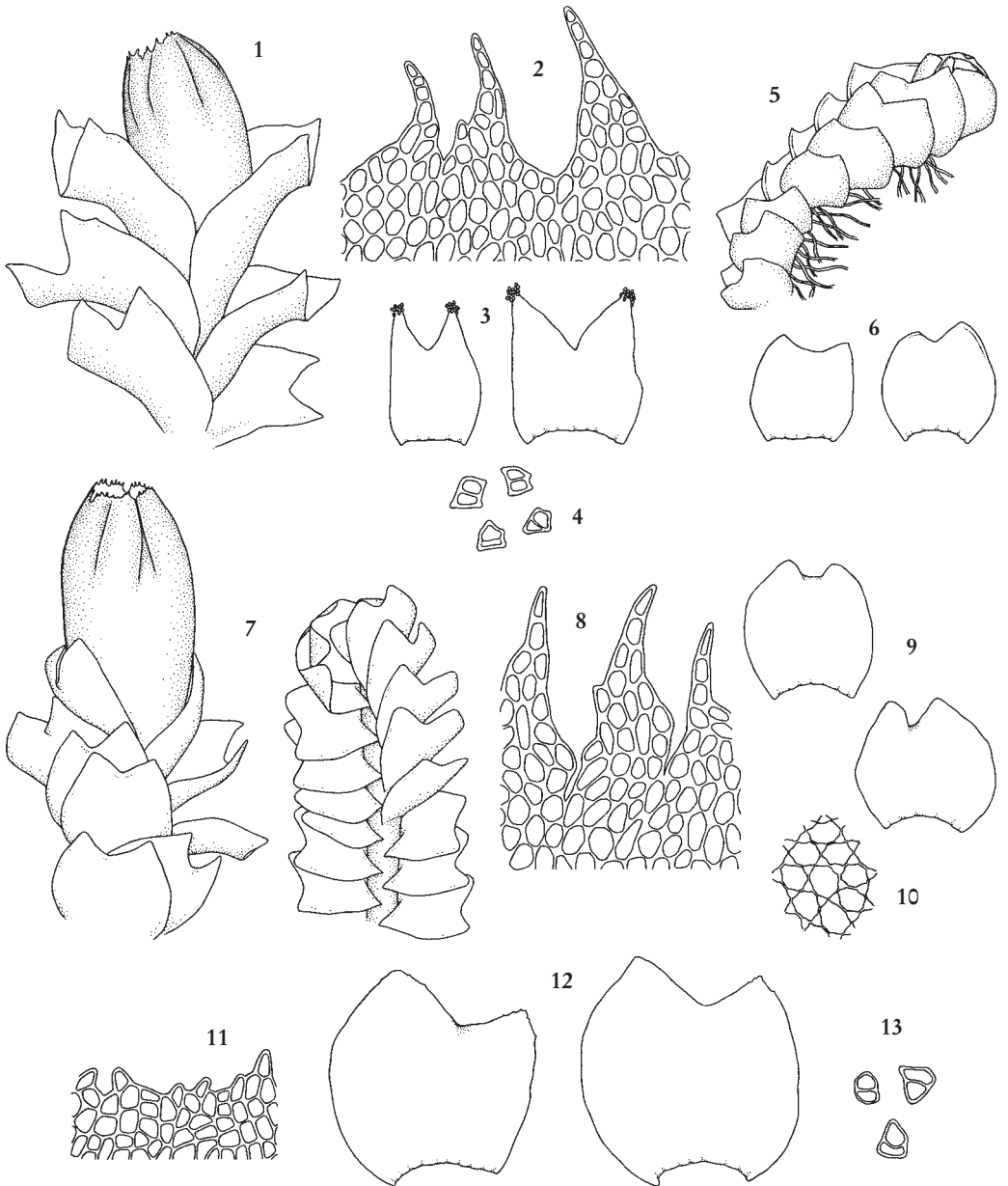


FIGURE 24. 1-4, *Lophozia ascendens*: 1, plant with perianth; 2, perianth mouth; 3, gemmiferous leaves; 4, gemmae. 5-6, *L. wenzelii*: 5, habit; 6, leaves. 7-10, *L. longiflora*: 7, plants with and without perianth; 8, perianth mouth; 9, leaves; 10, leaf cells. 11-13, *L. ventricosa*: 11, perianth mouth; 12, leaves; 13, gemmae. 1, 5, 7 ( $\times 16$ ); 3, 6, 9, 12 ( $\times 20$ ); 2, 8, 10, 11 ( $\times 160$ ); 4, 13 ( $\times 220$ ).

### **Gymnocolea** (Dumort.) Dumort.

Plants slender, flaccid. Stem 1-2 cm long, prostrate, slightly branched, innovating from below perianth. Leaves distant, imbricate or spreading, obliquely inserted, succubous, ovate or orbicular, longer than wide, upper leaves often concave, the rest more or less flat, bilobed to 1/3-1/2, with obtuse or rounded lobes; margin entire; median cells 20-30  $\mu\text{m}$  wide, trigones very small or lacking, 2-8 oil-bodies, 3-6 ? 3-8  $\mu\text{m}$ . Underleaves lacking or rudimentary. Gemmae lacking. Perianth ovoid or pyriform, smooth, contracted at mouth. Dioicous (fig. 25, 1-2)

**G. inflata** (Huds.) Dumort.

Plants calcifuge. Forms dark green or brownish patches submerged in stream margins, on peaty soils among *Sphagnum* or on heavy metal-rich soils, from the lowlands to the high mountains, in the Pyrenees, north and northwestern part of the Peninsula. Esp, Prt, And.

### **Anastrophyllum** (Spruce) Steph.

Plants small or medium-sized. Leaves more or less transversely inserted or dorsal part transverse and ventral part oblique, concave to channelled, bilobed to 1/3, sometimes asymmetrical with dorsal lobe smaller than ventral one; cells thick-walled, trigones small or lacking. Underleaves lacking or small and subulate. Gemmae on upper leaves, green or reddish, angulate. Perianth plicate above, usually dorsiventrally flattened, with lobed, denticulate mouth. Dioicous.

- 1 Gemmae at margins of appressed or erect leaves in modified shoots; rhizoids almost to stem apex; leaves 1,4-2 times as long as wide (fig. 25, 3-5)

**A. hellerianum** (Lindenb.) R.M.Schust.

Plants small, 2-5 mm long, 0,1-0,2 mm wide, green or brownish. Stem erect or procumbent. Grows on rotting stumps, in the high mountains of the Central Pyrenees. Esp, And.

- 1 Gemmae at margins of leaves in unmodified shoots; rhizoids scarce or lacking; leaves 0,8-1,2 times as long as wide (fig. 25, 6-9)

**A. minutum** (Schreb.) R.M.Schust.

Plants 1-3 cm long, 0,5-1,5 mm wide, green or brownish. Stem procumbent or ascending. Forms patches on soils or rocks, from the lowlands to the high mountains, in the northern part of the Peninsula. Esp, And.

### **Tritomaria** Schiffn. ex Loeske

Plants small or medium-sized. Stem prostrate or ascending. Leaves asymmetrical, transversely inserted, 3-lobed, lobes acute, the ventral longer and more curved than the dorsal one; cells with large trigones. Underleaves lacking. Gemmae usually present, borne at apex of upper leaves, 2-celled, ellipsoidal, pyriform or angulate. Dioicous.

- 1 Plants 3-5  $\times$  0,2-0,3 cm; leaves undulate, crisped when dry; usually gemmae lacking (fig. 25, 10-12)

**T. quinquedentata** (Huds.) H.Buch

Stem with ventral cortical cells brown or red in mature plants. Leaves strongly asymmetrical, lobes ovate-triangular; cells with 1-12 oil-bodies 2-8  $\mu\text{m}$  wide, trigones large, usually bulging. Forms patches on soils and rock, mainly on acidic, also among other bryophytes, in

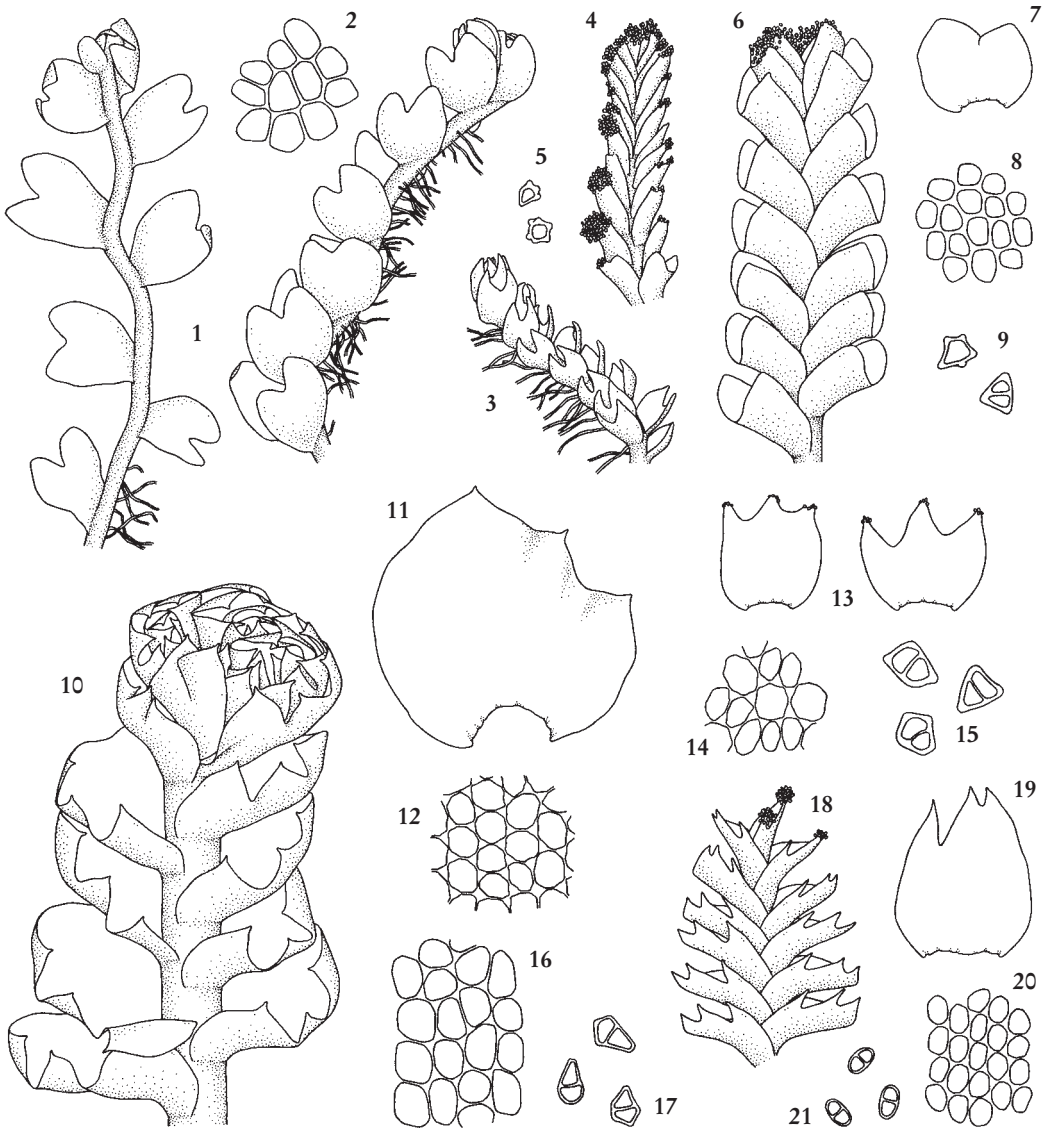


FIGURE 25. 1-2, *Gymnocolea inflata*: 1, habits; 2, leaf cells. 3-5, *Anastrophyllum hellerianum*: 3, habit; 4, gemmiferous shoot; 5, gemmae. 6-9, *A. minutum*: 6, habit; 7, leaf; 8, leaf cells; 9, gemmae. 10-12, *Tritomaria quinquedentata*: 10, habit; 11, leaf; 12, leaf cells. 13-15, *T. scitula*: 13, leaves; 14, leaf cells; 15, gemmae. 16-17, *T. exsectiformis*: 16, leaf cells; 17, gemmae. 18-21, *T. exsecta*: 18, habit; 19, leaf; 20, leaf cells; 21, gemmae. 10 ( $\times 14$ ); 1, 18 ( $\times 16$ ); 7, 11, 13, 19 ( $\times 20$ ); 3, 4, 6 ( $\times 32$ ); 2, 8, 12, 14, 16, 20 ( $\times 200$ ); 5, 9, 15, 17, 21 ( $\times 260$ ).

montane areas and high mountains, in the north and northeastern part of the Peninsula. Esp, Prt, And.

- 1 Plants 1-3 × 0,1-0,2 cm; leaves not undulate or crisped when dry; gemmae abundant 2
- 2 Leaf lobes very similar in size (fig. 25, 13-15) **T. scitula** (Taylor) Jörg.  
Plants prostrate, to 1 cm long. Leaves longer than wide, divided to 1/3 in 3 triangular lobes, acute; median cells 17-35 × 17-25 µm, with more or less bulging trigones. Gemmae brownish or reddish, angulate, 22-25 × 15-20 µm, 2-celled. Forms patches on wet, shaded, calcareous rocks, in the high mountains of the Central Pyrenees. Esp, And.
- 2 Ventral lobe much larger than the other two 3
- 3 Gemmae pyriform or angulate, 25-27 × 17-20 µm; median cells 17-25 µm wide (fig. 25, 16-17) **T. exsectiformis** (Breidl.) Loeske  
Dorsal lobe very acute; cells with 8-15 oil-bodies, trigones small, sometimes bulging. Forms patches on wet, acidic rocks and soils, in montane areas and high mountains of the northern part of the Peninsula. Esp, And.
- 3 Gemmae ellipsoidal, 15-17 × 10-12 µm; median cells 10-12 µm wide (fig. 25, 18-21) **T. exsecta** (Schmidel.) Loeske  
Dorsal lobe acute. Leaf cells with 2-8 oil-bodies, trigones small, not bulging. Grows on rotting fir and beech stumps, in montane areas and high mountains of the north and northeastern part of the Peninsula. Esp, And.

### **Jamesoniella** (Spruce) F.Lees

Plants to 2 cm long, dark green, brownish or reddish. Stem prostrate or ascending, sparsely branched. Leaves alternate, obliquely inserted, succubous, simple, sub-orbicular, some retuse, lower leaves spreading, the upper ones imbricate, pressed face to face; margin plane; cells 20-25 µm wide, thin-walled, with trigones, marginal cells smaller. Underleaves lacking or very small. Male bracts with well-developed, strongly incurved dorsal lobe. Female bracts narrower than leaves, erect, sheathing perianth, bearing 1-2 long cilia. Perianth mouth longly ciliate. Dioicous (fig. 26, 1-3) **J. autumnalis** (DC.) Steph.

Grows on wet, acidic soils, rotten wood and on other bryophytes such as *Leucobryum juniperoides* (Brid.) Müll.Hal., in humid forests. Rare, in the north of the Peninsula. Esp.

## **Fam. Jungermanniaceae**

### **Mylia** Gray

Plants medium-sized. Stem procumbent, to 4 cm long, slightly branched. Rhizoids abundant, attached at base of leaves. Leaves alternate, succubous, simple, obliquely inserted, more or less orbicular; margin entire; cuticle smooth; cells isodiametric, 50-70 µm wide, with large, bulging trigones and granulose oil-bodies. Underleaves small, lanceolate. Gemmiferous leaves ovate-lanceolate, usually with incurved margins and

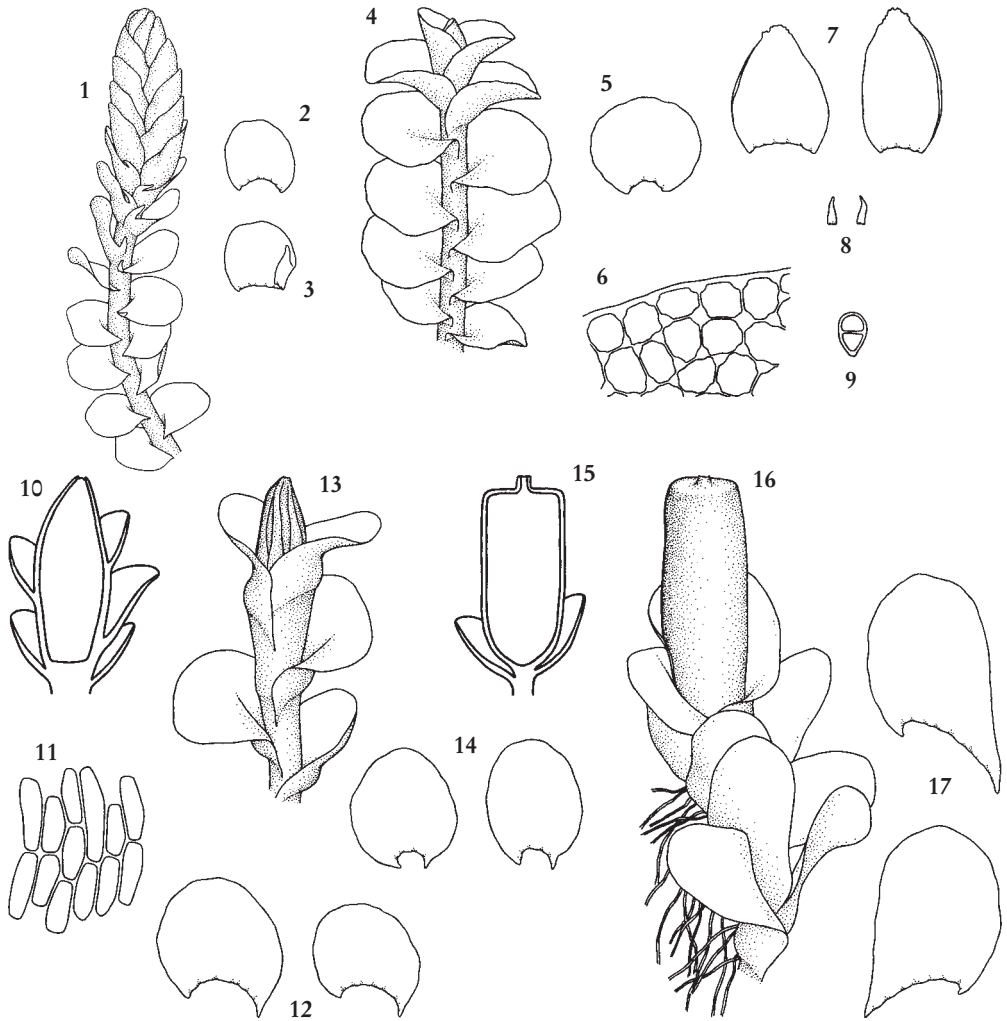


FIGURE 26. 1-3, *Jamesoniella autumnalis*: 1, male plant; 2, leaf; 3, male bract. 4-9, *Mylia anomala*: 4, habit; 5, leaf; 6, leaf marginal cells; 7, gemmiferous leaves; 8, underleaves; 9, gemma. 10-14, Subgen. Plectocolea. 10, section of perianth with perigynium. 11-12, *Jungermannia hyalina*: 11, perianth cells; 12, leaves. 13-14, *J. obovata*: 13, plant with perianth; 14, leaves. 15-17, Subgen. Liochlaena. 15, perianth section. 16-17, *J. leiantha*: 16, plant with perianth; 17, leaves. 16 ( $\times 10$ ); 4, 5, 7, 8, 12, 13, 14, 17 ( $\times 12$ ); 1, 2, 3 ( $\times 14$ ); 6, 9, 11 ( $\times 120$ ).

cells 2-3 times longer than wide. Gemmae ovoid, yellowish, 1-2-celled. Dioicous (fig. 26, 4-9)

**M. anomala** (Hook.) Gray

Grows among *Sphagnum*, in peatlands and on waterlogged soils, in the high mountains, in the north of the Peninsula and in the Pyrenees. Esp, And.

### **Jungermannia** L.

Plants small to large. Stems procumbent or erect, scarcely branched; medulla usually poorly differentiated. Leaves obliquely to transversely inserted, succubous, simple, reniform, orbicular or ovate, with narrowly to broadly rounded apex, occasionally retuse; cells with or without trigones. Underleaves lacking on sterile shoots. Gemmae rare, restricted to very few species. Perigynium sometimes present. Perianth ovoid to cylindrical, smooth or plicate, with beak or with crenulate to dentate, narrow mouth. Dioicous or paroicous.

- |   |   |  |
|---|---|--|
| 1 | Plants with well-developed perianths  | 2  |
| 1 | Plants sterile or with immature perianths   | 12   |
| 2 | Perigynium conspicuous, bearing 1-2(3) pairs of bracts; upper cells of perianth elongated, different from leaf cells (fig. 26, 10-14)   | (Subgen. <b>Plectocolea</b> ) 3  |
| 2 | Perigynium lacking or very short, bearing 1 pair of bracts; upper cells of perianth not elongated, similar in size and shape to leaf cells  | 4  |
| 3 | Plants dioicous; perianth exserted; leaves semicircular to reniform, wider than long (fig. 26, 11-12)   | <b>J. hyalina</b> Lyell  |
|   | Plants 0,7-3(4) mm wide, usually green, sometimes brownish green to reddish. Rhizoids originating from the ventral part of the stem or from the leaf insertion, not forming bundles, growing all along the stem, at least some rhizoids red. Leaves longly decurrent on the dorsal side, obliquely inserted; cuticle smooth; cells with trigones and 3-4 oil bodies. Dioicous. Forms large mats on acid to neutral soils and rocks in humid forests, often by streams, or wet areas, mostly in montane areas and high mountains. Scattered in the northern half of the Peninsula, Sierra Nevada and Algeciras mountains. Esp, Prt, And. |  |
| 3 | Plants paroicous; perianth emergent; leaves widely ovate to ovate-circular (fig. 26, 13-14)   | <b>J. obovata</b> Nees   |
|   | Plants 1,2-3 mm wide, dark to brownish green, sometimes reddish, with a strong smell of carrots. Rhizoids usually intensely red. Leaves orbicular to ovate, symmetrical, shortly or longly decurrent; cuticle coarsely striate; cells with small to medium-sized trigones. Paroicous. Perianth with a high perigynium, female bracts squarrose or patent (at least the upper pair). Grows on acid soil and humus in humid forests or open areas, in very moist or wet sites, in montane areas and high mountains. Scattered in the northwestern part of the Peninsula, Basque Mountains and in the Pyrenees. Esp, Prt, And.             |  |
| 4 | Perianth smooth, cylindrical, ending in a beak; perigynium lacking (fig. 26, 15-17)   | (Subgen. <b>Liochlaena</b> )<br>(fig. 26, 16-17) <b>J. leiantha</b> Grolle |



- Plants large, up to 5 mm wide, green or brownish. Leaves 1,1-1,25 × 0,9-1 mm, longer than wide, oblong-rectangular, more or less parallel-sided, shortly decurrent on the ventral side and longly decurrent on the dorsal side; cuticle finely striate. Gemmae very rare. Paroicous. Grows on wet, acidic or slightly basic rocks and soils, in montane areas and high mountains. Very rare, in the northwest of the Peninsula and in Central Pyrenees. Esp, And.
- 4 Perianth plicate at least in the upper third, beaked or not; perigynium lacking or sometimes present and very short 5
- 5 Perianth pyriform to clavate, ending in a beak; sometimes with a short perigynium (fig. 27, 1-10) (Subgen. **Solenostoma**) 6
- 5 Perianth fusiform, ovoid to clavate, gradually narrowed into apex, mouth wide, not beaked; perigynium lacking (fig. 27, 11-22) (Subgen. **Jungermannia**) 9
- 6 Plants dioicous; at least upper leaves with a conspicuous border of 1 row of bigger cells 7
- 6 Plants paroicous; leaves unbordered 8
- 7 Leaves reniform; border cells (42)48-58(70) × (20)25-35(40) μm, (1,4)1,5-2,5 times as long as wide (fig. 27, 2-3) **J. handelii** (Schiffn.) Amakawa  
Plants small to medium-sized, up to 2 mm wide, green to reddish. Leaves slightly patent on the ventral insertion. Leaf cells 40-50 × 30-40 μm, border cells with thin walls. Perianth plicate almost to base, pyriform. Grows in peaty heathlands. Very rare, in the northwestern part of the Peninsula. Esp.
- 7 Leaves usually orbicular; border cells (30)40-60(65) × (36)42-50 μm, (1)1,2-1,4 times as long as wide (fig. 27, 4-6) **J. gracillima** Sm.  
Plants very small to medium-sized, 0,3-1,6 mm wide, green to brownish or reddish. Leaf cells 25-35 × 22-25 μm, border cells strongly thick-walled. Perianth plicate in the upper part, with 4-5 keels marked only in its upper third. Grows on wet, acidic substrata, soil or humus, usually in areas with *Sphagnum*, mostly in open areas, but also in humid forests, in montane areas and high mountains. Distributed in the northern and western part of the Peninsula. Esp, Prt, And.
- 8 At least upper leaves reniform, clearly wider than long; rhizoids along stem, on leaves, perigynium or bracts; perigynium very short, always present (fig. 27, 7-8) **J. confertissima** Nees  
Plants medium-sized, up to 1,5 mm wide, brownish green. Rhizoids usually hyaline to brownish, rarely red, forming decurrent bundles along the stem. Leaves subtransversally inserted, usually asymmetrical, reniform, often with truncate apex; cells with usually medium-sized to large trigones. Perianths brownish to reddish. Grows on calcareous substrata, sometimes in wet sites, in the high mountains. Rare, in the Central Pyrenees. Esp, And.
- 8 Leaves mostly orbicular to rounded-cordate or rounded-reniform, usually as long as wide; rhizoids on the ventral part of stem; perigynium absent or very short (fig. 27, 9-10) **J. sphaerocarpa** Hook.  
Plants small to medium-sized, up to 2 mm wide, green to brownish or black. Leaves shortly and subtransversally inserted, patent. Perianths ovoid, beaked, with patent bracts. Grows



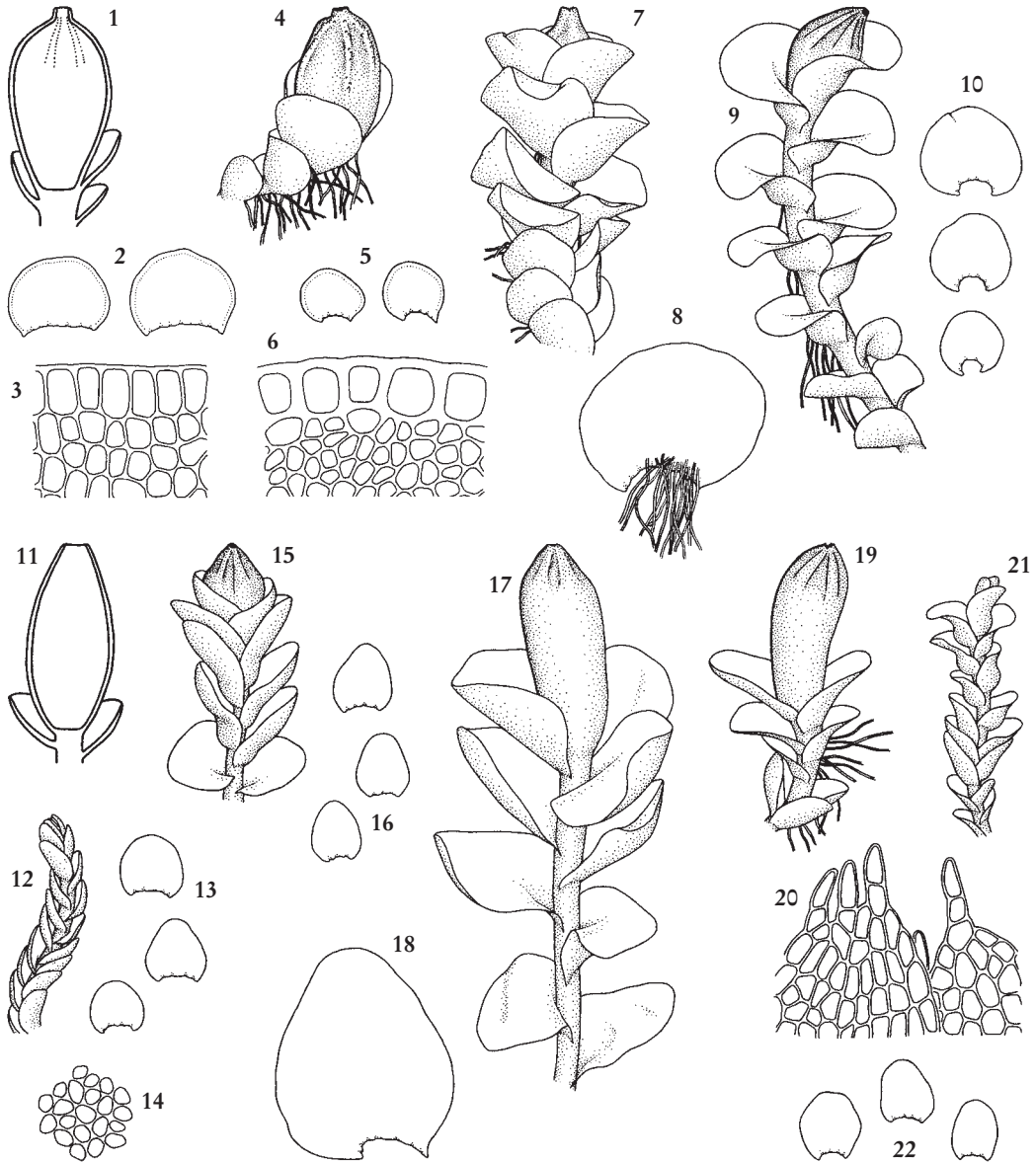


FIGURE 27. 1-10, Subgen. *Solenostoma*. 1, perianth section. 2-3, *Jungermannia handelii*: 2, leaves; 3, marginal cells. 4-6, *J. gracillima*: 4, plant with perianth; 5, leaves; 6, marginal cells. 7-8, *J. confertissima*: 7, plant with perianth; 8, leaf. 9-10, *J. sphaerocarpa*: 9, plant with perianth; 10, leaves. 11-22, Subgen. *Jungermannia*. 11, perianth section. 12-14, *J. polaris*: 12, habit; 13, leaves; 14, leaf cells. 15-16, *J. pumila*: 15, plant with perianth; 16, leaves. 17-18, *J. exsertifolia* subsp. *cordifolia*: 17, plant with perianth; 18, leaf. 19-22, *J. atrovirens*: 19, plant with perianth; 20, perianth mouth; 21, male plant; 22, leaves. 17 ( $\times 8$ ); 18 ( $\times 10$ ); 2, 4, 5, 7, 8, 9, 10, 15, 16 ( $\times 12$ ); 12, 19, 21 ( $\times 15$ ); 13, 22 ( $\times 20$ ); 3, 6 ( $\times 120$ ); 14, 20 ( $\times 150$ ).

- preferentially on acid substrata in wet sites, in montane areas and high mountains. Rare, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.
- 9 Plants paroicous 10
- 9 Plants dioicous 11
- 10 Perianth ovoid to clavate, with crenulate mouth; leaves cordate, subcordate or almost orbicular, with the widest part at leaf base; leaf cells  $15-25 \times 15-19 \mu\text{m}$ , with trigones (fig. 27, 12-14) **J. polaris** Lindb.  
Plants very small, less than 0,7 mm wide, dark green to brownish or black. Rhizoids hyaline. Leaves dorsally secund, usually very concave, widely inserted. Perianth not beaked. Grows on humus on calcareous rocks, in the high mountains. Rare, in the Cantabrian and Basque Mountains and in the Central Pyrenees. Esp, And.
- 10 Perianth fusiform, very long, with dentate-crenulate mouth; leaves ovate to elliptical, with the widest part in the middle; leaf cells  $25-35 (40) \times (18) 22-25 \mu\text{m}$ , without trigones (fig. 27, 15-16) **J. pumila** With.  
Plants medium-sized, up to 2,5 mm wide, green, sometimes brownish or blackish. Leaf cells with smooth cuticle. Grows on neutral to mildly acidic soils and rocks, often by streams or seeping sites, in open areas or in humid forests, in montane areas and high mountains. Rare, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt.
- 11 Leaves very large, cordate, rounded-triangular or orbicular, with loosely sheathing base, flaccid, narrowly inserted; male bracts terminal or intercalary; perianth with entire mouth (fig. 27, 17-18) **J. exsertifolia** Steph. subsp. **cordifolia** (Dumort.) Vána  
Plants to  $12 \times 0,4$  cm, dark green, blackish or reddish. Stem cells finely striate. Rhizoids scarce. Leaf cells  $20-28 \mu\text{m}$  wide. Perianth fusiform to clavate, slightly plicate near mouth. Forms large mats on acid rocks, sometimes semi-submerged, by streams and small lake banks, in montane areas and high mountains. Distributed in the northern half of the Peninsula and in Sierra Nevada. Esp, And.
- 11 Leaves ovate to cordate, never with sheathing base, not flaccid, rather widely inserted; male bracts terminal; perianth with dentate mouth (fig. 27, 19-22) **J. atrovirens** Dumort.  
Plants  $4 \times 0,4$  cm, pale to yellowish green. Rhizoids arising densely from stem. Leaves slightly decurrent on the dorsal side; cuticle verrucose-striate. Perianth obovoid to clavate, slightly plicate near mouth. Strongly calcicolous, grows on limestone, often associated with travertines, in montane areas and high mountains. Frequent in the northern half of the Peninsula, rare in the south and in Mallorca. Esp, Prt, And, Bl.
- 12 At least upper or best developed leaves with a conspicuous border of 1 row of much bigger cells 13
- 12 Leaves unbordered 14
- 13 Leaves reniform; border cells  $(42)48-58(70) \times (20)25-35(40) \mu\text{m}$ , (1,4)1,5-2,5 times as long as wide (fig. 27, 2-3) **J. handelii** (Schiffn.) Amakawa

Plants small to medium-sized, up to 2 mm wide, green to reddish. Leaves slightly patent on the ventral insertion. Leaf cells  $40-50 \times 30-40 \mu\text{m}$ , border cells with thin walls. Dioicous. Grows in peaty heathlands. Very rare, in the northwestern part of the Peninsula. Esp.

- 13 Leaves usually orbicular; border cells  $(30)40-60(65) \times (36)42-50 \mu\text{m}$ , (1)1,2-1,4 times as long as wide (fig. 27, 4-6) **J. gracillima** Sm.

Plants very small to medium-sized, 0,3-1,6 mm wide, green to brownish or reddish. Leaf cells  $25-35 \times 22-25 \mu\text{m}$ , border cells strongly thick-walled. Dioicous. Grows on wet, acidic substrata, soil or humus, usually in areas with *Sphagnum*, mostly in open areas, but also in humid forests, in montane areas and high mountains. Distributed in the northern and western part of the Peninsula. Esp, Prt, And.

- 14 Leaves reniform to reniform-orbicular, conspicuously wider than long, at least on the best developed branches or on the upper ones 15

- 14 Leaves ovate, cordate, oblong-rectangular, orbicular, as long as wide or longer than wide 16

- 15 Rhizoids originating from leaf cells (to half way up the leaf), forming decurrent bundles along the stem; leaves subtransversally inserted (fig. 27, 7-8)

**J. confertissima** Nees

Plants medium-sized, up to 1,5 mm wide, brownish green. Rhizoids usually hyaline to brownish, rarely red. Leaves asymmetrical, reniform, often with truncate apex; cells with usually medium-sized to large trigones. Paroicous. Grows on calcareous substrata, sometimes in wet sites, in the high mountains. Rare, in the Central Pyrenees. Esp, And.

- 15 Rhizoids originating from the ventral part of the stem or from the leaf insertion, not forming bundles, growing all along the stem; leaves obliquely inserted (fig. 26, 11-12)

**J. hyalina** Lyell

Plants 0,7-3(4) mm wide, usually green, sometimes brownish green to reddish. Leaves widely inserted, longly decurrent on the dorsal side; cuticle smooth; cells with trigones and 3-4 oil bodies. Dioicous. Forms large mats on acid to neutral soils and rocks in humid forests, often by streams, or wet areas, mostly in montane areas and high mountains. Scattered in the northern half of the Peninsula, Sierra Nevada and Algeciras mountains. Esp, Prt, And.

- 16 Leaf cells without trigones 17

- 16 Leaf cells with trigones 19

- 17 Leaves ovate to elliptical, widest at middle (fig. 27, 15-16) **J. pumila** With.

Plants medium-sized, up to 2,5 mm wide, green, sometimes brownish or blackish. Leaf cells  $25-35 (40) \times (18) 22-25 \mu\text{m}$ , without trigones; cuticle smooth. Paroicous. Grows on neutral to mildly acidic soils and rocks, often by streams or seeping sites; in open areas or in humid forests, in montane areas and high mountains. Rare, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt.

- 17 Leaves ovate to cordate, widest at base 18

- 18 Plants large, 2-12 cm long, dark green, blackish or often reddish at the oldest parts; leaves loosely sheathing at base, flaccid, narrowly inserted; plants often submerged in acid waters (fig. 27, 17-18) **J. exsertifolia** Steph. subsp. **cordifolia** (Dumort.) Váňa  
Plants to 0,4 cm wide. Stem cells finely striate. Rhizoids scarce. Leaves slightly decurrent on the dorsal side; cells 20-28  $\mu\text{m}$  wide. Forms large mats on acid rocks, sometimes semi-submerged, by streams and small lake banks, in montane areas and high mountains. Distributed in the northern half of the Peninsula and in Sierra Nevada. Esp, And.
- 18 Plants small to medium-sized, 0,3-4 cm long, green to yellowish green; leaves not sheathing, not flaccid, rather widely inserted; plants terricolous or saxicolous, calcicolous (fig. 27, 19-22) **J. atrovirens** Dumort.  
Plants to 0,4 cm wide. Rhizoids arising densely from stem. Leaf cells with verrucose-striate cuticle. Dioicous. Grows on limestone, often associated with travertines, in montane areas and high mountains. Frequent in the northern half of the Peninsula, rare in the south and in Mallorca. Esp, Prt, And, Bl.
- 19 Leaves oblong-rectangular, conspicuously longer than wide (fig. 26, 16-17) **J. leiantha** Grolle  
Plants large, up to 5 mm wide, green or brownish. Leaves 1,1-1,25  $\times$  0,9-1 mm, longer than wide, more or less parallel-sided, shortly decurrent on the ventral side and longly decurrent on the dorsal side; cuticle finely striate. Gemmae very rare. Paroicous. Grows on wet, acidic or slightly basic rocks and soils, in montane areas and high mountains. Very rare, in the northwest of the Peninsula and in Central Pyrenees. Esp, And.
- 19 Leaves cordate, cordate-rounded, orbicular, ovate, more or less as long as wide 20
- 20 Plants with a strong smell of carrots; rhizoids intensely red; leaf cells with cuticle coarsely striate (fig. 26, 13-14) **J. obovata** Nees  
Plants 1,2-3 mm wide, dark to brownish green, sometimes reddish. Leaves symmetrical, orbicular to ovate; cells with small to medium-sized trigones. Paroicous. Grows on acid soil and humus in humid forests or open areas, in very moist or wet sites, in montane areas and high mountains. Scattered in the northwestern part of the Peninsula, Basque Mountains and in the Pyrenees. Esp, Prt, And.
- 20 Plants without a smell of carrots; rhizoids hyaline; leaf cells with cuticle smooth or finely striate 21
- 21 Plants to 0,7 mm wide, usually blackish or very dark green; leaves widely inserted; leaf cells 15-25  $\times$  15-19  $\mu\text{m}$  (fig. 27, 12-14) **J. polaris** Lindb.  
Leaves dorsally secund, usually very concave. Paroicous. Grows on humus on calcareous rocks, in the high mountains. Rare, in the Cantabrian and Basque Mountains and in the Central Pyrenees. Esp, And.
- 21 Plants 0,5-2 mm wide; leaves shortly inserted; leaf cells 30-35  $\times$  25-30  $\mu\text{m}$  (fig. 27, 9-10) **J. sphaerocarpa** Hook.  
Plants green to brownish or black. Leaves shortly and subtransversally inserted, patent, mostly orbicular. Paroicous. Grows preferentially on acid substrata in wet sites, in montane areas and high mountains. Rare, in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.

## Nardia Gray

Plants minute to large, green or purplish. Stem prostrate or ascending, slightly branched. Rhizoids abundant. Leaves alternate, obliquely inserted, succubous, simple, orbicular or reniform, with rounded or retuse apex or bilobed; median cells with 1-4 oil-bodies, granulose or simple, 10-24  $\mu\text{m}$  long, trigones sometimes bulging or lacking. Underleaves lanceolate or subulate, small, entire, sometimes restricted to the stem apex. Gemmae lacking. Perianth short, with entire or dentate-crenulate mouth, immersed in a long perigynium. Dioicous or paroicous.

- 1 Stem 2-10 cm long, with hyaloderm; leaves appressed, decurrent on dorsal side (fig. 28, 1-4) **N. compressa** (Hook.) Gray

Plants green to reddish brown, laterally compressed, branched, sometimes with ventral flagelliform branches. Leaves simple, flat, reniform; median cells 25-35  $\mu\text{m}$  wide, smaller towards margins, thin or thick-walled, colourless or purplish red, with 1-3 shiny oil-bodies, trigones small to moderately large. Dioicous. Forms more or less extensive mats on wet or submerged rocks by streams, in the northern and western part of the Peninsula and in Sierra Nevada. Esp, Prt, And.

- 1 Stem to 4 cm long, without hyaloderm; leaves not appressed, not or only slightly decurrent on dorsal side 2

- 2 Leaves bilobed; median cells (8)10-12  $\mu\text{m}$ , with 1 oil-body (fig. 28, 5-7) **N. breidleri** (Limpr.) Lindb.

Plants minute, 1,5-3,5 mm long, purplish red or brownish red, usually with ventral flagelliform branches. Leaves erect, obliquely inserted, concave, lobes acute or obtuse, with acute or lunate sinus; median cells with reddish thick walls, trigones small or lacking. Perigynium bulbous. Dioicous. Grows in snow beds, in the high mountains. Very rare, in the Central Pyrenees. Esp, And.

- 2 Leaves entire, retuse or bilobed; median cells 20-40  $\mu\text{m}$  wide, with 2-4 oil-bodies 3

- 3 Leaves entire (fig. 28, 8-10) **N. scalaris** Gray

Stem 1-3 cm long, without flagelliform branches. Median cells 25-30  $\mu\text{m}$  wide, with trigones, simple, shiny oil-bodies, persisting for some time after drying; marginal cells similar to median cells. Dioicous. Forms extensive, green or brownish mats on wet soils and rocks, in montane areas and high mountains, in northern half and western part of the Peninsula. Esp, Prt, And.

- 3 Leaves retuse or bilobed 4

- 4 Leaves bilobed to 1/4-1/2 (fig. 28, 11-14) **N. insecta** Lindb.

Plants small, green to blackish green. Stem to 1-1,5 cm long. Leaves concave or plane; cells with 2-4 granulose, non-persistent oil-bodies. Parioicous. Grows on shaded, calcareous rocks, in the high mountains. Very rare, in the Pyrenees. Esp.

- 4 Leaves rounded, retuse to shallowly bilobed (fig. 28, 15-16) **N. geoscyphus** (De Not.) Lindb.

Plants about 1 cm, olive green or reddish. Stem prostrate, usually with ventral flagelliform branches. Rhizoids violet. Leaf cells with 2-3 granulose, opaque oil-bodies, not persisting on

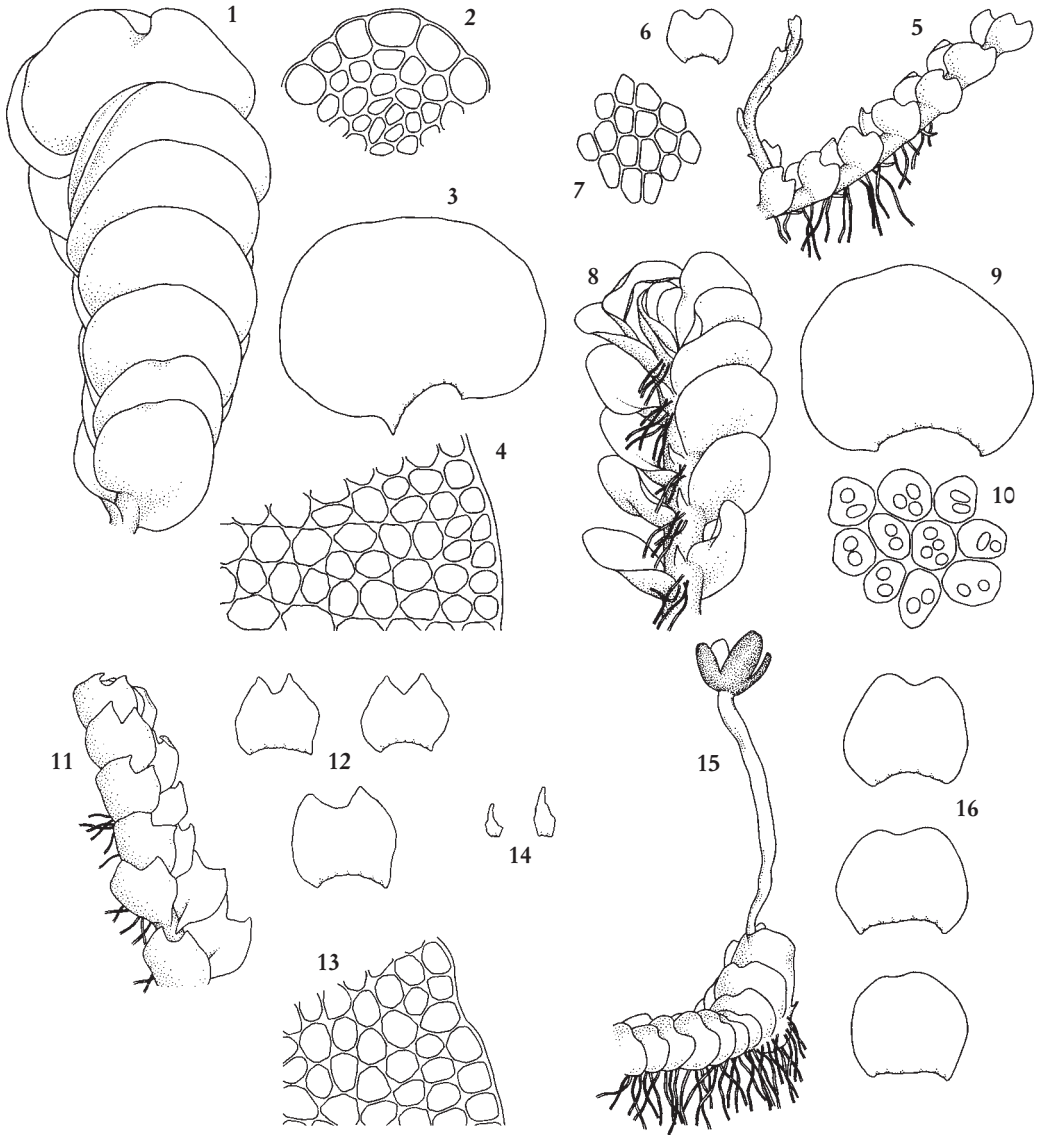


FIGURE 28. 1-4, *Nardia compressa*: 1, habit; 2, stem section; 3, leaf; 4, leaf cells. 5-7, *N. breidlerii*: 5, habit; 6, leaf; 7, leaf cells. 8-10, *N. scalaris*: 8, habit, ventral side; 9, leaf; 10, leaf cells. 11-14, *N. insecta*: 11, habit; 12, leaves; 13, leaf cells; 14, underleaves. 15-16, *N. geoscyphus*: 15, plant with sporophyte; 16, leaves. 1, 8, 15 ( $\times 12$ ); 11 ( $\times 14$ ); 3, 5, 9, 12, 14, 16 ( $\times 20$ ); 6 ( $\times 30$ ); 2, 4, 7, 10, 13 ( $\times 200$ ).

drying. Paroicous. Forms mats on wet soil, from the lowlands to the high mountains, in the Pyrenees and north of the Peninsula. Esp, Prt, And.

## Fam. Gymnomitriaceae

### Marsupella Dumort.

Plants 0,5-5 cm long. Branches julaceous. Leaves alternate, distant to imbricate, appressed, patent or erecto-patent, transversely inserted, orbicular, obcordate or ovate, bilobed or emarginate, lobes rounded, obtuse or acute, concave or channelled; margin plane or recurved near base; cells with 2-3 oil-bodies, trigones large, small or lacking. Underleaves lacking. Gemmae lacking. Perianth immersed among bracts. Dioicous or paroicous.

For determination, well-developed plants are required. Sinus size refers to upper leaves.

1 Stem with hyaloderm; plants 0,5-5 cm long 2

1 Stem without hyaloderm or hyaloderm poorly differentiated; plants 1(2) cm long 3

2 Leaf margins recurved, at least in some leaves; leaves with obtuse sinus, up to 1/5 length of leaf (fig. 29, 1-4) **M. emarginata** (Ehrh.) Dumort.

Plants very polymorphic, 2-5 cm long, usually green, occasionally brown. Stem erect; hyaloderm cells thin-walled and as wide or wider than medulla cells, 2-4 layers of small, thick-walled cortical cells between hyaloderm and medulla. Leaves erecto-patent, usually orbicular to obcordate, bilobed or emarginate; median cells 20-32 ? 14-20  $\mu\text{m}$ , with large trigones. Dioicous. Forms turfs on wet soils and rocks, in montane areas and high mountains. Distributed in the northern half of the Peninsula, rare in the south. Esp, Prt, And.

2 Leaf margins plane; leaves with acute to obtuse sinus, up to 1/2 length of leaf (fig. 29, 5-7) **M. sphacelata** (Lindenb.) Dumort.

Plants 1-3(4) cm long, usually brown to blackish brown. Stem erect or procumbent; hyaloderm cells twice as wide as medulla cells, 2-4 layers of small, thick-walled cortical cells between hyaloderm and medulla. Leaves ovate or sub-orbicular; median cells 14-16  $\mu\text{m}$  wide, with brownish walls and small trigones. Dioicous. Forms low turfs on wet rocks. Distributed in the northern half and west of the Peninsula. Esp, Prt.

3 Leaves concave, patent or erect, approximate to imbricate, sometimes dorsally secund; plants laterally compressed or not 4

3 Leaves channelled, spreading, imbricate to distant, not secund; plants not laterally compressed 6

4 Plants laterally compressed; leaves as long as wide (fig. 29, 8-10)

**M. brevissima** (Dumort.) Grolle

Plants 0,4-1,2 cm long, reddish brown to blackish. Stem without hyaloderm, branched. Leaves all similar in size, dorsally secund, sub-orbicular or ovate; dorsal margin slightly decurrent;



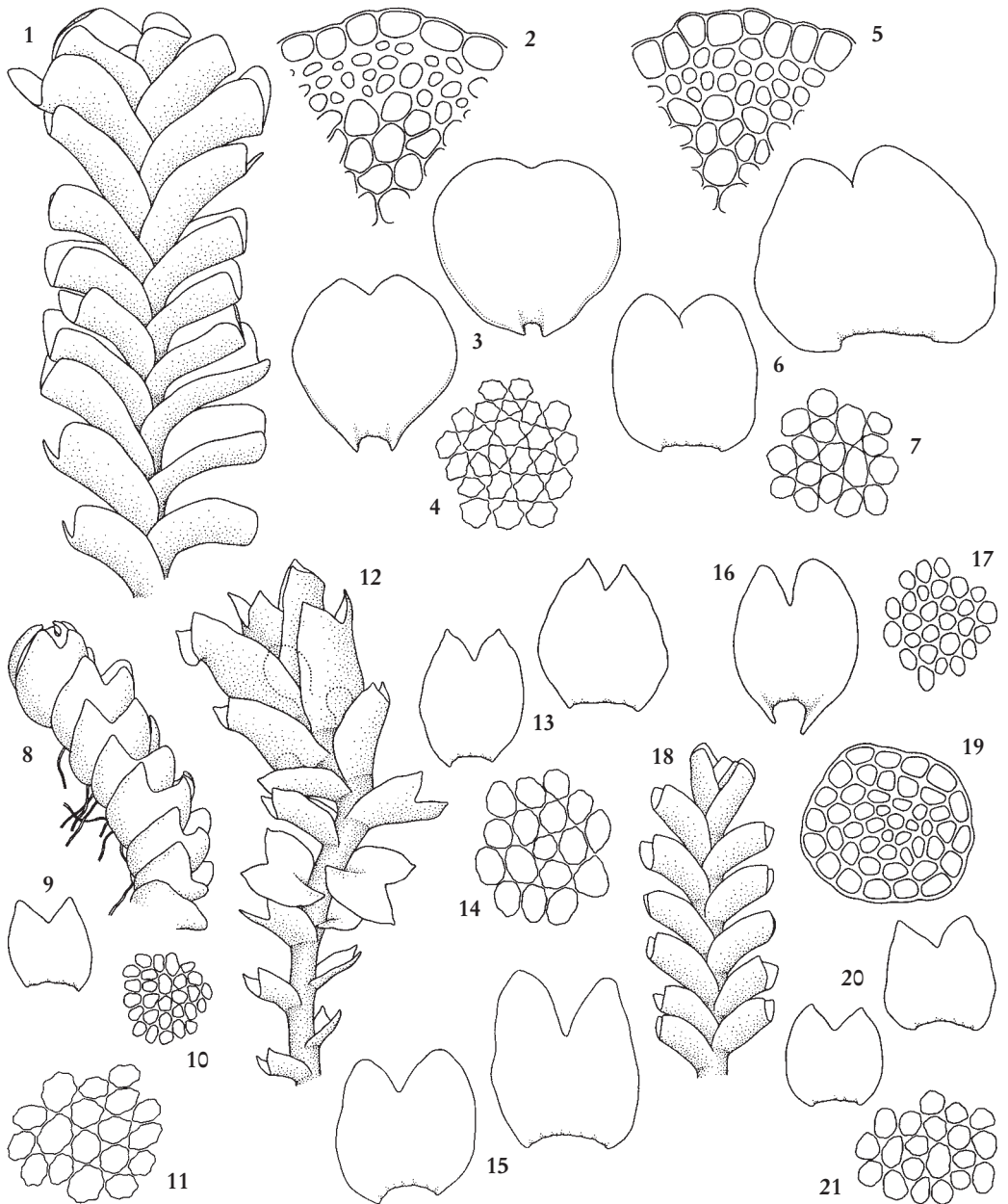


FIGURE 29. 1-4, *Marsupella emarginata*: 1, habit; 2, stem section; 3, leaves; 4, leaf cells. 5-7, *M. sphacelata*: 5, stem section; 6, leaves; 7, leaf cells. 8-10, *M. brevissima*: 8, habit; 9, leaf; 10, leaf cells. 11, *M. sparsifolia*, leaf cells. 12-14, *M. sprucei*: 12, habit; 13, leaves; 14, leaf cells. 15, *M. profunda*, leaves. 16-17, *M. alpina*: 16, leaf; 17, leaf cells. 18-21, *M. funckii*: 18, habit; 19, stem section; 20, leaves; 21, leaf cells. 1, 6 ( $\times 20$ ); 3 ( $\times 25$ ); 12 ( $\times 30$ ); 8, 9, 13, 15, 16, 18, 20 ( $\times 40$ ); 2, 4, 5, 7, 10, 11, 14, 17, 19, 21 ( $\times 220$ ).



- median cells 8-12  $\mu\text{m}$  wide, with convex, small or inconspicuous trigones. Paroicous or autoicous. Forms dense wefts on snow beds, in the Pyrenees. Esp, And.
- 4 Plants not laterally compressed; leaves longer than wide 5
- 5 Leaf cells 8-12  $\mu\text{m}$  wide; sinus rounded, 1/5-1/3 length of leaf  
**M. adusta** (Nees emend. Limpr.) Spruce  
 Plants up to 0,5 cm long. Stem without hyaloderm. Upper leaves larger than lower leaves; leaf lobes obtuse or rounded; cells thick-walled or with distinct trigones. Grows on granitic sands, in Serra da Estrela. Prt.
- 5 Leaf cells 12-26  $\mu\text{m}$  wide; sinus acute or narrowly rounded, 1/4-1/2 length of leaf (fig. 29, 11)  
**M. sparsifolia** (Lindb.) Dumort.  
 Plants to 1 cm long, reddish brown or blackish. Stem with poorly-differentiated hyaloderm. Leaf lobes acute or subacute; cells usually with large, bulging trigones. Paroicous. Grows on wet, acidic rocks in the high mountains, in the Pyrenees. And.
- 6 Plants paroicous; leaves gradually enlarged towards apex 7
- 6 Plants dioicous; leaves all similar in size 8
- 7 Leaf lobes acute or subacute, with sinus 60-90° (fig. 29, 12-14)  
**M. sprucei** (Limpr.) Bernet  
 Plants about 0,5 cm long, brownish red or blackish, clavate, usually fertile. Stem ascending or erect, without hyaloderm. Leaves ovate or sub-orbicular, imbricate to erecto-patent, as long as wide or a little longer, sinus to 1/5-1/3 of length of leaf; median cells 16-19  $\mu\text{m}$  wide, thin-walled or thick-walled, brown, with inconspicuous or distinct trigones. Female bracts with acute or apiculate, plane, lobes. Spores spherical, 10-12  $\mu\text{m}$  in diameter. Forms low turfs on metal-rich rocks, in montane areas and high mountains. Rare, Serra da Estrela and in the Pyrenees. Esp, Prt, And.
- 7 Leaf lobes rounded or obtuse, with sinus 40-60° (fig. 29, 15) **M. profunda** Lindb.  
 Plants to 0,5 cm long, blackish brown. Stem ascending or erect, without hyaloderm. Leaves sub-orbicular or ovate, bilobed to 1/3-1/2 of length of leaf; median cells 19-30  $\mu\text{m}$  wide, with bulging trigones. Female bracts with rounded, usually concave, lobes. Spores spherical, 7-10  $\mu\text{m}$  in diameter. Grows on acidic substrata, mainly in granitic rocks in open sites. Distributed in the west of the Peninsula. Prt.
- 8 Plants glossy, 0,3-1 mm wide; leaves sheathing at base, decurrent; sinus up to 1/5-1/3 of length of leaf; leaf cells 9-12  $\mu\text{m}$  wide (fig. 29, 16-17) **M. alpina** (Husn.) Bernet  
 Plants 1-2 cm long, brownish red. Stem erect, without hyaloderm. Leaves patent, sub-orbicular or ovate, nearly as wide as long; cells reddish or brownish, thick-walled, with distinct trigones. Forms low turfs in high mountains, in the Pyrenees and in the Central Range. Esp, And.
- 8 Plants dull, 0,3-0,6 mm wide; leaves not sheathing or decurrent; sinus up to 1/3-1/2 of length of leaf; leaf cells 12-14  $\mu\text{m}$  wide (fig. 29, 18-21)  
**M. funckii** (F. Weber & D. Mohr) Dumort.  
 Plants 0,4-1,2 cm long, brownish or blackish. Stem erect, without hyaloderm. Leaves patent or erecto-patent, ovate or sub-orbicular, a little longer than wide; median cells thick-walled, with

distinct trigones. Forms low, dense turfs usually on soils, in montane areas and high mountains. Scattered in the northern half of the Peninsula. Esp, Prt, And.

### Gymnomitrium Corda

Plants julaceous or dorsiventrally compressed, slender, to 2,5 cm long, usually clavate. Stem prostrate to erect, sparsely branched. Leaves alternate, densely imbricate, appressed, transversely inserted, concave, emarginate or bilobed, with acute sinus; margin entire or crenulate, usually hyaline; median cells 16-25 µm, thick-walled, trigones usually bulging, 2-3 oil-bodies. Underleaves lacking. Gemmae lacking. Dioicous.

- 1 Leaf margins crenulate, with a single row of elongated cells projecting as crenulations or teeth (fig. 30, 1-3) **G. crenulatum** Gottsche ex Carrington

Plants slightly dorsiventrally compressed, brownish red. Leaves with smooth cuticle; cells with small to medium-sized trigones, hyaline at margins. Forms dense mats on wet rocks, in the lowlands. Distributed in the north and northwestern part of the Peninsula. Esp, Prt.

- 1 Leaf margins entire to crenulate, with isodiametric marginal cells **2**

- 2 Plants dorsiventrally compressed, longly clavate at apex; leaf cuticle smooth; marginal cells of leaves hyaline, thin-walled, sometimes eroded (fig. 30, 4-6)

**G. corallioides** Nees

Plants silver green, blackish with age, more or less branched. Leaves with slightly crenulate margins; trigones large. Forms dense turfs in rock crevices, in high mountains in the Pyrenees. Esp, And.

- 2 Plants julaceous, sometimes shortly clavate; leaf cuticle finely papillose; marginal cells of leaves hyaline or not, thick-walled, in 1-2 rows, margin crenulate or entire **3**

- 3 Leaves mostly with acute lobes; margin entire or weakly crenulate; sinus acute and wide at base (fig. 30, 7-9) **G. concinnatum** (Lightf.) Corda

Plants yellowish or reddish brown. Leaf margin not hyaline; median cells of lamina with large, bulging trigones. Forms turfs on acidic rocks, in high mountains of the Pyrenees. Esp, And.

- 3 Leaves mostly with obtuse or rounded lobes; margin crenulate to base; sinus acute and narrow at base (fig. 30, 10-11) **G. obtusum** Lindb.

Plants whitish. Leaf margins hyaline; median cells of lamina with large trigones, not or only slightly bulging. Forms turfs on acidic rocks, in high mountains, in the Pyrenees, and north and northwestern part of the Peninsula. Esp, Prt, And.

### Fam. Arnelliaceae

#### Southbya Spruce

Plants small, up to 1 cm long. Stem prostrate, sparsely branched. Rhizoids scattered on stem, colourless to brownish. Leaves imbricate, transversely inserted, opposite, simple, ovate to more or less orbicular, concave, usually merged at base on dorsal side; margin

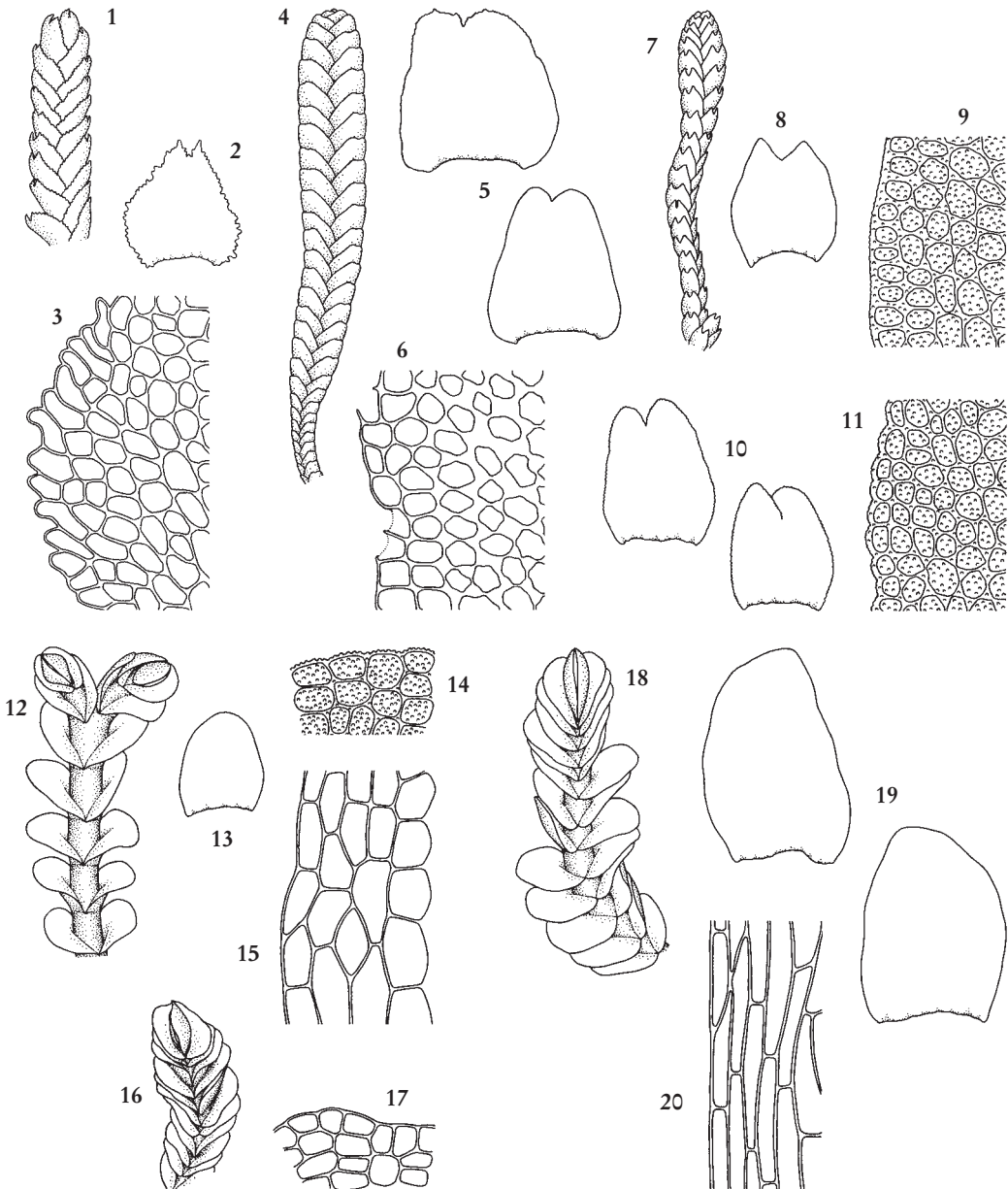


FIGURE 30. 1-3, *Gymnomitrium crenulatum*: 1, habit; 2, leaves; 3, leaf cells. 4-6, *G. corallioides*: 4, habit; 5, leaves; 6, leaf cells. 7-9, *G. concinnatum*: 7, habit; 8, leaf; 9, leaf cells. 10-11, *G. obtusum*: 10, leaves; 11, leaf cells. 12-15, *Southbya tophacea*: 12, habit; 13, leaf; 14, leaf cells; 15, basal cells of ventral margins. 16-17, *S. nigrella*: 16, habit; 17, leaf cells. 18-20, *Gongylanthus ericetorum*: 18, habit; 19, leaves; 20, basal cells of ventral margins. 4, 7 ( $\times 10$ ); 12, 16, 18 ( $\times 13$ ); 13, 19 ( $\times 20$ ); 1 ( $\times 25$ ); 5, 8, 10 ( $\times 30$ ); 2 ( $\times 50$ ); 14, 15, 17, 20 ( $\times 160$ ); 3, 6, 9, 11 ( $\times 230$ ).

entire, usually with some rhizoids; median cells isodiametric, basal cells of ventral margins 4 times as long as wide. Underleaves among female inflorescence, subulate. Inner female bracts with denticulate margins. Perianth shorter than bracts.

- 1 Dioicous; plants green to brownish; leaves with papillose cuticle; trigones small or lacking; male bracts with entire margins, strongly saccate (fig. 30, 12-15)

**S. tophacea** (Spruce) Spruce

Stem less than twice as wide as high in transverse section. Median cells of leaves (24)28-40  $\mu\text{m}$  wide, basal cells of ventral margins  $50 \times 20 \mu\text{m}$ . Dioicous. Forms compact, more or less extensive mats on soils and wet, calcareous rocks depressions and in dripping calcareous sites, in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, Bl.

- 1 Paroicous; plants dark green or blackish; leaves with smooth cuticle; trigones lacking; male bracts with dentate margins, slightly saccate (fig. 30, 16-17)

**S. nigrella** (De Not.) Henriq.

Stem at least twice as wide as high in transverse section. Young leaves usually with a small appendage on the ventral side near margin; median cells 32-40  $\mu\text{m}$  wide, basal cells of ventral margins  $75 \times 20 \mu\text{m}$ . Paroicous. Forms lax, blackish mats on wet, calcareous soils, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

### Gongylanthus Nees

Plants medium-sized, 1-2 cm long, green becoming brownish with age. Stem prostrate, usually simple. Rhizoids abundant, colourless or pale purplish. Leaves patent, transversely inserted, imbricate, opposite, simple, ovate or ovate orbicular, merged at base of the dorsal side; median cells 25-32  $\mu\text{m}$  wide, basal cells of ventral margins 80-100  $\mu\text{m}$  long, 4-6 times as long as wide. Underleaves lacking. Perianth lacking. Marsupium long. Dioicous (fig. 30, 18-20)

**G. ericetorum** (Raddi) Nees

Forms mats on acidic rocks and wet, sandy soils, in the lowlands and montane areas. Widespread throughout the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.

## Fam. Plagiochilaceae

### Pedinophyllum (Lindb.) Lindb.

Plants medium-sized, 1-4 cm long. Stem prostrate, irregularly branched. Rhizoids usually almost to the apex of stem. Leaves distant to imbricate, strongly obliquely inserted, succubous, alternate, simple, ovate, usually retuse, not or slightly decurrent; margin entire; median cells 20-28  $\mu\text{m}$  wide, thin-walled, trigones small or lacking. Underleaves small, filiform, caducous. Male inflorescence terminal or intercalary, long. Perianth terminal, laterally flattened. Autoicous (fig. 31, 1-3)

**P. interruptum** (Nees) Kaal.

Forms extensive, flat mats on wet calcareous soils, in the lowlands and montane areas, in the northern half of the Peninsula and in Sierra Nevada. Esp, And.

**Plagiochila** (Dumort.) Dumort.

Plants small to robust, to 10 cm long. Stem procumbent or ascending, slightly branched, frequently with flagelliform branches. Rhizoids scarce or lacking. Leaves alternate, strongly obliquely to longitudinally inserted, succubous, asymmetrical, persistent or caducous, convex, with rounded or truncate apex, rarely bilobed, with the dorsal margin decurrent or not; margin usually dentate or entire, plane or recurved; cells with or without trigones. Underleaves small or lacking, caducous, visible in the upper part of some stems. Plants rarely fertile, vegetative propagation by means of caducous leaves. Perianth large, laterally compressed. Dioicous.

- 1 Dorsal margin of leaves longly decurrent 2
- 1 Dorsal margin of leaves not decurrent 6

- 2 Leaves with a distinct medial band of elongated cells, showing an abrupt transition to median cells (fig. 31, 4) P. bifaria (Sw.) Lindenb.

**P. killarniensis** Pearson

Plants to 4(7) × 0,2 cm, yellowish green to brownish. Leaves approximate or slightly imbricate, patent to spreading, sometimes squarrose at stem base, persistent, centrally and longitudinally inserted on the dorsal side of stem, with truncate apex; dorsal margin entire, apex and ventral margins with spinose teeth; medial band 3–6-cells wide, yellowish; cells with large, bulging trigones. Forms turfs on humus-rich, acidic, shaded soils, rarely saxicolous, in the lowlands, hardly ever in montane areas, in the north and northwestern part of the Peninsula, rare in the west and in Algeciras Mountains. Esp, Prt.

- 2 Leaves with a poorly differentiated medial band of elongated cells, showing a gradual transition to median cells, or medial band lacking 3

- 3 Leaves with a poorly differentiated medial band of elongated cells; cuticle striate-papillose; leaves erecto-patent, sometimes caducous, with spiniform marginal teeth at apex and ventral margin (fig. 31, 5) P. spinulosa (Dicks) Dumort.

Plants to 6 × 0,3-0,4 cm, dark green to brownish. Stem sometimes partially denudate, with flagelliform branches. Leaves distant, erecto-patent, narrowed at rounded or truncate apex; dorsal margin entire; cells with large bulging trigones, rarely with small trigones. Grows on slopes and in acidic rock crevices, on wet and acidic substrata, rarely corticolous, by streams, in the lowlands, rarely in montane areas. Distributed in the north of the Peninsula. Esp.

- 3 Leaves without a medial band of elongated cells; cuticle smooth or faintly striate-papillose; leaves patent to erecto-patent, persistent, with triangular marginal teeth, rarely spiniform, or teeth lacking 4

- 4 Median cells of leaves 30-42 μm wide; dorsal cortical cells of stem 20-38 μm wide (fig. 31, 6) P. britannica Paton

Plants to 5 × 0,5-0,7 cm, yellowish brown or greenish brown, translucent. Stem pale. Leaves distant to imbricate, with rounded or truncate apex; margin usually with triangular or spinose teeth, sometimes entire; cells with small trigones or trigones lacking. Grows at base of beech trees and acidic rocks, in the north of the Peninsula. Esp.

- 4 Median cells of leaves 24-42 μm wide; dorsal cortical cells of stem 16-24 μm wide 5

- 5 Plants to 5 × 0,6 cm, with flagelliform branches; leaves 2,5-3 × (1,5)2-2,5 mm; cells with small to large and bulging trigones (fig. 31, 7-8) **P. porelloides** (Nees) Lindenb.  
Plants dark green. Leaves distant to nearly imbricate, variable in shape and size; margin dentate to nearly entire; median cells with 3-10(12) oil-bodies. Forms turfs on rocks, base of trees and wet, shaded, calcareous or slightly acidic soils, in forests and open sites, from the lowlands to high mountains. Distributed in the north, west and central part of the Peninsula, rarer in the south and in Mallorca. Esp, Prt, And, Bl.
- 5 Plants to 10 × 0,5-0,9 cm, without flagelliform branches; leaves 3-4 × 2,5-4,2 mm; cells with small trigones or trigones lacking (fig. 31, 9)  
**P. asplenioides** (L. emend. Taylor) Dumort.  
Plants light green or yellowish. Leaves nearly imbricate, translucent; cells thin-walled, median cells with 3-4 oil-bodies. Forms lax turfs on wet soils and rocks, usually by streams, on calcareous or slightly acidic and shaded sites, from the lowlands to high mountains, in the Pyrenees, north and northwestern part of the Peninsula, rare in the centre and in Sierra Nevada. Esp, And.  
Similar to *P. porelloides* but larger in all its parts.
- 6 Leaf bilobed, rarely 3-lobed; ventral margin of leaves entire or with a single tooth (fig. 31, 10-11)  
**P. exigua** (Taylor) Taylor  
Plants to 1,5 cm long, yellowish green or brownish. Stem partially or totally denudate, with flagelliform branches. Leaves caducous, distant, narrowed at base, bilobed to 1/3-1/2, lobes acute, sometime with a tooth in the ventral margin; median cells 23-34 × 22-30 μm, with small to large and bulging trigones. Forms lax turfs on humus-rich soils or saxicolous, in acidic substrata in shaded sites or in wet rocky places, in the lowlands, rarely in montane areas. Distributed in the north and northwestern part of the Peninsula. Esp.
- 6 Leaf simple, with rounded and spinose or narrowly 2-spinose apex; ventral margin of leaves with 1-10-celled teeth (fig. 31, 12)  
**P. punctata** (Taylor) Taylor  
Plants to 2,5 cm long, yellowish green or dark green. Stem occasionally depauperate, with flagelliform branches. Leaves caducous, distant or imbricate, widest near base, sub-orbicular; dorsal margin entire or occasionally with 1(2) teeth; median cells 20-30 × 18-28 μm, with large trigones. Forms dense turfs on shaded, acidic rocks, in the lowlands, rarely in montane areas. Distributed in the north and northwestern part of the Peninsula. Esp, Prt.

## Fam. Geocalycaceae

### Lophocolea (Dumort.) Dumort.

Plants small to large, pale green, yellowish green or bright green, very aromatic. Stem prostrate or procumbent, simple or branched. Rhizoids fascicled from the underleaves base. Leaves alternate, spreading, longitudinally inserted, succubous, simple or bilobed; cells thin-walled, trigones small or lacking. Underleaves bilobed, lobes usually diverging, with teeth on each side. Gemmae present or not. Male inflorescence spiciform, terminal or intercalary. Perianth 3-angled above, usually keeled, mouth 3-lobed, with ciliate to dentate lobes.

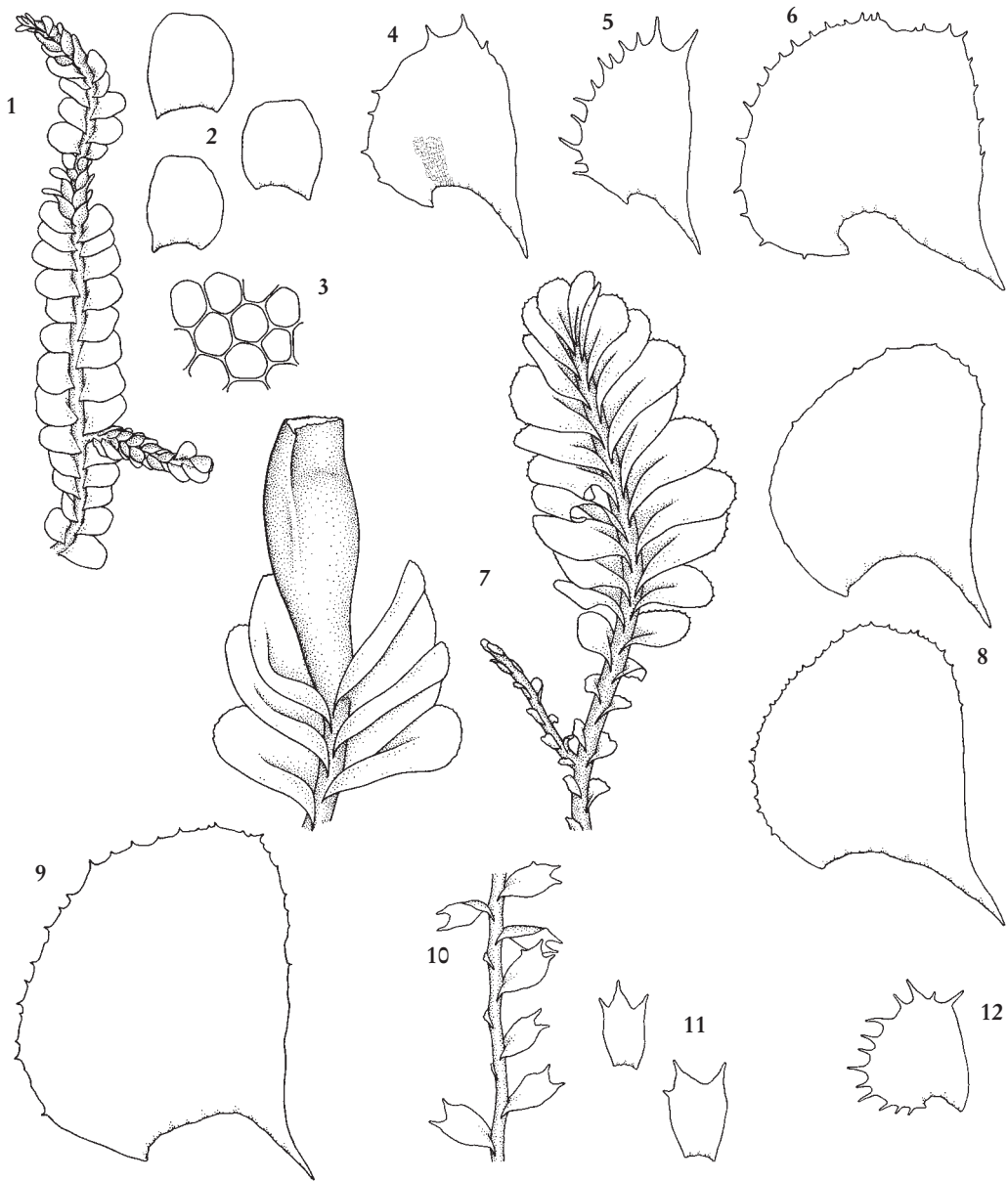


FIGURE 31. 1-3, *Pedinophyllum interruptum*: 1, plant with male inflorescences; 2, leaves; 3, leaf cells. 4, *Plagiochila bifaria*, leaf. 5, *P. spinulosa*, leaf. 6, *P. britannica*, leaf. 7-8, *P. porelloides*: 7, habits, with and without perianth; 8, leaves. 9, *P. asplenioides*, leaf. 10-11, *P. exigua*: 10, habit; 11, leaves. 12, *P. punctata*, leaf. 1, 7 ( $\times 6,5$ ); 10 ( $\times 12$ ); 2, 8, 9 ( $\times 12,5$ ); 4, 5, 6, 11, 12 ( $\times 16$ ); 3 ( $\times 200$ ).



- 1 Leaves mostly 3-lobed, usually with dentate margin (fig. 32, 1-3)  
**L. fragrans** (Moris & De Not.) Gottsche *et al.*  
 Plants to 1,5 cm long. Leaves 2-3-lobed; cells 16-23  $\mu\text{m}$  wide. Autoicous. Grows on wet, shaded rocks and on trunks by streams, in the lowlands, in the west and south of the Peninsula. Esp, Prt.
- 1 Leaves bilobed or simple with rounded or retuse apex, with entire margin 2
- 2 Upper leaves bilobed, with acuminate lobes (fig. 32, 4-5) **L. bidentata** (L.) Dumort.  
 Plants to 6 cm long. Leaf cells 25-40  $\mu\text{m}$  wide or more. Autoicous. Forms lax mats on humus, slopes or shaded and wet soils, in the lowlands and montane areas, in the northern half and western part of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.
- 2 Upper leaves simple with rounded or retuse apex or upper leaves bilobed with obtuse lobes 3
- 3 Upper leaves simple with rounded or retuse apex; gemmae rare (fig. 32, 6)  
**L. heterophylla** (Schrad.) Dumort.  
 Plants to 3 cm long. Lower leaves bilobed to 1/3, lobes acute or acuminate; cells 20-34  $\mu\text{m}$  wide. Paroicous. Grows on rotting stumps, humic slopes in forests, from the lowlands to high mountains, in the northern half and western part of the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.
- 3 Upper leaves bilobed, with acute or obtuse lobes; gemmae abundant (fig. 32, 7-8)  
**L. minor** Nees  
 Plants to 1,5 cm long. Leaf cells 25-30  $\mu\text{m}$ . Gemmiferous leaves with eroded margins, gemmae 30-40  $\times$  22-30  $\mu\text{m}$ , 1-celled, green. Grows on soils and rotting stumps, in shaded and wet sites, preferentially calcareous, from the lowlands to high mountains, in the northern half of the Peninsula. Esp, Prt (Extinct), And.

### Chiloscyphus Corda

Plants medium-sized, up to 6 cm long, pale green, dark green or blackish. Stem procumbent or erect. Leaves distant to imbricate, obliquely inserted, succubous, alternate, simple, oblong or rectangular, with rounded or retuse apex; cells thin-walled, trigones small or lacking. Underleaves bilobed, usually with subulate, parallel lobes, with teeth on one or both sides. Male inflorescence intercalary. Perianth short, with lobed mouth. Autoicous.

- 1 Median cells of leaf 30-40  $\mu\text{m}$  wide **C. pallescens** (Ehrh. ex Hoffm.) Dumort.  
 Plants pale green or yellowish. Leaves in young shoots retuse. Perianth usually with dentate or ciliate lobes at mouth. Grows by streams and in wet grasslands, from the lowlands to the high mountains. Distributed in the north and northwestern part of the Peninsula. Esp, Prt, And.
- 1 Median cells of leaf 20-30  $\mu\text{m}$  wide (fig. 33, 1-2) **C. polyanthos** (L.) Corda  
 Plants dark green or blackish. Leaves in young shoots rounded, rarely retuse. Perianth with entire or crenulate lobes at mouth. Grows on rocks, trees roots or soils by streams or lakes, in very wet sites, from the lowlands to the high mountains. Distributed in the northern half of the Peninsula and in Sierra Nevada. Esp, Prt, And.



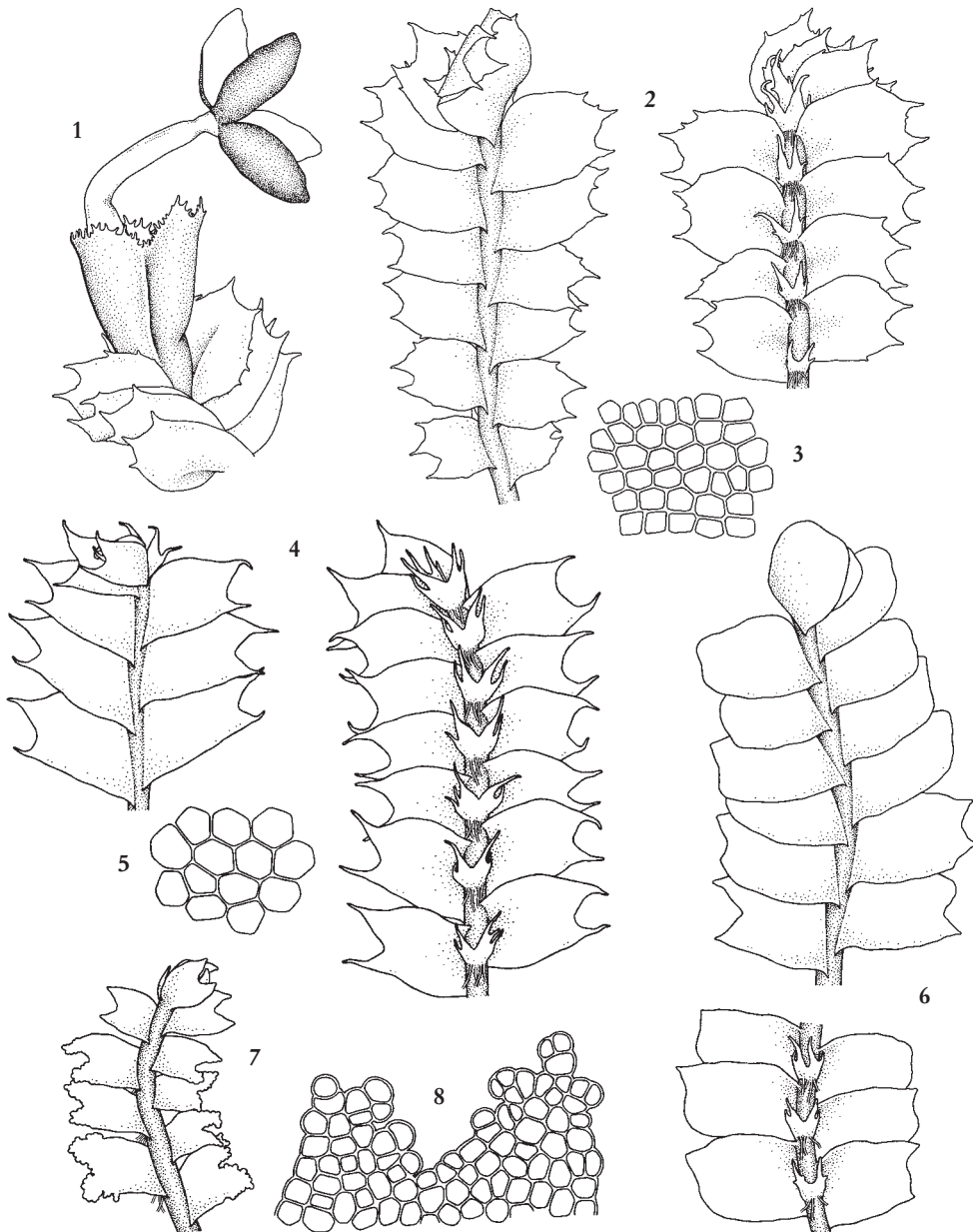


FIGURE 32. 1-3, *Lophocolea fragrans*: 1, plant with perianth and sporophyte; 2, habit, dorsal and ventral side; 3, leaf cells. 4-5, *L. bidentata*: 4, habit, dorsal and ventral side; 5, leaf cells. 6, *L. heterophylla*, habit, dorsal and ventral side. 7-8, *L. minor*: 7, habit; 8, apical part of leaf with gemmae. 4 ( $\times 19$ ); 1, 2, 6 ( $\times 21$ ); 7 ( $\times 24$ ); 3, 5, 8 ( $\times 170$ ).

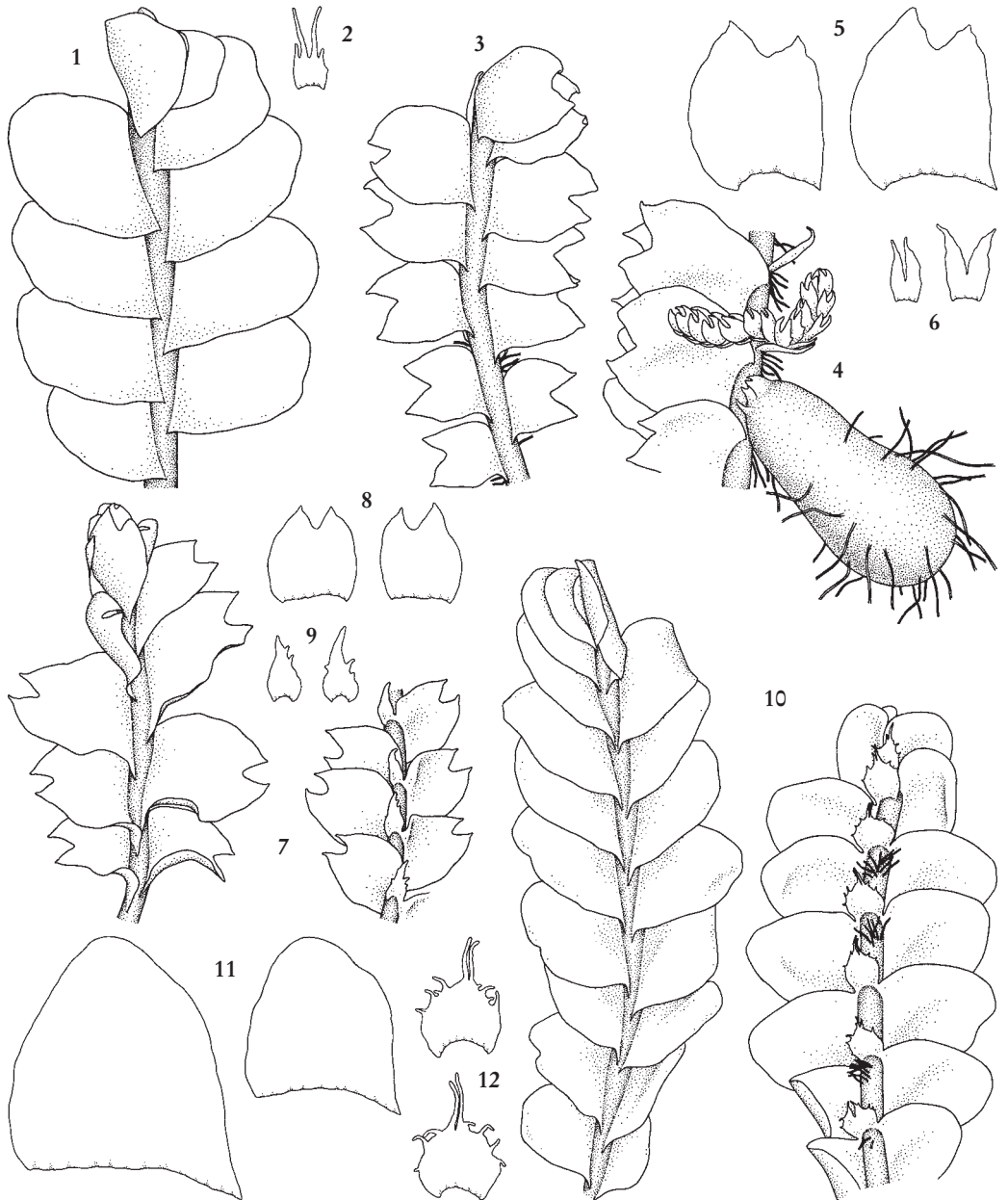


FIGURE 33. 1-2, *Chiloscyphus polyanthos*: 1, habit; 2, underleaf. 3-6, *Geocalyx graveolens*: 3, habit; 4, plant with male branches and marsupium, lateral view; 5, leaves; 6, underleaves. 7-9, *Harpantus scutatus*: 7, habit, dorsal and ventral side; 8, leaves; 9, underleaves. 10-12, *Saccogyna viticulosa*: 10, habit, dorsal and ventral side; 11, leaves; 12, underleaves. 1, 10 ( $\times 11$ ); 3, 4, 7 ( $\times 17$ ); 2, 5, 6, 8, 9, 11, 12 ( $\times 20$ ).

### Geocalyx Nees

Plants small to medium-sized, to 1,5 cm long, yellowish green. Stem prostrate, sparsely branched. Rhizoids scattered, on the ventral surface of stem. Leaves obliquely to longitudinally inserted, succubous, alternate, spreading, slightly longer than wide, bilobed; margin entire, dorsal margin slightly decurrent; cells thin-walled, with small trigones. Underleaves narrower than stem, bilobed to 3/4 to near base, usually with parallel lobes, margin entire. Marsupium cylindrical, to 2,5 mm long, rhizoid-covered. Dioicous (fig. 33, 3-6)

**G. graveolens** (Schrad.) Nees

Grows on wet, shaded acidic slopes, in the lowlands. Very rare, in the north of the Peninsula. Esp.

### Harpanthus Nees

Plants small to medium-sized, to 1 cm long, light green or yellowish green. Stem prostrate, sparsely branched. Rhizoids scattered, along ventral side of stem. Leaves spreading, longitudinally or obliquely inserted, succubous, bilobed to 1/6-1/4, lobes acute, sinus usually rounded; median cells thin or thick-walled, trigones medium-sized to large. Underleaves lanceolate or ovate-lanceolate, acute, margin entire or dentate, one margin fused at base to adjacent lateral leaf. Dioicous (fig. 33, 7-9)

**H. scutatus** (F. Weber & D. Mohr) Spruce

Grows on moist, acidic rocks and rotten trunks. Rare, in the north of the Peninsula. Esp.

### Saccogyna Dumort.

Plants medium-sized, to 5 cm long. Stem prostrate, simple or irregularly branched. Leaves very obliquely inserted, succubous, nearly opposed, imbricate, erecto-patent, simple, oblong-ovate to oblong, with rounded apex; dorsal margin decurrent. Underleaves almost semi-circular, as long as wide, somewhat wider than stem, partially connate to one or both adjoining leaves, bilobed to 1/2, with narrowly lanceolate lobes, margin dentate to lacinate. Dioicous (fig. 33, 10-12)

**S. viticulosa** (L.) Dumort.

Forms dark green to brownish green mats on shaded, humus-rich soils, calcifuge, mostly in forests, in the lowlands, rarely in montane areas. Distributed in the northern half of the Peninsula and in Algeciras Mountains. Esp, Prt.

## Fam. Scapaniaceae

### Diplophyllum (Dumort.) Dumort.

Plants small or medium-sized. Stem prostrate with ascending branches. Leaves transversely inserted, bilobed, conduplicate, carinate, basal part sheathing; lobes unequal, dorsal lobe smaller than ventral lobe, lingulate or ovate lingulate, apex rounded or obtuse and apiculate, erecto-patent to patent, ventral lobe lingulate, more than twice as long as wide, spreading; margin entire, dentate or denticulate. Underleaves lacking. Gemmae

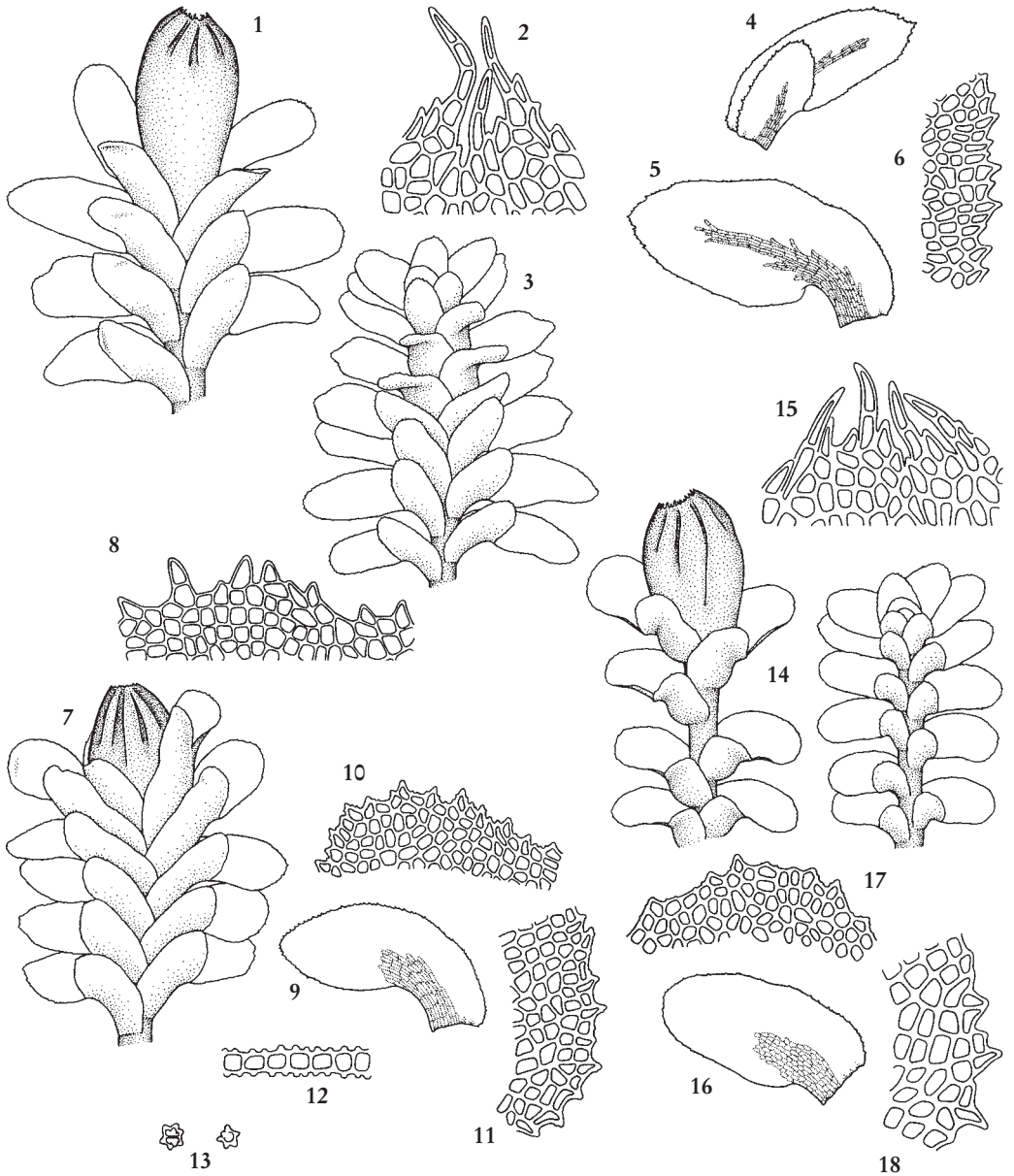


FIGURE 34. 1-6, *Diplophyllum albicans*: 1, plant with perianth; 2, perianth mouth; 3, male plant; 4, leaf; 5, ventral lobe; 6, marginal cells at base of ventral lobe. 7-13, *D. taxifolium*: 7, plant with perianth; 8, perianth mouth; 9, ventral lobe; 10, apical cells; 11, marginal cells at base of ventral lobe; 12, lobe section; 13, gemmae. 14-18, *D. obtusifolium*: 14, habits, with and without perianth; 15, perianth mouth; 16, ventral lobe; 17, apical cells; 18, marginal cells at base of ventral lobe. 1, 3, 7, 14 ( $\times 13$ ); 4, 5, 9, 16 ( $\times 30$ ); 2, 6, 8, 10, 11, 12, 13, 15, 17, 18 ( $\times 200$ ).

angulate, 1–2-celled. Perianth terminal, ovoid, dorsiventrally flattened, constricted at mouth, plicate above, with dentate to ciliate lobes at mouth.

- 1 Leaf lobes with a shiny medial band, of differentiated cells 3–8 times as long as wide (fig. 34, 1–6) **D. albicans** (L.) Dumort.

Plants to 4 × 0,4 cm, pale green to dark green or brown, sometimes reddish. Lobes with rounded to obtuse apex, sometimes apiculate; margin crenulate to serrate; cuticle finely papillose or smooth; basal cells at margin of ventral lobe mostly oblate or irregular; oil-bodies granulose. Gemmae 14–16 µm, green, brownish or reddish, 1-celled. Dioicous. Forms patches on wet, acidic soil or rocks, from the lowlands to the high mountains, in the western and northern half of the Peninsula. Esp, Prt, And.

- 1 Leaf lobes without a shiny band of differentiated cells or with band poorly differentiated at base with cells 1–4 times as long as wide 2

- 2 Median cells of ventral lobe 1,5–2 times longer than wide; lobe apex obtuse; plants dioicous (fig. 34, 7–13) **D. taxifolium** (Wahlenb.) Dumort.

Plants 2 × 0,25 cm, usually with yellow brownish to brownish pigmentation, never reddish. Lobes with entire, crenulate or dentate margin; cuticle papillose; basal cells at margins of ventral lobes mostly oblate and irregular. Gemmae occasional, 12–16 µm, green, (1)2-celled. Forms patches on wet, acidic soils and rocks, in montane areas and high mountains, in the northern part of the Peninsula, Central Range, Sierra Nevada and Serra da Estrela. Esp, Prt, And.

- 2 Median cells of ventral lobe 2–4 times longer than wide; lobe apex rounded; plants paroicous (fig. 34, 14–18) **D. obtusifolium** (Hook.) Dumort.

Plants 1 × 0,2 cm, usually with reddish purple pigmentation. Lobes with entire or dentate margin; cuticle papillose; basal cells at margins of ventral lobes mostly isodiametric. Gemmae 12–14 µm, green, brownish or reddish, 1-celled. Forms patches on clayey, acidic soils, in montane areas and high mountains, in the northern part of the Peninsula. Esp, And.

### **Douinia** (C.E.O.Jensen) H.Buch

Plants 2 cm long, olive green or glaucous. Stem procumbent or ascending. Rhizoids scattered on ventral side of stem. Leaves transversely inserted, bilobed, conduplicate; lobes pointed, ovate-lanceolate, dorsal lobe narrower and shorter than ventral lobe; margin entire or slightly denticulate; median cells 16–25 µm wide, thick-walled, trigones small or lacking; cuticle waxy. Underleaves lacking. Perianth elongated, plicate nearly from base, with ciliate lobes at mouth. Dioicous (fig. 35, 1–3) **D. ovata** (Dicks.) H.Buch

Grows in rock crevices or on trunks of trees, in montane areas, in the northern and western part of the Peninsula. Esp, Prt, And.

### **Scapania** (Dumort.) Dumort.

Plants small to robust, pale green, dark reddish brown, brown or purple. Stem procumbent, ascending or erect. Leaves bilobed, conduplicate, carinate, with winged keel or not; dorsal lobe smaller than ventral lobe or similar in size; ventral lobe less than twice as long as wide; margin entire, dentate or ciliate; cuticle smooth or papillose. Underleaves

lacking. Gemmae ovoid to ellipsoidal, rarely angulate, frequent at lobe margins and apex of upper leaves, 1–2-celled. Perianth with entire, dentate or ciliate mouth. Dioicous or rarely parioicous.

- 1 Dorsal and ventral lobe of leaves acute, dentate; dorsal lobe erect, parallel to stem; plants small (fig. 35, 4) **S. umbrosa** (Schrad.) Dumort.  
Plants to 1 cm long, green or reddish. Stem cortex with 2-4 layers of small, thick-walled cells. Ventral lobe decurrent. Gemmae 2-celled, ellipsoidal or cylindrical, in dark brown clusters at margins of apical leaves. Grows on rotten fir trunks and in rock crevices, in high mountains, in the Pyrenees and the Cantabrian Mountains. Esp, And.
- 1 Leaves not as above; plants small to large 2
- 2 Ventral and dorsal lobe similar in size or nearly so 3
- 2 Ventral lobe larger than dorsal lobe 6
- 3 Leaf cuticle strongly papillose (fig. 35, 5-8) **S. aequiloba** (Schwägr.) Dumort.  
Plants to 4 cm long, yellowish green or brownish. Leaves distant or approximate, lobes rounded, apiculate or acute, not decurrent; dorsal lobe abruptly narrowed at base, extending across stem, with the upper margin entire or sparsely dentate; marginal cells smaller than median cells, with thickened walls. Gemmae green, 2-celled, ellipsoidal. Grows on wet, shaded, preferentially calcareous substrata, in montane areas and high mountains. Distributed in north and northeastern part of the Peninsula. Esp, And.
- 3 Leaf cuticle smooth or slightly papillose 4
- 4 Dorsal lobe crossing stem (fig. 35, 9-10) **S. subalpina** (Nees ex Lindenb.) Dumort.  
Plants to 5 cm long, pale green to brown or reddish brown. Lobes usually flat, obtuse or rounded, keel slightly curved or nearly straight; margin denticulate, bordered with 2-3 rows of uniformly thickened marginal cells; cuticle weakly papillose; dorsal lobe not decurrent; ventral lobe longly decurrent. Gemmae ovoid or ellipsoidal, pale green. Grows on wet slopes, in montane areas. Rare, in the north and west of the Peninsula. Esp, Prt.
- 4 Dorsal lobe not crossing stem 5
- 5 Leaves with sheathing base; lobes ovate-rectangular, with rounded and sometimes apiculate to acute apex; plants light green to brownish (fig. 35, 11-13) **S. cuspiduligera** (Nees) Müll.Frib.  
Plants to 1,5 cm long. Leaves approximate or imbricate; margin entire; dorsal lobe reflexed or squarrose, not decurrent; ventral lobe decurrent; marginal cells in 1-4 rows, smaller than median cells, with uniformly thickened walls, forming a distinct border. Gemmae ellipsoidal, reddish or dark brown, (1)2-celled. Calcicolous, grows on wet rocks, in montane areas and high mountains. Rare, in the Pyrenees. And.
- 5 Leaves without sheathing base; lobes rectangular, with rounded apex; plants yellowish brown to reddish (fig. 35, 14-15) **S. compacta** (A.Roth) Dumort.  
Plants 0,5-2 cm long. Leaves imbricate, with erecto-patent non-decurrent lobes; margin entire, not bordered. Gemmae rare, ovoid, green or brown, 1–2-celled. Grows on acidic, wet soils and

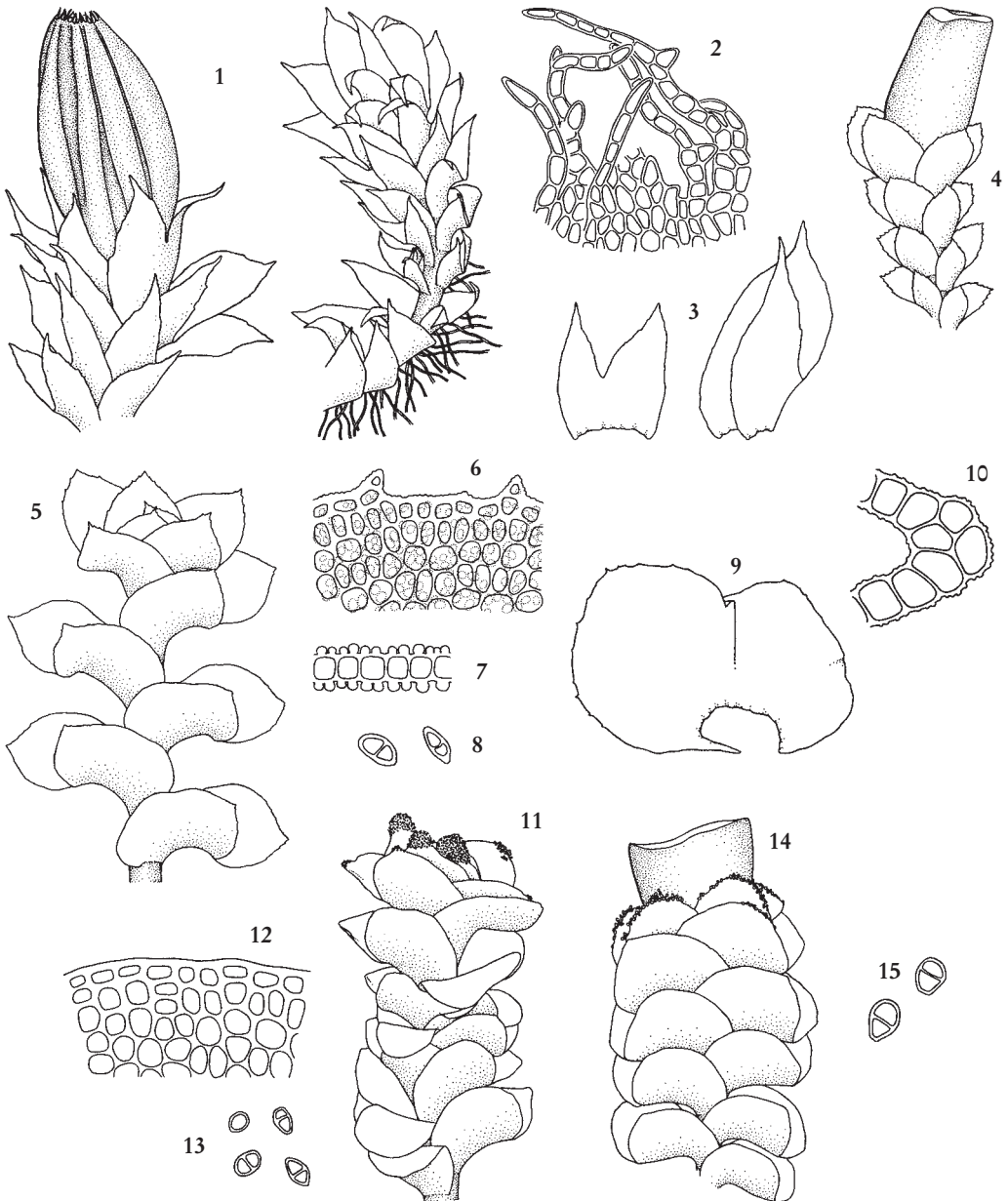


FIGURE 35. 1-3, *Douinia ovata*: 1, plants with and without perianth; 2, perianth mouth; 3, leaves. 4, *Scapania umbrosa*, plant with perianth. 5-8, *S. aequiloba*: 5, habit; 6, leaf marginal cells; 7, leaf section; 8, gemmae. 9-10, *S. subalpina*: 9, leaf; 10, keel section. 11-13, *S. cuspiduligera*: 11, habit; 12, leaf marginal cells; 13, gemmae. 14-15, *S. compacta*: 14, plant with perianth; 15, gemmae. 1, 4, 5, 9, 11, 14 ( $\times 14$ ); 3 ( $\times 24$ ); 2 ( $\times 140$ ); 6, 7, 8, 10, 12, 13, 15 ( $\times 214$ ).



rocks, in the lowlands and montane areas. Distributed in northern half and west of the Peninsula. Esp, Prt, And.

- 6 Leaf cuticle strongly papillose 7
- 6 Leaf cuticle smooth or slightly papillose 9
- 7 Gemmae angulate, reddish brown; plants calcifuge (fig. 36, 1-3) **S. verrucosa** Heeg  
Plants to 2,5 cm long, yellowish green. Leaves with decurrent ventral lobe. Grows on wet, shaded soils, in high mountains. Rare, in the eastern Pyrenees. Esp.
- 7 Gemmae ellipsoidal, green; plants calcicolous 8
- 8 Dorsal lobe decurrent, gradually narrowed at base (fig. 36, 4-6)  
**S. aspera** Bernet & M.Bernet  
Plants to 4 cm long, green or brownish. Leaves imbricate, lobes more or less decurrent, with rounded or obtuse apex, usually apiculate; dorsal lobe rectangular, extending across stem; margin more or less dentate, with 1-2-celled teeth, never dentate at base of lobes; marginal cells slightly smaller than median cells. Gemmae common, 2-4-celled. Grows in beechwoods, *Quercus ilex* L. forests and fir forests, in montane areas. Distributed in the northern half of the Peninsula and in Mallorca. Esp, And, Bl.
- 8 Dorsal lobe not decurrent, abruptly narrowed at base (fig. 35, 5-8)  
**S. aequiloba** (Schwägr.) Dumort.  
Plants to 4 cm long, yellowish green or brownish. Leaves distant or approximate, lobes rounded, apiculate or acute, not decurrent; dorsal lobe extending across stem, with the upper margin entire or sparsely dentate; marginal cells smaller than median cells, with thickened walls. Gemmae green, 2-celled. Grows on wet, shaded substrata, in montane areas and high mountains. Distributed in north and northeastern part of the Peninsula. Esp, And.
- 9 Ventral lobe not distinctly decurrent 10
- 9 Ventral lobe distinctly decurrent 19
- 10 Dorsal lobe narrow, usually 1,5-2,5 times as long as wide; oil-bodies large, to 20  $\mu\text{m}$  in diameter, persistent, occupying all lumen; plants calcicolous 11
- 10 Dorsal lobe wide, usually less than 1,5 times as long as wide; oil-bodies small, to 10  $\mu\text{m}$  in diameter, non-persistent, not occupying all lumen; plants calcicolous or not 12
- 11 Dorsal lobe gradually narrowed at base; margin entire; median cells with 1 oil-body (fig. 36, 7-9)  
**S. gymnostomophila** Kaal.  
Plants to 1 cm long. Leaf lobes ovate-oblong, acute, rounded or apiculate, not decurrent; dorsal lobe to 1/2-1/3 of the ventral lobe length, erect or patent; ventral lobe patent or squarrose; marginal cells smaller than median cells. Gemmae (1)2-celled, ovoid, ellipsoidal or pyriform, reddish brown. Grows on wet, calcareous ledges and in rock crevices, in montane areas and high mountains, in the Pyrenees and in the northeastern part of the Peninsula. Esp, And.
- 11 Dorsal lobe abruptly narrowed at base; margin entire or finely denticulate; median cells with more than 1 oil-body (fig. 36, 10-12) **S. calcicola** (Arnell & J.Perss.) Ingham



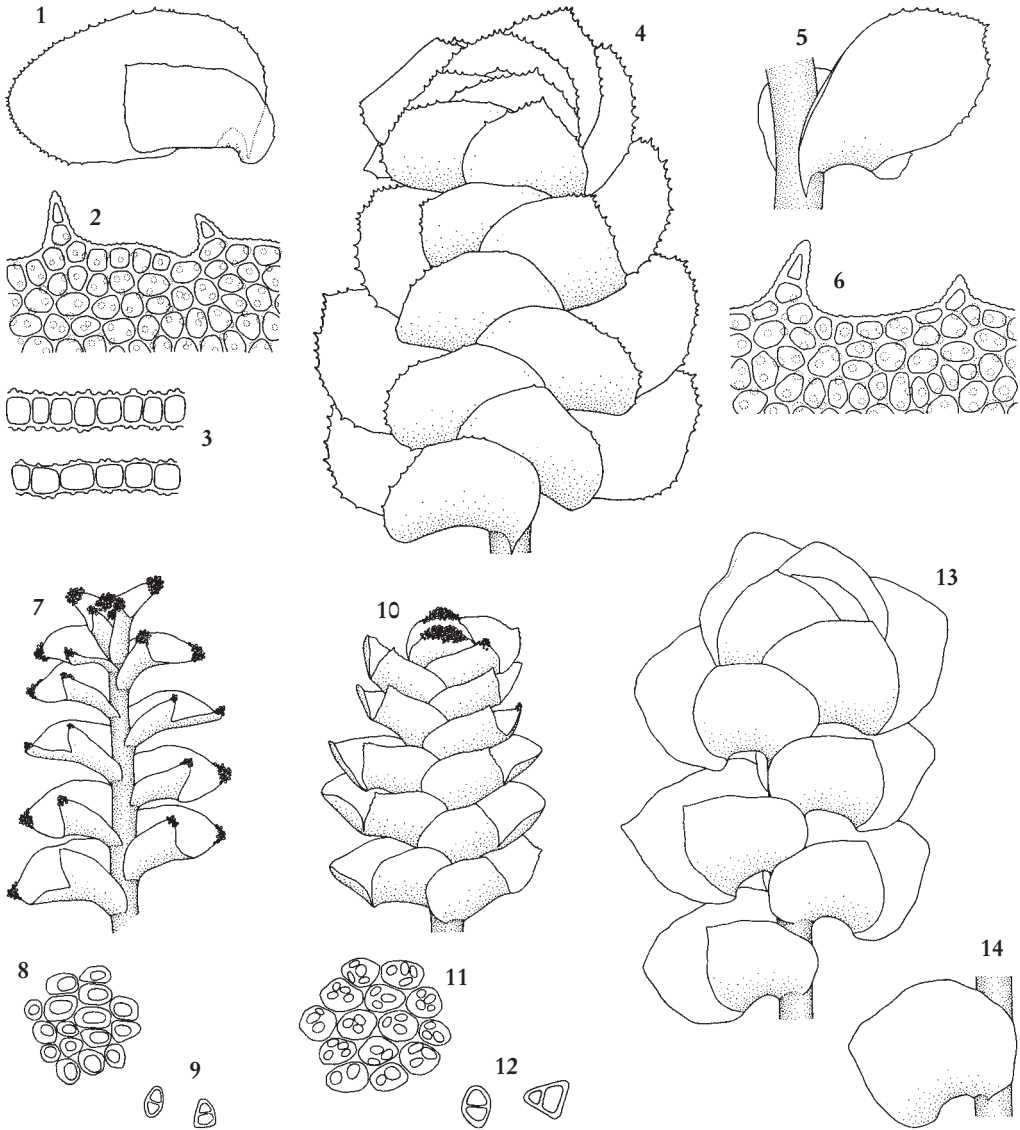


FIGURE 36. 1-3, *Scapania verrucosa*: 1, leaf; 2, leaf marginal cells; 3, leaf sections. 4-6, *S. aspera*: 4, habit; 5, ventral lobe; 6, leaf marginal cells. 7-9, *S. gymnostomophila*: 7, habit; 8, leaf cells; 9, gemmae. 10-12, *S. calcicola*: 10, habit; 11, leaf cells; 12, gemmae. 13-14, *S. irrigua*: 13, habit; 14, ventral lobe. 4 ( $\times 12$ ); 1, 5, 7, 10, 13, 14 ( $\times 14$ ); 2, 3, 6, 8, 9, 11, 12 ( $\times 214$ ).

- Plants 0,5-1,5 cm long, light green or yellowish. Leaves with smooth or more or less papillose cuticle; dorsal lobe patent or erecto-patent, ovate-oblong, obtuse, apiculate or not; ventral lobe ovate or reniform, rounded or obtuse and apiculate. Gemmae frequent, green or light brown, 2-celled, ellipsoidal, ovoid or pyriform. Perianth mouth dentate. Grows on calcareous rocks, from the lowlands to high mountains. Distributed in the north and east of the Peninsula. Esp.
- 12 Ventral lobe 1-1,5 times as long as wide; plants 1-6 cm long 13
- 12 Ventral lobe 1,5-2 times as long as wide; plants 0,2-0,8 cm long 14
- 13 Keel of leaves strongly semicircularly arched **S. paludicola** Loeske & Müll.Frib.  
Keel of leaves short; dorsal lobe crossing the stem, not decurrent; ventral lobe rarely decurrent below level of the insertion of the keel. Gemmae ellipsoidal, 1-2-celled, green. Grows among *Sphagnum*, in the high mountains, Very rare in the Cantabrian Mountains. Esp.
- 13 Keel of leaves straight or weakly arched (fig. 36, 13-14) **S. irrigua** (Nees) Nees  
Plants to 5 cm long, yellowish green, rarely brownish. Leaves with rounded, shortly apiculate lobes, or lobes acute with entire or few teeth at apex; dorsal lobe usually reflexed or squarrose, not decurrent or only slightly so; ventral lobe as wide as long or wider than long, abruptly narrowed at base. Gemmae green, ellipsoidal or ovoid, usually 2-celled. Grows on wet soils by streams, not submerged, and in peatlands, in high mountains. Distributed in the northern half of the Peninsula and in Sierra Nevada. Esp, And.
- 14 Ventral lobe bordered, with 1-2 rows of uniformly thickened cells, different from median cells 15
- 14 Ventral lobe not bordered, marginal cells with trigones, similar to median cells 16
- 15 Cortex of 1-2 layers of cells smaller than medullary cells; leaves carinate at base; gemmae 2-celled, green (fig. 37, 1) **S. curta** (Mart.) Dumort.  
Plants small, yellowish green. Stem poorly branched. Leaves not decurrent; dorsal lobe erecto-patent or erect, ovate, apiculate, with winged keel; ventral lobe patent or erecto-patent, ovate or obovate, with rounded, usually apiculate apex; margin entire or with small teeth and 1-2 rows of marginal cells, with uniformly thickened walls, mostly without oil-bodies; median cells with small trigones. Gemmae green, ellipsoidal, 2-celled. Perianth mouth dentate, with 1-3-celled teeth. Grows on wet, acidic rock ledges, from the lowlands to montane areas, in the northern half of the Peninsula. Esp, Prt.
- 15 Cortex of 1 layer of cells similar to than medullary cells; leaves not carinate at base; gemmae 1-celled, brownish red (fig. 37, 2) **S. carinthiaca** Lindb.  
Plants small, yellowish green. Leaves with non-winged keel; ventral lobe lingulate; margin bordered with oblate, thick-walled cells. Grows on rotten pine trunks, in very moist and shaded sites, in high mountains. Very rare, in the Pyrenees. And.
- 16 Gemmae 1-celled, reddish (fig. 37, 3-5) **S. apiculata** Spruce  
Plants yellowish green or brownish. Stem cortex 1-2 layers of cells, with cell walls uniformly thickened. Lobes not decurrent, entire, acute. Gemmiferous branches erect, with reduced, modified leaves. Perianth mouth entire. Grows on rotten trunks of fir and pine, in high mountains. Very rare, in the Pyrenees. And.
- 16 Gemmae 2-celled, green or brown 17

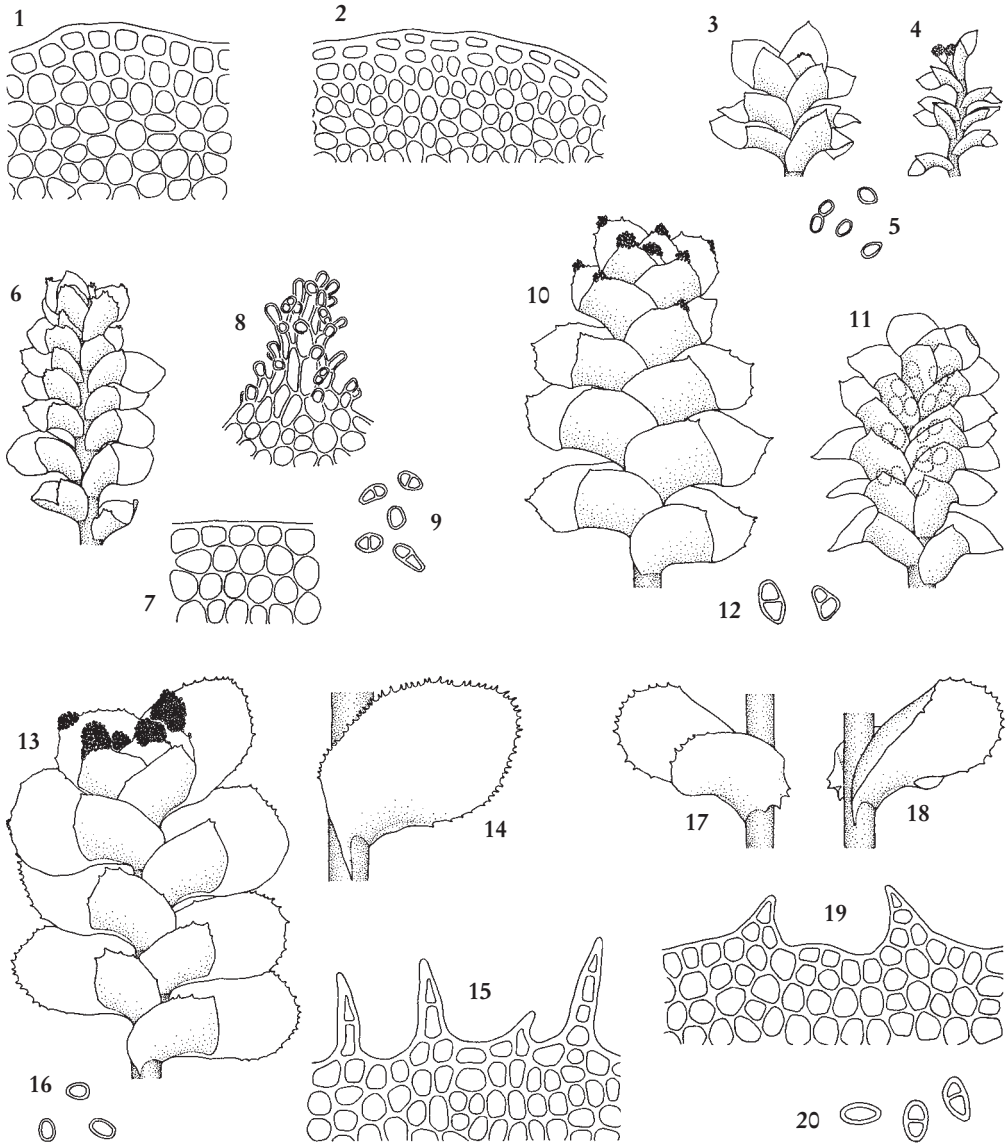


FIGURE 37. 1, *Scapania curta*, marginal cells of ventral lobe. 2, *S. carinthiaca*, marginal cells of ventral lobe. 3-5, *S. apiculata*: 3, habit; 4, gemmiferous plant; 5, gemmae. 6-9, *S. scandica*: 6, habit; 7, marginal cells of ventral lobe; 8, gemmiferous apex; 9, gemmae. 10-12, *S. praetervis*: 10, gemmiferous plant; 11, plant with antheridia; 12, gemmae. 13-16, *S. nemorea*: 13, habit; 14, ventral lobe; 15, marginal cells of ventral lobe; 16, gemmae. 17-20, *S. gracilis*: 17, leaf; 18, ventral lobe; 19, marginal cells of ventral lobe; 20, gemmae. 6, 10, 11, 13, 14 ( $\times 14$ ); 3, 4, 17, 18 ( $\times 16$ ); 8 ( $\times 140$ ); 1, 2, 5, 7, 9, 12, 15, 16, 19, 20 ( $\times 214$ ).

- 17 Perianth mouth entire; apex of propaguliferous leaves with digitiform teeth (fig. 37, 6-9)  
**S. scandica** (Arnell & H.Buch) Macvicar  
 Plants small, green, usually with reddish or purple areas. Stem cortex of 1-2 layers of cells slightly differentiated from medullary cells. Lobes more or less acute; ventral lobe attenuated at base, not decurrent; marginal cells thick-walled, similar to those of *S. curta*, not forming a distinct border. Gemmae ellipsoidal, green, occasionally reddish, 1-2-celled. Grows on acidic or slightly basic substrata, on small rock ledges, in high mountains, in the Pyrenees, Sierra Nevada and Serra da Estrela. Esp, Prt, And.
- 17 Perianth mouth ciliate; apex of propaguliferous leaves without digitiform teeth 18
- 18 Gemmae 15-30  $\mu\text{m}$  long; plants calcifuge **S. mucronata** H.Buch  
 Plants small. Species belonging to Section *Curtae* may need perianths for their determination. It is probable that *S. curta*, *S. praetervisa*, *S. scandica* and *S. mucronata* are present in our study area, but often we found them without perianths so some species collected on acidic substrata and named *S. curta* or *S. scandica* could be *S. mucronata*. Distributed in the north of the Peninsula. Esp.
- 18 Gemmae 28-35  $\mu\text{m}$  long; plants basiphile (fig. 37, 10-12) **S. praetervisa** Meyl.  
 Plants small, yellowish green or brownish, not reddish or purple. Leaf lobes with rounded or apiculate apex, rarely acute; margin entire or with a few 1-2(3)-celled teeth; dorsal lobe erecto-patent. Gemmae green, ovoid or ellipsoidal, 2-celled. Grows on basic rocks, from the lowlands to high mountains, in the Pyrenees, northeast and southeast of the Peninsula. Esp, And.
- 19 Leaf margins strongly dentate or ciliate; gemmae 1-2-celled; oil-bodies large, occupying the whole cell 20
- 19 Leaf margins entire or dentate; gemmae 2-celled; oil-bodies small 21
- 20 Leaf margins ciliate-dentate; gemmae in brownish clusters, 1-celled, with thin-walled cells (fig. 37, 13-16) **S. nemorea** (L.) Grolle  
 Plants to 6 cm long, green, rarely reddish or purple. Lobes decurrent; dorsal lobe ovate or ovate-orbicular, with winged keel; ventral lobe ovate-cordate. Forms small, lax wefts on wet, shaded, acidic rocks and slopes, from the lowlands to high mountains. Distributed in the northern half and west of the Peninsula and in Sierra Nevada. Esp, Prt.
- 20 Leaf margin coarsely toothed; gemmae in green clusters, 1-2-celled, with thick-walled cells (fig. 37, 17-20) **S. gracilis** Lindb.  
 Plants to 4 cm long, yellowish brown or pale brown. Dorsal lobe not decurrent or only slightly so, ovate or ovate-orbicular, auriculate and dentate at base; ventral lobe orbicular or ovate-lingulate, with slightly curved, winged keel. Grows on wet, shaded rocks and slopes and at base of trees, in the lowlands and montane areas. Distributed in the north and west of the Peninsula. Esp, Prt.
- 21 Dorsal lobe not decurrent, rounded quadrate or ovate-reniform (fig. 38, 1-3) **S. undulata** (L.) Dumort.  
 Plants to 7 cm long, yellowish green, dark green, reddish or brownish. Stem usually denudate at base. Leaves large, distant to imbricate, undulate or not, with slightly curved keel; ventral lobe quadrate, rounded or widely ovate, longly decurrent; margin entire or dentate. Grows on rocks, stones, tree roots and waterlogged soils, in or by streams in acidic sites. Distributed in the northern part and west of the Peninsula, in Sierra Nevada and in Algeciras Mountains. Esp, Prt, And.

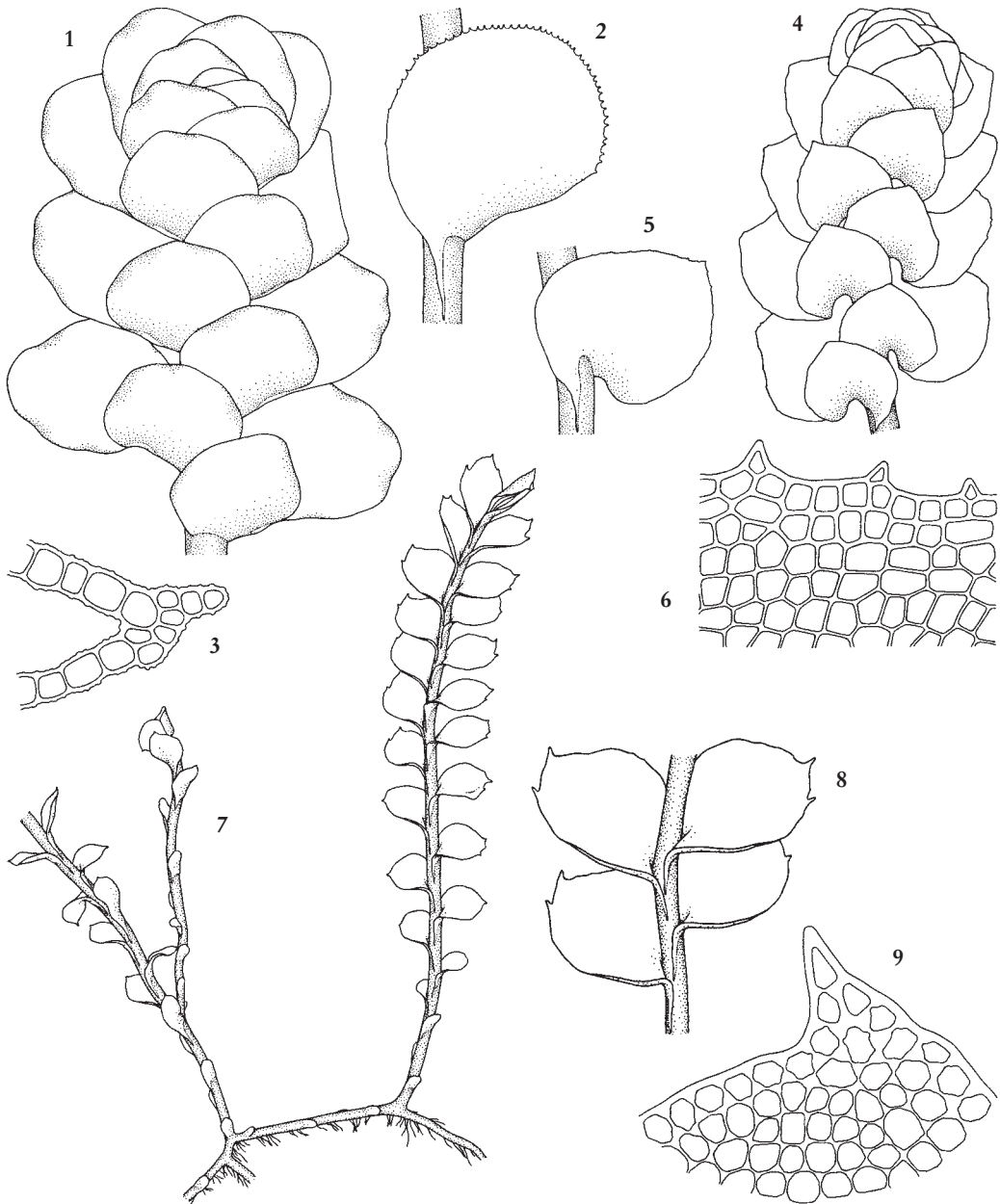


FIGURE 38. 1-3, *Scapania undulata*: 1, habit; 2, ventral lobe; 3, keel section. 4-6, *S. paludosa*: 4, habit; 5, ventral lobe; 6, marginal cells of lobe. 7-9, *Adelanthus decipiens*: 7, habit; 8, leaves; 9, leaf marginal cells. 7 ( $\times 6$ ); 1, 4 ( $\times 12$ ); 2, 5, 8 ( $\times 14$ ); 9 ( $\times 140$ ); 3, 6 ( $\times 214$ ).

- 21 Dorsal lobe decurrent, reniform or cordate (fig. 38, 4-6)

**S. paludosa** (Müll.Frib.) Müll.Frib.

Plants to 2 cm long, pale green or reddish. Lobes with short, arcuate or semi-circular keel; margin entire or dentate; cells without trigones or trigones very small, with 2-3 rows of thick-walled marginal cells. Grows on stones or submerged in running waters, in high mountains. Rare, in the Pyrenees and in the Cantabrian Mountains. Esp.

## Fam. Adelanthaceae

### Adelanthus Mitt.

Plants pale green to brownish or blackish. Stem creeping, with small and distant leaves; branches erect, to 2(2,5) cm long. Leaves simple, succubous, alternate, distant, erecto-patent to patent, concave, more or less orbicular, apex truncate, with 2-(3) teeth or acuminate; margin entire, dorsal margin incurved, longly decurrent; median cells isodiametric, (27)32-36  $\mu\text{m}$ , thin or thick-walled, trigones small to large; marginal cells in 1-2 rows, forming a distinct border, with thicker walls and large trigones. Underleaves lacking. Dioicous (fig. 38, 7-9)

**A. decipiens** (Hook.) Mitt.

Grows on wet or seeping, acidic rocks, in the lowlands. Very rare, in the north of the Peninsula. Esp.

## Fam. Cephaloziellaceae

### Cephaloziella (Spruce) Schiffn.

Plants small or minute, to 0,2 cm long, filiform. Stem usually procumbent, laterally or ventrally branched. Leaves distant or approximate, usually transversely inserted, rarely obliquely inserted, succubous, bilobed; margin entire to dentate or spinose. Underleaves bilobed, subulate or lacking. Gemmae common, on lobe apex of upper leaves, usually 2-celled, ellipsoidal or angulate. Perianth cylindrical to ellipsoidal, usually plicate, mouth usually unlobed or slightly lobed, mostly crenulate, crenulate-dentate or spinose, with narrow cells. Dioicous or autoicous.

Characters of leaves refer to stem leaves of non-propagiferous shoots.

- |   |  |                                       |
|---|--|---------------------------------------|
| 1 | Leaf margin dentate or spinose   | 2                                     |
| 1 | Leaf margin entire, scarcely dentate or spinose  | 4                                     |
| 2 | Gemmae angulate; underleaves lacking (fig. 39, 1-2)  | <b>C. turneri</b> (Hook.) Müll. Frib. |
|   | Plants green or brownish green. Leaves distant or approximate, usually channelled; leaf cells 10-13 $\mu\text{m}$ wide. Grows on wet, acidic, shaded slopes, in the lowlands and montane areas. Widespread throughout the Peninsula. Esp, Prt. |                                       |
| 2 | Gemmae ellipsoidal; underleaves present  | 3                                     |

- 3 Apical cell of lobes 8-15  $\mu\text{m}$  long; gemmae 12-20  $\mu\text{m}$  long; plants common, growing on acidic substrata (fig. 39, 3-7) **C. divaricata** (Sm.) Schiffn.  
Plants brownish red or blackish, rarely greenish. Cortical cells 8-14  $\mu\text{m}$  wide. Leaves distant to imbricate, patent or erect, usually channelled, lobes acute or obtuse, with 4-9 cells wide at base, 10-14  $\mu\text{m}$  wide; margin entire or dentate, sinus usually recurved; cuticle smooth, papillose or with projections on the dorsal side. Underleaves usually bilobed. Perianth mouth crenulate or spinose, with thick-walled cells, to 50  $\mu\text{m}$  long and 1,5-4 times as long as wide. Dioicous. Grows on slopes and acidic ledges and rock crevices, from the lowlands to high mountains. Widespread throughout the Peninsula. Esp, Prt, And.
- 3 Apical cell of lobes 15-34  $\mu\text{m}$  long; gemmae 20-24  $\mu\text{m}$  long; plants rare, growing on substrata rich in heavy metals (fig. 39, 8-10) **C. massalongi** (Spruce) Müll.Frib.  
Plants green, yellowish green, reddish brown or blackish. Leaf lobes 4-6 cells wide at base, 10-16  $\mu\text{m}$  wide; margin entire, crenulate or irregularly dentate, usually with conical projections on the dorsal side; cuticle densely papillose, rarely nearly smooth. Underleaves bilobed, entire or retuse. Perianth mouth dentate-crenulate, 4-6 times as long as wide. Grows on moist to wet mine spoil, banks and in crevices, in montane areas, in the north of the Peninsula and in Monchique. Esp, Prt.
- 4 Inner female bracts fused, forming a sheath; gemmae angulate 5
- 4 Inner female bracts not fused nor forming a sheath; gemmae ellipsoidal 6
- 5 Sheath round perianth scarcely lobed; female bracts with thick-walled marginal cells (fig. 39, 11-13) **C. calyculata** (Durieu & Mont.) Müll.Frib.  
Lobes of leaves 3-6 cells wide at base, 10-18  $\mu\text{m}$  wide; cuticle smooth. Gemmae 14-20  $\mu\text{m}$  wide. Cells of perianth mouth thick-walled, 10-16  $\mu\text{m}$  long. Autoicous. Grows on ledges and at base of shaded rocks, in the lowlands. Esp, Prt.
- 5 Sheath round perianth shallowly lobed (up to 1/3 of length); female bracts with thin-walled marginal cells (fig. 39, 14-15) **C. integerrima** (Lindb.) Warnst.  
Plants green, partially brownish or reddish. Leaf lobes 4-8 cells wide at base, 17-20  $\mu\text{m}$  wide; cuticle smooth. Gemmae 14-18  $\mu\text{m}$  wide. Cells of perianth mouth thin-walled, 16-22(30)  $\mu\text{m}$  long. Autoicous. Grows on shaded slopes, in montane areas. Very rare, in the north of the Peninsula. Esp.
- 6 Leaf lobes 2-5(6) cells wide at base, usually with 1-2 spiniform, multicellular lateral teeth 7
- 6 Leaf lobes 4-9 cells wide at base, without lateral teeth 8
- 7 Cells at base of leaf lobes 13-15  $\mu\text{m}$  wide, thin-walled; cortical cells thin-walled **C. elachista** (J.B.Jack ex Gottsche & Rabenh.) Schiffner  
Plants light green. Cortical cells 30-35  $\times$  13-15  $\mu\text{m}$ . Leaf lobes 3-4(5) cells wide at base; margin sinuose-dentate, with 1-2 spinose teeth near base; cuticle smooth or obscurely papillose. Underleaves sparse or lacking. Gemmae 24-27  $\times$  10-11  $\mu\text{m}$ . Perianth mouth crenulate, with thick-walled cells, 3-6 times as long as wide. Grows on wet, acidic substrata, on humus in humid forests or in peatlands, in high mountains. Rare, in Serra da Estrela. Prt.



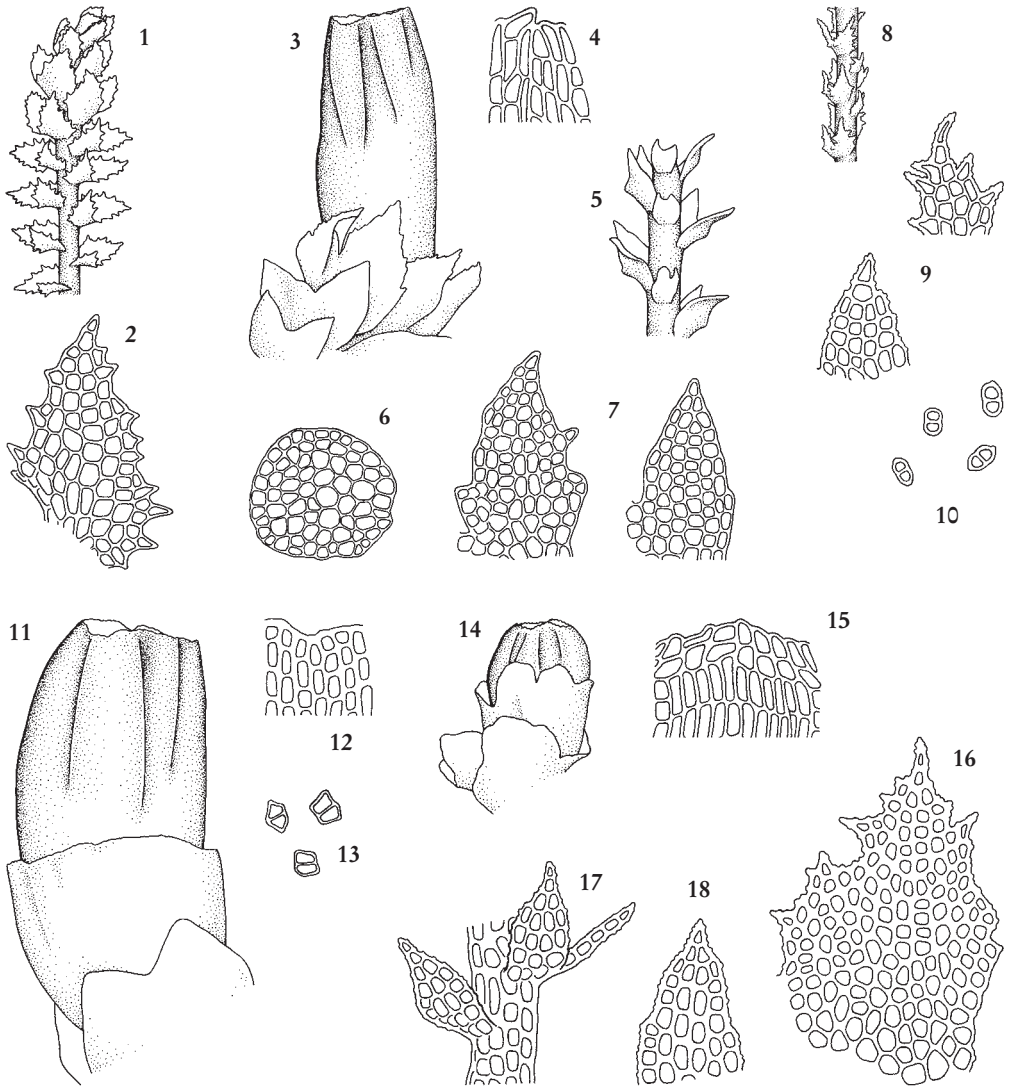


FIGURE 39. 1-2, *Cephaloziella turneri*: 1, habit; 2, leaf lobe. 3-7, *C. divaricata*: 3, perianth; 4, perianth mouth; 5, habit, ventral side; 6, stem section; 7, leaf lobes. 8-10, *C. massalongi*: 8, habit; 9, leaf lobes; 10, gemmae. 11-13, *C. calyculata*: 11, perianth; 12, perianth mouth; 13, gemmae. 14-15, *C. integerrima*: 14, perianth; 15, perianth mouth. 16-18, *C. spinigera*: 16, lobe of female bract; 17, stem and leaves; 18, leaf lobe. 11 ( $\times 40$ ); 1, 3, 5 ( $\times 45$ ); 8, 14 ( $\times 55$ ); 2, 4, 6, 7, 9, 12, 15, 16, 17, 18 ( $\times 180$ ); 10, 13 ( $\times 215$ ).



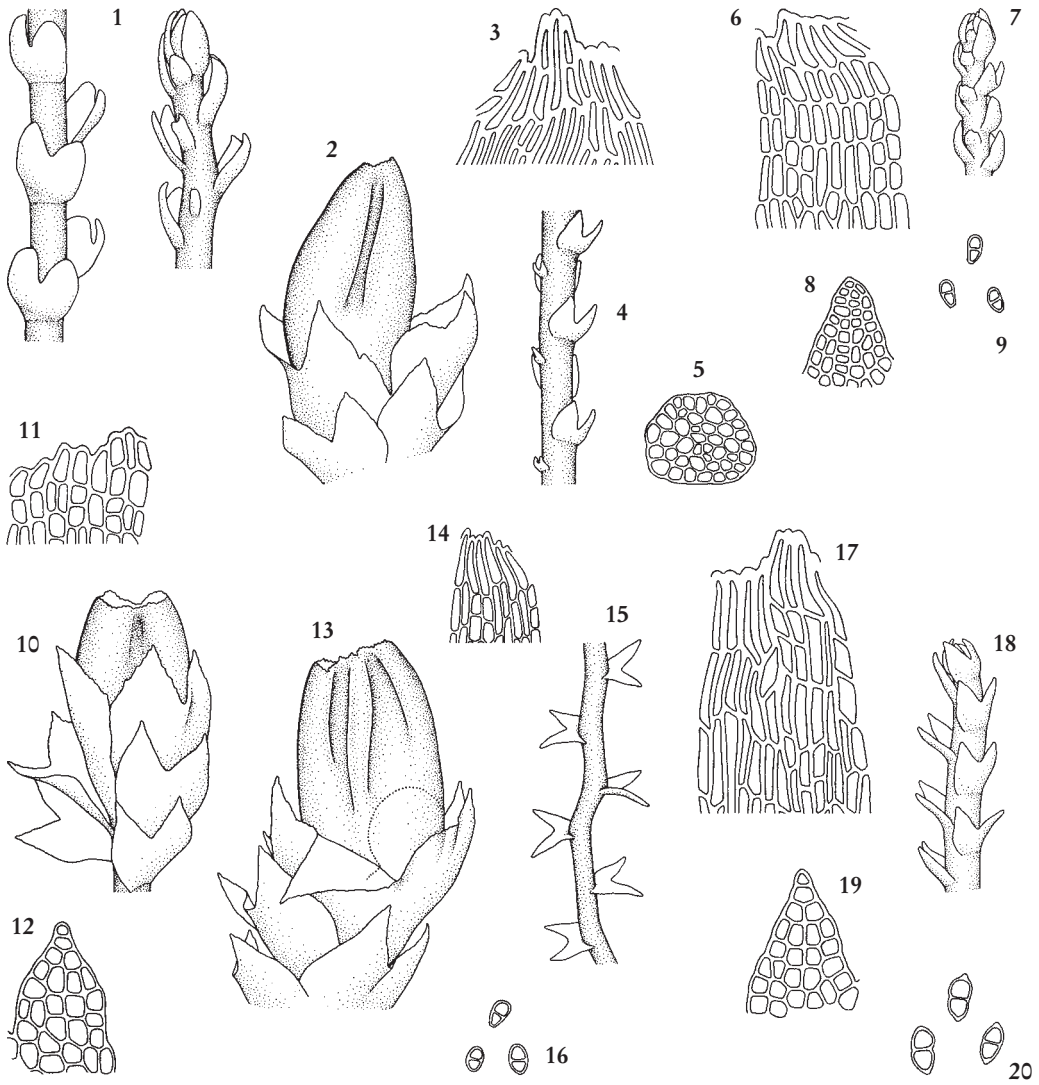


FIGURE 40. 1, *Cephaloziella grimsulana*, habits, dorsal and ventral sides. 2-5, *C. stellulifera*: 2, perianth; 3, perianth mouth; 4, habit; 5, stem section. 6-9, *C. rubella* var. *elegans*: 6, perianth mouth; 7, habit, ventral side; 8, leaf lobe; 9, gemmae. 10-12, *C. baumgartneri*: 10, perianth; 11, perianth mouth; 12, leaf lobe. 13-16, *C. hampeana*: 13, perianth; 14, perianth mouth; 15, habit; 16, gemmae. 17-20, *C. rubella* var. *rubella*: 17, perianth mouth; 18, habit; 19, leaf lobe; 20, gemmae. 1, 2, 4, 7, 10, 13, 15, 18 ( $\times 45$ ); 3, 5, 6, 8, 11, 12, 14, 17, 19 ( $\times 180$ ); 9, 16, 20 ( $\times 215$ ).

- 7 Cells at base of leaf lobes 10-13  $\mu\text{m}$  wide, thick-walled; cortical cells thick-walled (fig. 39, 16-18) **C. spinigera** (Lindb.) Warnst.  
Plants light green or yellowish. Cortical cells 16-18(30)  $\times$  11-13  $\mu\text{m}$ . Leaf lobes 2-5(6) cells wide at base; margin entire or sinuose, with 1-2 spinose teeth; cuticle slightly or strongly striate-papillose. Underleaves sparse or lacking. Gemmae ellipsoidal, green or brownish. Very rare, in the north of the Peninsula. Esp.
- 8 Underleaves present 9
- 8 Underleaves lacking 13
- 9 Cuticle usually papillose, sometimes with warts or projections on dorsal side; plants dioicous, usually sterile 10
- 9 Cuticle smooth, sometimes papillose; plants autoicous or paroicous, often fertile 11
- 10 Apical cells of lobes 8-15  $\mu\text{m}$  long; gemmae 12-20  $\mu\text{m}$  long; plants common, growing on acidic substrata (fig. 39, 3-7) **C. divaricata** (Sm.) Schiffn.  
Plants brownish red or blackish, rarely greenish. Cortical cells 8-14  $\mu\text{m}$  wide. Leaves distant to imbricate, patent or erect, usually channelled, lobes acute or obtuse, 4-9 cells wide at base, 10-14  $\mu\text{m}$  wide; margin entire or dentate, sinus usually recurved; cuticle smooth, papillose or with conical projections on the dorsal side. Underleaves usually bilobed. Gemmae ellipsoidal. Perianth mouth crenulate or spinose, with thick-walled cells, to 50  $\mu\text{m}$  long and 1.5-4 times as long as wide. Dioicous. Grows on slopes and acidic ledges and in rock crevices, from the lowlands to high mountains. Widespread throughout the Peninsula. Esp, Prt, And.
- 10 Apical cells of lobes 15-34  $\mu\text{m}$  long; gemmae 20-24  $\mu\text{m}$  long; plants rare, growing on substrata rich in heavy metals (fig. 39, 8-10) **C. massalongi** (Spruce) Müll.Frib.  
Plants green, yellowish green, reddish brown or blackish. Leaf lobes 4-6 cells wide at base, 10-16  $\mu\text{m}$  wide; margin entire, crenulate or irregularly dentate, with or without conical projections on the dorsal side; cuticle densely papillose, rarely nearly smooth. Underleaves bilobed, entire or retuse. Gemmae ellipsoidal. Perianth mouth dentate-crenulate, 4-6 times as long as wide. Grows on moist to wet mine spoil, banks and in crevices, in montane areas, in the north of the Peninsula and in Monchique. Esp, Prt.
- 11 Plants autoicous; leaf lobes obtuse (fig. 40, 1) **C. grimsulana** (J.B.Jack ex Gottsche & Rabenh.) Lacout.  
Plants reddish or blackish. Leaves erect, distant, lobes obtuse or rounded, 6-9 cells wide at base, 14-18  $\mu\text{m}$  wide; cuticle smooth. Underleaves ovate to lanceolate, usually bidentate or bilobed. Gemmae dark red or purplish, ovoid or ellipsoidal, 2-celled. Cells of perianth mouth 3-7 times as long as wide. Grows on wet rocks, in high mountains, in the Pyrenees. Esp.
- 11 Plants paroicous; leaf lobes acute 12
- 12 Leaf lobes 4-6(8) cells at base; leaf cells 14-20  $\mu\text{m}$  wide; male and female bracts patent or squarrose (fig. 40, 2-5) **C. stellulifera** (Spruce) Schiffn.  
Plants greenish. Cortical cells 16-24  $\mu\text{m}$  wide. Leaves distant, erecto-patent or spreading, lobes cells 12-16  $\mu\text{m}$  wide at base; cuticle smooth. Underleaves small, lanceolate, rarely bilobed. Gemmae green or reddish, ellipsoidal, 16-20  $\mu\text{m}$  long. Cells of perianth mouth to 80  $\mu\text{m}$  long,

- 3-6 times as long as wide, thick-walled. Grows on slopes, in small hollows and rock crevices, from the lowlands to high mountains. Widespread throughout the Peninsula and in Menorca. Esp, Prt, Bl.
- 12 Leaf lobes 6-9 cells at base; leaf cells 7-11  $\mu\text{m}$  wide; male and female bracts not squarrose (fig. 40, 6-9) **C. rubella** (Nees) Warnst. var. **elegans** (Heeg) R.M. Schust. Plants usually reddish. Cuticle smooth or papillose. Underleaves small. Gemmae reddish brown, ellipsoidal, 15-20(22)  $\mu\text{m}$  long. Cells of perianth mouth 20-30  $\mu\text{m}$  long, 1,5-4 times as long as wide. Grows on acidic soils. Rare, in the north of the Peninsula. Esp.
- 13 Leaves obliquely inserted; plants calcicolous, never with reddish pigments (fig. 40, 10-12) **C. baumgartneri** Schiffn. Plants green. Leaves erecto-patent or patent, sometimes squarrose, lobes (3)4-5 cells wide at base, 16-20  $\mu\text{m}$  wide; cuticle smooth. Gemmae green or brownish, ellipsoidal, 13-20  $\mu\text{m}$  long. Perianth mouth entire, crenulate or sinuose, with usually thick-walled cells, to 35  $\mu\text{m}$  long, 1,5-5 times as long as wide. Autoicous. Grows on slopes and wet and shaded rock ledges, in the lowlands. Widespread throughout the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.
- 13 Leaves transversely inserted; plants calcifuge, green, brownish or reddish 14
- 14 Leaf lobes (4)6-9 cells wide at base, these cells thin-walled; leaves distant, wider than stem, spreading (fig. 40, 13-16) **C. hampeana** (Nees) Schiffn. Plants greenish or brownish. Leaves patent or spreading; cells thin-walled or with slightly thickened walls, usually brownish, cells at base of lobes 12-15  $\mu\text{m}$  wide; cuticle smooth, rarely papillose. Gemmae 14-18  $\mu\text{m}$  long, reddish or brownish. Cells of perianth mouth to 50  $\mu\text{m}$  long, 2,5-5 times as long as wide, usually thin-walled. Autoicous. Grows on wet slopes and in small hollows, in the lowlands and montane areas. Widely distributed in the Peninsula, specially in the Mediterranean region, and in Menorca. Esp, Bl.
- 14 Leaf lobes 4-6 cells wide at base, these cells thick-walled; leaves distant to imbricate, as wide or narrower than stem, erecto-patent to erect (fig. 40, 17-20) **C. rubella** (Nees) Warnst. var. **rubella** Plants greenish, reddish or brownish. Leaf cells 11-13  $\mu\text{m}$  wide; cuticle smooth or nearly so. Gemmae 20-22(25)  $\mu\text{m}$  long, reddish brown. Cells of perianth mouth 50-70  $\mu\text{m}$  long. Paroicous. Grows on wet, acidic soils and rotting wood, in montane areas. Rare, in the north of the Peninsula. Esp, Prt.

## Fam. Cephaloziaceae

### **Cephalozia** (Dumort.) Dumort.

Plants small or very small. Stem procumbent, irregularly branched on the ventral side; cortex translucent, of large, thin-walled cells, medulla of small, thick-walled cells. Leaves distant to imbricate, alternate, subtransversely inserted to longitudinally inserted, succubous, bilobed. Underleaves lacking. Gemmae rare, 1-celled. Female bracts much longer than leaves, 2-5-lobed; perianth usually unistratose, 1-2-stratose at base, with crenulate to ciliate mouth. Dioicous or monoicous.

- 1 Leaves subtransversally inserted, never decurrent; leaf lobes never or very rarely connivent; plants frequently with red secondary pigmentation 2
- 1 Leaves obliquely to longitudinally inserted, decurrent or not; at least some leaves with connivent lobes; plants green or brownish but never reddish 3
- 2 Cortical cells of stem 15-25  $\mu\text{m}$  wide on the dorsal side; leaf cells 18-24(27)  $\mu\text{m}$  wide (fig. 41, 1) **C. ambigua** C. Massal.  
Plants up to 0,5 cm long, pale green. Leaves to 0,6  $\times$  0,4 mm, usually concave. Autoicous. Forms dense turfs on acidic soils in snow beds, in high mountains. Rare, in the Pyrenees and Cantabrian Mountains. Esp.
- 2 Cortical cells of stem 25-60  $\mu\text{m}$  wide on the dorsal side; leaf cells 25-40  $\mu\text{m}$  wide (fig. 41, 2-5) **C. bicuspidata** (L.) Dumort.  
Plants up to 3 cm long, variable in size, pigmentation, leaf insertion and imbrication. Leaves to 0,7  $\times$  0,8 mm, typical leaves with erect, long, narrow lobes, ending in 1-3(4) uniseriate cells, apical cell thick-walled above. Female bracts bilobed, variable at margins; perianth elongated, to 4 mm long, unistratose, with ciliate-dentate mouth, teeth 1-2-celled, sometimes with cilia 3(4)-celled. Autoicous. Terricolous or saprolignicolous, in wet sites, from the lowlands to montane areas. Distributed in the northern half and west of the Peninsula, occasionally in Sierra Nevada. Esp, Prt, And.
- 3 Apical cell of leaf lobes with uniformly thickened walls; perianth usually 2-stratose at least to 1/2 of its length; perianth mouth crenulate or crenulate-dentate, rarely nearly entire (fig. 41, 6-7) **C. pleniceps** (Austin) Lindb.  
Plants to 2 cm long, pale green or yellowish. Leaves widely sub-orbicular, 0,8(0,9)  $\times$  0,6(0,8) mm, not decurrent or only slightly so; lobes acute, 5-10 cells wide at base, these cells 20-60  $\mu\text{m}$  wide, ending in 1-2 cells. Gemmae occasional. Autoicous. Grows in wet, acidic sites, often among *Sphagnum*, in montane areas and high mountains, in the Pyrenees, Cantabrian Mountains and the Iberian Range. Esp, And.
- 3 Apical cell of leaf lobes thick-walled above; perianth unistratose, sometimes 2-stratose at base but then for less than 1/2 of its length; perianth mouth crenulate-dentate to ciliate 4
- 4 Plants shiny; leaf cells 28-50  $\mu\text{m}$  wide 5
- 4 Plants dull; leaf cells 25-35  $\mu\text{m}$  wide 6
- 5 Leaf lobes ending in a row of 2(3) cells, 2-5 cells wide at base; apical cell of lobes caducous (fig. 41, 8-9) **C. crassifolia** (Lindenb. & Gottsche) Fulford  
Plants up to 1,5 cm long, pale green or yellowish. Leaves short to longly decurrent. Female bracts with 2(3) lobes; perianth to 3,5 mm long, with 2-5-celled cilia at mouth. Dioicous. Lignicole, on wet, rotten wood, in the lowlands. Distributed in the north and northwestern part of the Peninsula. Esp.
- 5 Leaf lobes ending in a row of 1-2 cells, 3-6 cells wide at base; apical cell of lobes persistent (fig. 41, 10-11) **C. connivens** (Dicks.) Lindb.  
Plants up to 1,5 cm long, more or less shiny, pale green to yellowish. Leaves longitudinally inserted; dorsal margin longly decurrent. Female bracts 2-4(5)-lobed; perianth to 2 mm long,



FIGURE 41. 1, *Cephalozia ambigua*, habit. 2-5, *C. bicuspidata*: 2, perianth mouth; 3, habit; 4, stem section; 5, leaves. 6-7, *C. pleniceps*: 6, habit; 7, lobe apex. 8-9, *C. crassifolia*: 8, habit; 9, leaf lobe. 10-11, *C. connivens*: 10, habit; 11, leaf. 12-15, *C. loitlesbergeri*: 12, perianth; 13, perianth mouth; 14, leaf; 15, lobe apex. 16-19, *C. lunulifolia*: 16, perianth; 17, habit; 18, stem section; 19, leaves. 12, 16 ( $\times 19$ ); 1, 3, 5, 6, 8, 10, 17, 19 ( $\times 35$ ); 11, 14 ( $\times 70$ ); 2, 4, 7, 9, 13, 15, 18 ( $\times 100$ ).

with 2–5-celled cilia at mouth. Autoicous. Terricolous, in peatlands and other wet, acidic places, in montane areas and high mountains. Scattered in the Peninsula. Esp, Prt, And.

- 6 Plants mostly brownish; leaf lobes ending in a row of 2-3 cells; perianth mouth with 2–6-celled cilia (fig. 41, 12-15) **C. loitlesbergeri** Schiffn.

Plants to 2 cm long, pale green or yellowish, brownish in old parts. Stem with yellowish medullary cells, at least in mature plants. Leaves decurrent or not, obliquely inserted, slightly concave, ovate to sub-orbicular, lobes 4-6 cells wide at base. Gemmae absent. Female bracts with lobes ending in a uniseriate row of 2-6 cells. Autoicous. Saprolognicolous, in the high mountains. Very rare, in the Pyrenees. Esp.

- 6 Plants never brownish; leaf lobes ending in a row of 1-2 cells; perianth mouth with 1(2)-celled teeth (fig. 41, 16-19) **C. lunulifolia** (Dumort.) Dumort.

Plants to 2 cm long, green or yellowish green. Stem with hyaline medullary cells. Leaves decurrent or not, concave, plane, rarely convex, sub-orbicular or semi-ovate. Sometimes with 1-celled gemmae at shoot apex. Female bracts with lobes slightly incurved, ending in a uniseriate row of 1-2 cells. Dioicous. Lignicole, in montane areas and high mountains. Distributed in the Pyrenees, north and west of the Peninsula and in Algeciras Mountains. Esp, Prt, And.

### **Nowellia** Mitt.

Plants 1(2) cm long, delicate, light green. Stem procumbent, slightly branched. Leaves imbricate to distant, more or less transversely inserted, concave, with the ventral margin incurved to form a sac, narrowed at base, bilobed, asymmetrical; lobes longly acuminate, erect or more or less connivent, composed of 4-7 elongated uniseriate cells, sinus rounded. Underleaves lacking. Perianth cylindrical, plicate above, with ciliate mouth (fig. 42, 1)

**N. curvifolia** (Dicks.) Mitt.

Grows mainly on rotten stumps, also on wet soils and rocks, in the lowlands and montane areas of the north of the Peninsula. Esp, And.

### **Cladopodiella** H.Buch

Plants minute to medium-sized. Stem ventrally branched. Rhizoids often with swollen ends. Leaves alternate, obliquely inserted or sometimes subtransversely inserted to dorsal mid-line, succubous, bilobed; lobes obtuse or rounded; cells nearly quadrate, shortly rectangular or hexagonal, more or less thick-walled. Underleaves usually appressed, small, lanceolate, with acute or bilobed apex. Gemmae angulate, 1–2-celled or gemmae lacking. Female inflorescences on short ventral branches; perianth mouth crenulate. Dioicous.

- 1 Leaves flat; median cells of leaves 25–40  $\mu\text{m}$  (fig. 42, 2-6) **C. fluitans** (Nees) Spruce

Plants to 2,5 cm long. Stem procumbent. Leaves to 1,5 mm long, distant, spreading, obliquely inserted, ovate, lobe sinus to 1/4-1/3 of length of leaf; margin sometimes slightly recurved; cells thin-walled or thick-walled. Gemmae lacking. Grows submerged, in waterlogged soils with *Sphagnum*, in the lowlands and montane areas. Rare, in the north of the Peninsula and the Iberian Range. Esp.

- 1 Leaves concave; median cells of leaves 13–22  $\mu\text{m}$  (fig. 42, 7-9)

**C. francisci** (Hook.) Jörg.



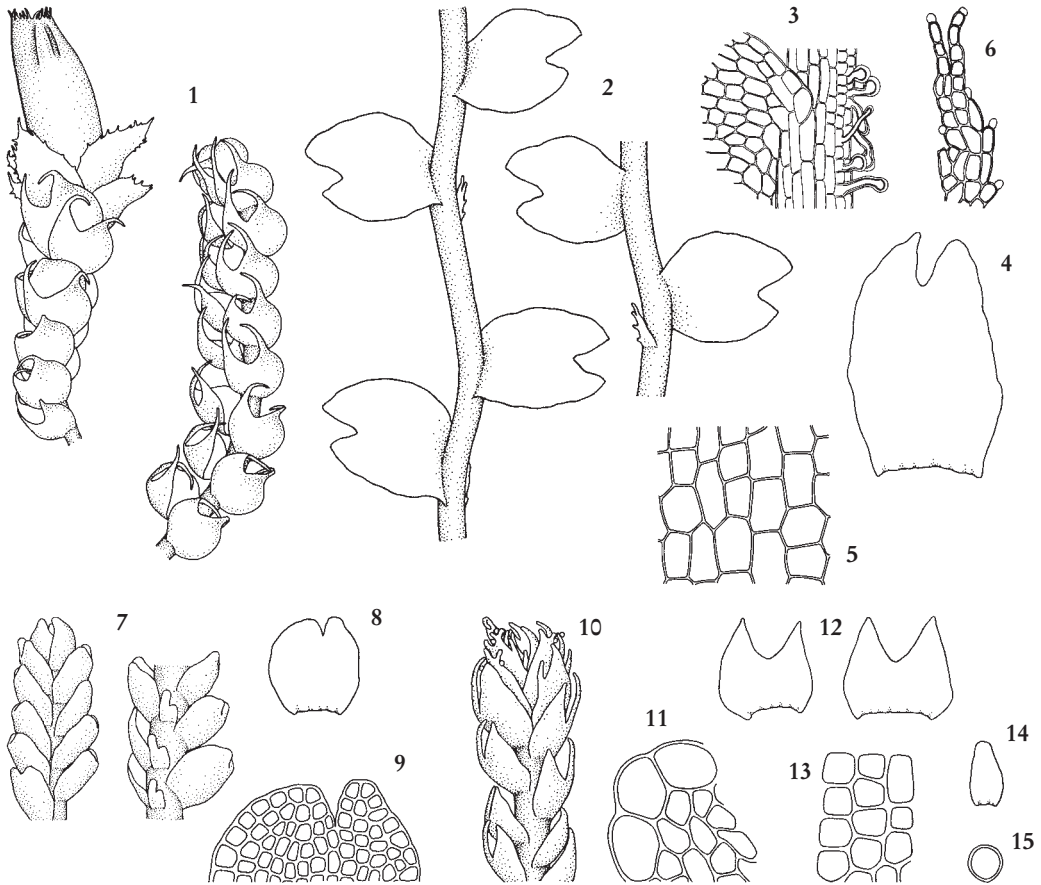


FIGURE 42. 1, *Nowellia curvifolia*, habits with and without perianth. 2-6, *Cladopodiella fluitans*: 2, habits, dorsal and ventral sides; 3, stem with rhizoids; 4, leaf; 5, leaf cells; 6, underleaf. 7-9, *C. francisci*: 7, habits, dorsal and ventral sides; 8, leaf; 9, leaf cells. 10-15, *Pleurocladula albescens*: 10, habit; 11, stem section; 12, leaves; 13, leaf cells; 14, underleaf; 15, gemma. 2 ( $\times 15$ ); 1 ( $\times 20$ ); 4, 12, 14 ( $\times 30$ ); 10 ( $\times 35$ ); 7, 8 ( $\times 50$ ); 3, 6 ( $\times 60$ ); 5, 9 ( $\times 120$ ); 11, 13, 15, ( $\times 200$ ).

Plants to 1,5 cm long. Stem procumbent or ascending. Leaves to 0,5 mm long, imbricate, obliquely inserted, subtransversely to dorsal side, orbicular-quadrate, sinus of lobe to 1/4-1/6 of length of leaf; cells thick-walled. Gemmae sometimes present at stem tips, angulate, 1-2-celled. Grows on very wet slopes. Very rare, in the northwestern part of the Peninsula. Esp.

### *Pleurocladula* Grolle

Plants up to 2 cm long, light green, whitish when dry. Stem procumbent or erect, with lateral branches; cortical cells large,  $36-80 \times 20-50 \mu\text{m}$ , hyaline. Leaves distant to nearly imbricate, transversely inserted, not decurrent, orbicular, very concave, bilobed;

lobes widely triangular, incurved; median cells 20-40  $\mu\text{m}$  wide, thick-walled. Underleaves ovate-lanceolate or ovate, 0,3-0,5 mm long, as wide as stem or more, with entire margin or with one tooth on both sides at base. Gemmae rare, spherical, on shoot apices, 1-celled. Dioicous (fig. 42, 10-15) **P. albescens** (Hook.) Grolle

Forms mats on snow beds, in the high mountains of the Central Pyrenees. Rare. Esp.

### **Odontoschisma** (Dumort.) Dumort.

Plants small to medium-sized. Stem prostrate or ascending; branches ventrally arising, often flagelliform. Leaves alternate, obliquely inserted, succubous, orbicular or ovate, concave, simple, with rounded or truncate apex; margin entire; cells 16-28  $\mu\text{m}$  wide, with small to large trigones, sometimes bulging, 2-4 oil-bodies. Underleaves usually caducous, small, with mucilaginous papillae. Gemmae on leaves and on underleaves at apex of ascending branches, ellipsoidal or ovoid, (1)2-celled, or gemmae lacking. Dioicous.

- 1 Leaves with 1-4 rows of marginal cells, uniformly thick-walled forming a poor border; median cells with rounded lumens, trigones not or hardly bulging; gemmae lacking (fig. 43, 1-3) **O. sphagni** (Dicks.) Dumort.

Plants to 8 cm long. Stem simple or sparsely branched. Leaves usually imbricate; cuticle smooth or papillose; cells with middle lamella inconspicuous. Grows in peatlands among *Sphagnum* and *Leucobryum*, on peaty slopes and seeping acidic rocks, in the lowlands and montane areas, in the northwestern part of the Peninsula. Esp.

- 1 Leaves unbordered; median cells with irregular lumens because of bulging trigones; gemmae often present **2**

- 2 Cuticle smooth; middle lamella of leaf cells visible; attenuate gemmiferous shoots lacking (fig. 43, 4-7) **O. elongatum** (Lindb.) A.Evans

Stem to 3 cm long. Leaves slightly imbricate. Usually without gemmae, if present gemmae ellipsoidal, brownish, 2-celled. Forms brownish mats by lakes, streams and in peatlands with *Sphagnum*, in high mountains in the Pyrenees and north of the Peninsula. Esp, And.

- 2 Cuticle more or less papillose; middle lamella of leaf cells indistinct; attenuate gemmiferous shoots often present (fig. 43, 8-11) **O. denudatum** (Nees) Dumort.

Plants to 2 cm long. Leaves imbricate, distant in attenuate shoots. Gemmae in groups, green, ovoid to ellipsoidal, 1-2-celled, 20-28  $\mu\text{m}$  long. Grows on rotting trunks and shaded rocks, in the lowlands and montane areas, in the north of the Peninsula. Esp.

## **Fam. Antheliaceae**

### **Anthelia** (Dumort.) Dumort.

Plants slim, up to 1,5 cm long, glaucous, secreting a whitish substance (forming crystalline filaments) that covers them. Stem prostrate to erect, irregularly branched. Leaves imbricate, appressed or erect, transversely inserted, bilobed to 4/5; lobes acute,



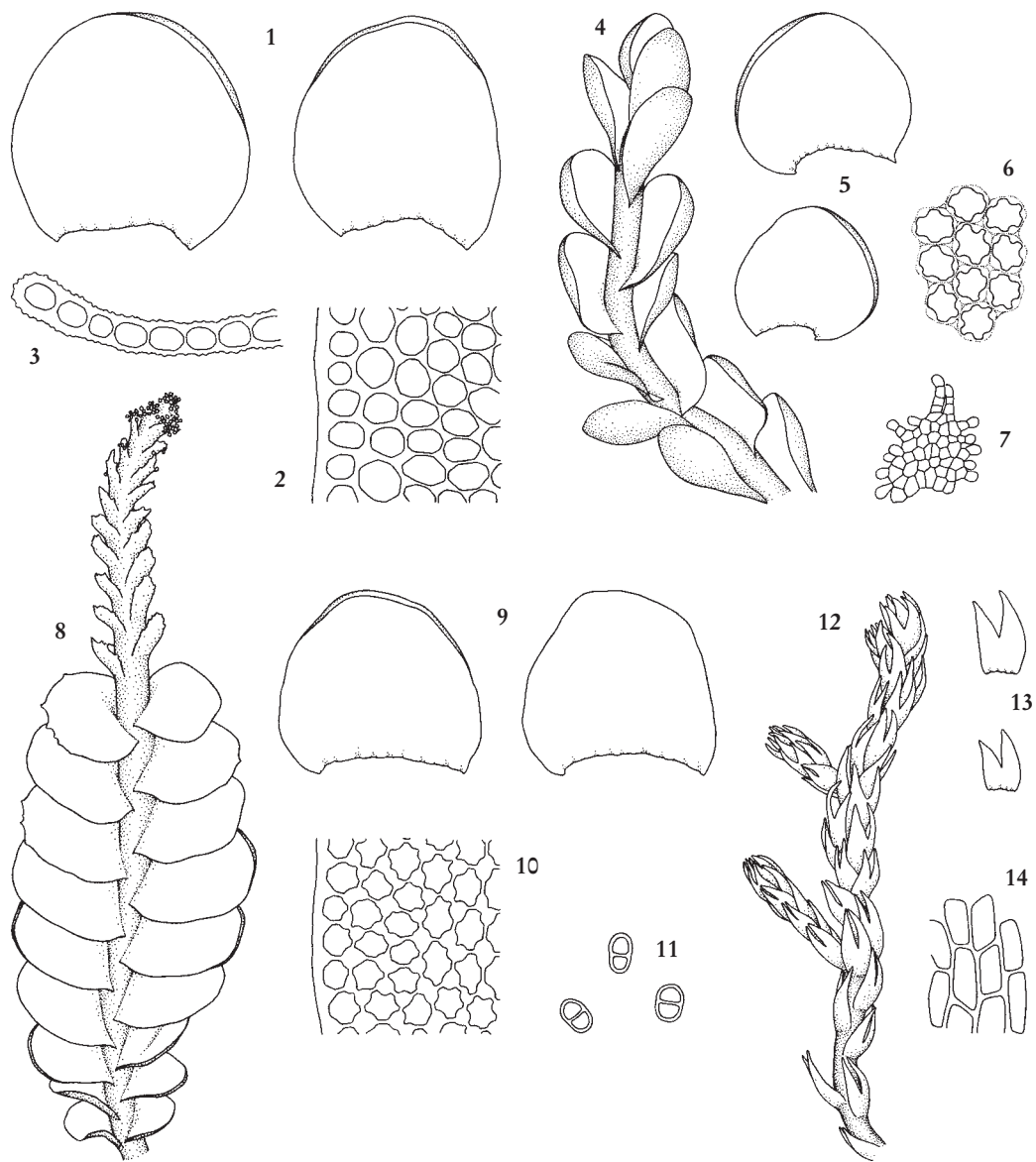


FIGURE 43. 1-3, *Odontoschisma sphagni*: 1, leaves; 2, leaf marginal cells; 3, leaf section. 4-7, *O. elongatum*: 4, habit; 5, leaves; 6, leaf cells; 7, underleaf. 8-11, *O. denudatum*: 8, gemmiferous shoot; 9, leaves; 10, leaf marginal cells; 11, gemmae. 12-14, *Anthelia juratzkana*: 12, habit; 13, leaves; 14, leaf cells. 8 ( $\times 15$ ); 4, 12 ( $\times 20$ ); 1, 5, 7, 9, 13 ( $\times 30$ ); 2, 3, 6, 10, 11, 14 ( $\times 200$ ).

with narrow sinus; margin entire; cells rectangular, without oil-bodies. Underleaves similar to leaves. Paroicous (fig. 43, 12-14) **A. juratzkana** (Limpr.) Trevis.

Forms extensive patches on wet soils and snow beds, in the high mountains. Distributed in the Pyrenees and in Sierra Nevada. Esp, And.

## Fam. Lepidoziaceae

### *Telaranea* Spruce ex Schiffn.

Plants slender and very small, to 1,5 cm long, pale green or yellowish green. Stem procumbent, with hyaloderm, irregularly pinnately branched. Leaves distant, transversely inserted, patent to erecto-patent, divided almost to base into (2)3(4) uniseriate lobes, lobes (4)5-6(7) cells long and 2 cells wide at base, lamina 1/2 cell deep. Underleaves less than half length of leaves, bilobed, lobes uniseriate, lamina 1 cell deep. Female bracts with ciliate-laciniate lobes, 2-3-cells wide, forked at the tips. Perianths not plicate, with laciniate mouth. Autoicous (fig. 44, 1-3) **T. europaea** J.J.Engel & G.L.Merr.

Grows on shaded, humid, acidic substrata, mostly by streams in forests. Distributed in the northern part of the Peninsula. Esp, Prt.

### *Kurzia* G. Martens

Plants small, yellowish to green or yellowish brown. Stem irregularly pinnately branched, usually with flagelliform branches. Leaves distant to imbricate, erecto-patent, transversely or slightly obliquely inserted, incubous, 3-4-lobed to near base, lobes narrow, 2-4 cells wide at base; cuticle finely papillose-striate or smooth. Underleaves similar to leaves or smaller. Male bracts straight or incurved, with obtuse or acute lobes. Female bracts with denticulate or ciliate margins, cilia to 9 cells long. Perianths cylindrical or fusiform, with ciliate mouth. Dioicous.

- 1 Female bracts with cilia to 9 cells long; male inflorescence 200-700  $\mu\text{m}$  wide, male bracts with rounded apical cells; median cells of leaf lobes 16-26  $\mu\text{m}$  wide (fig. 44, 4-7) **K. pauciflora** (Dicks.) Grolle

Plants not aromatic. Lobes of male bracts incurved, up to twice as long as lamina. Perianths to 4 mm long, very conspicuous, mouth with long cilia up to 4(6) cells long. Forms compact mats or creeping among other bryophytes, in peatlands and other open, wet, acidic sites with *Sphagnum*, in the lowlands and montane areas. Relatively frequent in the north and northwestern part of the Peninsula, rarer in the west. Esp, Prt.

- 1 Female bracts with cilia to 3 cells long; male inflorescence up to 350  $\mu\text{m}$  wide, male bracts with acute apical cells; median cells of leaf lobes 9-16  $\mu\text{m}$  wide **2**
- 2 Female bracts divided to 1/3(1/2), with many teeth to 3 cells long; lobes of male bracts more or less straight, as long as lamina (fig. 44, 8-10)

**K. sylvatica** (A.Evans) Grolle

Plants not aromatic. Perianth fusiform, up to 2,5  $\mu\text{m}$  long, mouth dentate-ciliate, with teeth less than 4 cells long. Forms loose and shallow mats on wet, acidic, shaded soils and rocks,

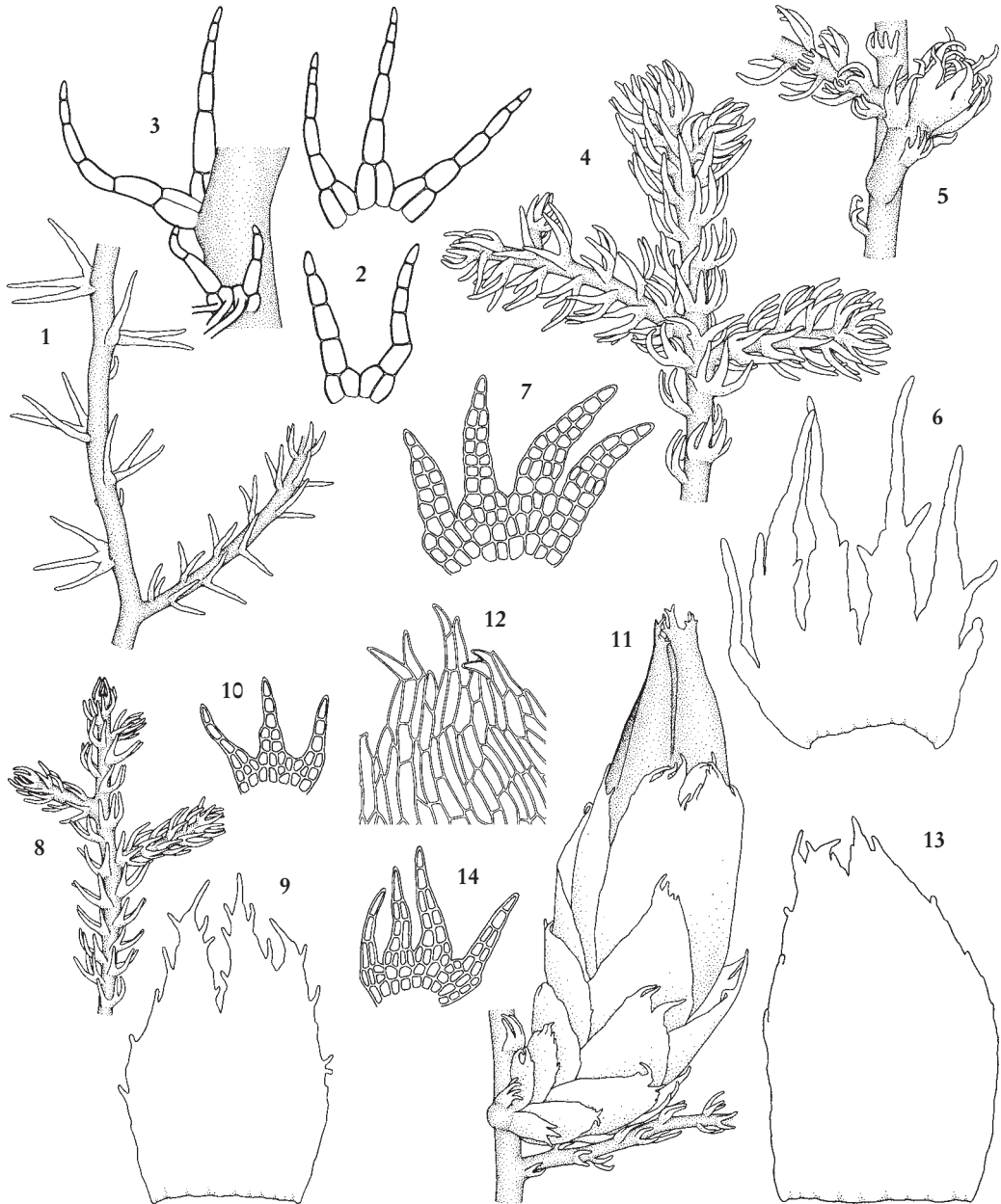


FIGURE 44. 1-3, *Telaranea europaea*: 1, habit; 2, leaves; 3, stem with leaf and underleaf. 4-7, *Kurzia pauciflora*: 4, habit; 5, female inflorescence; 6, female bract; 7, leaf. 8-10, *K. sylvatica*: 8, habit; 9, female bract; 10, leaf. 11-14, *K. trichoclados*: 11, perianth; 12, perianth mouth; 13, female bract; 14, leaf. 1, 4, 5, 11 ( $\times 35$ ); 8 ( $\times 40$ ); 6, 9, 13 ( $\times 70$ ); 2, 3, 7 ( $\times 90$ ); 10, 12, 14 ( $\times 100$ ).

preferentially in forests, in the lowlands. Very rare, in the north and northeastern part of the Peninsula. Esp.

- 2 Female bracts emarginate or divided to 1/5, with few teeth to 2 cells long; lobes of male bracts incurved, twice as long as lamina (fig. 44, 11-14)

**K. trichoclados** (K.Müller) Grolle

Plants strongly aromatic. Perianth cylindrical fusiform, up to 2,5  $\mu\text{m}$  long, mouth spinose-dentate, with teeth 1(2) cells long. Vegetative propagation by means of more or less cylindrical, thickened portions of the stem, with minute leaves, 1-2(3) cells high. Forms compact, deep mats, calcifuge, on organic soils, rocks and rotten wood, mostly in open areas and rocky cliffs, in the lowlands and montane areas. Distributed in the north of the Peninsula. Esp.

**Lepidozia** (Dumort.) Dumort.

Plants medium-sized. Stem prostrate, regularly or irregularly 1-2-pinnately branched, sometimes with flagelliform branches. Leaves distant to imbricate, incubous, obliquely inserted, often asymmetrical, 3-4-lobed, divided to 1/3-1/4; cuticle smooth or papillose; leaf cells 20-30  $\mu\text{m}$  wide, thick-walled. Underleaves similar but smaller than leaves. Autoicous or synoicous.

- 1 Leaves closely imbricate, covering the dorsal part of stem; leaf lobes 7-12 cells wide at base (fig. 45, 1-4)

**L. cupressina** (Sw.) Lindenb.

Plants yellowish green, to 5 cm long. Forms dense mats on acidic rocks, humus and holly trees, in the lowlands. Rare in the north of the Peninsula. Esp.

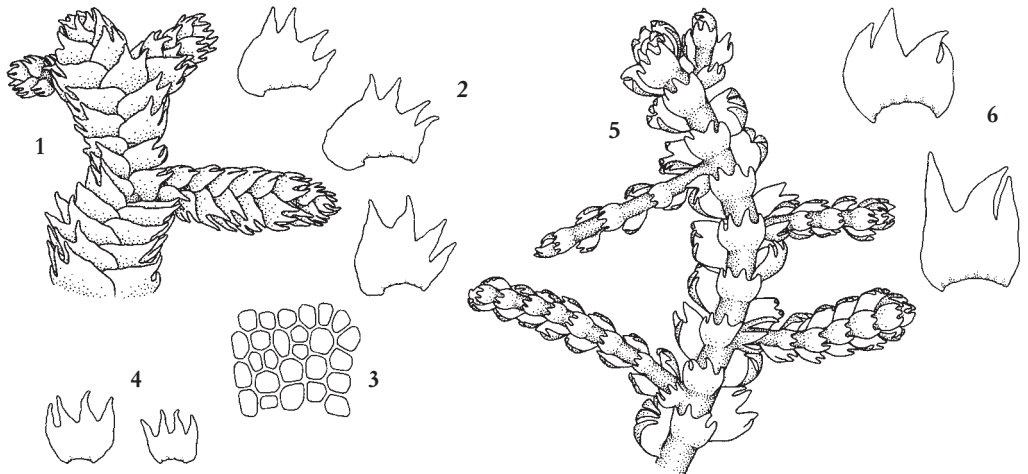


FIGURE 45. 1-4, **Lepidozia cupressina**: 1, habit; 2, leaves; 3, leaf cells; 4, underleaves. 5-6, **L. cupressina**: 5, habit, ventral side; 6, leaves. 5 ( $\times 16$ ); 1 ( $\times 20$ ); 2, 4, 6 ( $\times 24$ ); 3 ( $\times 140$ ).

- 1 Leaves distant to slightly imbricate, not covering the dorsal part of stem; leaf lobes 4-7 cells wide at base (fig. 45, 5-6) **L. reptans** (L.) Dumort.  
Plants dull dark green, to 3-4 cm long. Forms dense mats or grows among other bryophytes on rotten stumps, acidic rocks and soils, in montane areas and high mountains, in the northern half of the Peninsula and in Monchique. Esp, Prt, And.

### **Bazzania** Gray

Plants small to robust, procumbent. Stem branched, usually with ventral flagelliform branches. Leaves obliquely or longitudinally inserted, incubous, simple, alternate, oblong or ovate to ovate-lanceolate, usually asymmetrical, with 1-3 teeth at apex or without teeth; cells with or without trigones. Underleaves small, simple or lobed, wider than long, with sinuose to dentate margins. Male inflorescence on short ventral branches. Female inflorescence on short ventral branches, with lobate bracts; perianth ovoid to fusiform. Dioicous.

- 1 Plants large, (2)5-8 × (0,1)0,2-0,4(0,5) cm; leaf apex transversely truncate, with (2)3 equal teeth; trigones usually large (fig. 46, 1-5) **B. trilobata** (L.) Gray  
Leaves imbricate, overlapping the stem, plane, horizontally spreading, oblong to ovate, slightly asymmetrical, convex at apex. Underleaves irregularly rectangular, twice as wide as stem, apex with 4-5 small lobes, margins dentate or sinuose. Saxicolous forms smaller. Forms green or greenish olive mats, shiny when wet, becoming whitish on drying, on humus banks, acidic rocks, tree bases and decaying logs, in montane areas.  
var. **depauperata** (Müll.Frib.) Grolle: Plants to 2 × 0,1(0,15) cm. Leaf cells 30 × 23 µm. Very rare, in montane areas in the north of the Peninsula. Esp.  
var. **trilobata**: Plants 5-8 × 0-4-0,5 cm. Leaf cells 43 × 25 µm. Distributed in the north and northwestern part of the Peninsula and in Sintra. Esp, Prt (Extinct).
- 1 Plants 1,5-3 × 0,1-0,2 cm; leaf apex obliquely truncate, more or less acute, with (0)1-3 unequal teeth; trigones weak or lacking **2**
- 2 Leaves caducous, distant, plane, some of them damaged; leaf apex entire or with 2 obtuse, unequal teeth (fig. 46, 6-10) **B. flaccida** (Dumort.) Grolle  
Plants 0,1-0,15 cm wide. Stem with denudate areas owing to fallen leaves. Leaves longitudinally inserted, narrowly ovate-triangular, not exceeding the median line of stem; median and basal cells 16-22 µm wide. Underleaves 1-1,5 as wide as stem, with sinuose or crenulate margins, usually entire. Forms olive green to brownish mats, dull when dry, not becoming whitish on drying, in acidic rock crevices and on humus and basic and acidic rocks, in shaded sites, in montane areas and high mountains. Distributed in the north and northeastern part of the Peninsula. Esp.
- 2 Leaves not caducous or damaged, slightly imbricate, strongly concave; leaf apex with (2)3 acute, unequal teeth (fig. 46, 11-15) **B. tricrenata** (Wahlenb.) Lindb.  
Plants 0,15-0,25 cm wide. Leaves obliquely inserted in short arch, widely triangular, asymmetrical, hardly exceeding the median line of stem; basal cells 25 × 20 µm, larger than median ones. Underleaves twice as wide as stem, with sinuose margins. Forms brownish or reddish mats, very bright when dry, not becoming whitish on drying. Grows on wet or very humid, deeply shaded, acidic rocks, sometimes in rock crevices in shaded sites, in high mountains, rarely in montane areas. Distributed in the Cantabrian Mountains and in the Pyrenees. Esp, And.

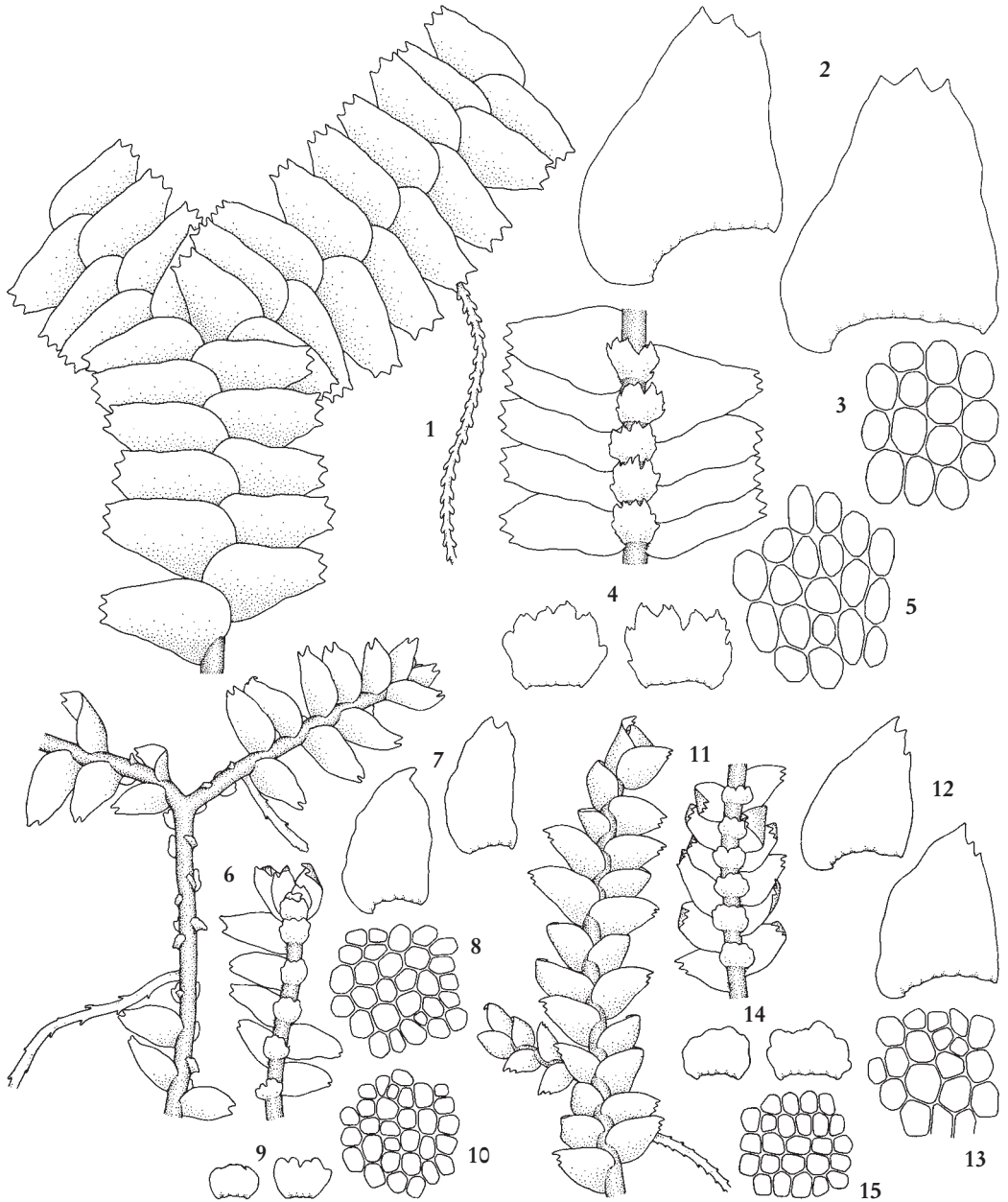


FIGURE 46. 1-5, *Bazzania trilobata*: 1, habits, dorsal side with flagelliform branch and ventral side; 2, leaves; 3, leaf cells; 4, underleaves; 5, underleaf cells. 6-10, *B. flaccida*: 6, habits, dorsal and ventral sides; 7, leaves; 8, leaf cells; 9, underleaves; 10, underleaf cells. 11-15, *B. tricrenata*: 11, habits, dorsal and ventral sides; 12, leaves; 13, leaf cells; 14, underleaves; 15, underleaf cells. 1 ( $\times 7.5$ ); 6, 11 ( $\times 12$ ); 2, 4 ( $\times 14$ ); 7, 9, 12, 14 ( $\times 24$ ); 3, 5, 8, 10, 13, 15 ( $\times 140$ ).

## Fam. Calypogeiaceae

*Calypogea* Raddi

Plants small, light green or bluish. Stem prostrate, often with erect propaguliferous branches. Rhizoids abundant, at base of underleaves. Leaves obliquely inserted, incubous, more or less ovate, flat, simple with rounded or bidentate apex or bilobed; ventral margin more or less decurrent; cells thin-walled, trigones small or lacking, 2-3 oil-bodies, granulose, colourless or blue. Underleaves wider than stem, bilobed, retuse, emarginate or rounded at apex, 2-14 cells deep from sinus to rhizoidal area. Gemmae 1-2-celled, greenish, grouped at apex of attenuate stems. Male inflorescence spiciform, rare, small. Female bracts on the ventral side of stem; perianth lacking. Marsupium subterranean, dark brown, covered by rhizoids.

- 1 Leaves bilobed, lobes divergent, sinus rounded; underleaves deeply bilobed, lobed bifid, acute, 1-2 cells deep from sinus to rhizoidal area (fig. 47, 1-4)

*C. arguta* Nees & Mont.

Leaves with papillose cuticle; cells 50-75 × 25-30 µm. Grows on wet, shaded, clayey or sandy soils, in the lowlands and montane areas. Distributed in the northern and western part of the Peninsula, rare in the northeast and in Algeciras Mountains. Esp, Prt.

- 1 Leaves simple or bilobed with non-divergent lobes and narrow sinus; underleaves simple or bilobed, more than 2 cells deep from sinus to rhizoidal area 2

- 2 Underleaves emarginate or bilobed to 1/3, 4-14 cells deep from sinus to rhizoidal area 3

- 2 Underleaves bilobed to 1/2-1/3, 1-4 cells deep from sinus to rhizoidal area 5

- 3 Underleaves 4-6 cells deep from sinus to rhizoidal area, these cells 36-75 µm long; leaves usually as wide as long (fig. 47, 5-7) *C. muelleriana* (Schiffn.) Müll.Frib.

Grows on wet soils or rotten logs, from the lowland to the high mountains, in the northern and western part of the Peninsula, Algeciras Mountains and Monchique. Esp, Prt, And.

- 3 Underleaves 7-14 cells deep from sinus to rhizoidal area, these cells 20-50 µm long; leaves 1-1,3 times as long as wide 4

- 4 Some leaves with elongated marginal cells; oil-bodies present only in 1-3 rows of marginal cells; underleaves slightly bilobed, with more or less acute sinus (fig. 47, 8-10)

*C. neesiana* (C.Massal. & Carestia) Müll.Frib.

Forms mats on wet, acidic soils and rocks, from the lowland to the high mountains, in the northern part of the Peninsula. Esp, And.

- 4 Marginal cells of leaves quadrate, usually with some elongated cells intermixed; oil-bodies present in all leaf cells; underleaves entire or emarginate (fig. 47, 11-13)

*C. integristipula* Steph.

Forms mats on humus-rich soils, rocks and rotten stumps, in montane areas and high mountains. Rare, in the Pyrenees, Esp, And.



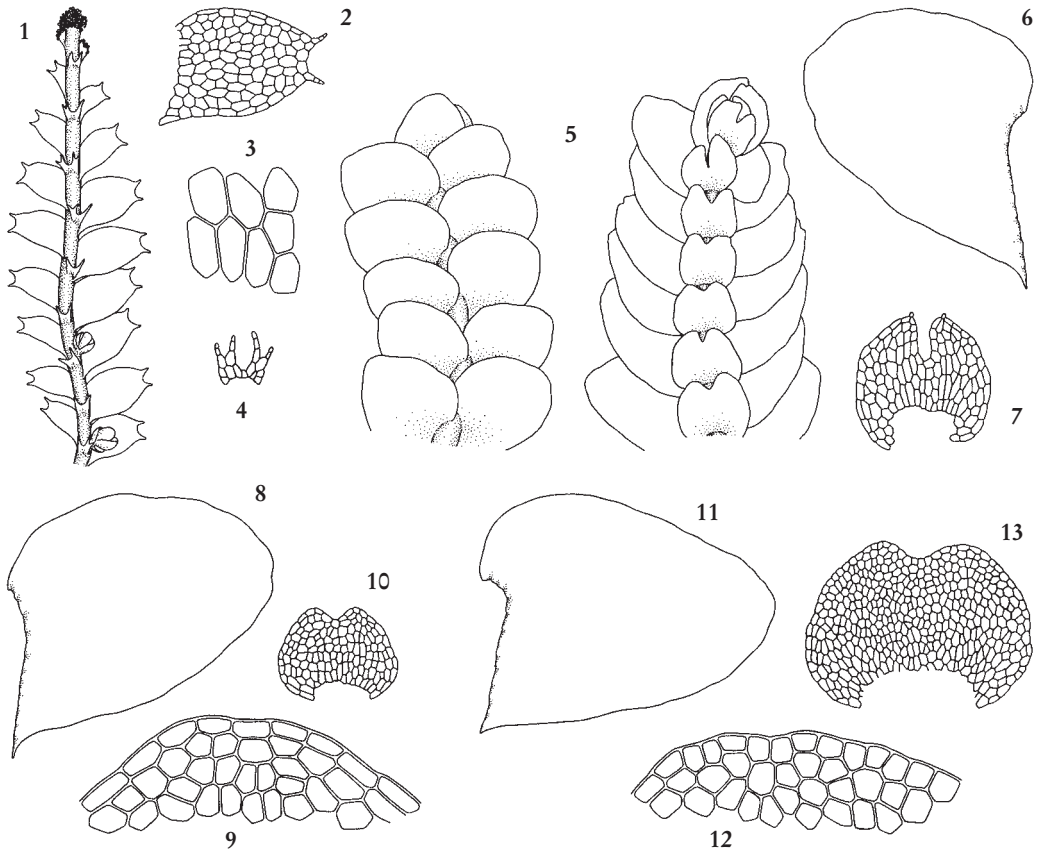


FIGURE 47. 1-4, *Calypogeia arguta*: 1, habit, ventral side; 2, leaf; 3, leaf cells; 4, underleaf. 5-7, *C. muelleriana*: 5, habits, dorsal and ventral sides; 6, leaf; 7, underleaf. 8-10, *C. neesiana*: 8, leaf; 9, leaf marginal cells; 10, underleaf. 11-13, *C. integristipula*: 11, leaf; 12, leaf marginal cells; 13, underleaf. 1, 5 ( $\times 14$ ); 2, 4, 6, 7, 8, 10, 11, 13 ( $\times 34$ ); 3, 9, 12 ( $\times 100$ ).

- 5 Median cells of leaves  $30-40 \times 25-35 \mu\text{m}$ ; plants 0,8-1,8 mm wide; median cells of underleaves  $30-40(50) \mu\text{m}$  long 6
- 5 Median cells of leaves  $45-75 \times 30-45 \mu\text{m}$ ; plants to 4 mm wide; median cells of underleaves  $40-80 \mu\text{m}$  long 7
- 6 Leaves distant to approximate, usually widest at base, with acute, obtuse or bidentate apex; underleaves less than twice as wide than stem (fig. 48, 1-4)

***C. sphagnicola* (Arnell & J.Perss.) Warnst. & Loeske**

Grows among *Sphagnum* in wetlands, from the lowland to the high mountains, in the northern and western part of the Peninsula. Esp, Prt, And.



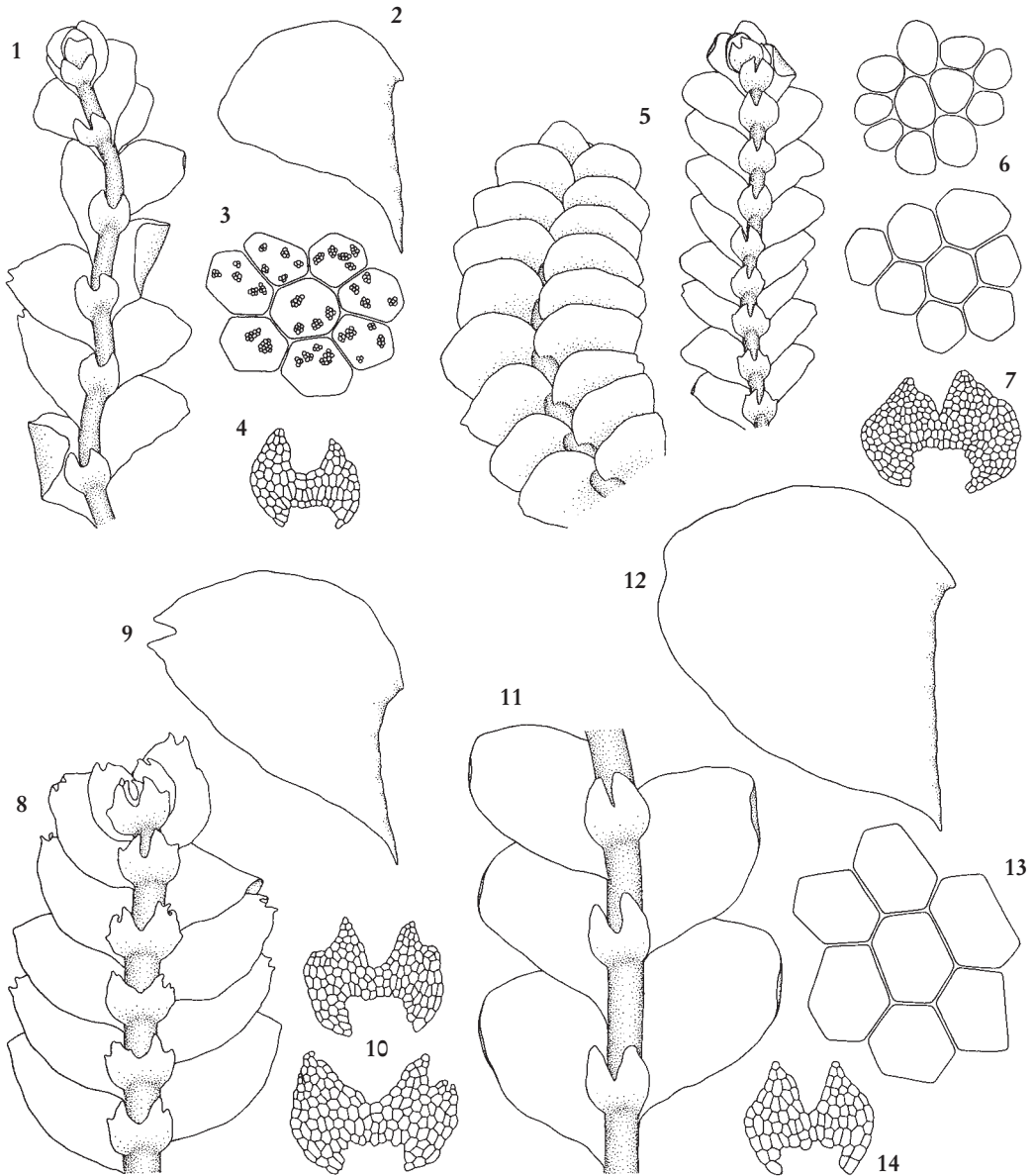


FIGURE 48. 1-4, *Calypogeia sphagnicola*: 1, habit, ventral side; 2, leaf; 3, leaf cells; 4, underleaf. 5-7, *C. suecica*: 5, habits, dorsal and ventral sides; 6, leaf cells; 7, underleaf. 8-10, *C. fissa*: 8, habit, ventral side; 9, leaf; 10, underleaves. 11-14, *C. azurea*: 11, habit, ventral side; 12, leaf; 13, leaf cells; 14, underleaf. 1, 5, 8, 11 ( $\times 14$ ); 12 ( $\times 30$ ); 2, 4, 7, 9, 10, 14 ( $\times 34$ ); 3, 6, 13 ( $\times 200$ ).

- 6 Leaves imbricate, widest 1/3-1/2 from base, with rounded, truncate or retuse apex; underleaves 2-3,5 times as wide as stem (fig. 48, 5-7)  
**C. suecica** (Arnell & J.Perss.) Müll.Frib.  
Grows on rotten stumps. Rare, in the Central Pyrenees and west of the Peninsula. Esp, Prt.
- 7 Oil-bodies colourless; leaf apex bidentate or more or less acute; leaves widest 1/3 from base (fig. 48, 8-10) **C. fissa** (L.) Raddi  
Grows on wet, shaded, acidic, humus-rich soils and at base or trunks and rhizome ferns, from the lowlands to the high mountains, in the northern and western part of the Peninsula, rare in the south. Esp, Prt, And.
- 7 Oil-bodies bluish; leaf apex obtuse or rounded; leaves usually widest near base (fig. 48, 11-14) **C. azurea** Stotler & Crotz  
Forms mats on wet, shaded, acidic soil and slopes and in rock crevices, from the lowlands to the high mountains. Distributed in the northern part of the Peninsula and Algeciras Mountains. Esp, Prt, And.

### Fam. Pseudolepicoleaceae

#### **Blepharostoma** (Dumort.) Dumort.

Plants to 1,5 cm long. Stem procumbent or ascending, irregularly branched. Leaves transversely inserted, lacinate, divided almost to base into 3-4(5) segments, each of 1 row of cells. Underleaves similar to leaves, usually 3-lobed. Monoicous. Perianth more or less cylindrical, contracted to longly ciliate mouth (fig. 49, 1-3)

**B. trichophyllum** (L.) Dumort.

Grows on wet, shaded humic soils, in rock crevices and on rotten stumps, from the lowlands to the high mountains, in the northern part of the Peninsula and in Algeciras Mountains. Esp, And.

### Fam. Trichocoleaceae

#### **Trichocolea** Dumort.

Plants to 10 cm long, having a fluffy appearance. Stem procumbent or ascending, 1-3 regularly pinnately branched; paraphyllia simple or branched, abundant on the dorsal side or stem and branches. Leaves transversely inserted, succubous, asymmetrical, lamina very reduced, deeply divided into 3-5 unequal lobes; margin with uniseriate laciniae. Underleaves bilobed, lacinate, smaller than leaves. Dioicous (fig. 49, 4-7)

**T. tomentella** (Ehrh.) Dumort.

Forms patches on wet soils and rocks by streams or on wet slopes, in montane areas, in the northern part of the Peninsula. Esp, Prt.

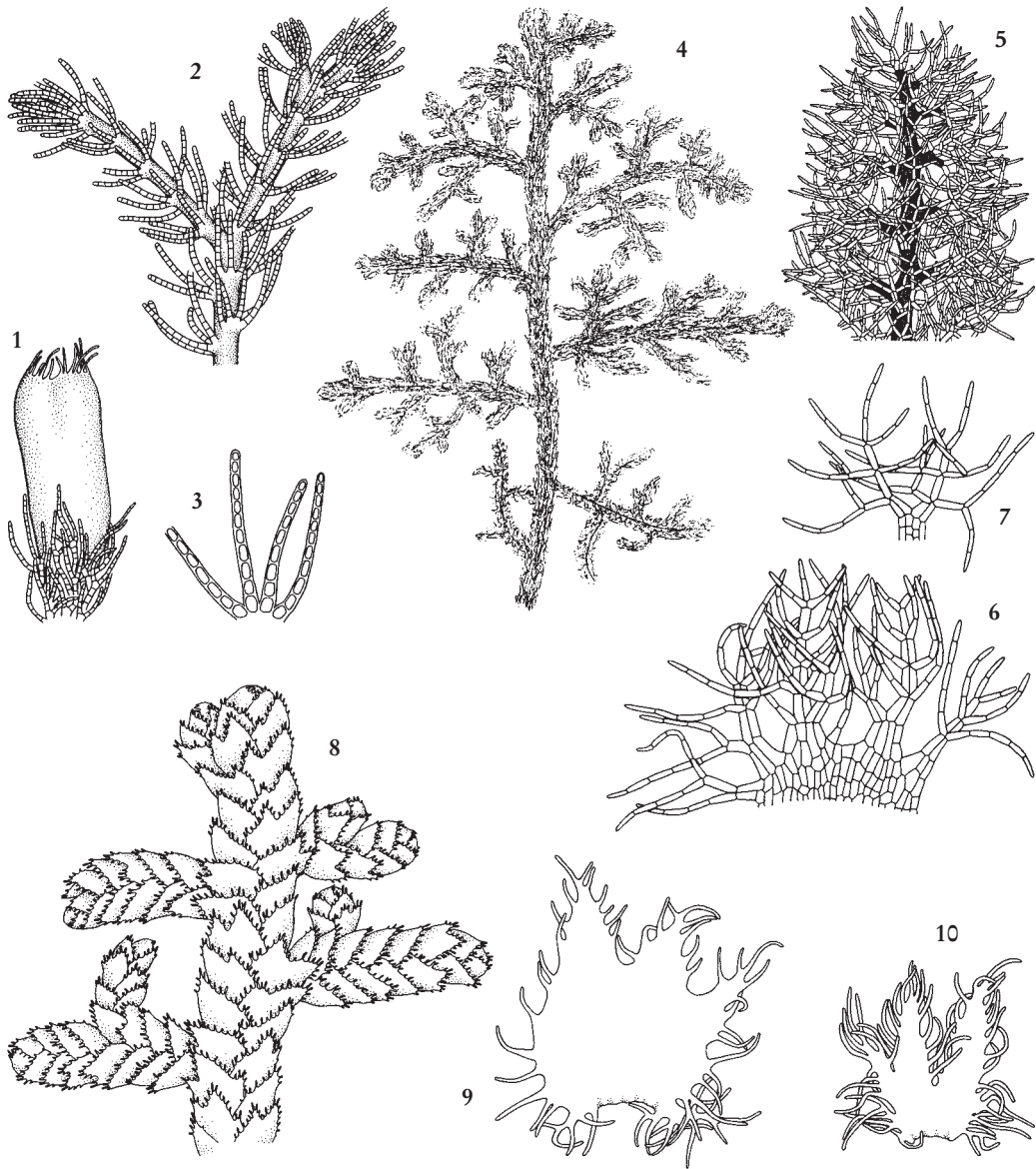


FIGURE 49. 1-3, *Blepharostoma trichophyllum*: 1, perianth; 2, habit; 3, leaf. 4-7, *Trichocolea tomentella*: 4, habit; 5, branch; 6, stem leaf; 7, branch leaf. 8-9, *Ptilidium ciliare*: 8, habit; 9, leaf. 10, *P. pulcherrimum*, leaf. 4 (×4); 8 (×8); 1, 9, 10 (×20); 2, 5 (×34); 3, 6, 7 (×54).

## Fam. Ptilidiaceae

### Ptilidium Nees

Plants to 5 cm long, yellowish, reddish brown or brownish. Stem prostrate, ascending or erect, 1-2 irregularly pinnately branched. Leaves almost transversely inserted, concave, bilobed, usually with ventral lobe or both lobes subdivided, giving leaves appearance of being 2-5-lobed; margin with simple or with basally-branched cilia, or laciniate. Underleaves similar to leaves but smaller, bifid or ciliate. Perianth cylindrical to clavate, with ciliate mouth. Dioicous.

- 1 Leaves divided to 1/2 in triangular or lanceolate lobes; the largest lobes 12-33 cells wide at base (fig. 49, 8-9) **P. ciliare** (L.) Hampe

Stem erect or ascending. Base of the largest lobe wider than marginal cilia length. Forms lax or dense tufts on acidic rocks and wet, humus-rich soils, in montane areas and high mountains, in the northern part of the Peninsula. Esp, And.

- 1 Leaves divided to 3/4 in narrowly lanceolate lobes; the largest lobes 5-10(12) cells wide at base (fig. 49, 10) **P. pulcherrimum** (Weber) Vain

Stem prostrate. Base of the largest lobe narrower than marginal cilia length. Forms dense patches on acidic rocks or rotten wood, in high mountains. Very rare, in the mountains of the north of the Peninsula and in Central Pyrenees. Esp.

## Fam. Radulaceae

### Radula Dumort.

Plants to 3 cm long, pale green to dark green or yellowish, in small, flattened mats. Stem prostrate, irregularly pinnately branched. Rhizoids sporadic, arising from ventral lobe, near to the keel. Leaves approximate or imbricate, spreading, alternate, incubous, bilobed, conduplicate, dorsal lobe ovate-orbicular or ovate, exceeding or not the stem, ventral lobe smaller, 1/3-1/5 of the size of dorsal lobe and appressed to it, rectangular, not crossing the stem; cells hexagonal, trigones minute or lacking, 1 large, central oil-body, rarely 2-3. Underleaves lacking. Gemmae, when present, developed in leaf margins, pluricellular, irregularly discoid. Perianth 2-4 times as long as wide. Paroicous or dioicous.

- 1 Dorsal margin of leaf not crossing the stem; gemmae very rare (fig. 50, 1-3)

#### **R. holtii** Spruce

Stem with thin-walled medullary cells. Median cells of leaves 15-25  $\mu\text{m}$  wide; marginal cells 12-18  $\mu\text{m}$  wide. Male inflorescences of 1-2 pairs of saccate bracts, below female bracts. Paroicous. Female bracts smaller than leaves, not saccate; usually with trumpet-shaped perianth. Grows on acidic rocks, bark of trees and by streams, in the lowlands. Distributed in the northwestern part of the Peninsula. Esp, Prt.

- 1 Dorsal margin of leaf crossing the stem; gemmae often present

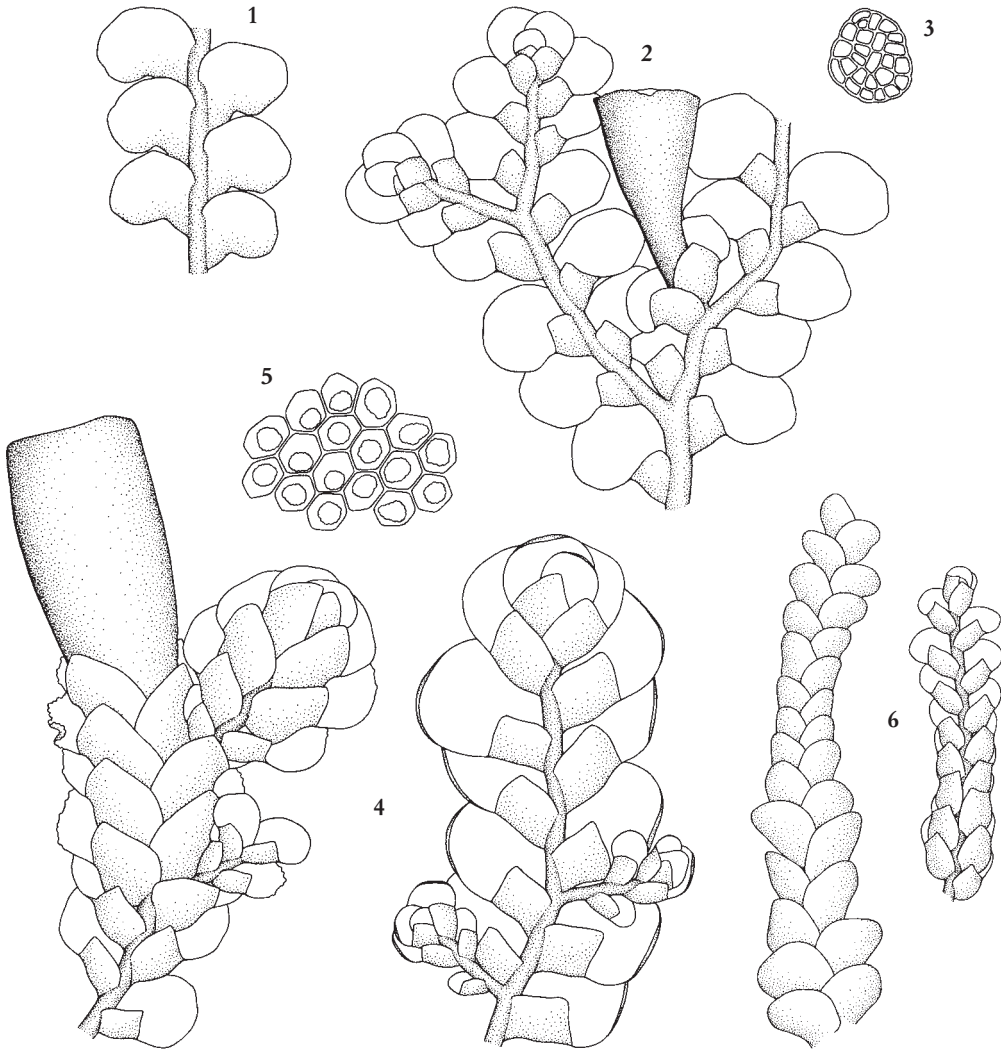


FIGURE 50. 1-3, *Radula holtii*: 1, plant, dorsal side; 2, plant with perianth, ventral side; 3, gemma. 4-5, *R. complanata*: 4, plants with and without perianth, ventral side; 5, leaf cells. 6, *R. lindenbergiana*, male plants, dorsal and ventral sides. 1, 2, 4, 6 ( $\times 16$ ); 3, 5 ( $\times 180$ ).

- 2 Paroicous, usually with perianths (fig. 50, 4-5) ***R. complanata* (L.) Dumort.**  
 Stem with thick-walled medullary cells. Median cells of leaves 20-30  $\mu\text{m}$  wide; marginal cells 16-24  $\mu\text{m}$  wide. Male inflorescences of 1-4 pairs of saccate bracts, at base of 2 saccate female bracts; perianth oblong. Grows on bark of trees and bushes, rarely on wet or shaded rocks, from the lowlands to high mountains. Widespread throughout the Peninsula and in Mallorca, Menorca and Pityusic Islands. Esp, Prt, And, Bl.

- 2 Dioicous, rarely with perianths (fig. 50, 6) **R. lindenberiana** C.Hartm.  
 Stem with thick-walled medullary cells. Median cells of leaves 15-23  $\mu\text{m}$  wide; marginal cells 10-18  $\mu\text{m}$  wide. Male inflorescences spiciform, of numerous, strongly imbricate, saccate bracts. Female inflorescences with bracts similar to vegetative leaves. Grows on wet, shaded rocks and bark of trees, in the lowlands and montane areas. Distributed in northern half of the Peninsula and mountain ranges of the west and south and in Mallorca. Esp, Prt, Bl.

## Fam. Porellaceae

### Porella L.

Plants medium-sized or robust. Stem procumbent, 1-3-pinnate. Leaves bilobed, conduplicate, with very short keel; dorsal lobe curved and shortly inserted, incubous, covering the stem, more or less orbicular, with entire or dentate margin; ventral lobe smaller, more or less parallel to stem. Underleaves large, more or less decurrent, margin plane to recurved, entire or dentate. Male inflorescence spiciform, ovate or elliptical, with saccate, imbricate bracts. Female plants usually more robust than male plants; archegonia and 1 pair of bracts on very short branches; perianth usually flattened, convex on the dorsal side, with ciliate or entire mouth. Dioicous.

- 1 Ventral lobe of leaves narrower than stem 2
- 1 Ventral lobe of leaves as wide or wider than stem 3
- 2 Underleaves longly decurrent, with undulate margins; median cells of dorsal lobe 30-40  $\mu\text{m}$  wide (fig. 51, 1-2) **P. cordaeana** (Huebener) Moore  
 Plants to 10 cm long, dark green, dull. Stem irregularly pinnately branched. Dorsal lobe of leaves imbricate to distant, cordate to ovate, with entire or sinuose margin, with 1-several large teeth near insertion, cells with small trigones; ventral lobe acute, undulate, decurrent. Underleaves often dentate at base. Forms lax mats on rocks or at base of trees, in wet or periodically submerged sites, in the lowlands and montane areas, in the north and the eastern part of the Peninsula. Esp, Prt, And.
- 2 Underleaves slightly decurrent, with plane margins; median cells of dorsal lobe (18)23-28  $\mu\text{m}$  wide (fig. 51, 3-4) **P. pinnata** L.  
 Plants to 6 cm long, dark green to blackish, dull. Stem irregularly pinnately branched. Dorsal lobes imbricate or approximate to distant, ovate to rectangular, rounded at apex; ventral lobe oblong or ovate, plane, slightly decurrent, with rounded apex; margin entire; cells with small trigones. Underleaves wider than stem. Grows on submerged rocks and roots in streams, in the northwestern part of the Peninsula. Esp, Prt.
- 3 Margin of underleaves flat, coarsely dentate to spinose ciliate (fig. 51, 5-7) **P. arboris-vitae** (With.) Grolle  
 Plants to 10 cm long, light green or brownish, with metallic sheen, acrid to the taste. Dorsal lobe imbricate, widely ovate, usually with acute, apiculate, more or less dentate apex; ventral lobe lanceolate, oblong or ovate, not decurrent, with spinose margin, rarely entire; cells with small trigones. Underleaves orbicular or oblong, longly decurrent. Forms mats on basic rocks and

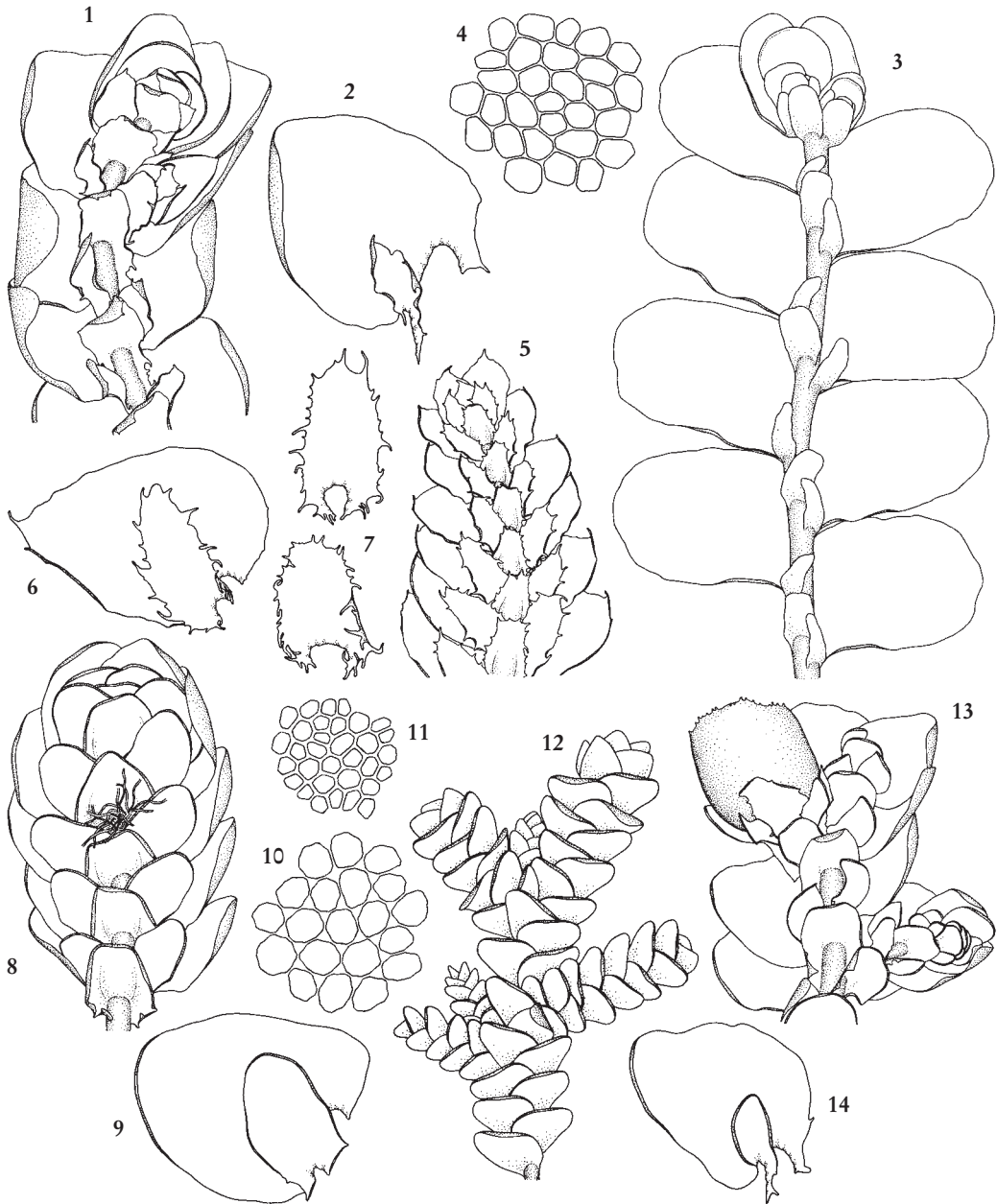


FIGURE 51. 1-2, *Porella cordaeana*: 1, habit, ventral side; 2, leaf. 3-4, *P. pinnata*: 3, habit, ventral side; 4, leaf cells. 5-7, *P. arboris-vitae*: 5, habit, ventral side; 6, leaf; 7, underleaves. 8-10, *P. obtusata*: 8, habit, ventral side; 9, leaf; 10, leaf cells. 11, *P. canariensis*, leaf cells. 12-14, *P. platyphylla*: 12, habit, dorsal side; 13, plant with perianth, ventral side; 14, leaf. 12 ( $\times 6$ ); 1, 3, 5, 8, 13 ( $\times 12$ ); 2, 6, 7, 9, 14 ( $\times 14$ ); 4, 10, 11 ( $\times 180$ ).



tree trunks, sometimes even hanging from trunks of bushes, in humid sites, in the lowlands and montane areas. Distributed in the northern half and eastern part of the Peninsula, very rare in the south, and in Mallorca. Esp, Prt, And, Bl.

- 3 Margin of underleaves recurved or undulate, entire or with short teeth on decurrent margin 4
- 4 Underleaves not or hardly decurrent; ventral lobe not decurrent 5
- 4 Underleaves decurrent; ventral lobe short or longly decurrent 6
- 5 Median cells of dorsal lobe 25-35  $\mu\text{m}$  wide (fig. 51, 8-10) **P. obtusata** (Taylor) Trevis  
Plants to 8 cm long, with or without metallic sheen. Dorsal lobe orbicular or ovate, with rounded apex; margin entire, more or less recurved; cells with large, bulging trigones. Ventral lobe wider than stem; margin entire. Underleaves similar in size to ventral lobe, with entire, recurved margins, not or only slightly decurrent. Perianth mouth irregularly dentate, with papilla-like teeth. Forms large wefts on acidic or basic rocks and soils, in the lowlands and montane areas. Widespread in the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 5 Median cells of dorsal lobe 18-25  $\mu\text{m}$  wide (fig. 51, 11) **P. canariensis** (F. Weber) Underw.  
Plants to 9 cm long, usually without metallic sheen. Dorsal lobe obtuse-rounded or with slightly truncate or acute apex; margin entire; cells with uniformly thickened walls. Ventral lobe with entire or sparsely dentate margins. Underleaves usually with sparsely dentate, sometimes entire margins, not or only slightly decurrent. Perianth mouth dentate to sparsely spinose, without papillae-like teeth. Saxicolous or corticolous, in the lowlands. Rare, in the north and west of the Peninsula and in Algeciras Mountains. Esp, Prt.
- 6 Median cells of dorsal lobe 25-35  $\mu\text{m}$  (fig. 51, 12-14) **P. platyphylla** (L.) Pfeiff.  
Plants to 8 cm long, dull. Stem regularly pinnately branched. Dorsal lobe cordate, convex, obtuse; ventral lobe as wide as stem, ovate, narrow, obtuse, longly or shortly decurrent; median cells of dorsal lobes with small or large, usually bulging trigones. Underleaves twice as wide as the ventral lobe, widely decurrent, with any teeth in the decurrence. Female bracts and ventral lobe entire, occasionally with 1-2 teeth, with rounded apex; perianth mouth sparsely ciliate. Forms mats on rocks, trunks of trees, in the lowlands and montane areas. Widespread in the Peninsula and in Mallorca. Esp, Prt, And, Bl.
- 6 Median cells of dorsal lobe 38-40  $\mu\text{m}$  **P. x baueri** (Schiffn.) C.E.O. Jensen  
Plants usually up to 8 cm long. Stem usually not regularly branched. Female bracts and ventral lobe dentate, with more or less acute apex. Perianth mouth densely ciliate. Forms mats on mostly calcareous soils and tree trunks, in montane areas. Scattered in the northern half of the Peninsula. Esp.

## Fam. Frullaniaceae

### Frullania Raddi

Plants small to medium-sized, dull green, reddish or dark brown. Stem irregularly branched or 1-3-pinnately branched. Rhizoids fascicled from underleaf base. Leaves



imbricate, bilobed, conduplicate, keel short or vestigial, incubous; dorsal lobe orbicular or ovate; ventral lobe smaller, involute, helmet-shaped or sac-shaped, sometimes evolute; leaf cells more or less thick-walled, sometimes with trigones, usually with ocelli arranged in 1-2 rows, spreading or in small groups in mid-leaf. Stylus present between ventral lobe and stem. Underleaves bilobed. Male inflorescences spiciform, on short branches, with imbricate bracts. Female inflorescences at the end of branches, with 2-5 pairs of bilobed, flat bracts. Perianth obovoid, with lateral and one or more ventral keels, abruptly narrowed in a beak. Dioicous.

- 1 Ventral lobe as long as wide, helmet-shaped; dorsal lobe without ocelli 2
- 1 Ventral lobe longer than wide, sac-shaped; dorsal lobe with or without ocelli 5
- 2 Ventral lobe more than 1/2 of dorsal lobe size; leaf cells thin-walled, with small trigones (fig. 52, 1-2) **F. oakesiana** Austin  
Plants to 0,8 mm wide. Dorsal lobe rounded at apex. Stylus 3-4 cells wide at base, ending in a uniseriate row of 3-5 cells. Grows generally on holly trees, in the lowlands and montane areas, in the northwestern part of the Peninsula. Esp, Prt.
- 2 Ventral lobe less than 1/2 of dorsal lobe size; leaf cells thick-walled, usually with bulging trigones 3
- 3 Stylus lanceolate, 4-8 cells wide at base, uniseriate or biseriate above; perianth trigonous, with 1 ventral keel (fig. 52, 3-5) **F. dilatata** (L.) Dumort.  
Plants to 4 cm long and to 1,5 mm wide, usually dark brown or reddish brown. Leaf cells more or less thick-walled, with large trigones. Perianth tuberculate in all its surface. Grows appressed to substrata, on rocks and bark of trees, from the lowlands to high mountains. Widespread in the Peninsula and in Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.
- 3 Stylus filiform or subulate, 2-6 cells wide at base, uniseriate above; perianth flattened, with 2-3 ventral keels 4
- 4 Underleaves with obtuse or subacute lobes and entire lateral margins, rarely with 1 small tooth (fig. 52, 6-9) **F. cesatiana** De Not.  
**F. riparia** Hampe ex Lehm.  
Plants to 2 cm long and 1,2 mm wide. Ventral lobe sometimes evolute. Stylus filiform, 2-4 cells at base, ending in a uniseriate row of 6-7 cells. Perianth with 2-3 narrow, ventral keels. Forms lax, light green or brown mats on rocks, soils and bark of trees, in very wet sites, in the lowlands and montane areas. Distributed in the northeastern part of the Peninsula and in Mallorca and Menorca. Esp, Bl.
- 4 Underleaves with acute lobes and lateral margins with 1-2 acute teeth (fig. 52, 10-12) **F. azorica** Sim-Sim, Sérgio, Mues & Kraut  
Plants to 0,8 mm wide, dark green or brownish. Stylus subulate, 3-6 cells wide at base, ending in a uniseriate row of 4-7 cells. Perianth with 2 broad, weakly tuberculate ventral keels. Grows appressed to bark of trees, in montane areas. Rare, in Serra da Estrela. Prt.
- 5 Dorsal lobe without ocelli (fig. 52, 13) **F. teneriffae** (F. Weber) Nees  
Plants to 6 cm long. Dorsal lobe acuminate or apiculate, ventral lobe reddish, darker than dorsal lobe, sometimes evolute. Stylus linear, 1-2-seriate, sometimes with a tooth near base.

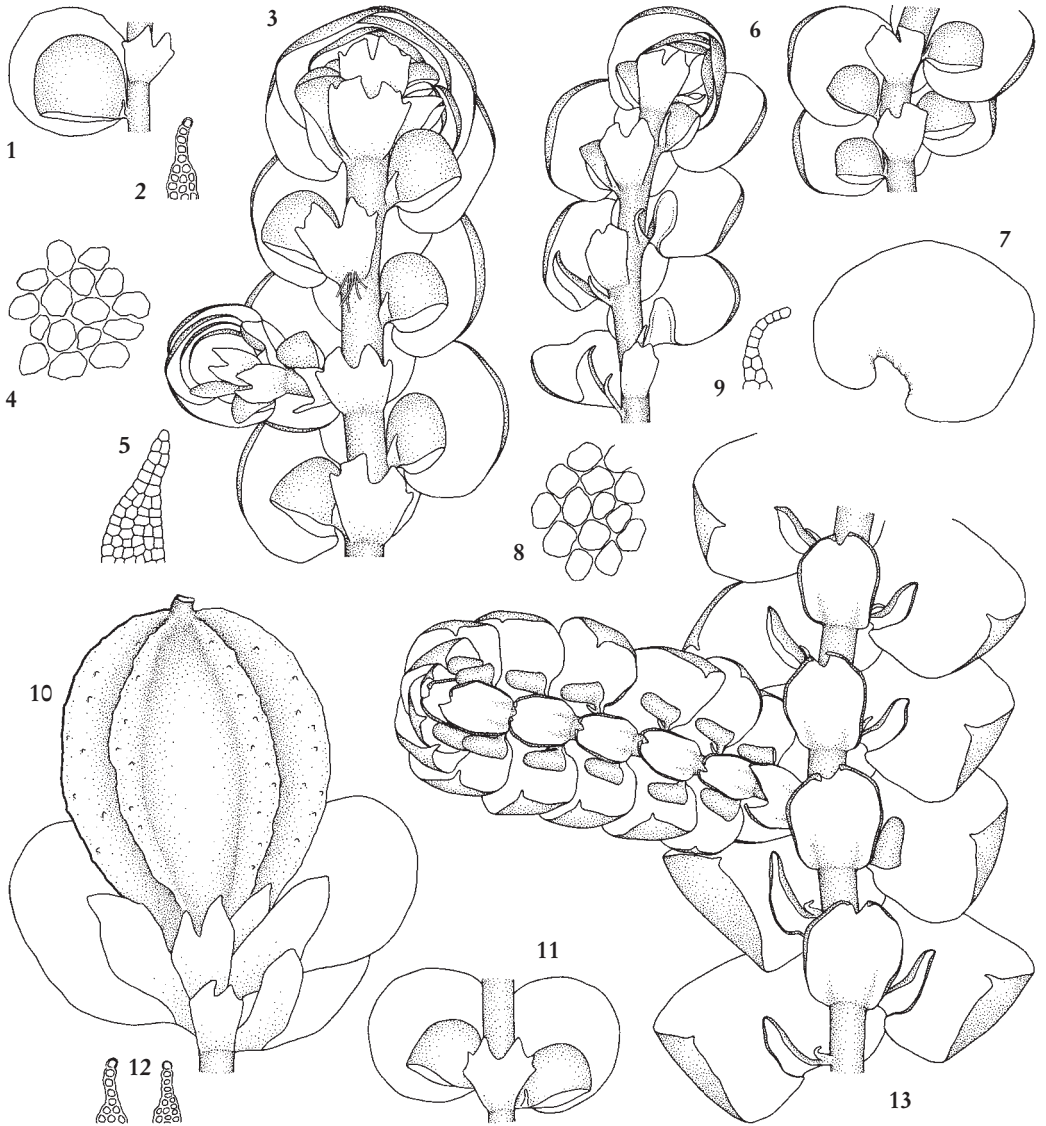


FIGURE 52. 1-2, *Frullania oakesiana*: 1, leaf and underleaf; 2, stylus. 3-5, *F. dilatata*: 3, habit, ventral side; 4, leaf cells; 5, stylus. 6-9, *F. cesatiana*: 6, habits, ventral side; 7, dorsal lobe; 8, leaf cells; 9, stylus. 10-12, *F. azorica*: 10, perianth; 11, leaf and underleaf; 12, styli. 13, *F. teneriffae*, habit, ventral side. 10, 13 ( $\times 25$ ); 1, 3, 6, 11 ( $\times 35$ ); 7 ( $\times 45$ ); 2, 5, 9, 12 ( $\times 107$ ); 4, 8 ( $\times 200$ ).

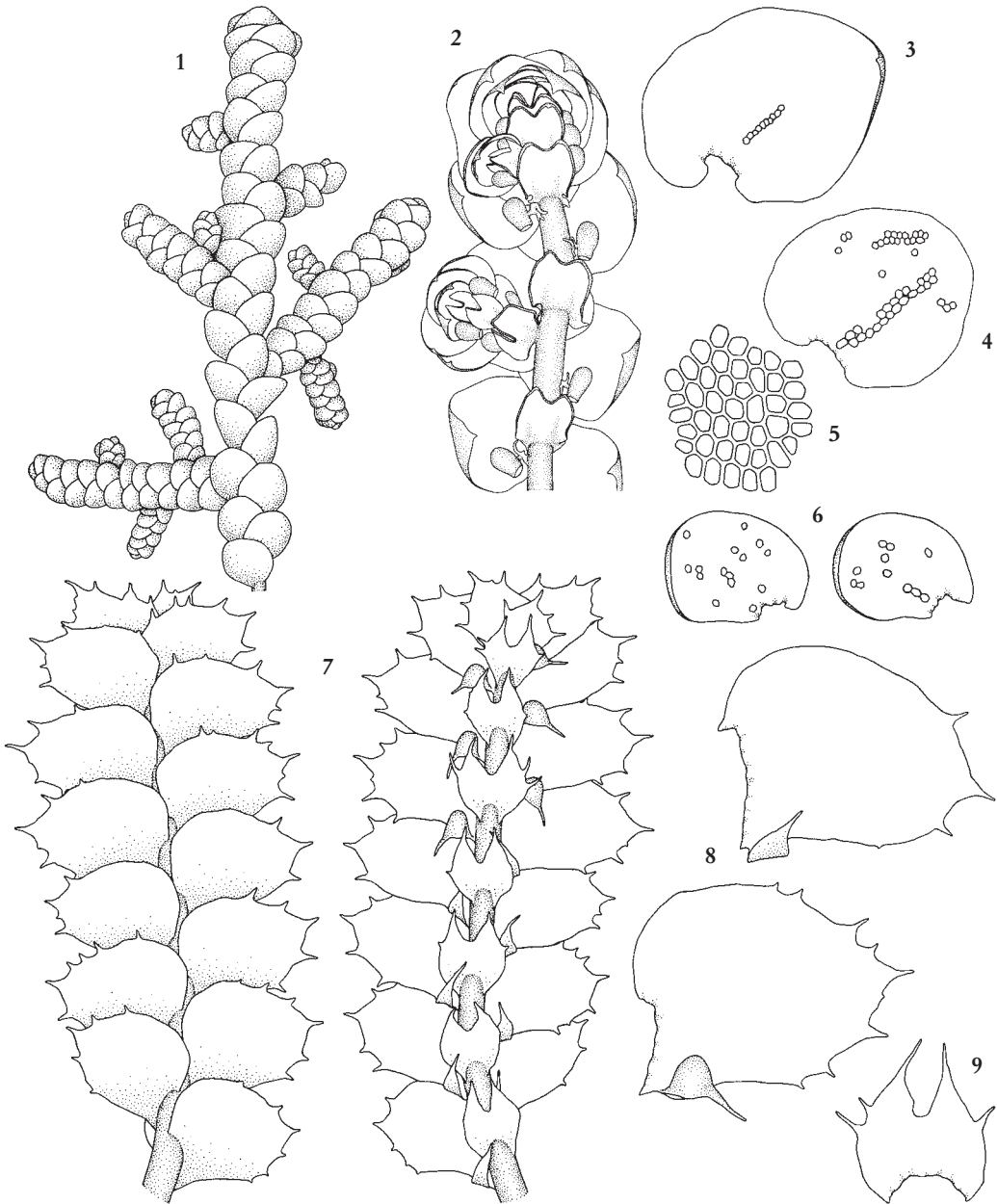


FIGURE 53. 1-3, *Frullania tamarisci*: 1, habit, dorsal side; 2, habit, ventral side; 3, dorsal lobe. 4-5, *F. microphylla*: 4, dorsal lobe; 5, cells of dorsal lobe. 6, *F. fragilifolia*, dorsal lobes. 7-9, *Jubula hutchinsiae*: 7, habits, dorsal and ventral sides; 8, leaves; 9, underleaf. 1 ( $\times 10$ ); 7 ( $\times 20$ ); 2 ( $\times 25$ ); 8, 9 ( $\times 30$ ); 3, 4, 6 ( $\times 45$ ); 5 ( $\times 200$ ).

- Underleaves elongated. Grows on rocks and bark of trees, in wet forests. Rare, in the south of the Peninsula. Esp, Prt.
- 5 Dorsal lobe with ocelli 6
- 6 Plants to 1 mm wide; leaves persistent; dorsal lobe acute or apiculate; ocelli in uniseriate row or scattered; underleaves with recurved margins, usually with auricles (fig. 53, 1-3) **F. tamarisci** (L.) Dumort.  
Plants polymorphic, to 10 cm long, reddish brown. Dorsal lobe concave, with recurved apex. Stylus 1-2-seriate, forming a disc at base. Forms dense pendent or ascending wefts on rocks and bark of trees, from the lowlands to high mountains. Widespread in the Peninsula and in Mallorca and Menorca. Esp, Prt, And, Bl.
- 6 Plants to 0,7 mm wide; leaves often caducous; dorsal lobe rounded; ocelli arranged in 2 rows or scattered; underleaves with plane margins, without auricles 7
- 7 Dorsal lobe with ocelli in 2 rows and with some scattered ocelli; median cells 13-15  $\mu\text{m}$  wide, uniformly thickened, without trigones (fig. 53, 4-5) **F. microphylla** (Gottsche) Pearson  
Plants to 4 cm long, dark green or reddish. Leaves caducous. Underleaves with acute lobes, entire, rarely with a small, obtuse tooth. Stylus often present, linear, sometimes with a laminar appendage at base. Forms small mats, appressed to substrata, corticolous, rarely saxicolous, in shaded sites. Rare, in the north, west of the Peninsula and in Algeciras Mountains. Esp, Prt.
- 7 Dorsal lobe with scattered ocelli; median cells 17-20  $\mu\text{m}$  wide, with thin or slightly thickened walls, with minute trigones (fig. 53, 6) **F. fragilifolia** (Taylor) Gottsche, Lindenb. & Nees  
Plants to 5 cm long, reddish to reddish brown, glossy, with branches appressed to substrata. Stylus often present, linear, sometimes with a laminar appendage at base. Underleaves with obtuse lobes, sometimes with an obtuse or rarely acute lateral tooth. Grows on very shaded rocks and bark of trees, in montane areas. Distributed in the northern half and west of the Peninsula. Esp, Prt.

## Fam. Jubulaceae

### Jubula Dumort.

Plants to 2 cm long, dark green. Stem irregularly pinnately branched. Leaves imbricate, longitudinally inserted, incubous, bilobed almost to base, conduplicate, dorsal lobe ovate; margin spinosely toothed or ciliate, ventral lobe much smaller than underleaves, helmet-shaped or ovate-lanceolate, sometimes recurved, with or without a long distal cilium; cells of dorsal lobe thin-walled, without trigones. Underleaves bilobed to 1/3-1/2, acute with entire to spinose-dentate or ciliate margin. Male inflorescences on short branches. Female bracts with lanceolate, dentate ciliate lobes. Perianth truncate-obovate, up to 2,2 mm long. Autoicous or dioicous (fig. 53, 7-9)

#### **J. hutchinsiae** (Hook.) Dumort.

Grows on wet, shaded, preferentially acidic rocks and slopes by streams, in forests, in the lowlands. Distributed in the north of Spain. Esp.

## Fam. Lejeuneaceae

### *Marchesinia* Gray

Plants to 3 cm long, 2 mm wide, olive green or brownish. Stem procumbent, sparsely branched. Rhizoids fascicled from the underleaves base. Leaves incubous, bilobed, conduplicate, dorsal lobe imbricate, ovate-orbicular, with entire margin, crossing stem, ventral lobe smaller, sub-orbicular, usually with 2 teeth at margin; median cells of dorsal lobes 25-30  $\mu\text{m}$  wide, thin-walled, trigones lacking or very small. Underleaves orbicular, entire or retuse, 3-4 times wider than stem. Autoicous. Perianth dorsiventrally compressed (fig. 54, 1-2)

***M. mackaii*** (Hook.) Gray

Grows on calcareous or acidic rocks and bark of trees, in the lowlands. Scattered on the periphery of the Peninsula and in Mallorca. Esp, Prt, Bl.

### *Drepanolejeunea* (Spruce) Schiffn.

Plants minute, to 1 cm long, pale green to yellowish green. Stem prostrate, irregularly branched, sometimes with flagelliform branches. Leaves distant to approximate, erectopatent, bilobed, conduplicate; dorsal lobe convex at base, ovate-lanceolate, abruptly narrowed in an often reflexed, acute or acuminate apex, with 1-2-celled teeth at the end; ventral lobe inflated, 1/2-2/3 length of dorsal lobe, ovoid, with a 1-celled apical tooth, elongated, acute, usually curved. Underleaves bilobed, lobes diverging, acuminate, 2 cells wide at base, sinus lunate. Perianth 5-keeled almost to base, dentate, with beaked mouth. Dioicous or autoicous (fig. 54, 3-4)

***D. hamatifolia*** (Hook.) Schiffn.

Grows on humid, acidic rocks, sometimes on tree bark, in forests, sometimes by streams, in the lowlands. Distributed in the north and northwestern part of the Peninsula and in Sintra. Esp, Prt.

### *Harpalejeunea* (Spruce) Schiffn.

Plants small, 1 cm long, yellowish or greenish yellow. Stem procumbent, branched. Leaves distant to almost imbricate, spreading, bilobed, conduplicate; dorsal lobe ovate, acute; ventral lobe ovate, inflated, 1/2 length of dorsal lobe; margin entire; median cells 15-20  $\mu\text{m}$ , smooth, 4-6 granulose oil-bodies, 2-5 ocelli at base of dorsal lobes. Underleaves twice as wide as stem, triangular or obcordate, with divergent, rounded lobes, 4-6 cells wide at base. Dioicous (fig. 54, 5)

***H. molleri*** (Steph.) Grolle

Grows on wet, acidic rocks, rotten wood or as an epiphyte or on other bryophytes, in the lowlands. Distributed in north and western part of the Peninsula, rare in the northeast and in Algeciras Mountains. Esp, Prt.

### *Lejeunea* Lib.

Plants small or very small, usually creeping, light green, dark green or yellowish. Stem with 7-12 cortical cells and 4-15 medullary cells. Rhizoids fascicled from the underleaves base. Leaves incubous, bilobed, conduplicate; dorsal lobe rounded to ovate, more or less flat, with entire margin; ventral lobe to 1/2 length of dorsal lobe, sometimes



FIGURE 54. 1-2, *Marchesinia mackaii*: 1, habits, dorsal and ventral sides; 2, leaf. 3-4, *Drepanolejeunea hamatifolia*: 3, habits, dorsal and ventral sides; 4, underleaf. 5, *Harpalejeunea molleri*, habit, ventral side. 1, 2 ( $\times 20$ ); 3, 5 ( $\times 75$ ); 4 ( $\times 200$ ).

reduced or vestigial, with a short, blunt, apical teeth bearing a proximal hyaline papilla; cuticle smooth or slightly papillose; leaf cells with or without trigones, oil-bodies simple or granulose, numerous or scarce, persistent or not. Underleaves bilobed, with straight or connivent lobes. Male inflorescence usually on short branches. Female inflorescence on stem or on short branches, sometimes with subperianthal innovations; perianth beaked, with 1-5 crenulate or smooth keels or keels absent. Autoicous.

- 1 Plants to 1,2 cm long, 0,3-0,5(0,8) mm wide; dorsal lobe of leaves elliptical or semi-ovate, rounded or subacute at apex; cuticle slightly papillose; perianth smooth (fig. 55, 1-2) **L. mandonii** (Steph.) Müll. Frib.

Plants light green or whitish. Leaves usually distant, 0,2-0,4 mm long; ventral lobe 1/3-1/2 length of leaf, with a subglobose hyaline papilla; leaf cells 17-23  $\mu\text{m}$  wide, 8-15 oil-bodies per cell, simple or slightly granulose, not persistent. Underleaves (1,85)2-3 times wider than stem. Perianth with 1 subperianthal innovation. Grows in mostly granitic rocks and crevices or as an epiphyte, in permanent wet and shaded sites, in the lowlands, near coastal areas. Rare, in the north and western part of the Peninsula. Esp, Prt.

- 1 Plant size and leaf shape variable; cuticle smooth; perianth 5-keeled 2

- 2 Dorsal lobe of leaves ovate or slightly elliptical, rounded to subacute at apex; leaves usually distant; oil-bodies simple, numerous, not persistent or in globose, dark clusters in dried plants; subperianthal innovations lacking (fig. 55, 3) **L. holtii** Spruce

**L. eckloniana** Lindenb.

Plants to 2(2,5) cm long, 0,6-1,5(1,8) mm wide, dark green to greyish. Stem sparsely branched. Leaves 0,5-0,9(1) mm long; ventral lobe less than 1/4 length of leaf, with an elongated hyaline papilla; leaf cells 20-40  $\times$  20-34  $\mu\text{m}$ , oil-bodies very small. Underleaves 1,5-3(4) times wider than stem. Perianth widely keeled in the upper 1/2. Grows on rocks and earthy ledges, by streams or waterfalls, usually in waterlogged sites, also in oak woods and riverside forests, in the lowlands. Rare, in the north and northwest of the Peninsula. Esp, Prt.

- 2 Dorsal lobe of leaves elliptical, suborbicular, subquadrate, obovate or ovate; leaves distant or imbricate; oil-bodies simple or granulose, numerous or scarce, persistent or not; subperianthal innovations present 3

- 3 Underleaves usually contiguous in mature stems; oil-bodies numerous, simple, glistening, persistent; perianth narrowly keeled in the upper 1/2-1/4 (fig. 55, 4-6)

**L. cavifolia** (Ehrh.) Lindb.

Plants 1,6(2) cm long, 0,4-1,5 mm wide, green to yellowish. Leaves usually imbricate, 0,45-0,74 mm long; ventral lobe 1/4-1/2 length of leaf, with elongated hyaline papilla; leaf cells 24-45  $\times$  20-38  $\mu\text{m}$ . Underleaves 2-4 times wider than stem. Perianth with smooth keels and with (1)2 subperianthal innovations. Saxicolous, terricolous-saxicolous or epiphytic, in sheltered habitats, forests, bushes, rocky sites, usually on neutro-basic substrata, from the lowlands to high mountains. Distributed in the northern half, rarer in Sierra Nevada, Algeciras Mountains and Mallorca, Menorca and Pithyusic Islands. Esp, Prt, And, Bl.

- 3 Underleaves distant in mature stems; oil-bodies 2-6(8) per cell, granulose, opaque, not persistent; perianth keeled to below middle 4



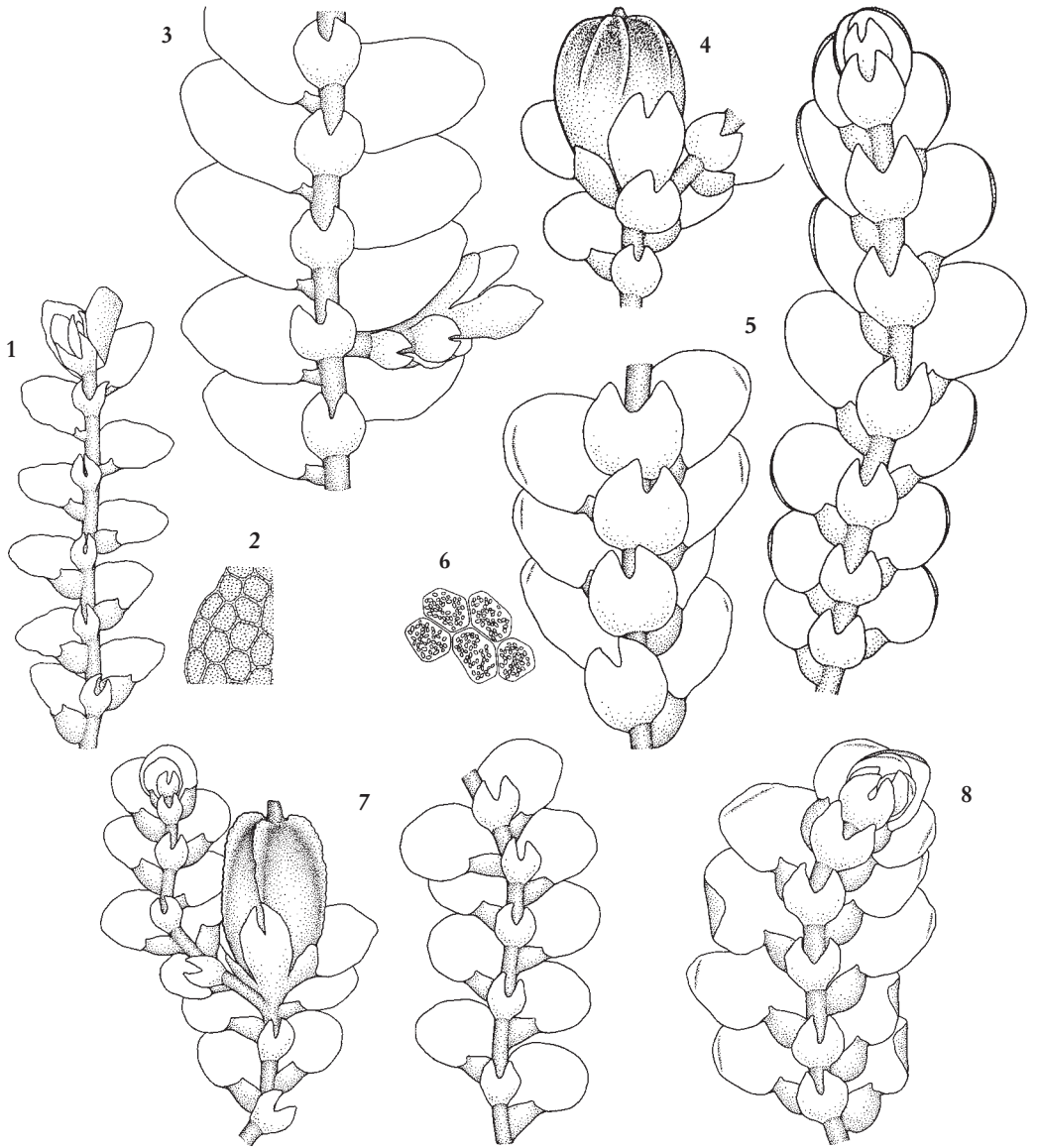


FIGURE 55. 1-2, *Lejeunea mandonii*: 1, habit, ventral side; 2, cuticle. 3, *L. holtii*, plant with female branch, ventral side. 4-6, *L. cavifolia*: 4, perianth; 5, habits, ventral side; 6, leaf cells with oil-bodies. 7, *L. lamacerina*, plants with and without perianth. 8, *L. patens*, habit, ventral side. 3, 4, 5, 7, 8 ( $\times 33$ ); 1 ( $\times 39$ ); 2, 6 ( $\times 200$ ).



- 4 Angle between dorsal lobe and keel obtuse to straight, 110-180°; keel straight, more or less convex; leaves distant to imbricate (fig. 55, 7) **L. lamacerina** (Steph.) Schiffn.  
Plants to 1,5(2) cm long, 0,4-1,5 mm wide, green to yellowish. Leaves 0,6-0,8 mm long; ventral lobe 1/5-1/2 length of leaf, generally variable in shape along the stem, with an elongated hyaline papilla; leaf cells 16-34  $\mu\text{m}$  wide. Underleaves 2-3 times wider than stem. Perianth with smooth or more or less crenulate keels, and 0-2 subperianthal innovations. Grows on moderately acidic rocks and soils, at base of trees in riverside forests or in wet forests in general, in the lowlands and montane areas. Distributed in the north and west of the Peninsula and in the Spanish Central Range and the Algeciras Mountains. Esp, Prt.
- 4 Angle between dorsal lobe and keel nearly right-angled, 70-90°; keel strongly convex; leaves usually imbricate (fig. 55, 8) **L. patens** Lindb.  
Plants to 2 cm long, 0,3-1,2 mm wide, pale green to whitish. Leaves 0,45-0,60 mm long; ventral lobe 1/3-1/2 length of leaf, not very variable in shape along the stem, with an elongated hyaline papilla; leaf cells 16-30  $\times$  (12)16-26  $\mu\text{m}$ . Underleaves 2-3 times wider than stem. Perianth with more or less crenulate keels, and 1-2 subperianthal innovations. Grows on shaded rocks and earthy ledges, in wet forests, in the lowlands. Rare, in the north and northwest of the Peninsula. Esp, Prt.

### **Microlejeunea** Steph.

Plants minute, less 1 cm long. Stem prostrate, sparsely branched. Leaves bilobed, conduplicate; dorsal lobe ovate or cordate, slightly convex, with obtuse or rounded apex, ventral lobe inflated, ovate, a little shorter than dorsal lobe, with a 1-celled tooth; margin entire; median cells 16-24  $\mu\text{m}$  wide, trigones small, 3-8 granulose oil-bodies, usually 1-3 ocelli at base. Underleaves bilobed, lanceolate, usually connivent, with acute sinus. Dioicous (fig. 56, 1)

**M. ulicina** (Taylor) A.Evans

Grows on bark of trees, rarely on wet rocks, in the lowlands. Distributed in the northern and western part of the Peninsula, rare in the northeast and in Algeciras Mountains. Esp, Prt.

### **Cololejeunea** (Spruce) Schiffn.

Plants minute, to 6 mm long, light green to yellowish. Stem prostrate, irregularly branched; branches with a collar at base. Leaves erect or erecto-patent, imbricate to distant, bilobed, conduplicate; dorsal lobe ovate to ovate-lanceolate, convex; ventral lobe similar to or 1/2 length of dorsal lobe, inflated, with 1-2 teeth at apex, 1-2-celled; margin entire, crenulate or dentate; cells smooth or with rounded or conic papillae. Stylus filiform, of 1-several uniseriate cells. Underleaves lacking. Gemmae on leaves, pluricellular, discoid, unistratose, rarely 2-stratose in the centre. Perianth obovoid or pyriform, 5-keeled at least at apex. Autoicous.

- 1 Dorsal lobe of leaves ovate-orbicular, rounded, similar to ventral lobe or a little larger (fig. 56, 2) **C. minutissima** (Sm.) Schiffn.  
Stem sometimes geniculate. Dorsal lobe with median cells (16)20-24  $\mu\text{m}$  wide, mostly isodiametric; ventral lobe with a small, 2-celled tooth at apex. Stylus 1-celled, ephemeral. Grows appressed to bark of trees, or on other bryophytes, rarely on rocks, in the lowlands. Distributed in the north and western part of the Peninsula, rare in the northeast. Esp, Prt.

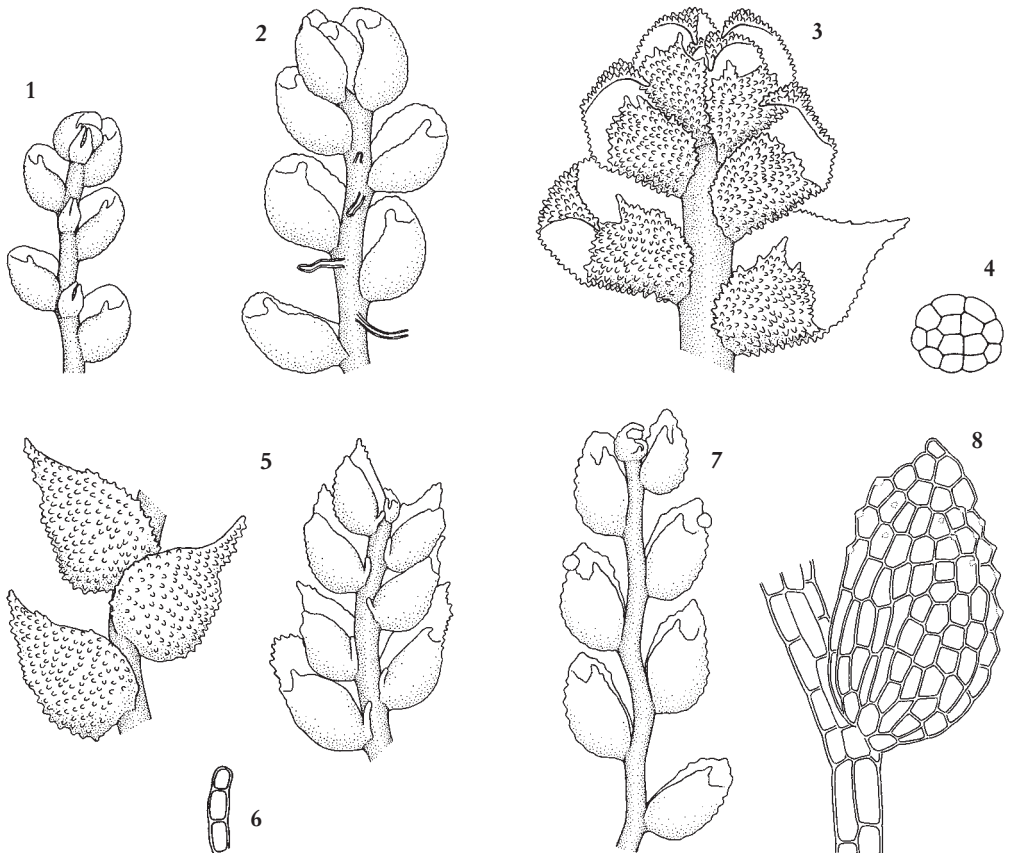


FIGURE 56. 1, *Microlejeunea ulicina*, habit, ventral side. 2, *Cololejeunea minutissima*, habit, ventral side. 3-4, *C. rossettiana*: 3, habit, ventral side; 4, gemma. 5-6, *C. calcarea*: 5, habits, dorsal and ventral sides; 6, stylus. 7-8, *Aphanolejeunea microscopica*: 7, habit, ventral side; 8, dorsal lobe. 1, 2, 3, 5, 7 ( $\times 75$ ); 4, 6, 8 ( $\times 200$ ).

- 1 Dorsal lobe of leaves ovate or ovate-lanceolate, acuminate, twice as long as ventral lobe 2
- 2 Margins of ventral lobe almost plane, dentate, with conically papillose cells; stylus unicellular, ephemeral (fig. 56, 3-4) **C. rossettiana** (C.Massal.) Schiffn.  
Grows on shaded, calcareous rocks, wall of caves, bark of trees or on other bryophytes, in the lowlands and montane areas. Scattered on the periphery of the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.
- 2 Margins of ventral lobe incurved, entire, with smooth cells; stylus 2-4-celled, persisting (fig. 56, 5-6) **C. calcarea** (Lib.) Schiffn.

Grows on shaded, wet, calcareous rocks, bark of trees or on other bryophytes, in wet sites, in the lowlands and montane areas. Distributed in the north and northeastern part of the Peninsula and in Mallorca. Esp, Bl.

### **Aphanolejeunea** A.Evans

Plants slender, minute, to 5 mm long, pale green or whitish. Stem prostrate, irregularly branched; branches without a collar at base. Leaves distant, patent or erect, bilobed, conduplicate; dorsal lobe narrowly oblong-ovoid, convex, with obtuse or acute apex, margin smooth or crenulate owing to bulging cells, apical cells flat or bulging, median cells irregular, 12-20  $\mu\text{m}$  wide, smooth; ventral lobe similar to dorsal lobe in shape and size, inflated, margin incurved near apex, with 1(2) short teeth, 1-2-celled. Underleaves lacking. Gemmae discoid, pluricellular, ellipsoidal, with some bulging marginal cells, (60)85-110  $\mu\text{m}$  wide, at margins or on the dorsal side of leaf lobes. Paroicous (fig. 56, 7-8)

**A. microscopica** (Taylor) A.Evans

Grows on wet siliceous rocks and rotten trunks by streams. Very rare, in the northwestern part of the Peninsula. Esp.

## Cl. ANTHOCEROTOPSIDA (HORNWORTS)

Plants with dorsiventral symmetry, thallose, dull, dark green, becoming blackish when dry, usually forming rosettes, more or less lobate. Thallus prostrate, with internal mucilage-filled cavities invaded by globose *Nostoc* colonies, usually in ventral part; cells mostly with a single plate-like, large chloroplast. Rhizoids unicellular, smooth. Antheridia clustered in cavities. Capsule projecting from the surface of thallus, cylindrical, with columella, wall green with stomata, dehiscing by 2 valves; seta lacking. Pseudoelaters present.

### O. Anthocerotales Fam. Anthocerotaceae

#### *Anthoceros* L.

Thalli cavernous, without ventral tubers; cells with 1(4) chloroplasts per cell. Antheridia numerous, more than 10 per cavity, antheridial wall of 4 rows of cells. Spores polar, grey, dark brown to blackish, spinose, punctate or with lamellae, with or without a defined trilete mark in the proximal face. Monoicous.

- 1 Spores smoky-grey to blackish, 40-60 (65)  $\mu\text{m}$  in diameter, proximal faces spinose or lamellate, with conspicuous trilete mark bordered by a smooth band (fig. 57, 1)

#### *A. caucasicus* Steph.

Plants in irregular erect, compact rosettes, variable in size. Thalli with lacerate lobes, frequently crisped. Antheridia 120-180  $\mu\text{m}$  long. Capsule cylindrical, 2-4 cm long. Spores translucent. Grows on road ledges and wet slopes by streams or springs, usually on acidic substrata, in the lowlands and montane areas. Scattered in the west of the Peninsula. Esp, Prt.

- 1 Spores dark brown to blackish, 30-44 (53)  $\mu\text{m}$  in diameter, proximal face nearly smooth and punctate, with less-defined trilete mark and without band 2

- 2 Antheridia 120-250  $\mu\text{m}$  long (fig. 57, 2-5)

#### *A. punctatus* L.

Plants in rosettes, 1-3,5 cm in diameter. Thalli irregularly divided into lobes with undulate-crisped margins. Capsule cylindrical 2-3 cm long. Spores distal face with numerous spines frequently united in base. Grows in grasslands and on road ledges and wet slopes by streams or springs, usually on acidic substrata. Scattered in the Peninsula. Esp, Prt.

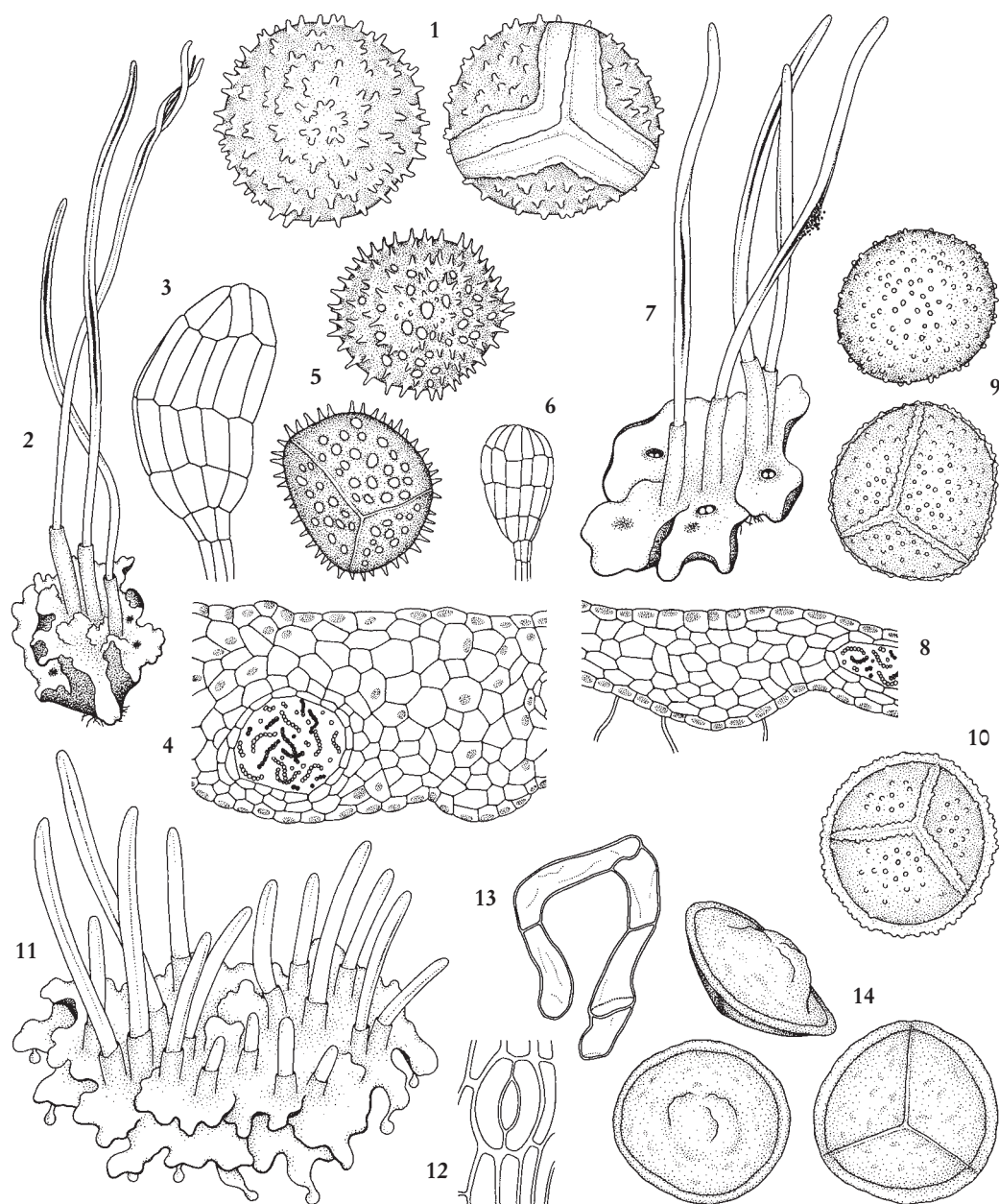


FIGURE 57. 1, *Anthoceros caucasicus*, spores, distal and proximal face. 2-5, *A. punctatus*: 2, thallus with sporophytes; 3, antheridium; 4, thallus section; 5, spores, distal and proximal face. 6, *A. agrestis*, antheridium. 7-9, *Phaeoceros laevis*: 7, thallus with sporophytes; 8, thallus section; 9, spores, distal and proximal face. 10, *P. carolinianus*, spore, proximal face. 11-14, *Phymatoceros bulbiculosus*: 11, thallus with sporophytes; 12, stoma; 13, pseudoelater; 14, spores, in profile, distal and proximal face. 2, 7, 11 ( $\times 2,5$ ); 4, 8 ( $\times 60$ ); 3, 12 ( $\times 200$ ); 6 ( $\times 250$ ); 13 ( $\times 450$ ); 1, 5, 9, 10, 14 ( $\times 550$ ).

- 2 Antheridia 60-80  $\mu\text{m}$  long (fig. 57, 6) **A. agrestis** Paton  
 Similar to *A. punctatus*, but generally forming smaller rosettes to 1 cm in diameter and more crisped at margins. Grows by roads and in fields, on acidic substrata. Rare, in the west of the Peninsula. Prt.

## O. Notothyladales Fam. Notothyladaceae

### Phaeoceros Prosk.

Thalli solid, with or without short marginal or ventral tubers; cells with 1(2) chloroplasts per cell. Antheridia (1)2-6(8) per cavity, cells of antheridial wall not arranged in rows. Spores polar, yellow when completely mature, densely papillose-spinulose on distal face, with equatorial wing more or less conspicuous, with trilete mark in the proximal face. Monoicous or dioicous.

- 1 Plants dioicous; proximal face of spore totally finely granulose or papillose, with inconspicuous wing (fig. 57, 7-9) **P. laevis** (L.) Prosk.  
 Plants in rosettes to 5 cm in diameter. Thalli repeatedly and irregularly lobate, simple or with entire or crenulate margins, frequently crisped, sometimes with tuber-like thickenings on the ventral side. Capsule cylindrical, to 4 cm long. Spores 25-45  $\mu\text{m}$  in diameter, yellow; distal face convex, papillose-granulose; proximal face with trilete mark. Dioicous. Grows on wet slopes and soils, in herbaceous vegetation, mainly on acidic substrata, from the lowlands to high mountains. Distributed in the Peninsula and in Mallorca and Menorca. Esp, Prt, Bl.
- 1 Plants monoicous; proximal face of spore with scattered minute papillae only in central part, wing evident, about 3-5  $\mu\text{m}$  wide (fig. 57, 10) **P. carolinianus** (Michx.) Prosk.  
 Similar to *P. laevis*. Spores 35-50  $\mu\text{m}$  in diameter, yellow; proximal face finely granulose to smooth. Monoicous. Grows on wet, shaded sites, in the lowlands. Distributed in the west of the Peninsula, rare in the north and northeastern part. Esp, Prt.

## O. Phymatocerotales Fam. Phymatocerotaceae

### Phymatoceros Stotler *et al.* emend. Duff *et al.*

Thalli solid with long-stalked ventral tubers; cells with 1(2) chloroplasts per cell. Antheridia 1-3(4) per cavity, cells of antheridial wall not arranged in rows. Spores polar, yellow to brownish when completely mature, thin-walled, smooth or obscured by late spore wall deposition, with equatorial wing; distal face convex, with 1-3 distal protuberances (fig. 57, 11-14)

**P. bulbiculosus** (Brot.) Stotler *et al.*  
**Phaeoceros bulbiculosus** (Brot.) Prosk.

Plants frequently dimorphic, not forming rosettes. Thalli 1-3 cm in diameter, divided in irregular lobes. Capsule cylindrical, short, to 0,8-1,5(2) cm long. Spores 45-58(62)  $\mu\text{m}$  in diameter, yellow but in mature capsules, become brownish black, smooth or finely papillose. Generally dioicous rather than monoicous. Grows in open, exposed sites during the rainy season, on alluvial soil, ravine margins and wet, exposed slopes, on acidic substrata, rarely on calcareous or schist rocks, in the lowlands. Distributed in the western half of the Peninsula, rare in the east. Esp, Prt.





## GLOSSARY

- acumen** Long and tapering point forming an angle less than 45°.
- acuminate** Ending in an acumen [fig. B, 1].
- acute** Tapering to a point forming an angle 45°-90° [fig. B,1].
- air canal** Narrow air cavity delimited by vertical columns of green cells, in many *Riccia* spp. [fig. C, 3].
- air chamber** In most complex thallose liverworts, specialized internal air-containing cavity, pored and usually lined with photosynthetic filaments [fig. C,3].
- alternate** Leaves positioned at different levels on opposite sides of stem (cf. *opposite*) [fig. A, 1].
- alveolate** Having alveoli.
- alveolus / alveoli (pl.)** Area on a surface, usually limited by lamellae, e.g. in some spores of *Riccia* and *Fossombronia* [fig. D, 4].
- angulate** Having angles or corners [fig. 24, 4].
- antheridium / antheridia (pl.)** Male reproductive organ [fig. 57, 3].
- apex** The tip or summit of a structure.
- apical** At apex or tip; referring to the apex.
- apiculate** Ending in an apiculus [fig. B, 1].
- apiculus / apiculi (pl.)** Short abrupt point.
- appendage** An external body part, or natural prolongation; in some Marchantiales, a lobe at apex or at margin of ventral scales [fig. C, 2].
- appressed** Closely applied, as the leaves against the stem [fig. A, 2].
- archegonium / archegonia (pl.)** Female reproductive organ.
- arcuate** Curved.
- areola / areolae (pl.)** An angular-shaped areas visible on a smooth dorsal surface, in some Marchantiales [fig. C, 2].
- ascending** Growing upwards from an older part applied to substrate.
- attenuate** Tapering gradually.
- auricle** Small, ear-like lobe at the basal margin of a leaf.
- auriculate** Having auricles.
- autoicous** Monoicous plant, having archegonia and antheridia in separate inflorescences on the same plant [fig. B, 4].
- axis / axes (pl.)** 1. The main stem; a conceptual line around which structures (leaves, branches, etc.) develop. 2. An imaginary line through the middle of a structure.
- basal** At the base of a structure; referring to the base.
- beak** Projection formed by strong constriction below perianth mouth [fig. 52, 10].
- biconvex** Convex on both sides.
- bidentate** Two-toothed [fig. B, 1].

- bifid** Deeply divided into two parts [fig. 21, 3].
- bilobed** Divided into two lobes [fig. A, 3].
- bract** Modified leaf associated with a reproductive organ [fig. D, 3].
- branch** Lateral division of the main axis.
- caducous** Falling off early [fig. 46, 6].
- calyptra** A membranous covering of haploid tissue over the developing sporophyte.
- capsule** Terminal part of the sporophyte, containing spores and usually elaters or pseudoelaters [fig. D, 2].
- carinate** Longitudinally folded forming a keel [fig. 38, 3].
- cavernous** Filled with cavities or hollow areas [fig. 57, 4].
- central strand** Longitudinal cylinder of small, thin-walled cells at the centre of the midrib [fig. 17, 3].
- channelled** Groove-shaped, U-shaped in cross-section [fig. A, 3; C, 3].
- chlorenchyma** Specialized layer of chlorophyll-containing cells [fig. C, 3].
- chlorophyllose** Containing chlorophyll; generally green unless masked by some other pigments.
- ciliate** Having cilia [fig. B, 2].
- cilium / cilia (pl.)** Fine hairs, usually unicellular and unbranched, at the margin of a structure.
- clavate** Club-shaped [fig. 13, 11; 30, 4].
- collar** Lobes around the base of a branch, in *Cololejeunea*.
- columella** Central column of sterile tissue in the capsule of Anthocerotae.
- concave** Curved inwards [fig. C, 3].
- conduplicate** Bilobed leaf with the two lobes placed together face to face, with the keel conspicuous or lacking [fig. A, 3].
- confluent** Merging together seamlessly.
- connivent** Directed or pointing together, though not fused, as the tips of leaf lobes inclined and converging towards one another [fig. A, 3].
- constricted** Abruptly narrowed [fig. 2, 10].
- convex** Curving outwards [fig. C, 3].
- cordate** Heart-shaped [fig. 51, 2].
- coriaceous** Of or like leather.
- cortex** Outer layer or layers of cells of a stem surrounding the medulla.
- cortical** Referring to the cortex.
- crenulate** With minute, rounded projecting cell walls along the margin [fig. B, 2].
- crisped** Strongly curled and twisted [fig. 18, 1].
- cuticle** The outer layer of the external wall of cells.
- cylindrical** Cylinder-shaped, e.g. capsule or perianths in some species [fig. 26, 16].
- decurrent** Anything which extends below its point of origin on a structure. Leaves with basal margins extending below the stem past the leaf insertion [fig. 31, 7; 31, 8].
- dehisce** Opening to releasing spores.
- dentate** With teeth [fig. B, 2].
- denticulate** Finely dentate [fig. B, 2].
- denudate** Stem with leaves worn away or lost [fig. 46, 6].
- depauperate** Poorly developed.
- digitiform** Finger-shaped [fig. 10, 7; 37, 8].
- dimorphic** Having two different forms.
- dioicous** Producing archegonia and antheridia on separate plants [fig. B, 4].
- discoïd** Flattened and disclike or platelike [fig. 5, 5].
- distal** Away from the base or point of attachment (cf. *proximal*) [fig. D, 4].
- divergent** Spreading in opposite directions [fig. 47, 2].
- dorsal** Said of the upper surface, away from the substrate of stems or thalli (cf. *ventral*) [fig. A, 1; C, 2; C, 3]. Of a leaf, the underside.

- dorsiventral** Flattened, with distinct upper (dorsal) and lower (ventral) surfaces.
- elater / elaters (pl.)** Differentiated elongate cell, sterile, normally with one to three helicoidal wall thickenings, found interspersed among the spore mass in most liverwort capsules [fig. 18, 3].
- ellipsoidal** An elliptical solid [fig. 22, 4].
- elliptical** Ellipse-shaped [fig. A, 3].
- emarginate** Broad rounded apex shallowly divided with an acute sinus [fig. B, 1].
- emergent** Partially exposed [fig. 26, 13].
- entire** Smooth on the margin; lacking teeth [fig. B, 2].
- ephemeral** Short-lived.
- epidermis** The outer cell layer of a stem or thallus [fig. C, 3].
- epiphyte** A plant growing on another plant, usually a tree or a shrub.
- epiphytic** Growing on another plant.
- erect** Vertical [fig. A, 2].
- erecto-patent** Posture between erect and patent, leaves making an angle with the stem of 45° or less [fig. A, 2].
- eroded** Worn away [fig. 30, 6].
- evolute** Of a ventral lobe which is unrolled or plane [fig. 53, 8].
- filiform** Having the form of or resembling a thread.
- flaccid** Soft, limp, not rigid.
- flagelliform** Slender, whiplike stem or branch, leafless or with much reduced leaves [fig. 46, 1].
- flank** Dorsal surface between the median groove and the margin of thallus, in *Riccia*, [fig. C, 2].
- foliose** leafy or leaf-like.
- furcate** Divided into two equal parts [fig. C, 1].
- fusiform** Spindle-shaped.
- gametophyte** The haploid, gamete-producing generation; in bryophytes, the dominant generation.
- gemma / gemmae (pl.)** Propagule globose, ellipsoidal, cylindrical, angulate or stellate, uni- or pluricellular [fig.].
- gemmiferous** Bearing gemmae [fig. 37, 4].
- geniculate** Sharply bent as a knee.
- germinative pore** Small opening in the wall of a spore [fig. D, 4].
- gibbous** Swollen or bulging on one side [fig. A, 3].
- glabrous** Smooth; not papillose, rough or hairy.
- glaucous** With a whitish, greyish, or bluish bloom.
- globose** Spherical.
- granulose** Roughened with minute, blunt projections. See also oil-body granulose.
- habit** General appearance of a plant.
- helicoid** Twisted or shaped like a spiral, helix, or the thread of a screw [fig. 18, 3; 18, 16].
- high mountains** Referring to land above c. 1800 m.
- humic** Rich in partly decayed vegetation and other organic matter.
- humus** Decomposing organic material.
- hyaline** Colourless and transparent.
- hyaloderm** Uni- or pluristratose outer layer of cortex of comparatively large, thin-walled, colourless cells [fig. 29, 2].
- imbricate** Closely appressed and overlapping, like shingles on a roof [fig. A, 1].
- immersed** 1. Submerged. 2. Sunk inside a structure [fig. D, 1; D, 2].
- incubous** Leaves, in plant dorsal view, so placed that the upper part of each one covers the base of the leaf next above it (cf. *succubous*) [fig. A, 1].
- incurved** 1. Curved inward and upward. 2. Applied to a leaf or thalli margins curved towards the dorsal side (cf. *recurved*) [fig. 38, 8].
- inflated** Swollen, strongly concave.
- inflorescence** Gametangia and surrounding bracts [fig. D, 3].

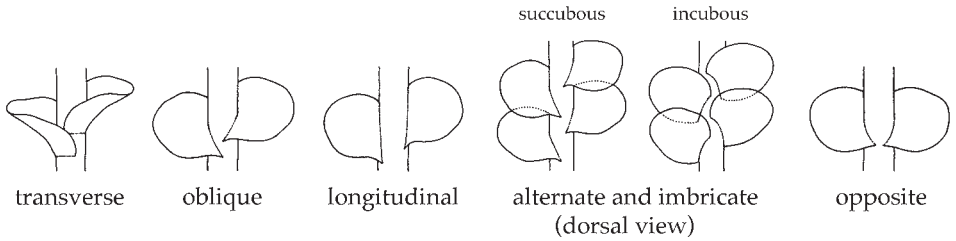
- innovation** A lateral branch that forms at base of or within an inflorescence after the sex organs have matured.
- insertion** Line or point of attachment of a structure; applied to leaves and branches on a stem [fig. A, 1].
- intercalary** Between base and apex of stem.
- involucre** A protective sheath of tissue of thallose origin surrounding antheridia, archegonia or the sporophyte [fig. D, 3; 16, 6].
- involute** Rolled inwards.
- isodiametric** About as broad as long.
- julaceous** Stem or branch with cylindrical appearance, because of the strongly imbricate, concave leaves [fig. 30, 7].
- keel** Ridge formed along a sharp fold of a leaf, perianth or involucre [fig. 38, 3; 52, 10].
- lacerate** Deeply and irregularly cut or torn.
- lacinate** Fringed with cilia [fig. B, 2].
- lamella / lamellae (pl.)** Perpendicular, small lamina, along a thallus, perianth or spore surface. See also middle lamella [fig. D, 4].
- lamina** 1. Thin or thinner part of thallus on each side of midrib [fig. 6, 2]. 2. Simple leaf. 3. In a lobed leaf, part below lobes.
- lanceolate** Lance-shaped [fig. A, 3].
- leaf** A photosynthetic, laminal outgrowth from the stem.
- lenticular** Shaped like a lentil or a double-convex lens [fig. 5, 7].
- linear** Long, narrow and with parallel sides, applied to leaves, appendages and cells.
- lingulate** Tongue-shaped [fig. A, 3].
- lobate** Divided into lobes.
- lobe** Division of a leaf or a thallus [fig. A, 3; C, 2].
- longitudinal insertion** Applied to leaves which line of attachment is parallel to axis [fig. A, 1].
- lowlands** Referring to land up to c. 800 m.
- lumen / lumina (pl.)** The cell cavity inside the cell walls.
- lunate** Shaped like a crescent moon [fig. 3, 3; 4, 7].
- margin** The edge of a laminal structure [fig. C, 2].
- marsupium / marsupia (pl.)** A swollen and elongate pouch-like structure with rhizoids, developed at stem and that penetrates downward into the substrate and encloses and protects the sporophyte [fig. 33, 4].
- mat** A densely interwoven, horizontal growth form.
- median** Middle or central.
- Mediterranean Region** [fig. 1].
- medulla / medullae (pl.)** The central region of a stem, surrounded by cortex.
- medullary** Of or relating to the medulla.
- middle lamella** A colourless or less often pigmented layer between cellulose walls of adjacent cells [fig. 43, 6].
- midrib** Thickened central part of thallus [fig. C, 2; C, 3].
- monoicous** With antheridia and archegonia on the same plant, including *autoicous*, *paroiicous* and *synoicous*.
- montane areas** Referring to land c. 800-1800 m.
- mouth** Opening of the perianth or involucre.
- mucilage** A clear, gel-like, slimy secretion of some liverworts.
- mucilaginous** Relating to or secreting mucilage.
- obcordate** Heart-shaped, with the point of attachment at the narrow end [fig. 29, 3].
- oblique insertion** Applied to leaves which line of attachment is diagonal to axis [fig. A, 1].
- oblong** Rectangular with rounded corners or ends, applied to cells and leaves [fig. A, 3].
- obovate** Egg-shaped with apex broader than base [fig. A, 3].

- obovoid** An obovate solid [fig. 52, 10].
- obtuse** Broadly pointed, more than 90° [fig. B, 1].
- ocellus / ocelli (pl.)** Leaf cell having one large oil body and lacking chloroplasts, also found in underleaves, bracts and perianths of certain leafy liverworts [fig. 53,6].
- oil-body** Intracellular opaque or translucent bodies containing oil.
- oil-body granulose** Oil-body consisting of two or more oil-containing structures [fig. 48, 3].
- oil-body simple** Oil-body consisting of a single oil-containing structure [fig. 28, 10].
- opposite** Leaves positioned at the same level on opposite sides of stem (cf. *alternate*) [fig. A, 1].
- orbicular** Circular in outline [fig. A, 3].
- ovate** Egg-shaped with base broader than apex [fig. A, 3].
- ovoid** An egg-shaped solid.
- palmate** With finger-like lobes radiating from centre [fig. C, 1].
- papilla / papillae (pl.)** Minute, rounded projection [fig. 10, 6; 10, 8].
- papillose** Having papillae [fig. 30, 9; 35, 6-7].
- paraphyllum / paraphyllia (pl.)** Small, filiform or laminal outgrowths, sometimes branched, scattered on the stem.
- paricous** Monoicous plant with the antheridia just below the archegonia but in separated inflorescences [fig. B, 4].
- parenchyma** A tissue of relatively undifferentiated, usually thin-walled, isodiametric, non-chlorophyllose cells [fig. C, 3].
- patent** Leaf forming an angle about 45-60° with the stem [fig. A, 2].
- pedicel** A thin, more or less long support for some antheridia, archegonia or propagules [fig. 4, 8; 57, 6].
- pedicellate** Having or supported by a pedicel.
- perianth** Tubular structure formed by the fusion of two or three leaves that protects the archegonia or the sporophyte [fig. D, 3].
- perigynium / perigynia (pl.)** A somewhat fleshy, tubular structure around the archegonial cluster and developing sporophyte, derived from peripheral axial cells elevating the perianth (when present) and female bracts [fig. D, 3].
- pinnate** With numerous, spreading branches on opposite sides of the stem [fig. 15, 9].
- plano-convex** Of an axis of thallus that is flat above and convex below.
- pligate** With longitudinal furrows or pleats [fig. 35, 1].
- polyicous** Said of a species, in which there coexists the dioicous form with any type of monoicous form.
- pore** Opening on the dorsal surface of the thallus [fig. C, 2].
- pore compound** Pore surrounded by two or more rings of superposed cells [fig. C, 3; 5, 10].
- pore simple** Pore surrounded by one or more concentric but not superposed cells [fig. C, 3; 4, 4].
- procumbent** Laying flat on the ground but not attached by rhizoids.
- prominent** Obvious, standing out, like the pores of some thallose liverworts [fig. 4, 4].
- propagule / propagules (pl.)** Body serving for vegetative reproduction of the plant.
- propaguliferous** Having propagules.
- prostrate** Lying flat on the ground and attached by rhizoids; creeping.
- proximal** Near the base or point of attachment (cf. *distal*) [fig. D, 4].
- pseudoelater** Unicellular or multicellular sterile filament found interspersed among the spore mass in the capsule, in the hornworts.
- pseudoperianth** Tissue surrounding the developing sporophyte [fig. D, 3].
- punctate** Dotted, usually referring to spore markings [fig. 57, 5].
- pyriform** Pear-shaped [fig. 13, 12].
- receptacle** 1. Disc or wart-like mass of tissue bearing antheridia or archegonia and found directly on the thallus, inside the thallus, or elevated [fig. D, 1; D, 2]. 2. Asexual reproductive structure in the Marchantiales [fig. 5, 6].

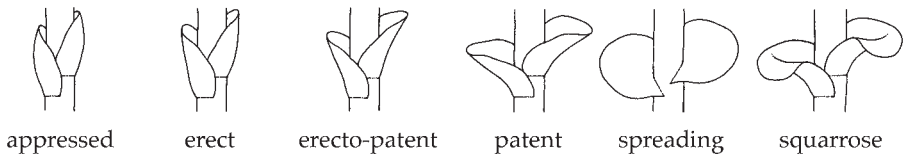
- recurved 1.** Curved downward and backwards. **2.** Applied to a leaf or thalli margins curved towards the ventral side (cf. *incurved*) [fig. 21, 11].
- reflexed** Leaves bent down and inwards, between spreading and squarrose.
- reniform** Kidney-shaped [fig. A, 3].
- reticulate** Forming a network [fig. C, 2].
- retuse** Broad rounded apex shallowly divided with a rounded sinus [fig. B, 1].
- rhizoidal** Referring to the rhizoids.
- rhizoids** Unicellular, root-like filaments that arise from thallus or stem, usually anchor the gametophyte to the substratum [fig. C, 3; 28, 8].
- rosette** A growth habit with thalli radiating from a central point, as in *Riccia* or in hornworts. [fig. C, 1].
- rudimentary** Incompletely developed.
- saccate** Sac-like; abruptly and deeply concave.
- saprolignicolous** Living on rotten wood.
- saxicolous** Growing on rocks.
- scale 1.** Leaf-like, unistratose structure, often hyaline or reddish; ventral scales most commonly occur along the ventral surface in thallose liverworts [fig. C, 2; C, 3]. **2.** Linear appendage on the stalk of receptacles in the Marchantiales [fig. 3, 2].
- secund** Said of leaves or branches strongly turned to one side [fig. 29, 8].
- seriate** Arranged in rows.
- sessile** Without a stalk.
- seta / setae (pl.)** Part of sporophyte holding the capsule [fig. D, 2].
- sheathing** Surrounding and clasping the stem or the perianth [fig. 39, 11].
- simple 1.** Of leaves or amphigastria, not lobed [fig. 27, 18]. **2.** Thallus or stem not branched [fig. C, 1]. **3.** See also oil-body simple.
- sinuose** Wavy or uneven, applied to leaf margins or cell walls [fig. B, 2].
- sinus** Notch or indentation between two adjacent lobes [fig. A, 3].
- spathulate** Spoon-shaped, narrow at base and gradually broad above.
- spiciform** Spike-shaped [fig. 50, 6].
- spine** Short, sharp-pointed tooth [fig. D, 4].
- spinulose** Minutely spiny.
- spore** A unicellular, haploid reproductive body produced in the sporangium as a result of meiosis.
- sporophyte** The spore-bearing, diploid generation, remaining attached to the gametophyte.
- spreading** Leaf forming an angle about 90° with the stem [fig. A, 2].
- squarrose** Leaves spreading at right angles, upper part strongly curved back at an angle of 90° or more [fig. A, 2].
- stalk** Structure that supports male and female receptacles, in some Marchantiales [fig. D, 1; D, 2].
- stellate** Star-shaped.
- stem** The main axis of a foliose gametophyte.
- stoma / stomata (pl.)** Minute, epidermal opening of the capsule, usually at base, surrounded by two reniform cells, in Anthocerotes.
- stria / striae (pl.)** Fine ridge or line.
- striate** Having striae.
- stylus / styli (pl.)** A small, narrow or flattened structure found between the ventral lobe and the stem in certain leafy liverworts [fig. 52, 2].
- subulate** Leaves long and narrowly triangular with an acute or rounded apex [fig. A, 3].
- succubous** Leaves, in plant dorsal view, so placed that the upper part of each one is covered by the base of the next higher leaf [fig. A, 1].
- tetrad** A group of 4; e.g. spore tetrad: group of four developing spores remaining united at maturity [fig. 13, 13].
- thallose** Of or pertaining to a thallus.

- thallus / thalli (pl.)** A more or less flattened, gametophyte, not differentiated into a stem and leaves.
- transverse insertion** Applied to leaves whose line of attachment is at right angles to axis [fig. A, 1].
- trigone** Thickened walls at the corners of three adjoining cells [fig. B, 3].
- trilete** Applied to bipolar spores with a triradiate ridge on the proximal face and a more or less convex distal face [fig. D, 4; 7, 11].
- truncate** Abruptly cut off at the apex [fig. B, 1; 13, 6].
- tuber** A subterranean outgrowth produced on the marginal or ventral surface of thallus [fig. 57, 11].
- tubercle** Small blunt protuberance.
- tuberculate** With small, blunt protuberances [fig. 9, 7; 52, 10].
- tuft** Growth form with stems erect but radiating at the edges.
- turf** Growth form with stems erect, parallel and close together; often covering extensive areas.
- underleaves** Leaves, usually smaller and often with a shape different from that of the other leaves on the stem, in a row on the ventral side of the stem [fig. 32, 4].
- undulate** Wavy [fig. 3, 1; 13, 3].
- unistratose** One-layered.
- valve** One of the parts into which the capsule of most liverworts and hornworts separates upon dehiscence [fig. 32, 1].
- ventral** Said of the lower surface, next to the substrate of stems or thalli (cf. *dorsal*) [fig. C, 2; C, 3].  
Of a leaf, the side facing the axis, the upperside.
- verrucose** Warty or roughened [fig. 3, 2].
- wart** A small, ± rounded elevation or protuberance.
- warty** Covered with small wart-like protuberances [fig. 3, 4].
- weft** A loosely interwoven, often ascending growth form.
- wing** 1. Lamina of thallus [fig. C, 2; C, 3]. 2. A laminal expansion or appendage such as the margin of a spore, the keel of a perianth or involucre, or folded leaf [fig. D, 4; 52, 10].
- winged** Having wings.

**1. Leaf insertion and orientation**



**2. Leaf arrangements**



**3. Leaf and underleaf shapes**

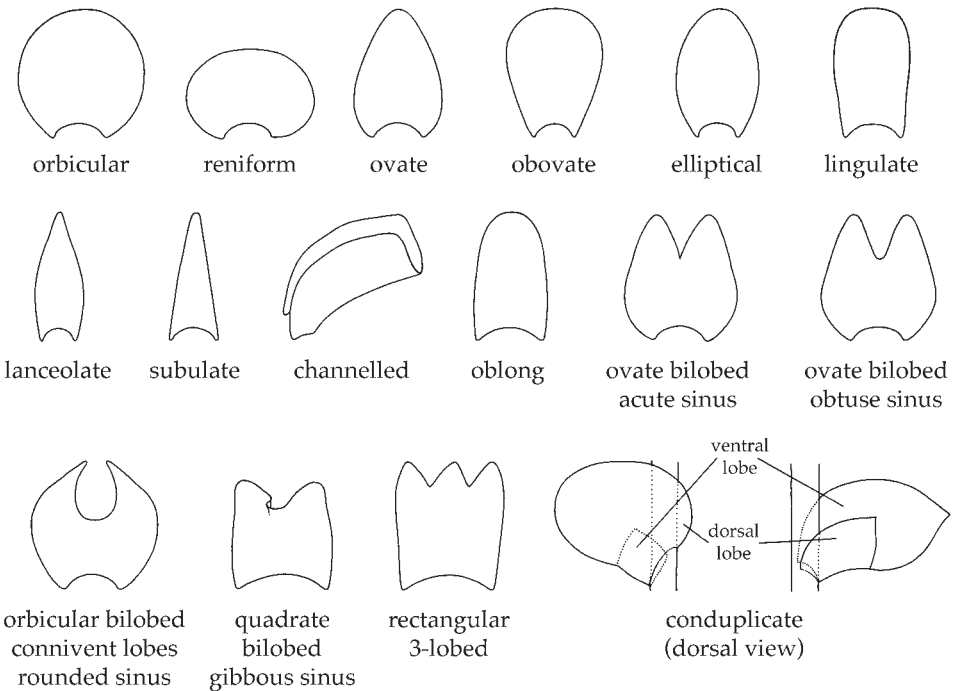
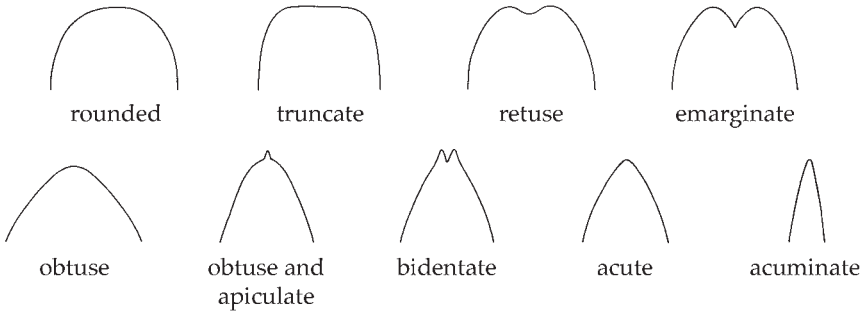


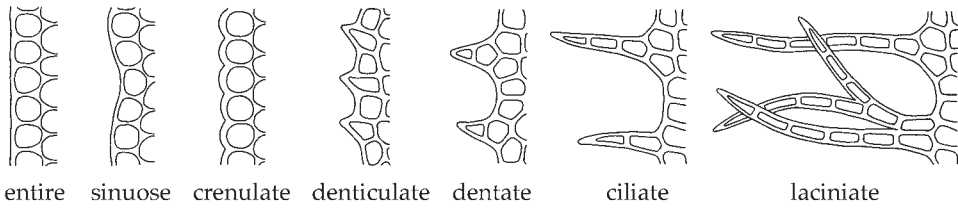
FIGURE A



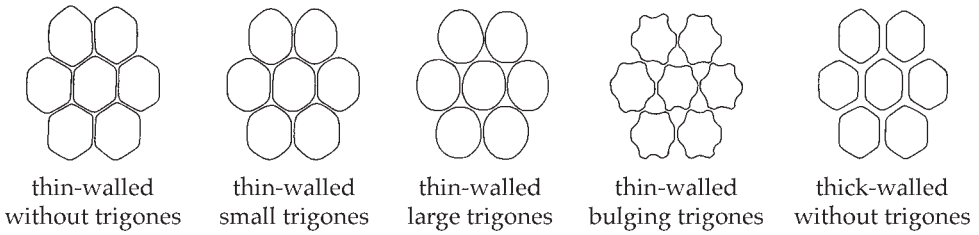
**1. Apices of leaves and underleaves**



**2. Margins of leaves, underleaves and perianth mouth**



**3. Cells**



**4. Distribution of gametangia**

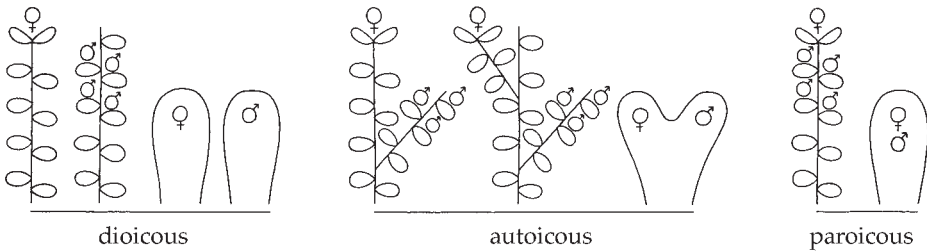
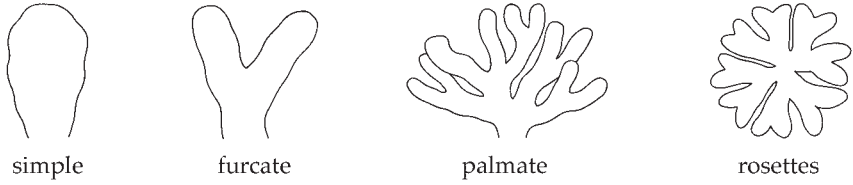
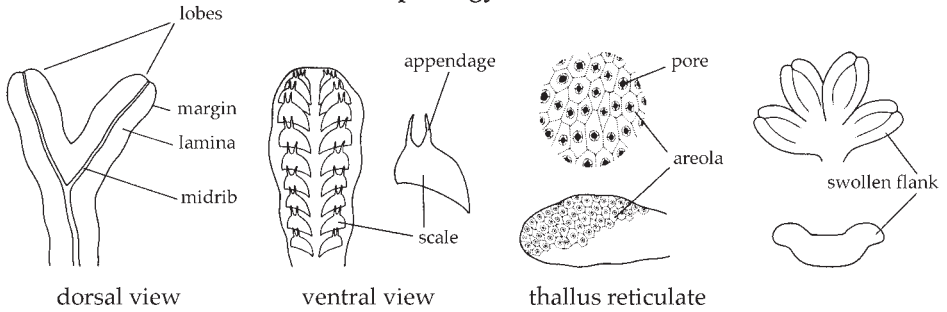


FIGURE B

**1. Thallus branching**



**2. Morphology of thallus**



**3. Thallus in section**

Thalli without internal differentiation



Thalli with internal differentiation

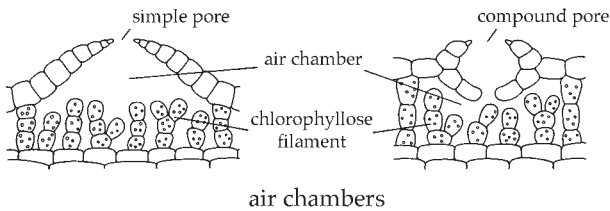
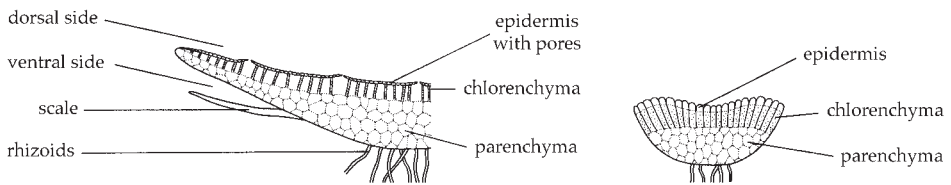
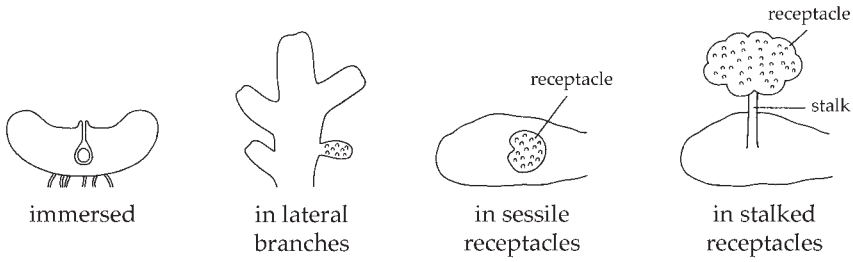
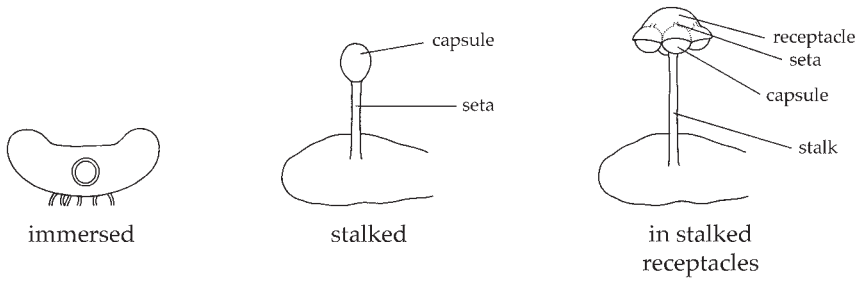


FIGURE C

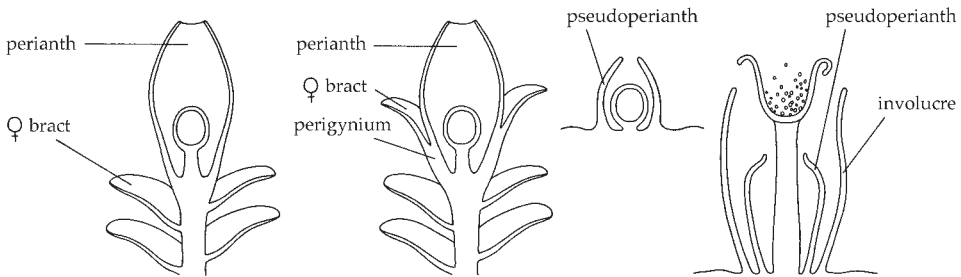
**1. Antheridia location in thallose hepatics**



**2. Capsule location in thallose hepatics**



**3. Inflorescence structures**



**4. Bipolar spores**

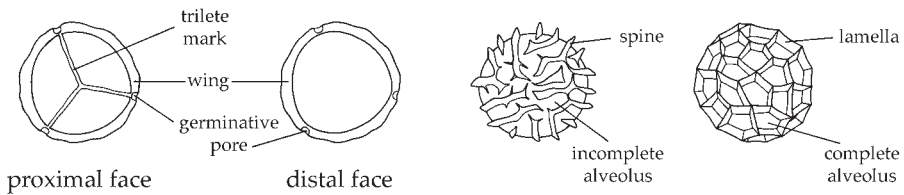


FIGURE D



# COLLECTION, IDENTIFICATION AND PRESERVATION OF BRYOPHYTES

**Collection.** A suitable season for collecting bryophytes is subject to the geographical situation and the altitude of the studied area and always depends on humidity. The best moment is the day after a rainy day when the plants are spread and show best their macroscopic characters. Hygrophilous species can be found in good condition throughout the year. Saxicolous, epiphytic and terricolous species grow well in shaded and sheltered montane areas but when exposed and under long drought conditions (frequent in the Mediterranean region) they can appear damaged.

Specimens should be collected as complete as possible; the ideal would be fertile material but in the Iberian Peninsula many species are never or only rarely found in this state. In those perennial species that thrive and spread by vegetative reproduction alone, whether by propaguliferous gemmae or by gametophytic fragmentation, usually the characters of the gametophyte are enough for identification.

For bryophyte collecting a knife is very useful to remove specimens adhering to rock or bark. Also indispensable is a hand-lens of 8x or 10x magnification to verify if the sample collected is complete and in good condition, since good material is essential for successful determination. Each sample should be placed in a numbered paper packet for later study, with as much information as possible, especially locality, ecology, altitude and date, being written in a field notebook. After collection, material should be exposed on absorbent paper for drying.

**Identification.** For the study of hepatics it is recommended that material as fresh as possible be used, specially in thallose hepatics, also in leafy hepatics because oil-bodies, very important for determination in some species, are perishable. Also users must taking into account that a thallus cross-section is almost always required when identifying thallose liverworts, and the frequent need for perianths or female bracts to reach to species level in leafy liverworts.

For examination of dry material it is necessary to moisten the plant, when it will recover its natural form, after which the different parts can be separated for study. Bryophytes retain this facility of recovery from desiccation for a long time. For microscopical observation leaves or any other plant part should be placed on a microscope slide, a drop of water added and a cover-slip applied. With leafy hepatics it is recommended that two shoots are mounted on one slide, one with the dorsal side up, the other ventral side up. Lactophenol (50% lactic acid and 50% phenol) is a recommended mounting medium since it clears the cytoplasm thus making it easier to observe such characters as cell shape and size.

**Conservation and storage.** Specimens are often small and it is advisable to place these in specially folded paper packets to avoid losing them. A numbered label with the identity of the specimen, its locality, ecology, altitude, collector's name, date and any other useful data, should be attached to the outer flap of the packet. For better conservation, the paper packets may be glued onto paper sheets which are taxonomically or alphabetically arranged, and placed in closed boxes, thus forming an herbarium.

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